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Natural Resource Stewardship and Science

A Vegetation Classification and Map

White Sands National Monument

Natural Resource Report NPS/CHDN/NRR—2019/1906



ON THE COVER

Representative vegetation communities of White Sands National Monument. Photography by E. Muldavin, Charlie Jackson, Yvonne Chauvin, and Jamie Thompson

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Acronyms and Abbreviations

AA:	Accuracy Assessment
BCE:	Before Common Era
CE:	Common Era
CHDN:	Chihuahuan Desert Network
DOQQ:	Digital Orthophotograph Quarter Quadrangle
DRG:	Digital Raster Graphics
ESRI:	Environmental Systems Research Institute
ETM:	Enhanced Thematic Mapper
FGDC:	Federal Geographic Data Committee
GIS:	Geographic Information System
GPS:	Global Positioning System
ITIS:	Integrated Taxonomic Information System
LiDAR:	Light Detection and Ranging
NAIP:	National Agriculture Imagery Program
NDSVI:	Normalized Senescent Difference Vegetation Index
NDVI:	Normalized Difference Vegetation Index
NHNM:	Natural Heritage New Mexico
NPS:	National Park Service
NRCS:	Natural Resource Conservation Service
NVCS:	National Vegetation Classification Standard
PA:	Plant Association
USGS:	United States Geological Survey
UNM:	University of New Mexico
USNVC:	United States National Vegetation Classification

Executive Summary

A vegetation classification and map for White Sands National Monument, New Mexico is presented as part of the National Park Service Inventory & Monitoring – Vegetation Inventory Program to classify, describe, and map vegetation communities in more than 280 national park units across the United States. Building on a legacy mapping project from the 1990s, we updated the classification and built a new map using the latest aerial imagery and mapping technologies to meet current NPS standards.

Embedded in the enclosed Tularosa Basin is a world-renowned and unique gypsum landscape. Along with its many gypsum landforms such as dunes, alluvial flats, playas, and desert piedmonts, the vegetation communities and ecology of White Sands National Monument are as dynamic as they are diverse. Following the US National Vegetation Classification standard (USNVC), we identified 50 plant associations, many of them unique to the Southwest. Within the gypsum dune system alone, we describe 19 gypsophilous plant associations that belong to the USNVC Chihuahuan Gypsophilous Grassland and Scrub groups. They range from shrublands that colonize and stabilize the dunes to a variety of grassland and shrublands that dominate the wind-scoured interdune flats. In addition, maintained by the shallow groundwater of the basin, there are pockets of riparian woodlands (Western Interior Riparian Forest & Woodland – NVC Group G797) dominated by Rio Grande cottonwood. Surrounding the dunelands are expansive alluvial basin bottomlands, alkali flats, and playas, which support grassland and shrubland associations dominated by salt-tolerant species. Here, we identified four associations belonging to the Chihuahuan Lowland Basin Semi-Desert Scrub and Grassland groups (G299 and G489, respectively) plus eight from periodically flooded areas that belong to the North American Desert Alkaline-Saline Wet Scrub (G537) and North American Desert Alkaline-Saline Marsh & Playa (G538) groups. In addition, there are areas dominated by a combination of quartz and gypsic sands that are represented by two Chihuahuan Desert Sand Scrub (G287) associations and one Chihuahuan Sandy Plains Semi-Desert Grassland (G491) association. Some of these sandy zones are dominated by honey mesquite coppice dunes and are part of the North American Warm Desert Ruderal Scrub group. Along the western margin of the monument are alluvial fan piedmonts composed of sediments derived from the neighboring San Andres Mountains limestones and sandstones. Here, we identified four associations of the Chihuahuan Creosotebush - Mixed Desert Scrub Group, which is widespread throughout the Chihuahuan Desert. Lastly, there are stands of exotic and invasive saltcedar (*Tamarix chinensis*) that occur in both the dune areas and surrounding flats. These are represented by four associations belonging to the Interior West Ruderal Riparian Forest & Scrub. The classification was based on 737 vegetation plots collected between 1993 and 2016. Full descriptions and diagnostic keys to the plant associations along with an overall plant species list are provided as appendices.

Based on the vegetation classification and associated plot data, the vegetation map was developed using a combined strategy of automated digital object-oriented image classification and direct-analog image interpretation of four-band NAIP aerial photography from 2005, 2014, and 2016, and Landsat Enhanced Thematic Mapper satellite imagery. The map was designed to facilitate ecologically based natural resources management at a 1:24,000 scale with 0.5-ha minimum map unit size. The map legend was hierarchically structured with an upper Level 1 of nine map units corresponding in most cases to the USNVC Group level and a Level 2 composed of 22 nested map units reflecting various combinations of plant associations. A field-based accuracy assessment using 678 vegetation revealed a Level 1 overall accuracy of 90% (88% k-hat adjusted) and 79% (78% k-hat adjusted) at Level 2. An annotated legend with summary descriptions of the units, distribution maps, aerial photo examples of map unit polygons, and representative photos are provided in an appendix. Large wall-size poster maps at 1:35,000 scale were also produced following NPS cartographic standards. The report, plot data, and spatial layers are available at https://www.nps.gov/im/vmi-whsa.htm.

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Chapter 1: Introduction

Background, Scope, and Products

White Sands National Monument (NM) is world-renowned for its expansive gypsum dunelands that occupy the majority of the park and are part of the world's largest gypsum dunefield (712 square km; 275 square miles). The dunelands themselves are variable in form and age and are imbedded in a complex landscape of ancient lake beds, gypsum outcrops, and flats that make up the southern Tularosa Basin of New Mexico. This unique setting gives rise to diverse and unique vegetation communities that, in turn, provide special habitats and forage for wildlife as well as exceptional recreational opportunities for park visitors. The National Park Service (NPS) has sought to manage these biological resources with the same care and attention as that given to the geologic, scenic, and other values. Accordingly, along with comprehensive biological inventories and monitoring, a key to effective biological management is the development of a high-resolution vegetation map that can support such activities as flora and fauna habitat modeling, recreation planning, restoration management, ecological research, and broad-scale facilities planning.

To meet this objective, Natural Heritage New Mexico (NHNM)[1], in collaboration with the NPS Chihuahuan Desert Inventory and Monitoring Network (CHDN), NatureServe[2], and the staff at White Sands NM developed a vegetation classification and vegetation map for the park following the national standards of National Park Service Vegetation Mapping Program[3]. Accordingly, the vegetation classification follows the US National Vegetation Classification (USNVC)[4] hierarchy and the final vegetation map was developed at a 1:24,000 scale and with at least a 0.5-ha (1.24-ac) minimum map unit size. The classification was based on an analysis of 715 field vegetation plots and classifies vegetation down to the plant association level of the USNVC. Using the field vegetation plots as "training" samples, the map was developed using a combination of automated image analysis (image segmentation and supervised classifications) and direct image interpretation of a combination of 2011, 2014, and 2016 aerial imagery. An accuracy assessment was also conducted based on 678 plots distributed in stratified random design across the park. Map units were designed to support ecologically-based natural resources management with an emphasis on uses for fire, wildlife, and recreation management.

Here we report on the outcomes that include: 1) details on the methods of vegetation classification and mapping; 2) an overview of the classification and ecology of the vegetation communities of the park; 3) the final vegetation map and accuracy assessment; 4) plant community descriptions and a diagnostic key; and 5) a vouchered species list. In addition, all field data have been compiled into an NPS PLOTS relational database according to NPS standards, and all spatial data and report elements have been made ready for web-based applications (https://www.nps.gov/im/vegetation-inventory.htm).

Park Environment

Location, cultural setting, and environmental history

The White Sands NM is located in south-central New Mexico and is bounded by the White Sands Missile Range to the north, west and south, and Holloman Air Force Base to the east (Figure 1). The study area incorporates the entire monument of 60,049 ha (148,384 ac). The western portion of the monument is under joint jurisdiction with White Sands Missile Range and the Department of Defense, but the National Park Service is responsible for overall management. US Highway 70 flanks the southeast boundary of the park and provides the main route to the park entrance and the visitor center. From the visitor center, there is a main paved "loop" road that runs north to the "Heart of the Sands" that provides the visitor primary access to the dunes. There are other road access points along the boundary, but most of these are restricted-use from neighboring military lands.

Physiographically, the park lies within the southern portion of the Tularosa Basin, a closed basin in south-central New Mexico bounded on the west by the San Andres Mountains and the Sacramento Mountains to the east (Figure 2). These ranges are the primary source of most of the surface and ground water that accumulates within the playa lakes and dunefields of the park. The park contains approximately half of the White Sands dunefield with White Sands Missile Range and Holloman Air Force Base having stewardship of the remaining dunefield. The dunefield is structurally complex and dominates the eastern and southern portions of park (see Geology section below). Sediments deposited in ancestral glacial Lake Otero are found in Alkali Flat, and Lake

1 A division of the Museum of Southwestern Biology at the University of New Mexico (https://nhnm.unm.edu/).
2 The national network organization of Natural Heritage Programs and Conservation Data Centers. See: http://www.natureserve.org/.
3 https://www.nps.gov/im/vegetation-inventory.htm
4 http://usnvc.org

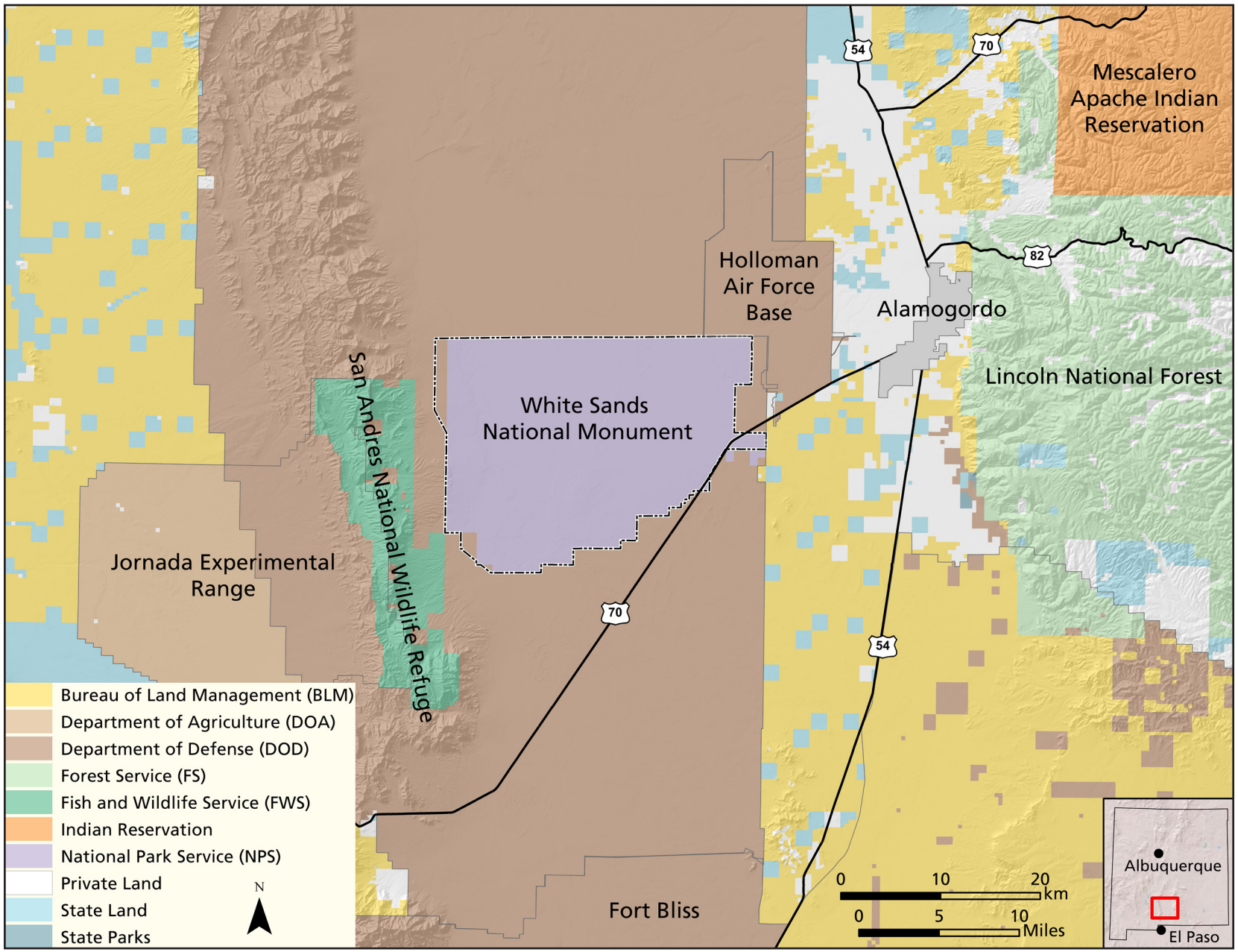


Figure 1. White Sands National Monument is located in south-central New Mexico and is surrounded by White Sands Missile Range and Holloman Air Force Base.

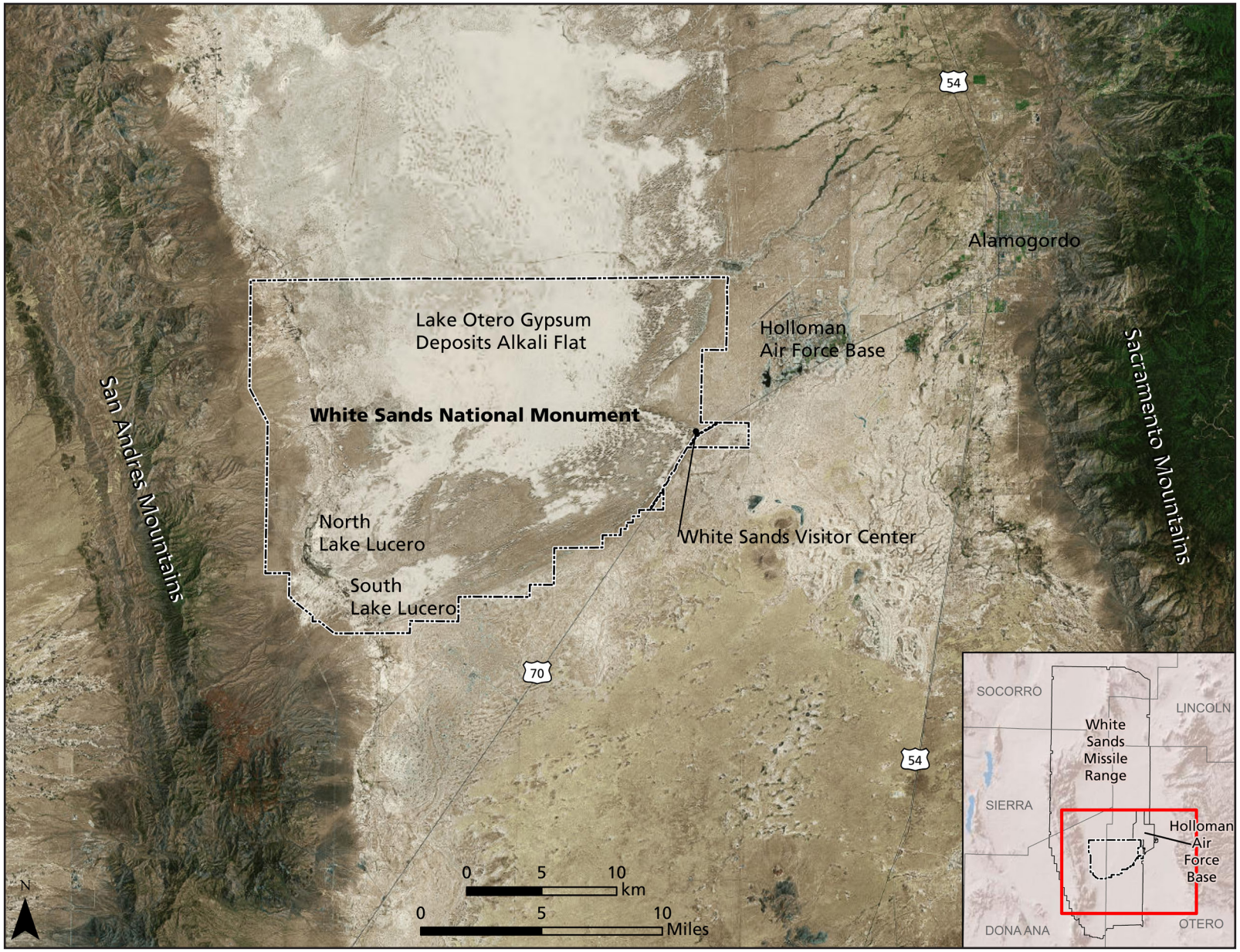


Figure 2. White Sands National Monument is located at the lower end of the Tularosa Basin, a closed basin whose waters are fed by ephemeral washes draining the San Andres Mountains to the west and Lost River out of the Sacramento Mountains to the east. Note the extensive gypsum dunefield in the eastern portion of monument.

Lucero form at the western boundary of the dunes. Lake Lucero is topographically the lowest area within the basin (1,185 m; 3,888 ft) and the largest playa within the monument with water levels that fluctuate seasonally depending on inflow and evaporation (Bennett and Wilder 2009). The monument also includes a small lake across US Highway 70 that is sustained by well water (Garton Lake).

Culturally, the park has a long history of human occupation along the ancestral Lake Otero dating to the Paleoindian Period some 10,000 BCE (White 2003). During the Archaic Period, from 5,000 BCE to 200 CE, the dunes may have been a hunting/gathering ground. After 200 CE, the Jornada Mogollon emerged as the dominant culture in the Tularosa Basin until about 1400 CE. There are remnants of prehistoric campfires and roasting pits dating from the Archaic period and continuing to the Jornada Mogollon within the monument. The hearths date between 1760 BCE and 1290 CE, and locally changed the sand chemistry from gypsum ($CaSO_4 \cdot 2H_2O$) to anhydrite or hemihydrate (like plaster of Paris) ($CaSO_4 \cdot 0.5H_2O$) resulting in the development of relatively small, hardened pedestals. White (2003) reported that 32 hearth sites had been documented at the monument, but many more were thought to exist. Neville et al. (2010) identified 41 potential new sites through remote sensing, of which 26 were confirmed. They identified an additional 882 sites that may potentially be hearths. Hence, human occupation may have been extensive throughout the dunes, although perhaps transitory. Based on pollen analysis, the hearths from both the Archaic and Jornada Mogollon periods were used in a climate with greater moisture and rainfall than today. This suggests that ponds and playas were possibly more numerous then and that they served as hunting areas and sites for wild plant gathering and ultimately supported a significant human population during those periods. From the 1500s to the late 1800s, the Apache dominated the area, although they preferred settlement in the foothills and used the White Sands area only for trails and temporary camps.

Occupation and use during the Spanish Colonial period (1600 to 1850 CE) was apparently limited (Reid 1979). The Apache are thought to have prevented Mexican settlement in the area, although Mexican traders gathered gypsum and salt in the area. However, with Anglo settlement from 1870 onwards, the ranching industry flourished in the Tularosa Basin and, along with it, impacts to the monument area likely increased. There was increased water and road development, and livestock use in the grassy areas until the establishment of the monument in 1933 (mostly in the eastern and southern portions). The impact of historical livestock grazing is not clear; old livestock trails and roads are still evident, but whether grazing altered dune movements and dynamics is equivocal (Reid 1980). In the 1940s, grazing was halted in the surrounding lands as they were withdrawn for military use (to create White Sands Missile Range and Holloman Air Force Base). Yet while cattle were removed, wild horse herds grew large along with populations of Oryx or gemsbok (*Oryx gazella*), an African antelope introduced for hunting during the 1950s in the neighboring San Andres Mountains to the west. The Oryx in particular became a major issue in vegetation resource protection, and were removed from the monument during the 1990s, with only occasional vagrants since.

According to Bennett and Wilder (2009), the purpose for establishing the monument in 1933 was given in Herbert Hoover's presidential proclamation as:

"Whereas it appears that the public interest would be promoted by including the lands hereinafter described within a national monument for the preservation of the white sands and additional features of scenic, scientific, and educational interest…."

Since that time, the monument has become an international tourist destination and an important component of the local economy. Visitorship has risen from 12,000 at inception to over 500,000 a year, and the population of nearby Alamogordo now exceeds 35,000, supported primarily by tourism and military interests. Because it is concentrated in mostly non-vegetated dune areas, Reid (1980) did not consider this high rate of visitorship a threat to biological resources. As surrounding towns and cities (e.g., El Paso) grow, there are concerns about the impact of pollution and additional draw-downs of groundwater on the monument, but this complex issue remains to be explored (Bennett and Wilder 2009).

Climate

The climate of White Sands NM is characterized by cool-to-cold, dry winters, and warm-to-hot but often wet (monsoonal) summers. The mean daily temperature extremes range between –5° C and 14° C (23° F and 57° F) in January, and 15° C to 36 °C (59° F and 97° F) in June (Figure 3). The coldest recorded daily temperature at the monument was –31.7 °C (–25° F) and the warmest, 43.9° C (111° F)[5].

The average annual precipitation is 228 mm (9.0 in) and is distinctly bimodal with the majority (65%) coming in summer (April–September) and the remaining 35% during winter. Winter precipitation is delivered principally as a mix of rain and snow by low-pressure systems that sweep

5 Western Regional Climate Center: White Sands Natl Mon, New Mexico (299686) (https://wrcc.dri.edu/cgi-bin/cliMAIN.pl?nm9686)

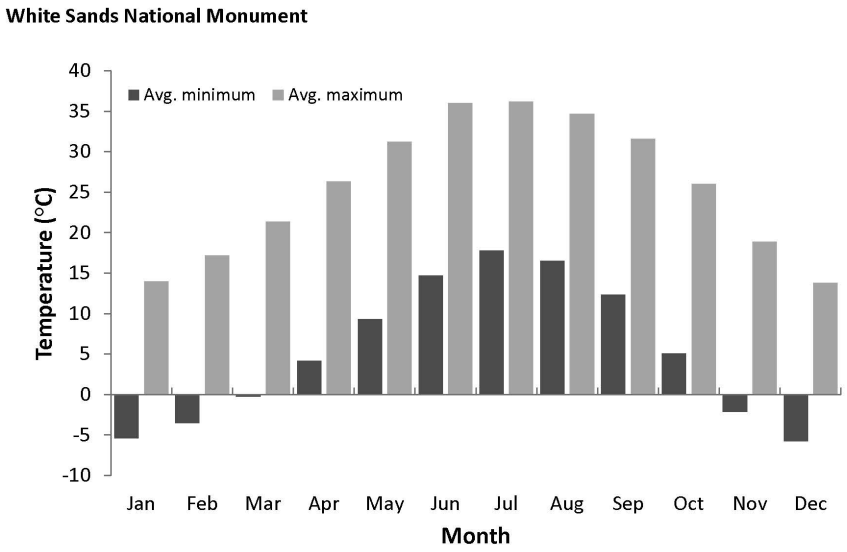


Figure 3. Average monthly minimum and maximum daily temperatures at White Sands National Monument (Coop station 299686; source: Western Regional Climate Center, wrcc@dri.edu).

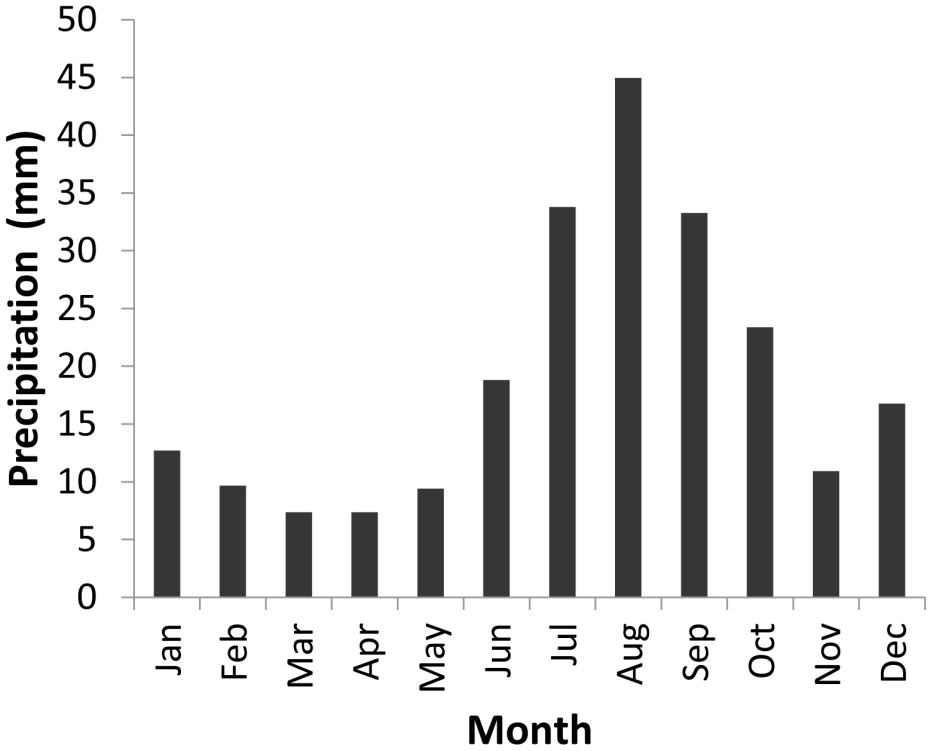


Figure 4. Average monthly precipitation distribution at White Sands National Monument (Coop station 299686; source: Western Regional Climate Center, wrcc@dri.edu). Summer rainfall predominates, but in any given year winter precipitation can be significant, particularly in years where the El Niño/Southern Oscillation (ENSO) index is positive (i.e., an El Niño year).

from west to east across the Southwest, coalescing with moisture from the Pacific Ocean or Gulf of Mexico. Winter precipitation is generally followed by a seasonal dry period during the months of May and June (Figure 4). This dry period is defined as much by the increased potential evapotranspiration that accompanies increased day length, solar radiation and temperatures, as by decreased precipitation. The spring dry period is usually relieved by the onset of the Mexican monsoon. This weather pattern typically delivers at least 40% of the annual precipitation from July through September, and is associated mostly with short-duration, high-intensity thunderstorms. Each summer, as high pressure becomes entrenched off the coast of Baja California, low pressure in the Southwest feeds Pacific moisture across the region, fueling the development of afternoon thunderstorms. The magnitude, frequency, and tracking of individual large, intense thunderstorm cells during this period can account for large year-to-year variability in annual rainfall and between local areas.

Precipitation can be highly variable over time. The driest year on record was 71.1 mm (2.8 in) in 1956, the terminal year of the "1950s" drought (1951 to 1956) where precipitation averaged half of normal (114 mm; 4.5 in). Annual precipitation dipped below 125 mm (5 in) again in 1964 and in 2003. In contrast, annual precipitation exceeded 530 mm (20.9 in) in 1941, and the 20-year span between 1978 and 1997 saw at-or-above-normal precipitation (285 mm; 22.8 in). With respect to project sampling during 2007 and 2008 and in 1993 for an earlier vegetation map of White Sands NM (Muldavin et al. 1994), precipitation was at or above normal.

Winds are predominantly out of the southwest during the fall and winter, and peak in the spring months where speeds can easily exceed 12.9 m/s (25 knots). They shift to southeasterly during the summer months and are generally lower in speed (Fryberger 2001). The strong winds also occur during the drier periods and set the stage for the movement of sands and structuring of the dunes according to the prevailing southwest-to-northeast wind direction (Kocurek et al. 2007).

Landscape context

Geology, soils, and hydrology

Geology plays a defining role in structuring the vegetation of the monument. Hawley et al. (2005) mapped the surficial geology in broad terms (Figure 5). The gypsum lacustrine deposits in ancestral glacial Lake Otero (LSy) and the Lake Lucero playa (PS) that lie along the west side of the monument are the source of the gypsum sands that accumulate in the eolian dunefield (EDS), driven by the predominantly westerly wind. There are low-lying, inactive gypsiferous dunes and sand sheet deposits (ES) due east of Lake Lucero along the southern boundary, and areas that are a mix of lacustrine and eolian deposits (LE and ELS). Along the western margin of the park are alluvial fans (AF and AFy) that extend out from the San Andres Mountains and rim lake bottoms. Similarly, alluvial fans with surficial sand deposits extend into the park along the eastern boundary (EAF).

Fryberger (2001) mapped in detail the major geomorphic features of these areas (Figure 6). Along the western boundary, he separated out the gypsiferous outcrops between the flats of Lake Otero deposits and the alluvial fans of the mountain front. These secondary deposits of gypsum are the fundamental source of sands for the dunefield. Within Lake Otero deposits (also known as Alkali Flat), he differentiated the active lake basin that still floods on occasion from a drier scour platform to the east that transitions to the main dunefields. The dunefields are further differentiated in a barchanoid dunefield composed of crescent-shaped dunes with a long axis parallel to prevailing wind and arms that extend downwind, and transverse ridge dunes composed of coalesced barchan dunes. Barchanoid dunes can have long, gradual slopes up the windward side to a crest followed by a slip-face slope (a steep, drop-off on the leeward side) (Mangimeli 2007). These dunes are actively moving and are the "Heart of the Sands" destination for most visitors.

Farther east, the barchan dunes give way to parabolic dunes, which are also crescent-shaped but with arms that are stabilized by vegetation and that extend upwind in the opposite direction to that of barchan dunes. These are active dunes as well, with intervening wind-scoured deflation plains that are typically vegetated. The main dune systems are highly dynamic. As winds scour the interdune areas and drive sands over the dune crests, the slip-faces collapse on the leeward side, causing the dunes to creep forward and fill the interdune deflation plain area in front of them (Figure 7). McKee (1966) indicated that rates of dune advance of 12 m/year (39 ft/year) were possible. Reid (1980), using repeat aerial photography, arrived at rates of 1.8 to 3.8 m/year (5.9 to 9.8 ft/year) among parabolic dunes. Based on trenches and interdune features, Kocurek et al. (2007) estimated active dune migration rates at between 0.5 and 1.5 m/year (1.6 and 4.9 ft/year). Patrick (1980) estimated that this cycle of filling and exposing interdune areas among parabolic dunes takes between 40 and 100 years, depending on the length of the interdune area.

Towards the margins of the parabolic dunefields, dunes become smaller and more stabilized by vegetation, and are mostly inactive. There are large areas of wind-scoured gypsic crusts directly downwind of Lake Lucero, which likely contributes less gypsum sand to dune development (Bennett and Wilder 2009).

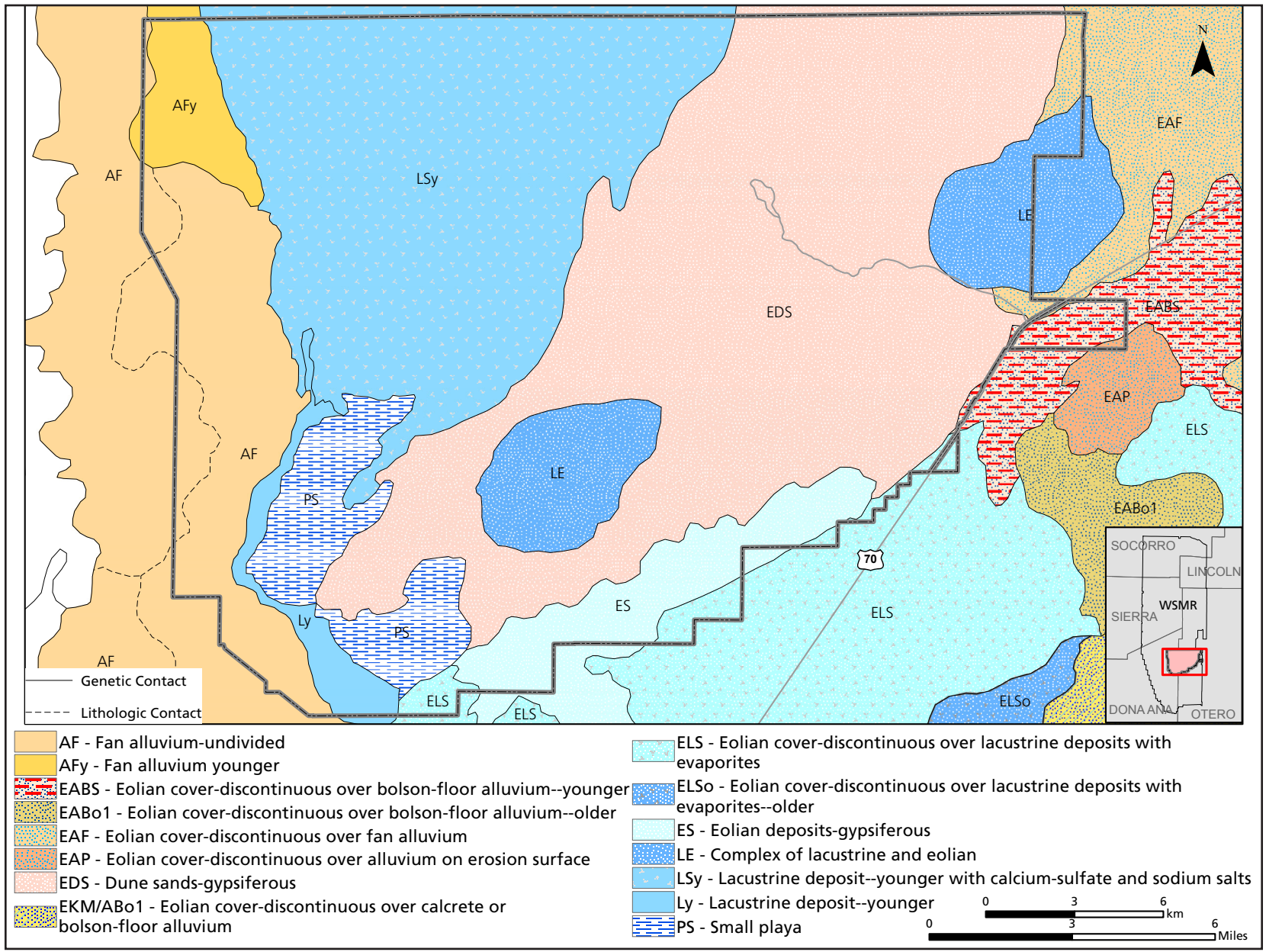


Figure 5. General surficial geology of White Sands National Monument as mapped by Hawley et al. (2005). Gypsum dunefields are mapped as eolian dunefields (EDS) which have their origins as wind-blown sands out of the ancestral glacial Lake Otero deposits (LSy) and the Lake Lucero playa (PS) that lie along the west side of the monument. Flats and playas are flanked along their western edge by alluvial fans originating out of the San Andres Mountains (AF and AFy).

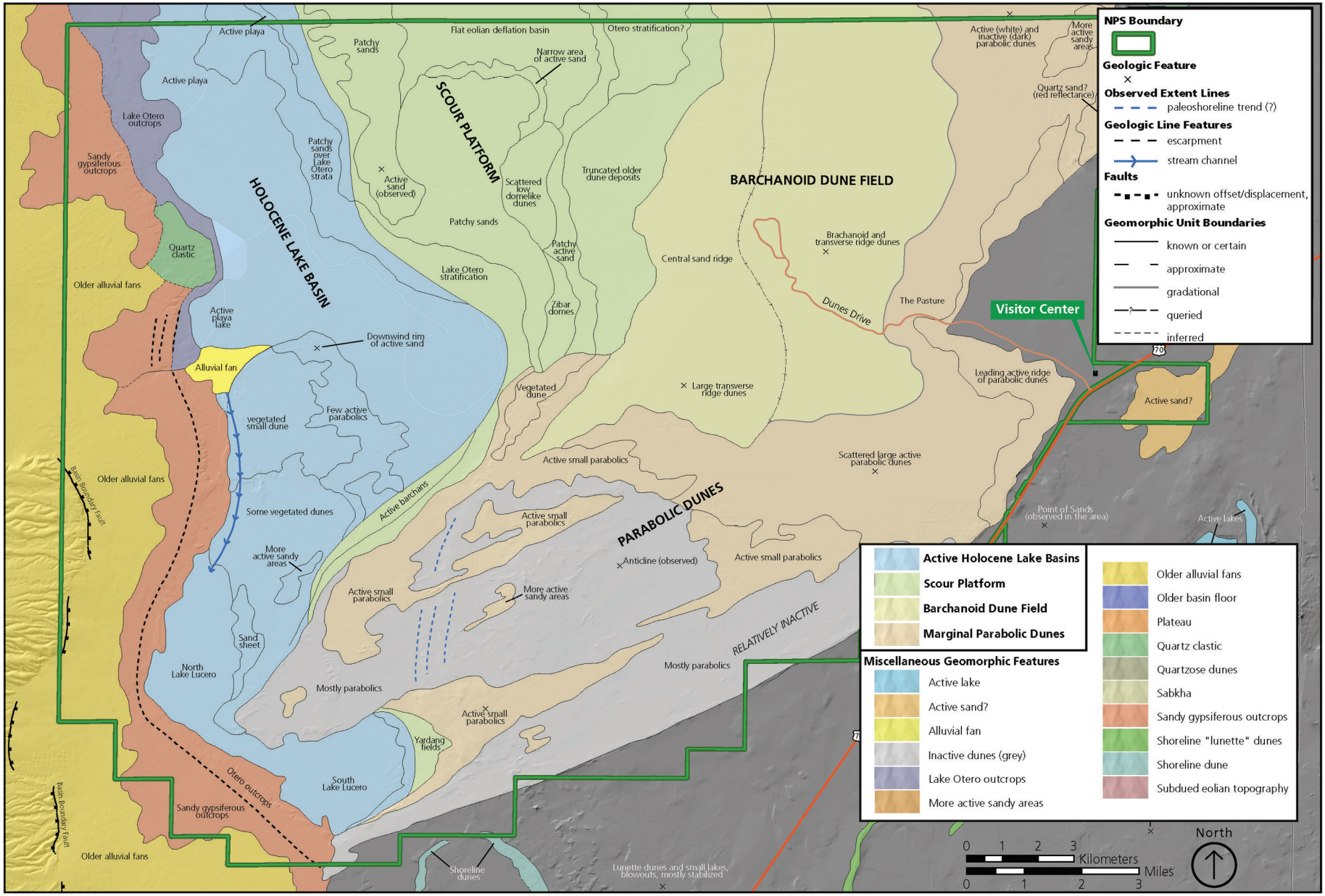


Figure 6. Major geomorphic features of White Sands National Monument. The gypsum dunefield and adjacent flats are structurally complex. The eastern and southern margins of the dunes are primarily parabolic dunes that are stabilized or partially stabilized by vegetation. Vegetation is sparse in the interior mobile barchanoid dunefield and in the western alkali flats and playa lake bottoms (map by Fryberger 2001 as presented in KellerLynn 2012).

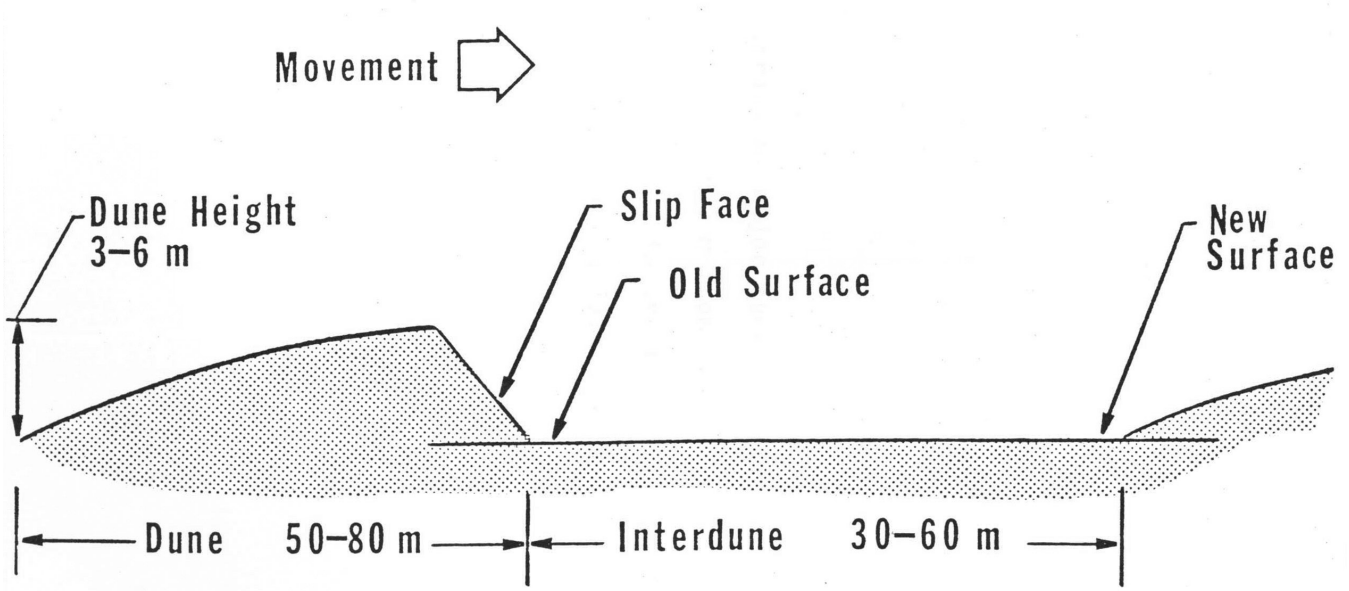


Figure 7. Diagram of a typical duneland system morphology of active dunes migrating across previously wind-scoured interdune areas (from Reid 1980).

Moisture accumulation also plays a significant role in this landscape. The Tularosa Basin has no outlet, thus Lake Lucero and portions of the ancestral Lake Otero deposits (Alkali Flat) can seasonally flood, inundating over 2,500 ha (6,178 ac). Given that these ephemeral lakes occur at the lowest elevation of the basin floor, salts tend to accumulate during the repeated wetting and drying cycle. This leads to highly saline soil conditions and the production of precipitates such as gypsum and various sodium salts. In addition, the basin bottom as a whole has a shallow water table and the interdune spaces often fill with water during the rainy season (Figure 8). This seasonal flooding likely affects vegetation composition directly, plus the dune system as a whole is considered a wet eolian system, where intermittent moisture physically slows dune development and movement (Kocurek et al. 2007), potentially aiding dune stabilization.

Soil patterns follow closely that of the surficial geology and geomorphic features (Figure 9; Table 1). That is, there are a suite of soil units closely associated with the central dunefield of both barchan and parabolic dunes (with the Lark and Transformer the predominant soil series); inactive dunes/scoured gypsic crusts along the southern boundary (mostly Corvus, Astrobee, Peligro, Piedrablanca, and Nasa with some Lark); Lake basin or playa of lacustrine deposits to the west and southwest (a mix of Lacarreta, Salago, Ratscat, Andrecito, Mamtrack, Sabkha, and Torbellino soils series); older basin floor and mostly non-gypsic sites to the east (Yesum, Nasa, Loki, Jato, Hermes, and Globe are the most prevalent series), and the alluvial fan piedmont to the far west (Agustin, Vado, Riverwash, Mimbres, Chutum, Ybar, Queencreek, Agustin, and Stagecoach)[6]. Reid (1980) conducted detailed soil-nutrient and moisture studies and described four major soil groups from lower to higher nutrient content: 1) transverse/barchan dunes with relatively low nitrogen content (91-204 ppm) and salinity; 2) the more stable parabolic dunes (N 181-4156 ppm); 3) plains (N 316-1010 ppm), and 4) variable soils of high salinity (N 163-1011 ppm), primarily associated with alluvial alkali flats.

Previous vegetation classification and mapping studies

Given the unique geological setting, most vegetation studies have focused on the flora and ecology of individual species in relation to gypsum outcrops and dune dynamics (see Emerson 1935; Schaffner 1948; Shields 1956; and Lozano 1979). Reid (1979; 1980) and Patrick (1980) conducted extensive studies on succession and were the first to describe the vegetation communities (associations) for the park. They identified approximately 27 associations based on ordination-derived diagnostic species. Within the active dune system, they described a five-stage successional sequence that occurs spatially as the interdune areas are uncovered and subsequently buried. In the first stage, where the first five meters (16 ft) or so of the deflation plain is exposed at the windward side of a dune's base, *Muhlenbergia pungens* (sandhill muhly) and *Oenothera pallida* (pale evening primrose) dominate. From five to 100 m (16 to 328 ft), *Schizachyrium neomexicanum* (New Mexico bluestem) is the dominant, forming a conspicuous grassland. Between 100 and 800 m (328 and 2,625 ft), the *Bouteloua breviseta*

6 Details for each soils series can be found at: https://soilseries.sc.egov.usda.gov.



Figure 8. In general, the water table is near the surface (left). During the summer rainy season, shallow ephemeral lakes can form in the interdune areas (right).

(gypsum grama)/*Tiquilia hispidissima* (hairy crinklemat) association prevails. At 800 to 1500 m (2,625 to 4,921 ft), the most scoured areas, grass cover diminishes again, with patches of *Sporobolus nealleyi* (gyp dropseed) along with *Tiquilia hispidissima*. Lastly, where the slip faces give way and bury the interdune areas in front of them, *Muhlenbergia pungens* and a mixture of more sand-tolerant grasses re-establish along with other shrubs such as *Ephedra torreyana* (Torrey's jointfir) and *Poliomintha incana* (frosted mint). On the dunes themselves, especially among the parabolic dunes, *Poliomintha incana* is the key stabilizing shrub along with *Rhus microcephala* (littleleaf sumac), *Rhus trilobata* (skunkbush sumac), and *Yucca elata* (soaptree yucca). Outside the dune system, Reid (1979) identified six associations characterized by the dominance of salt-tolerant, halophytic, species such as A*llenrolfea occidentalis* (iodinebush), *Suaeda suffrutescens* (desert seepweed), and *Atriplex canescens* (fourwing saltbush).

With respect to vegetation maps, Reid (1980) produced a generalized (approximately alliance-level) paper vegetation map on multiple sheets for the western portion of the monument based on 1979 aerial photography, but this has not been brought into a GIS. A 1:24,000-scale map based on thematic-mapper satellite imagery was produced by Muldavin et al. (1994) and included the development of a vegetation classification of 22 plant associations among 12 alliances based on 243 field plots. This map was later incorporated into the vegetation classification and map for the White Sands Missile Range, which shares joint management over areas of the monument (Muldavin et al. 2000). The 1994 map and classification also provide the foundation for a vegetation map for neighboring Holloman Air Force Base (Muldavin et al. 1997). Lastly, a map of saltcedar (*Tamarix chinensis*) distribution in the park was developed by Muldavin et al. (2010) for use in control programs by park managers. The plot data from the 1994 map and the 2010 saltcedar map have been incorporated into the current project.

Table 1. White Sands NM soils units categorized by major geomorphic types. Map unit number and name, as in Figure 9.

Geomorphic Type	Map Unit Number	Map Unit Name
Active dunes—barchanoid and parabolic (north-central)	9	Astrobee-Lark association, 0 to 35 percent slopes
	32	Gyplaya gypsiferous sand, 0 to 4 percent slopes
	96	Lark-Astrobee-Nasa complex, 0 to 40 percent slopes
	97	Lark-Piedrablanca-Wulie complex, 0 to 25 percent slopes
	43	Lark-Transformer association, 0 to 40 percent slopes
	44	Lark-Transformer association, 0 to 90 percent slopes, duneland
	42	Lark association, 5 to 90 percent slopes, duneland
	82	Transformer gypsiferous sand, 0 to 5 percent slopes
Inactive dunes/scoured gypsic crusts (south)	10	Astrobee-Lark-Nasa complex, 0 to 20 percent slopes
	92	Corvus-Astrobee-Lark complex, 0 to 25 percent slopes
	93	Corvus-Peligro-Nasa complex, 0 to 5 percent slopes
	63	Peligro gypsiferous sandy loam, 0 to 15 percent slopes
	99	Piedrablanca-Wulie-Nasa complex, 0 to 6 percent slopes
Lake basin (west)	94	Lacarreta-Salago-Ratscat complex, 0 to 3 percent slopes
	95	Lark-Andrecito association, 0 to 15 percent slopes
	46	Llano-Ratscat complex, 0 to 7 percent slopes
	50	Mamtrack-Lark-Transformer complex, 0 to 15 percent slopes
	72	Salago-Sabkha association, 0 to 3 percent slopes
	100	Salago gypsiferous sandy loam, 0 to 1 percent slopes
	73	Salago-Typic Aquisalids-Petrogypsic Haplosalids complex, 0 to 5 percent slopes
	101	Torbellino-Lark association, 0 to 15 percent slopes
Older basin floor (east)	21	Corvus-Peligro complex, 0 to 10 percent slopes
	28	Flake-Saltspring complex, 0 to 3 percent slopes
	30	Globe-Jato-Peligro complex, 0 to 20 percent slopes
	38	Hermes loam, 0 to 4 percent slopes
	47	Loki-Jato-Hermes complex, 0 to 5 percent slopes
	57	Nasa-Yesum complex, 0 to 6 percent slopes
	90	Yesum gypsiferous fine sandy loam, saline, 0 to 3 percent slopes
	91	Yesum gypsiferous sandy loam, 0 to 9 percent slopes
	5000	MLRA-42 Gypsic Aquisalids and Gypsic Haplosalids soils, 0 to 1 percent slopes
Alluvial Fan Piedmont (far west)	4	Agustin-Vado-Riverwash complex, 1 to 10 percent slopes
	56	Mimbres-Chutum-Ybar complex, 0 to 5 percent slopes
	66	Queencreek-Agustin-Stagecoach complex, 0 to 14 percent slopes
	86	Typic Torriorthents-Corvus complex, 0 to 6 percent slopes

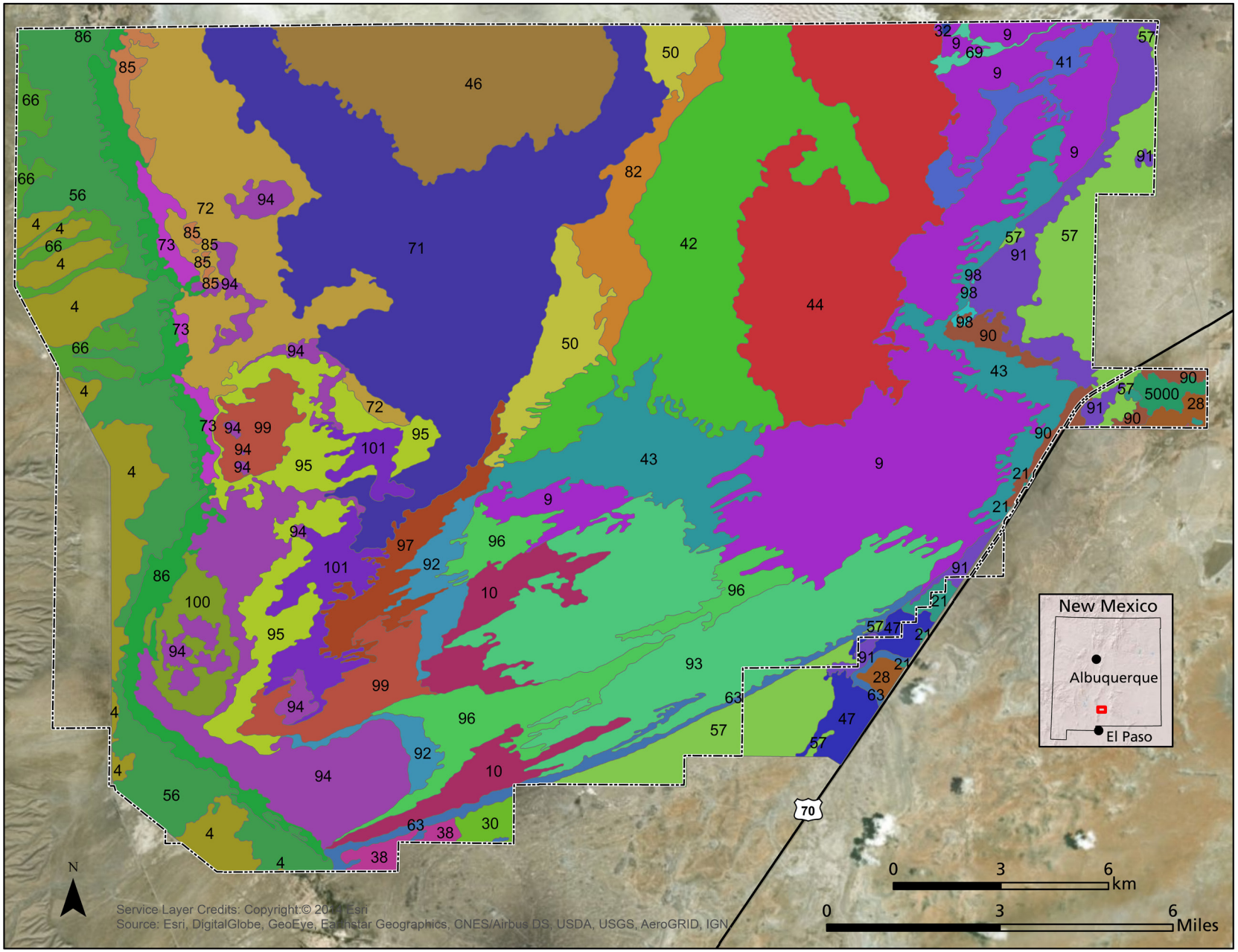


Figure 9. Soil map of White Sands National Monument (USDS-NRCS 2017). Note how soil types more or less follow the pattern of the surficial geology (see Figures 5 & 6).

Soil Map
White Sands National Monument
Legend

- 4. Agustin-Vado-Riverwash complex, 1 to 10 percent slopes
- 9. Astrobee-Lark association, 0 to 35 percent slopes
- 10. Astrobee-Lark-Nasa complex, 0 to 20 percent slopes
- 21. Corvus-Peligro complex, 0 to 10 percent slopes
- 28. Flake-Saltspring complex, 0 to 3 percent slopes
- 30. Globe-Jato-Peligro complex, 0 to 20 percent slopes
- 32. Gyplaya gypsiferous sand, 0 to 4 percent slopes
- 38. Hermes loam, 0 to 4 percent slopes
- 41. Lark association, 0 to 60 percent slopes, duneland
- 42. Lark association, 5 to 90 percent slopes, duneland
- 43. Lark-Transformer association, 0 to 40 percent slopes
- 44. Lark-Transformer association, 0 to 90 percent slopes, duneland
- 46. Llano-Ratscat complex, 0 to 7 percent slopes
- 47. Loki-Jato-Hermes complex, 0 to 5 percent slopes
- 50. Mamtrack-Lark-Transformer complex, 0 to 15 percent slopes
- 52. Matador-Bomber association, 0 to 5 percent slopes
- 56. Mimbres-Chutum-Ybar complex, 0 to 5 percent slopes
- 57. Nasa-Yesum complex, 0 to 6 percent slopes
- 63. Peligro gypsiferous sandy loam, 0 to 15 percent slopes
- 66. Queencreek-Agustin-Stagecoach complex, 0 to 14 percent slopes
- 69. Rioperdido-Harses association, 0 to 4 percent slopes
- 71. Salago-Llano complex, 0 to 2 percent slopes
- 72. Salago-Sabkha association, 0 to 3 percent slopes
- 73. Salago-Typic Aquisalids-Petrogypsic Haplosalids complex, 0 to 5 percent slopes
- 82. Transformer gypsiferous sand, 0 to 5 percent slopes
- 85. Typic Petrogypsids-Oxyaquic Torriorthents complex, 0 to 8 percent slopes
- 86. Typic Torriorthents-Corvus complex, 0 to 6 percent slopes
- 90. Yesum gypsiferous fine sandy loam, saline, 0 to 3 percent slopes
- 91. Yesum gypsiferous sandy loam, 0 to 9 percent slopes
- 92. Corvus-Astrobee-Lark complex, 0 to 25 percent slopes
- 93. Corvus-Peligro-Nasa complex, 0 to 5 percent slopes
- 94. Lacarreta-Salago-Ratscat complex, 0 to 3 percent slopes
- 95. Lark-Andrecito association, 0 to 15 percent slopes
- 96. Lark-Astrobee-Nasa complex, 0 to 40 percent slopes
- 97. Lark-Piedrablanca-Wulie complex, 0 to 25 percent slopes
- 98. Massasauga-Sabkha association, 0 to 2 percent slopes
- 99. Piedrablanca-Wulie-Nasa complex, 0 to 6 percent slopes
- 100. Salago gypsiferous sandy loam, 0 to 1 percent slopes
- 101. Torbellino-Lark association, 0 to 15 percent slopes
- 5000. MLRA-42 Gypsic Aquisalids and Gypsic Haplosalids soils, 0 to 1 percent slopes

USDA, Natural Resources Conservation Service (NRCS) and USDI National Park Service. 2017. Soil Survey of White Sands National Monument, New Mexico. (Accessible online at: https://www.nrcs.usda.gov/Internet/FSE_MANUSCRIPTS/new_mexico/whitesandsNM2017/WhiteSands781.pdf).

Chapter 2: Vegetation Classification

A consistent, ecologically based vegetation classification is the foundation for the development of an information–rich vegetation map. Vegetation classifications are ground-based descriptions of vegetation patterns that take into account floristic composition and abundance, site characteristics, and ecological dynamics. Accordingly, for White Sands NM, we used extensive field sampling and analysis to develop a hierarchical classification following the National Vegetation Classification Standard (NVCS) (Federal Geographic Data Committee 2008). The outcome was the identification and description of a suite of plant associations that are singularly, or in combination, components of map units designed to meet targeted uses of a vegetation map (see Chapter 3: White Sands National Monument Vegetation Map). Here, we describe our methods for classification development and provide an overview and discussion of the White Sands NM classification.

Classification Methods

The National Vegetation Classification Standard

The classification system used in CHDN vegetation mapping projects is based on the NVCS adopted by the Federal Geographic Data Committee (FGDC) in 1997 and updated in 2008 (FGDC 1997; 2008). The 2008 revised standard adopted by the FGDC contains substantial revisions to the upper levels of the USNVC hierarchy (Version 2; FGDC 2008) and now includes eight levels (Table 2). Per Jennings et al. (2009) and Faber-Langendoen et al. (2017), the upper three levels indicate physiognomic characteristics that reflect geographically widespread (global) topographic and edaphic factors. The middle three levels are new to the USNVC hierarchy and focus on largely biogeographic and habitat factors, along very broad, regional-to-continental topographic, edaphic, and disturbance gradients. The lower two levels, alliance and association, are distinguished by differences in floristic composition. Alliances are physiognomically-distinct groups of plant associations sharing one or more differential or diagnostic species. These are commonly the dominant(s) species found in the uppermost strata of the vegetation. The plant association is the fundamental unit of the classification and, following the International Botanical Congress of 1910, is defined as a community of definite floristic composition (i.e., a repeating assemblage of species), uniform physiognomy, and habitat conditions. NPS classification and mapping follow the FGDC (2008) standard and focus on the group and plant association (PA) levels. (Here the alliance level was not used because it is currently provisionally defined and is under review.) Global descriptions of units of classification are available at http://usnvc.org/explore-classification/.

Field Methods

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

Field crews were composed of one or two people with a senior technician crew chief, who was responsible for botany and vegetation sampling, while the second and third members were junior technicians responsible for gathering tree and fuels data, photographs, and Global Positioning System (GPS) locations. Plots were established in large stands of vegetation representative of the typical vegetation at a site (greater than one ha or 2.5 ac). Plots were generally 400 m^2 (4,305 ft^2) and square, but occasionally other sizes and shapes were used to fit the structure of a community, especially along drainages where vegetation stands conform to the channel shape.

For standard plots, a list of all vascular plant species, stratified by life form (tree, shrub, subshrub, grass, and forb layers) and height strata was compiled, and cover visually estimated across the plot for each species using a modified Domin-Krajina Cover Scale (Table 3) (Mueller-Dombois and Ellenberg 1974). This cover scale, with it finer classes at low cover values, has been found to be effective for accurately evaluating canopy cover in low production arid environments like that of White Sands NM while still having the appropriate precision for vegetation classification. At the beginning of each field campaign, teams were trained by NHNM senior staff in estimating cover reliably and consistently building up from the 1-meter (3.3 ft) quadrat level to that of the 400 m^2 (4,305 ft^2) of a standard plot size. In addition, four plot photos are taken

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

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

Table 3. Modified Domin-Krajina Vegetation Cover Scale from Mueller-Dombois and Ellenberg (1974). Cover Class is the scalar value assigned in the field; Percent Canopy Cover is the range of cover the class represents; m^2/ 400 m^2 is the actual area represented by the cover class within the 400m^2 plot; and Midpoint % Cover is the midpoint canopy cover value used in data analysis.

Cover Class	Percent Canopy Cover	m^2/ 400m^2		Midpoint % Cover
		Min	Max	
+0	[Outside plot]	–	–	[0.001]
+	<0.05	–	<0.2	0.01
1	<0.1	0.2	<0.4	0.05
2	<1	0.4	<4	0.5
3	1 – 5	4	<20	2.5
4	5 – 10	20	<40	7.5
5	10 - 25	40	<100	17.5
6	25 - 33	100	<132	29.0
7	33 - 50	132	<200	41.5
8	50 - 75	200	<300	62.5
9	> 75	300	400	87.5

in the cardinal directions for quality control. For 26 of the plots, species outside the immediate boundary but still within the homogenous vegetation patch were recorded but not assigned cover. Total non-overlapping cover was also recorded by stratum. Site attributes for plots, including slope percent, aspect, slope shape, surface rock type, and ground cover (percent rock, gravel, bare soil, and litter) were noted, along with narratives on species composition and site conditions. Plot locations were recorded with a Garmin GPS Model 12 with +/- 10-m accuracy. For each plot, at least four photos were taken in the four directions from plot center, with each photo containing a placard noting the project, sampling date, and plot number. The compass direction and focal length of each shot was logged for future reference. See Appendix A for the NHNM field survey handbook, examples of sampling forms, and detailed descriptions of sampling procedures.

We primarily used standard plots to support vegetation classification development, and three to five plots can be established in a day. For maximizing ground control for the mapping process, we employed stripped-down mapping plots (quick plots) for which only the cover of dominant species in each strata was recorded, along with a reduced set of site parameters. Anywhere from 6 to 12 of these quick plots could be established in a day, depending on logistics (all accuracy assessment plots were of this style). Including the legacy data from the first White Sands NM map (Muldavin et al 1994), a total of 737 plots were collected for the classification and mapping portion of the project between 1993 and 2016 (Figure 10). Of these, 420 were standard plots and 317 were quick plots.

We collected plant voucher specimens to confirm field identifications when necessary. These are currently housed at the University of New Mexico Herbarium. NHNM botanist Yvonne Chauvin identified specimens to the lowest level possible, given the material at hand, and assigned names according to the PLANTS database (USDA-NRCS 2009) and the Integrated Taxonomic Information System (ITIS). When those two databases did not agree, we used the more recently updated database. Qualifying specimens were accessioned with both UNM accession numbers and NPS record numbers tied to the Herbarium and NPS databases. A species list derived from the plot data is provided in Appendix B.

All vegetation and site data were entered into the Microsoft Access NHNM Ecology database and quality-controlled through error-checking computer routines and manual read-backs. Each record contains the comprehensive documentation of the plot location, dimensions, vegetation composition, tree stand structure, site characteristics, vegetation classification, and photo points. All plot data and associated location information and metadata were transferred to a stand-alone NPS-developed Microsoft Access relational database (PLOTS v. 4.0). While no structural changes were made to the NPS database template, we did add selected fields that allow the tracking back of all data to the NHNM database.

Vegetation analysis

To develop the vegetation classification, the plot data were analyzed using standard tabular comparison techniques and principal component analysis and detrended correspondence analysis ordinations (Becking 1957; Mueller-Dombois and

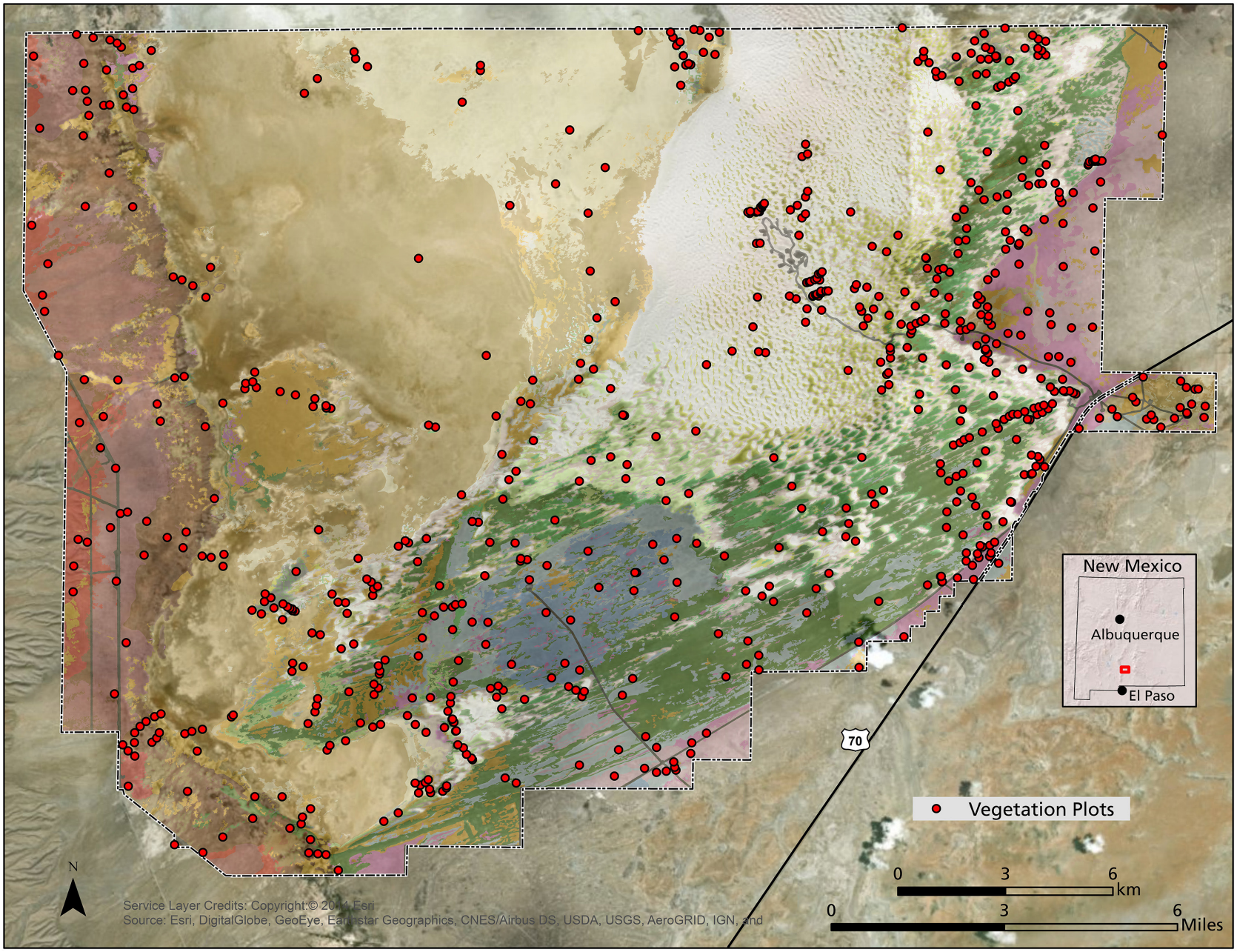


Figure 10. Distribution of 737 vegetation plots used in the development of the vegetation classification for White Sands National Monument.

Ellenberg 1974; Ludwig and Reynolds 1988; McCune and Grace 2002). These analyses were based primarily on species-level canopy-cover values with some grouping at the genus level where taxonomic units were ambiguous (abundance scalar values were converted to percent-cover mid-point values). Data on site characteristics such as elevation, slope, aspect, and landform were also used to supplement the analysis. In general, each plot was classified into a particular plant association (PA) based on codominance and/or other groups of differential species. Phases of associations were assigned as necessary to further define the character of the plant community. For the new USNVC Standard (FGDC 2008), associations were assigned to groups based on a working classification developed by NatureServe in collaboration with government agencies and Natural Heritage network ecologists. The resulting hierarchical classification was reviewed by NatureServe ecologists responsible for maintenance and consistency of the USNVC. Currently, the USNVC continues to be revised to meet the new standard and not all groups have been defined. Hence, we had the opportunity here to propose new groups for review as part of the analysis (described below). Final summary floristic and site tables by plant association were computed and were the basis for plant association descriptions and dichotomous keys.

Classification Results

The vegetation of White Sands NM is diverse and reflects both the complex dune systems that have developed over the last 7,000 years and the surrounding alkali flats, playas, and alluvial fans. We identified 50 plant associations (PAs) among 14 groups of the USNVC. In Tables 4A - 4D, we present the PAs ordered by USNVC hierarchy along with their classification status, number of White Sands NM plots, and NatureServe database code. Thirteen of the PAs were considered established types according to the USNVC; i.e., they are well documented either in the park or in the region, and have been entered in the USNVC database and assigned database codes as Standard Associations. The remaining 27 are provisional plant associations pending review for inclusion in the USNVC. They have been assigned a provisional NHNM database code pending acceptance into the USNVC. We provide draft local plant association descriptions of floristic composition site characteristics along with diagnostic keys in Appendices C and D. We have cross-walked each PA to the map units in the vegetation map legend (see White Sands National Monument Vegetation Map chapter for a description of map unit structure).

Classification Overview

Following the structure of the classification in Table 2 but focusing on the macrogroup and group tiers of the USNVC hierarchy, we provide a summary of the composition, structure, and environments of vegetation associations found within the monument. The various elements of the USNVC are also linked to full descriptions available at USNVC.org.

Class: 1 Forest & Woodland

At White Sands NM, there are two macrogroups in the Forest and Woodland (1) Class, Temperate & Boreal Forest and Woodland (1.B) Subclass, Temperate Flooded & Swamp Forest (1.B.3) Formation, and Western North American Interior Flooded Forest (1.B.3.Nd) Division (Table 5). The macrogroups are the Interior Warm & Cool Desert Riparian Forest (M036) and Interior West Ruderal Flooded & Swamp Forest & Woodland (M298).

Table 5. Hierarchy of the Forest and Woodland (1) Class for Macrogroups found at White Sands NM following the USNVC Classification.

Level	Unit
Class	Forest & Woodland (1)
Subclass	Temperate & Boreal Forest & Woodland (1.B)
Formation	Temperate Flooded & Swamp Forest (1.B.3)
Division	Western North American Interior Flooded Forest (1.B.3.Nd)

Macrogroup: M036. Interior Warm & Cool Desert Riparian Forest

This macrogroup represents lowland, primarily broad-leaf deciduous riparian woodlands of the desert Southwest and California. While normally found along riparian corridors, on White Sands NM, the macrogroup is represented by two groups of associations that occur within the dunes and on the alkali flats and playas where shallow groundwater and periodic flooding can sustain wetland communities (see Figure 8).

The Western Interior Riparian Forest & Woodland (G797) is dominated by the native riparian *Populus deltoides* ssp. *wislizeni* (Rio Grande cottonwood), and is represented by two associations that form conspicuous patches within the dunes. The *Populus deltoides* ssp. *wislizeni* / *Schizachyrium scoparium* Flooded Woodland PA is characterized by scattered riparian trees and shrubs with a grassy ground cover. The PA occurs in interdune areas where the water table remains relatively near the surface, particularly during the summer monsoon rainy season. Because the dunes are active, as they creep forward into the interdune spaces, they bury the cottonwood community, but cottonwoods themselves can survive, extending their shoots out through the summits of the dunes. In this process, shrubs such as *Poliomintha incana* and *Yucca elata* (soaptree yucca) also become established on the dunes, creating the unique *Populus deltoides* ssp. *wislizeni* / *Poliomintha incana* Flooded Forest association (Figure

Table 4A. White Sands National Monument vegetation classification for the 1.B.3.Nd Western North American Interior Flooded Forest Division (Class = 1 Forest and Woodland; Subclass = 1.B Temperate & Boreal Forest & Woodland; Formation = 1.B.3 Temperate Flooded & Swamp Forest; and Division = 1.B.3.Nd Western North American Interior Flooded Forest)*

Macrogroup	Group	Plant Association	# of plots	Code	Map Units
M036. Interior Warm & Cool Desert Riparian Forest	G797. Western Interior Riparian Forest & Woodland	*Populus deltoides* ssp. *wislizeni* / *Poliomintha incana* Flooded Forest	12	CEGL005972	1A, 2A
	G797. Western Interior Riparian Forest & Woodland	*Populus deltoides ssp. wislizeni* / *Schizachyrium scoparium* Flooded Woodland	5	CEGL005973	1A, 2A
M298. Interior West Ruderal Flooded & Swamp Forest & Woodland	G510. Interior West Ruderal Riparian Forest & Scrub	*Tamarix chinensis (Allenrolfea occidentalis)* Alkali Flat Ruderal Shrubland	19	CEPP007468	8A
	G510. Interior West Ruderal Riparian Forest & Scrub	*Tamarix chinensis* - Dune Ruderal Shrubland	17	CEPP007477	8B
	G510. Interior West Ruderal Riparian Forest & Scrub	*Tamarix chinensis* / *Distichlis spicata* Ruderal Shrubland	7	CEPP007471	8A
	G510. Interior West Ruderal Riparian Forest & Scrub	*Tamarix chinensis* / *Sporobolus airoides* Ruderal Shrubland	25	CEPP007475	8A

*See Table 2 for USNVC hierarchical level definitions. "# of plots" is the number of plots used to describe the association. "Code" is either the NatureServe national database code (CEGL numbers) for established PAs or NHNM code (NPS or NHNM codes) for provisional ones. Map Unit refers to the vegetation map units in which the plant association occurs (see Tables 11 &12A-12J).

Table 4B. White Sands National Monument vegetation classification for the 2.C.5.Nd North American Western Interior Brackish Marsh, Playa & Shrubland Division (Class = 2 Shrub & Herb Vegetation; Subclass = 2.C Shrub & Herb Wetland; Formation = 2.C.5 Salt Marsh; and Division = 2.C.5.Nd North American Western Interior Brackish Marsh, Playa & Shrubland)*

Macrogroup	Group	Plant Association	# of plots	Code	Map Units
M082. Warm & Cool Desert Alkali-Saline Marsh, Playa & Shrubland	G537. North American Desert Alkaline-Saline Wet Scrub	*Allenrolfea occidentalis - Atriplex canescens* / *Sporobolus airoides* Shrubland	11	CEPP007404	4A
	G537. North American Desert Alkaline-Saline Wet Scrub	*Allenrolfea occidentalis* / Sparse Shrubland	23	CEPP007408	4A, 9B
	G537. North American Desert Alkaline-Saline Wet Scrub	*Allenrolfea occidentalis* / *Suaeda nigra* Shrubland	13	CEPP005787	4A, 9B
	G537. North American Desert Alkaline-Saline Wet Scrub	*Atriplex canescens* / *Suaeda nigra* Shrubland	10	CEPP007421	5A
	G537. North American Desert Alkaline-Saline Wet Scrub	*Suaeda nigra* Wet Shrubland	2	CEGL001991	4A
	G538. North American Desert Alkaline-Saline Marsh & Playa	*Distichlis spicata* Alkaline Wet Meadow	2	CEGL001770	3A
	G538. North American Desert Alkaline-Saline Marsh & Playa	*Sporobolus airoides - Distichlis spicata* Wet Meadow	1	CEGL001687	3A
	G538. North American Desert Alkaline-Saline Marsh & Playa	*Sporobolus airoides* Monotype Grassland	44	CEGL001688	3A, 5A

*See Table 2 for USNVC hierarchical level definitions. "# of plots" is the number of plots used to describe the association. "Code" is either the NatureServe national database code (CEGL numbers) for established PAs or NHNM code (NPS or NHNM codes) for provisional ones. Map Unit refers to the vegetation map units in which the plant association occurs (see Tables 11 &12A-12J).

Table 4C. White Sands National Monument vegetation classification for the 3.A.2.Na North American Warm Desert Scrub & Grassland Division (Class = 3 Desert & Semi-Desert; Subclass = 3.A Warm Desert & Semi-Desert Woodland, Scrub & Grassland; Formation = 3.A.2 Warm Desert & Semi-Desert Scrub & Grassland; and Division = 3.A.2.Na North American Warm Desert Scrub & Grassland)*

Macrogroup	Group	Plant Association	# of plots	Code	Map Units
M086. Chihuahuan Desert Scrub	G288. Chihuahuan Creosotebush - Mixed Desert Scrub	*Larrea tridentata / Muhlenbergia porteri* Shrubland	2	CEGL001272	6A
	G288. Chihuahuan Creosotebush - Mixed Desert Scrub	*Larrea tridentata - Parthenium incanum* Shrubland	2	CEGL001274	6A
	G288. Chihuahuan Creosotebush - Mixed Desert Scrub	*Larrea tridentata* / Sparse Understory Shrubland	12	CEGL001276	6A, 7B
	G288. Chihuahuan Creosotebush - Mixed Desert Scrub	*Flourensia cernua / Muhlenbergia porteri* Shrubland	4	CEPP007428	7B
	G299. Chihuahuan Desert Lowland Basin Scrub	*Atriplex canescens* / Sparse Shrubland	4	CEPP007413	5A, 5B
	G299. Chihuahuan Desert Lowland Basin Scrub	*Flourensia cernua / Sporobolus airoides* Shrubland	3	CEGL001337	7B
	G299. Chihuahuan Desert Lowland Basin Scrub	*Prosopis glandulosa / Sporobolus airoides Shrubland*	28	CEGL001385	7B
	G299. Chihuahuan Desert Lowland Basin Scrub	*Rhus trilobata / Sporobolus airoides* Shrubland	1	CEPP007446	5A
	G287. Chihuahuan Desert Sand Scrub	*Poliomintha incana / Sporobolus flexuosus* Shrubland	5	NHNM000615	1A
	G287. Chihuahuan Desert Sand Scrub	*Psorothamnus scoparius / Sporobolus flexuosus* Shrubland	3	CEGL001695	1A
	G847. Chihuahuan Gypsophilous Scrub	*Atriplex canescens / Sporobolus nealley*i Shrubland	45	CEPP007287	1B
	G847. Chihuahuan Gypsophilous Scrub	*Larrea tridentata / Sporobolus nealleyi* Shrubland	1	CEPP007342	1B
	G847. Chihuahuan Gypsophilous Scrub	*Poliomintha incana / Bouteloua breviseta* Gypsophilous Shrubland	14	CEPP007347	1A
	G847. Chihuahuan Gypsophilous Scrub	*Poliomintha incana / Muhlenbergia pungens* Gypsophilous Shrubland	14	CEGL002672	1A
	G847. Chihuahuan Gypsophilous Scrub	*Poliomintha incana* Gypsum Dune Shrubland	39	CEPP007391	1A
	G847. Chihuahuan Gypsophilous Scrub	*Rhus trilobata / Bouteloua breviseta* Gypsophilous Dune Shrubland	3	CEPP007400	1A
	G847. Chihuahuan Gypsophilous Scrub	*Rhus trilobata - Poliomintha incana* Gypsophilous Dune Shrubland	3	CEPP007401	1A

Table 4C (continued). White Sands National Monument vegetation classification for the 3.A.2.Na North American Warm Desert Scrub & Grassland Division (Class = 3 Desert & Semi-Desert; Subclass = 3.A Warm Desert & Semi-Desert Woodland, Scrub & Grassland; Formation = 3.A.2 Warm Desert & Semi-Desert Scrub & Grassland; and Division = 3.A.2.Na North American Warm Desert Scrub & Grassland)*

Macrogroup	Group	Plant Association	# of plots	Code	Map Units
M087. Chihuahuan Semi-Desert Grassland	G489. Chihuahuan Semi-Desert Lowland Grassland	*Pleuraphis mutica - Sporobolus airoides* Grassland	1	CEPP007435	3A
	G491. Chihuahuan Sandy Plains Semi-Desert Grassland	*Yucca elata / Sporobolus flexuosus* Shrubland	1	CEPP007481	1A
	G492. Chihuahuan Gypsophilous Grassland	*Tiquilia hispidissima / Bouteloua breviseta - Mentzelia humilis* Dwarf-shrub Grassland	27	CEGL004573	2C
	G492. Chihuahuan Gypsophilous Grassland	*Tiquilia hispidissima / Sporobolus nealleyi* Dwarf-shrub Grassland	47	CEGL001546	2C
	G492. Chihuahuan Gypsophilous Grassland	*Schizachyrium neomexicanum - Abronia angustifolia* Grassland	4	CEPP007448	2D
	G492. Chihuahuan Gypsophilous Grassland	*Bouteloua breviseta - Schizachyrium neomexicanum* Grassland	32	CEPP007423	2A
	G492. Chihuahuan Gypsophilous Grassland	*Bouteloua breviseta - Sporobolus airoides* Grassland	7	CEPP007424	2B
	G492. Chihuahuan Gypsophilous Grassland	*Ephedra torreyana / Bouteloua breviseta* Dwarf-shrub Grassland	36	CEPP007425	2A, 2B
	G492. Chihuahuan Gypsophilous Grassland	*Ephedra torreyana / Sporobolus airoides* Dwarf-shrub Grassland	1	CEPP007427	2D
	G492. Chihuahuan Gypsophilous Grassland	*Tiquilia hispidissima / Acleisanthes lanceolata* Dwarf-shrubland	2	CEPP007479	2C
	G492. Chihuahuan Gypsophilous Grassland	*Frankenia jamesii / Sporobolus airoides* Grassland	29	CEPP007433	2F
	G492. Chihuahuan Gypsophilous Grassland	*Sporobolus airoides - Abronia angustifolia* Grassland	27	CEPP007453	2D
	G492. Chihuahuan Gypsophilous Grassland	*Sporobolus airoides - Schizachyrium neomexicanum* Grassland	35	CEPP007463	2D, 2E
	G492. Chihuahuan Gypsophilous Grassland	*Sporobolus nealleyi - Sporobolus airoides* Grassland	7	CEPP007465	2C, 3A
M512. North American Warm Desert Ruderal Scrub & Grassland	G819. North American Warm Desert Ruderal Scrub	*Prosopis glandulosa / Atriplex canescens* Ruderal Shrubland	22	CEGL001382	7A
	G819. North American Warm Desert Ruderal Scrub	*Prosopis glandulosa* / Sparse Shrubland, *Larrea tridentata* Phase	4	CEPP007442	6A
M117. North American Warm Semi-Desert Cliff, Scree & Rock Vegetation	G569. North American Warm Semi-Desert Cliff, Scree & Pavement Sparse Vegetation	Sparse Vegetation / Alluvial Flat	32	NPS_NM049	1B, 1C, 2A-F, 3A, 4A, 5A, 5B, 7B, 8A, 9B
	G569. North American Warm Semi-Desert Cliff, Scree & Pavement Sparse Vegetation	Sparse Vegetation / Dune	8	NPS_NM096	1A, 8B, 9A
	G569. North American Warm Semi-Desert Cliff, Scree & Pavement Sparse Vegetation	Sparse Vegetation / Alluvial Fan	1	NPS_NM105	9C

*See Table 2 for USNVC hierarchical level definitions. "# of plots" is the number of plots used to describe the association. "Code" is either the NatureServe national database code (CEGL numbers) for established PAs or NHNM code (NPS or NHNM codes) for provisional ones. Map Unit refers to the vegetation map units in which the plant association occurs (see Tables 11 &12A-12J).

Table 4D. White Sands National Monument vegetation classification for the 3.B.1.Ne Western North American Cool Semi-Desert Scrub & Grassland Division (Class = 3 Desert & Semi-Desert; Subclass = 3.B Cool Semi-Desert Scrub & Grassland; Formation = 3.B.1 Cool Semi-Desert Scrub & Grassland; and Division = 3.B.1.Ne Western North American Cool Semi-Desert Scrub & Grassland)*

Macrogroup	Group	Plant Association	# of plots	Code	Map Units
M093. Great Basin Saltbush Scrub	G300. Intermountain Shadscale - Saltbush Scrub	*Atriplex canescens* / *Sporobolus airoides* Shrubland	35	CEGL001291	5A, 5B

*See Table 2 for USNVC hierarchical level definitions. "# of plots" is the number of plots used to describe the association. "Code" is either the NatureServe national database code (CEGL numbers) for established PAs or NHNM code (NPS or NHNM codes) for provisional ones. Map Unit refers to the vegetation map units in which the plant association occurs (see Tables 11 &12A-12J).



Figure 11. The *Populus deltoides* ssp. *wislizeni* / *Poliomintha incana* Flooded Forest PA is a member of the Western Interior Riparian Forest & Woodland Group. In this uncommon association of the gypsum dune system of White Sands NM, cottonwoods extend their stems up through the dune as they are buried and survive, while their roots often remain in contact with a shallow water table (photo: Amanda Kennedy).

11). According to Reid (1979), cottonwood has been able to establish in this environment due to its ability to survive both burial as dunes advance and by having a root system that can tolerate exposure when deflation of the dune occurs.

Macrogroup: M298. Interior West Ruderal Flooded & Swamp Forest & Woodland

The Interior West Ruderal Riparian Forest & Scrub Group (G510) is represented by four associations dominated by the exotic and invasive *Tamarix chinensis*. The *Tamarix chinensis* Dune Ruderal Shrubland PA is primarily found as scattered stands among the smaller dunefields on the west side of the monument (Figure 12). The *Tamarix chinensis* (*Allenrolfea occidentalis*) Alkali Flat Ruderal Shrubland PA occurs mostly on the western alkali alluvial flats and is characterized by very



Figure 12. The *Tamarix chinensis* - Dune Ruderal Shrubland PA occurs primarily as small, coppice-like dunes on the western side of White Sands NM and is a representative of the Interior West Ruderal Riparian Forest & Scrub Group (photo: Charlie Jackson).

open *Tamarix chinensis* stands with or without *Allenrolfea occidentalis*. *Tamarix chinensis* / *Distichlis spicata* Ruderal Shrubland and *Tamarix chinensis* / *Sporobolus airoides* Ruderal Shrubland PAs commonly occur on less alkaline and gypsic alluvial bottoms and in drainages around the eastern and southern periphery of the dunefields (Figure 13). See Muldavin et al. (2010) for a map of saltcedar on the monument.

Class: 2 Shrub & Herb Vegetation

At White Sands NM, there is one macrogroup, Warm & Cool Desert Alkali-Saline Marsh, Playa & Shrubland (M082), in the Shrub & Herb Vegetation (2) Class, Shrub & Herb Wetland (2.C) Subclass, Salt Marsh (2.C.5) Formation, and North American Western Interior Brackish Marsh, Playa & Shrubland (2.C.5.Nd) Division (Table 6).

Table 6. Hierarchy of the Shrub & Herb Vegetation (2) Class for Macrogroups found at White Sands NM following the USNVC Classification.

Level	Unit
Class	Shrub & Herb Vegetation (2)
Subclass	Shrub & Herb Wetland (2.C)
Formation	Salt Marsh (2.C.5)
Division	North American Western Interior Brackish Marsh, Playa & Shrubland (2.C.5.Nd)

Macrogroup: M082. Warm & Cool Desert Alkali-Saline Marsh, Playa & Shrubland

Among the many shrubland and grassland communities of White Sands NM, there is a group of eight PAs that are specifically associated with periodically flooded alkali flats and playas of Southwestern desert basins. Hence, they fall within the North American Desert Alkaline-Saline Marsh & Playa (G538) and North American Desert Alkaline-Saline

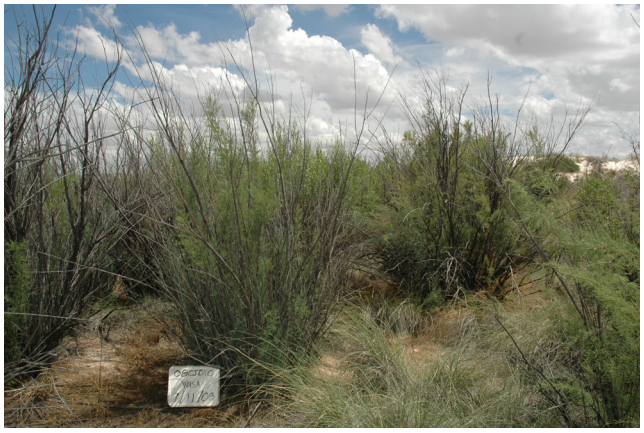


Figure 13. On White Sands NM, the *Tamarix chinensis* / *Sporobolus airoides* Ruderal Shrubland PA can form dense stands along drainages and low-lying areas where water may accumulate (photo: Charlie Jackson).

Wet Scrub (G537). As with many of the *Tamarix* associations above, the communities are commonly dominated by halophytic to moderately salt-tolerant species such as *Allenrolfea occidentalis*, *Suaeda nigra* (bush seepweed), and *Atriplex canescens*. The *Allenrolfea occidentalis* Sparse Shrubland PA is characterized by very open shrub canopies of *Allenrolfea occidentalis* with little or no intervening shrub or grass cover (Figure 14). *Suaeda nigra* can co-dominate with *Allenrolfea* and can form dense shrublands on the flats as well, e.g., the *Allenrolfea occidentalis* / *Suaeda nigra* Shrubland PA (Figure 15). *Atriplex canescens* can also dominate or co-dominate relatively dense shrublands, e.g., the *Atriplex canescens* / *Suaeda nigra* Shrubland (Figure 16). Salt-tolerant grasses such as *Sporobolus airoides* and occasionally *Distichlis spicata* can be abundant in the intershrub spaces, e.g., the *Allenrolfea occidentalis* - *Atriplex canescens* / *Sporobolus airoides* Shrubland (Figure 17). Finally, there are sites where shrubs are uncommon or absent and the *Distichlis spicata* Alkaline Wet Meadow, the *Sporobolus airoides* - *Distichlis spicata* Wet Meadow, or the *Sporobolus airoides* Monotype Grassland PA prevail with a luxuriant cover of grasses (Figure 18).



Figure 14. The *Allenrolfea occidentalis* Sparse Shrubland PA is member of the North American Desert Alkaline-Saline Wet Scrub Group and occurs in periodically flooded and often alkaline alluvial flats that border the dunefields (photo: Charlie Jackson).



Figure 15. The *Allenrolfea occidentalis* / *Suaeda nigra* Shrubland PA can form moderately dense shrublands on alluvial flats on the periphery of the dunelands and in the interdune areas. (photo: Yvonne Chauvin).



Figure 16. The *Atriplex canescens* / *Suaeda nigra* Shrubland is a common association on expansive alluvial flats that flank the dune system (photo: Yvonne Chauvin).



Figure 17. The *Allenrolfea occidentalis* - *Atriplex canescens* / *Sporobolus airoides* Shrubland is another element of the alluvial flats that lie adjacent to the dunefields (photo: Yvonne Chauvin).



Figure 18. In the *Sporobolus airoides* - *Distichlis spicata* Wet Meadow PA shrubs are minor or absent and sites tend to be in lower, more moist positions in the alluvial flat landscape. Sites also tend to be less alkaline and gypsic (photo: Yvonne Chauvin).

Class: 3 Desert & Semi-Desert, Subclass 3A Warm Desert & Semi-Desert Woodland, Scrub & Grassland

At White Sands NM, there are four macrogroups in the Desert & Semi-Desert (3) Class, Warm Desert & Semi-Desert Woodland, Scrub & Grassland (3.A) Subclass, Warm Desert & Semi-Desert Scrub & Grassland (3.A.2) Formation, and North American Warm Desert Scrub & Grassland (3.A.2.Na) Division. These macrogroups are Chihuahuan Desert Scrub (M086), Chihuahuan Semi-Desert Grassland (M087), North American Warm Desert Ruderal Scrub & Grassland (M512), and North American Warm Semi-Desert Cliff, Scree & Rock Vegetation (M117) (Table 7).

Table 7. Hierarchy of the Desert & Semi-Desert (3) Class, Warm Desert & Semi-Desert Woodland, Scrub & Grassland (3.A) Subclass for Macrogroups found at White Sands NM following the USNVC Classification.

Level	Unit
Class	Desert & Semi-Desert (3)
Subclass	Warm Desert & Semi-Desert Woodland, Scrub & Grassland (3.A)
Formation	Warm Desert & Semi-Desert Scrub & Grassland (3.A.2)
Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)

Macrogroup: M086. Chihuahuan Desert Scrub

Chihuahuan Desert Scrub communities of this macrogroup are represented on White Sands NM by four diverse groups. Perhaps the most conspicuous is Chihuahuan Gypsophilous Scrub (G847) represented by eight plant associations. The shrubs *Poliomintha incana*, *Yucca elata*, and *Rhus trilobata* are the primary shrub colonizers of the dunes themselves, which may lead to stabilization. Shrubs likely establish first in scoured interdune flats and then extend their shoots to the dune surface as they are buried in moving sands. In early stages of colonization, herbaceous cover is low with only scattered grasses and forbs and is represented by the *Poliomintha incana* Gypsum Dune Shrubland PA (Figure 19). The shrubs act to anchor the shifting sands, which can potentially lead to further stabilization and the development of well-vegetated parabolic dunes depending on the amount of windblown sands and their source. With stabilization grass cover increases, and the *Poliomintha incana* / *Bouteloua breviseta* Gypsophilous Shrubland and *Poliomintha incana* / *Muhlenbergia pungens Gypsophilous Shrubland* PAs along with occasional stands of *Rhus trilobata* / *Bouteloua breviseta* Gypsophilous Dune Shrubland and *Rhus trilobata* - *Poliomintha incana* Gypsophilous Dune Shrubland tend to dominate the dune crests, particularly among the smaller and lower peripheral parabolic dunes (Figure 20). In the interdune flats and outside the dunelands proper there two are shrublands dominated by the tall shrubs *Larrea tridentata* (creosotebush) and *Atriplex canescens* with *Sporobolus nealleyi* in the shrub understories or intershrub spaces (although overall herbaceous cover is low): *Atriplex canescens* / *Sporobolus nealleyi* Shrubland and *Larrea tridentata* / *Sporobolus nealleyi* Shrubland PAs.

Chihuahuan Desert Sand Scrub (G287) is represented by two non-gypsophilic PAs that form small coppice dunes or stabilize parabolic dunes dominated by either *Psorothamnus scoparius* (broom dalea) or *Poliomintha incana* but where herbaceous cover is commonly low with only scattered grasses or barren ground in the interdune spaces (e.g., *Psorothamnus scoparius* / *Sporobolus flexuosus* Shrubland). Here, sands have accumulated around the bases of the shrubs, gradually building mounds or coppices around the plants as they extend their shoots above the "coppice" dune surface. These rounded, vegetation-stabilized dunes generally range between one and five meters (3.3 to 16.4 ft) in height



Figure 19. The *Poliomintha incana* Gypsum Dune Shrubland PA is representative of the type of vegetation to first colonize active dunes. The shrubs likely get established before burial and then extend their stems. Herbaceous cover and diversity is very low (photo: Yvonne Chauvin).



Figure 20. The *Poliomintha incana* / *Muhlenbergia pungens* Gypsophilous Shrubland PA is prevalent among the more stabilized parabolic dunes on the periphery of the dunefield (photo: Esteban Muldavin).

and are usually composed of quartz (sandstone-derived) sands or occasionally gypsum. Closely associated with this group is the North American Warm Desert Ruderal Scrub (G819) where invasive *Prosopis glandulosa* (honey mesquite) has formed coppice dunes as a function degradation of sandy plains grasslands by wind erosion following heavy grazing, e.g., the *Prosopis glandulosa - Atriplex canescens* Ruderal Shrubland PA (Figure 21). Although *Prosopis glandulosa* is native, it is considered invasive in non-riparian situations. Such is the case on sandy soils, where past disturbances, principally grazing, have promoted the invasion of mesquite and caused erosion on land that once supported grassland. Interdune spaces are usually blown free of soil and lack significant vegetation cover.

The Chihuahuan Creosotebush - Mixed Desert Scrub Group (G288) consists of open shrubland PAs that occur on coalesced alluvial fan piedmonts and alluvial aprons bordering the alluvial flats and playas on the western part of monument. This group contains three associations dominated by *Larrea tridentata* and one by *Flourensia cernua* (tarbush). Stands typically have gravelly desert pavements that are sparsely vegetated, e.g., the *Larrea tridentata - Parthenium incanum* Shrubland and *Larrea tridentata* / Sparse Understory Shrubland PA (Figure 22). On some sites, particularly near the distal ends of the fans, grasses such as *Muhlenbergia porteri* or *Sporobolus airoides* (alkali sacaton) can be common within the shrub canopies and occasionally extending into the intershrub spaces (e.g., the *Flourensia cernua* / *Muhlenbergia porteri* Shrubland or *Larrea tridentata* / *Muhlenbergia porteri* Shrubland PAs).

The Chihuahuan Desert Lowland Basin Scrub (G299) Group is characterized by sparse to dense shrublands dominated by either *Atriplex canescens*, *Flourensia cernua*, *Prosopis glandulosa*, or *Rhus trilobata* and usually have a grassy herbaceous layer of *Sporobolus airoides* (Figure 23). There are four associations that occur mostly on the alluvial flats surrounding the dunefield, and are intermixed with the *Sporobolus airoides* Monotype Grassland PA of the North American Desert Alkaline-Saline Marsh & Playa Macrogroup described above (M082).

Macrogroup: M087. Chihuahuan Semi-Desert Grassland

Chihuahuan Semi-Desert Grasslands on White Sands NM occupy much of the interdune flats and surrounding basin bottom flats and are represented by three groups. Primary among them is Chihuahuan Gypsophilous Grassland (G492) represented by 12 PAs. There are six grassland PAs primarily associated with the interdune deflation plains



Figure 21. The *Prosopis glandulosa - Atriplex canescens* Ruderal Shrubland PA forms low-lying coppice dunes from blowing quartz sand, although it occasionally occurs in gypsum areas as well (photo: Jamie Thompson).



Figure 22. The *Larrea tridentata* / Sparse Understory Shrubland PA occurs on the lower alluvial fan piedmonts that extend out of the San Andres Mountains on the western side of White Sands NM. The PA is a member of the widespread Chihuahuan Creosotebush - Mixed Desert Scrub Group and is found throughout the Chihuahuan Desert (photo: Jamie Thompson).



Figure 23. The *Atriplex canescens* / *Sporobolus airoides* Shrubland pictured here in the southeastern portion of the monument is a representative of the Intermountain Shadscale – Saltbush Scrub Group (photo: Yvonne Chauvin).

that are variously dominated by the *Bouteloua breviseta*, *Schizachyrium neomexicanum*, and *Sporobolus airoides* along with scattered shrubs such as *Ephedra torreyana*, and *Tiquilia hispidissima*. They reflect a gradient of successional development along the gradient from the more stable peripheral vegetated parabolic dunelands to the most active in the barchanoid dunes in the "Heart of the Sands." For example, the *Bouteloua breviseta - Schizachyrium neomexicanum* Grassland, *Bouteloua breviseta - Sporobolus airoides* Grassland, and *Ephedra torreyana / Bouteloua breviseta* Dwarf-shrub Herbaceous Grassland PAs can form relatively luxuriant grasslands and are most prevalent among the peripheral parabolic dunes where they likely act to further stabilize the dune system (Figure 24). *Bouteloua breviseta* in particular appears important in colonizing sandy plains and low-lying dunes, and also occurs on some of the less mobile larger dunes. The *Yucca elata / Sporobolus flexuosus* Shrubland also occurs intermixed among *Bouteloua breviseta* associations on the dunes but also commonly occurs on non-gypsum sandy substrates elsewhere in the northern Chihuahuan Desert and is classified here as Chihuahuan Sandy Plains Semi-Desert Grassland (G491).

Progressing into the active dune system, the interdune areas have been wind-scoured, leaving a shallow sheet of sand or crusty exposed secondary gypsum. Here *Bouteloua breviseta*-dominated grasslands give way to the *Sporobolus airoides - Schizachyrium neomexicanum* Grassland and *Frankenia jamesii / Sporobolus airoides* Shrubland PAs. The former dominates much of the middle portion of the dunefield (Figure 25), while the latter is more prevalent going north into the increasingly scoured areas with more active dunes (Figure 26). New, exposed wind-scored surfaces are usually sparsely vegetated with scattered gypsophilous dwarf shrubs (e.g., the *Tiquilia hispidissima / Acleisanthes lanceolata* Dwarf-shrubland PA). The end of the stability gradient, where vegetation becomes very sparse or absent, is where the *Sporobolus airoides - Abronia angustifolia* Grassland PA occurs, often against the face of moving dunes (Figure 27).

In contrast, sites where the sands have been scoured away by the winds leaving behind rugged gypsum crusts support sparse grasslands represented by the *Tiquilia hispidissima / Sporobolus nealleyi* Dwarf-shrub Grassland and *Tiquilia hispidissima / Bouteloua breviseta - Mentzelia humilis* Dwarf-shrub Grassland PAs. These sites typically occur in the larger interdune deflation plains among the parabolic dunes and on the periphery of the dune system as a whole (Figure 28).

In the surrounding alluvial flats of the monument and in large interdune areas, extensive grasslands occur that are dominated by the *Pleuraphis mutica - Sporobolus airoides* Grassland PA (Figure 29). Soils on these sites tend to be less



Figure 24. The *Ephedra torreyana / Bouteloua breviseta* Dwarf-shrub Grassland PA is an example of gypsum grama-dominated communities that characterize the more stabilized peripheral dunes (photo: Esteban Muldavin).



Figure 25. Stands of the *Sporobolus airoides - Schizachyrium neomexicanum* Grassland PA dominate the middle portion of the dune system where the dunes are still somewhat active and the interdune areas more scoured than near the periphery, exposing underlying gypsum crusts (photo: Yvonne Chauvin).



Figure 26. Out in the active barchanoid dunefield in the Heart of the Sands, vegetation becomes sparser and open grasslands such as this one of the *Frankenia jamesii / Sporobolus airoides* Shrubland PA are the most common (photo: Esteban Muldavin).

gypsophilic, and hence this PA is considered part of the Chihuahuan Semi-Desert Lowland Grassland Group (G489) rather that the above gypsic group. It is also often found with the *Sporobolus airoides* Monotype Grassland PA of the North American Desert Alkaline-Saline Marsh & Playa Group (G538), and together they form extensive swards across the basin-bottom landscape surrounding the gypsum lands. On wetter sites, these PAs give way to the *Sporobolus airoide*s - *Distichlis spicata* Wet Meadow, *Sporobolus airoides* Monotype Grassland, and *Distichlis spicata* Alkaline Wet Meadow PAs of the North American Desert Alkaline-Saline Marsh & Playa (G538) described above.

Macrogroup: M512. North American Warm Desert Ruderal Scrub & Grassland

This macrogroup represents disturbed warm, semi-arid grasslands and desert thornscrub that occur in the southwestern U.S. and northern Mexico. Vegetation of the macrogroup ranges from monocultures of non-native graminoid species or a mix of several non-native forbs and graminoids (e.g., *Eragrostis curvula* (weeping lovegrass), *Eragrostis lehmanniana* (Lehmann lovegrass), *Pennisetum ciliare* (buffelgrass), *Pennisetum setaceum* (crimson fountaingrass), *Sorghum halepense* (Johnsongrass), *Brassica tournefortii* (Asian mustard), etc.), and upland desert scrub dominated by invasive native shrub species.

North American Warm Desert Ruderal Scrub (G819) Group is represented on White Sands NM by degraded grasslands and shrublands that have been invaded by *Prosopis glandulosa* and *Prosopis velutina* (velvet mesquite). It does not include *Prosopis* spp.-dominated stands that occur naturally in desert drainages, washes and riparian areas (bosque).

Macrogroup: M117. North American Warm Semi-Desert Cliff, Scree & Rock Vegetation

The North American Warm Semi-Desert Cliff, Scree & Rock Vegetation Macrogroup and the North American Warm Semi-Desert Cliff, Scree & Pavement Sparse Vegetation (G569) Group reflect sparsely vegetated sites on dunes, alluvial fans, and alluvial flats, i.e., Sparse Vegetation / Alluvial Flat, Sparse Vegetation / Alluvial Fan, and Sparse Vegetation / Dune.

Class: 3 Desert & Semi-Desert, Subclass: 3.B Cool Semi-Desert Scrub & Grassland

At White Sands NM, the Great Basin Saltbush Scrub (M093) Macrogroup is in the Desert & Semi-Desert (3) Class, the Cool Semi-Desert Scrub & Grassland (3.B) Subclass, Warm Desert & Semi-Desert Scrub & Grassland (3.B.1) Formation,



Figure 27. In the heart of the active barchanoid dunes, vegetative cover becomes increasingly limited. This is an example of the *Sporobolus airoides - Abronia angustifolia* Grassland PA in the process of being buried by the slip face of a moving dune front (photo: Y. Chauvin).



Figure 28. The *Tiquilia hispidissima / Sporobolus nealleyi* Dwarf-shrub Grassland Vegetation occurs on non-dune gypsum crust soils that occur in the surrounding alluvial flats and in the interdune flats (photo: Esteban Muldavin).



Figure 29. The *Sporobolus airoides* Monotype Grassland is a common association of the non-gypsophilous alluvial flats that surround the dunefield along the eastern margins of the monument (photo: Yvonne Chauvin).

and Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne) Division (Table 8).

Table 8. Hierarchy of the Desert & Semi-Desert (3) Class, Cool Semi-Desert Scrub & Grassland (3.B) Subclass for Macrogroups found at White Sands NM following the USNVC Classification.

Level	Unit
Class	Desert & Semi-Desert (3)
Subclass	Cool Semi-Desert Scrub & Grassland (3.B)
Formation	Cool Semi-Desert Scrub & Grassland (3.B.1)
Division	Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)

Macrogroup: M093. Great Basin Saltbush Scrub

The Intermountain Shadscale – Saltbush Scrub (G300) Group is represented by the *Atriplex canescens* / *Sporobolus airoides* Shrubland, a PA widespread from the Great Basin down through the Chihuahuan Desert. It commonly found intermixed with Chihuahuan Semi-Desert Lowland Grassland in the lowland basin flats to the east of the dunefield.

Classification Discussion

Daubenmire (1974) suggested that plant communities integrate all impinging environmental conditions; hence, the classification and description of plant associations provides a framework for understanding the ecological composition and structure of a given landscape. Accordingly, plant associations are used in the mapping process to define map unit components—providing the information linkage between a vegetation community's spatial distribution and its ecology. The outcome is that by grouping land areas based on the ability to support similar associations, general management observations and recommendations can be made for each grouping. In addition, resource managers have found that the classification of vegetation into plant associations has provided insight and the ability to predict vegetation changes in response to various disturbance processes.

The development of a vegetation classification is an incremental process of successive approximation (Shimwell 1971), and we would suggest that the classification presented here represents a significant revision and refinement of the previous work of Reid (1980) and Muldavin et al. (1994; 1997; and 2000) in depth and detail. Direct comparisons with Reid (1980) were problematic because he did not provide quantitative data on species composition nor descriptions beyond species lists of associations. With respect to Muldavin et al. (1994, 1997, and 2000), we retained 19 PAs described there, dropped nine and reclassified the plots according to the classification revision presented here. Of the 16 associations listed for neighboring Holloman Air Force Base (Muldavin et al. 1997), only three were not confirmed on White Sands NM. In addition, the seven gypsophilous associations identified on White Sands Missile Range are still reflected in this classification. Together, this should aid cross-jurisdictional natural resource management.

Further work is needed to reconcile these differences regionally across the CHDN parks and neighboring landscapes, particularly with respect to other gypsophilous communities in New Mexico and west Texas (e.g., Guadalupe Mountains National Park) that may have a bearing on the classification. In addition, the majority of the plant associations described here are provisional pending acceptance into the national classification, and, therefore, this classification as whole remains provisional and subject to change pending review by appropriate entities. To address this, we would suggest a network-wide analysis in a national context to determine if the provisional types proposed here should be accepted into the national classification.

Chapter 3: White Sands National Monument Vegetation Map

Mapping Process Overview

The White Sands NM vegetation map was developed using a combined strategy of automated digital image classification and direct analog image interpretation of aerial photography and satellite imagery. Initially, the aerial photography and satellite imagery were processed and entered into a GIS along with ancillary spatial layers. A working map legend of ecologically based vegetation map units was developed using the vegetation classification described in Chapter 2: Vegetation Classification as the foundation. The intent was to develop map units that targeted the plant-association level wherever possible within the constraints of image quality, information content, and resolution. With the provisional legend and ground-control points provided by the field-plot data (the same data used to develop the vegetation classification), a combination of heads-up screen digitizing of polygons based on image interpretation and supervised image classifications were conducted. The outcome was a vegetation map composed of a suite of map units defined by plant associations and represented by sets of mapped polygons with similar spectral and site characteristics.

The key mapping standards of the National Vegetation Mapping Program (https://www.nps.gov/im/vegetation-inventory.htm) call for spatial data to be provided with a horizontal positional accuracy meeting National Map Accuracy Standards at the 1:24,000 scale, i.e., each well-defined object in the spatial database must be within 6 mm (1/50-of-an-inch) display scale or 12.2 m (40 ft) of its actual location. In addition, each vegetation map class (unit) should meet or exceed 80% accuracy at the 90%-confidence level, and the minimum mapping unit should be 0.5 ha (1.24 ac). Details of the accuracy assessment for the White Sands NM vegetation map are provided in Chapter 4: Accuracy Assessment.

Mapping Methods

Map development was conducted in two phases. In the first phase, an automated object-based classification was used to develop a draft polygon vegetation map (completed in 2014). In the second phase, the draft map was revised using analog aerial imagery interpretation of the most recent aerial imagery available. For the map, a hierarchical legend was developed to reflect spatial pattering and ecological relatedness vegetation at different scales based on USNVC groups and collections of plant associations.

Data sources and processing

Aerial photography

Initially, the 2005 New Mexico statewide acquisition Digital Ortho-photo Quarter Quads (DOQQs) were used as the foundation imagery for the vegetation map[1]. These DOQQs came as separate natural color and color-infrared sets which altogether gathered four separate bands of spectral reflectance values from the visible blue to the near-infrared (NIR) wavelengths at a 1-m (3.3-ft) spatial resolution. These four separate bands were combined into one file and then mosaicked together. The ortho-photo mosaic was resampled to a 2-m (6.6-ft) spatial resolution, reducing its overall file size by a factor of four without substantially reducing the detail.

Despite their finer spatial detail, the DOQQs deliver only a minimal spectral capability, but as they do have bands capturing both visible red and NIR wavelengths, we were able to compute a Normalized Difference Vegetation Index (NDVI) on the mosaic and used as a layer to enhance the vegetative component of the landscape. A NDVI emphasizes vigorous green plant growth by comparing a strong chlorophyll reflectance in the NIR wavelengths against chlorophyll absorption in the visible red wavelengths (Equation 1).

$$NDVI = ((NIR - red) / (NIR + red) + 1) * 100 \quad \text{(Eq. 1)}$$

As mentioned above, DOQQs provide valuable spatial detail. One way to represent this spatial detail is to create a texture image that quantifies the amount of change in the brightness values between neighboring image cells. In this case, a texture image was created by averaging the variance of the DOQQ mosaic at three different scales or kernel sizes (3x3 cells - 36 m^2 (387 ft^2), 5x5 cells – 100 m^2 (1,076 ft^2), and 7x7 cells – 196 m^2 (2,110 ft^2)). The variance was computed as shown in Equation 2:

$$Variance = \sum ((x - M)2/(n-1)) \quad \text{(Eq. 2)}$$

where x is the value of a particular pixel, M is the mean value for the moving window kernel, and n is the kernel size. The resulting image represents areas of heterogeneous responses such as shrublands with higher values and areas with homogeneous responses such as dunelands and alkali flats with low values.

Satellite imagery

To complement the digital aerial photography, we used two multi-spectral satellite Landsat Enhanced Thematic

1 https://gdg.sc.egov.usda.gov/

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

The advantages and disadvantages of using Landsat imagery are almost the opposite of using air photos. While ETM's spatial resolution (30-m (98-ft) pixels) is much coarser than that of the air photo, and individual plants cannot be resolved, the ETM's spectral resolution extends to the near- and mid-infrared wavelengths, which are important regions for differentiating vegetation and the underlying soil reflectance responses (Table 9). Each band represents a specific range of light wavelengths and suite of spectral responses. Enhanced Thematic Mapper Bands 2, 3, 4, and 5 are particularly useful for vegetation, while Bands 3, 5, and 7 are responsive to variations in surface geology. Surface geology and soil discrimination are important in developing mapping units of the sparse vegetation communities that occur in the study area. The ETM Band 6 records surface temperature and can be an indirect measure of moisture content. It can be important in discriminating between different plant and soil types; however, it was not used because it has a much coarser spatial resolution (60 x 60 m; 197 x 197 ft).

The two available ETM scenes used were acquired over the area on June 16, 2005 and on August 3, 2005. These multi-temporal scenes capture the seasonal vegetation changes of deciduous shrub leaf-out, forb emergence, and transition from cool-to warm-season grasses. Although the ETM images were already geo-corrected, they were re-rectified to the ortho-photo mosaic. This was to ensure that the images overlaid each other directly. The ETM images were resampled to a 2-m (6.6-ft) spatial resolution using a cubic convolution and projected into the ortho-photo mosaic's projection.

Using the ETM spectral bands, four vegetation indices were computed to enhance various vegetation or ecosystem characteristics. These included two different Normalized Difference Senescent Vegetation Indices (NDSVI1) (Equation 3), (NDVSI2) (Equation 4), the NDVI (Equation 5), the infrared index (Equation 6), and the vegetative moisture index (Equation 7) computed as follows:

NDSVI1 = ((Band 5 – Band 3) / (Band 7 + Band 3) + 1) * 100 (Eq. 3)

NDSVI2 = ((Band 7 – Band 3) / (Band 7 + Band 3) + 1) * 100 (Eq. 4)

NDVI = ((Band 4 – Band 3) / (Band 4 + Band 3) + 1) * 100 (Eq. 5)

Infrared index = ((Band 5 – Band 7) / (Band 5 + Band 7) + 1) * 100 (Eq. 6)

Moisture index = ((Band 4 – Band 5) / (Band 4 + Band 5) + 1) * 100 (Eq. 7)

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

Table 9. Landsat Enhanced Thematic Mapper Plus spectral band descriptions used in the image analysis.

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

centered around 0, and turns it into a positive integer value centered around 100.

The NDSVIs enhance the spectral characteristics of senescent vegetation (specifically grasses), which have a relatively low reflectance response in the red wavelengths (Band 3) and a high reflectance in the mid-infrared wavelengths (Band 5 and Band 7). The infrared index compares relatively high reflectance values in the shorter wavelengths of the mid-infrared (Band 5) against strong absorption at the longer wavelengths of the mid-infrared (Band 7) caused by water molecules found in soil and vegetation. Similarly, the moisture index enhances shadowing and leaf-water content in plants.

An albedo (average reflectance) image was computed from the ortho-photo mosaic and the spatial detail was merged with the ETM data using a principal components technique. This resulted in the ETM and derived images having a 2-m (6.6-ft) spatial resolution with a portion of the air photo detail infused into them. All of the source and derived layers were then compiled into a single image of 28 image bands, as listed in Table 10, available for the classification process. These bands provide the foundation for all subsequent image analysis and mapping.

Geographic Information System (GIS) structure and software and ancillary datasets

All imagery and other spatial data layers were compiled into a geodatabase and GIS using ArcGIS 10.4 (ESRI 2015). To support the mapping process, we acquired a standard set of relevant spatial data layers including digital elevation models, digital raster graphics (DRGs) of 1:24,000-scale USGS topographic maps, roads, ownership, geology (Hawley et al. 2005; Fryberger 2001) and soils (USDA-NRCS 2017). These were re-projected where necessary and imported into an ArcGIS geodatabase framework.

Vegetation map units and legend development

The development of map units (map classes) and construction of a map legend was an iterative process that integrated the ecological vegetation classification units of the USNVC (plant associations, groups, etc.) described in Chapter 2 with their spatial distribution as determined by the quality of the remote sensing imagery and depth of on-the-ground reconnaissance work. Using the legacy White Sands NM vegetation map (Muldavin et al. 1994) as the base, we hierarchically structured the legend into two tiers: a basic lower Level 2 composed of simple map units or complexes as defined by plant associations from Tables 4A-4D, and an upper Level 1, which groups the Level 2 map units to the group level of the NVCS (FGDC 2008). For each map unit, the most predominant associations are identified as primary components of the unit (collectively greater than 50% of the aerial extent of the unit), while associations known to be less common from ground reconnaissance are designated as secondary components (collectively <50% of the area). In addition, those associations estimated to occupy less than an estimated 10% of the area of unit are designated as inclusions. Final map unit component association assignment was based on the plot data. That is, each plot was intersected with the map layer in the GIS and then each map unit attributed based on the distribution of plots among plant associations for that provisional unit. While some units were defined by one or two primary plant associations and were relatively simple, others were complexes of plant associations. The map and its

Table 10. Compiled air photo, Landsat Thematic Mapper and derivative images to be used in subsequent vegetation map classification.

Image Bands	Band Description
Band 1	2005 Airphoto Visible Blue
Band 2	2005 Airphoto Visible Green
Band 3	2005 Airphoto Visible Red
Band 4	2005 Airphoto Near-Infrared
Band 5	2005 Airphoto NDVI
Band 6	2005 Airphoto Texture
Band 7	June 16 2005 Landsat Visible Blue
Band 8	June 16 2005 Landsat Visible Green
Band 9	June 16 2005 Landsat Visible Red
Band 10	June 16 2005 Landsat Near-Infrared
Band 11	June 16 2005 Landsat Mid-Infrared
Band 12	June 16 2005 Landsat Mid-Infrared
Band 13	August 3 2005 Landsat Visible Blue
Band 14	August 3 2005 Landsat Visible Green
Band 15	August 3 2005 Landsat Visible Red
Band 16	August 3 2005 Landsat Near-Infrared
Band 17	August 3 2005 Landsat Mid-Infrared
Band 18	August 3 2005 Landsat Mid-Infrared
Band 19	June 16 2005 NDSVI1
Band 20	June 16 2005 NDVI
Band 21	June 16 2005 Moisture
Band 22	June 16 2005 Infra-red Index (II)
Band 23	June 16 2005 NDSVI2
Band 24	August 3 2005 NDSVI1
Band 25	August 3 2005 NDVI
Band 26	August 3 2005 Moisture
Band 27	August 3 2005 Infra-red Index (II)
Band 28	August 3 2005 NDSVI2

legend went through several iterations as ground data were gathered through the years and new imagery acquired.

Object-oriented Image Classification

Image segmentation techniques were used to build the base map. This technique uses an object-oriented method that segments the imagery into objects of similar color, contrast, and shape. The advantage of this approach is that these objects will preserve edge boundaries of detailed surface features such as roads, dunes, and drainages – features that would be lost or misclassified in a pixel-based classification. These objects can then be classified based on their object-derived statistics or turned into polygons for editing and assigned a class value in a GIS by interpreting photos and referring to the pixel-based classification.

The level of detail was controlled by the scale parameter, a unit-less abstraction that considers each object based on its homogeneity of color and shape, each of which is weighted from 0 to 1. The smaller the scale factor, the more detail is represented and the more the image is segmented into objects, with a scale factor of 1 theoretically representing individual pixels. Depending on how much the shape factor is weighted, the shape's smoothness and compactness are also considered with each of those sub-factors receiving a weighting from 0 to 1. Through an iterative process of adjusting the scale parameter and the other factors, the resulting objects were assessed as to how well they map the features on the ground until a good result is obtained.

The object-oriented map was developed using the 2005 aerial photo bands and Definiens Imaging (Version 5) software (http://www.definiens.com/). The color factor (0.9) was strongly weighted over the shape factor (0.1) and the shape sub-factors of smoothness and compactness were weighted equally (0.5) with a scale factor of 50; this resulted in about 18,000 objects. These objects were then converted into shapefile polygons for use in the GIS.

Supervised Classification

A simultaneous raster-based image classification was conducted using a combined merged-image dataset. The classification was based on a supervised approach whereby 'seed' polygons were digitally drawn in spectrally homogeneous areas around selected vegetation field plots with the help of the ancillary data such as field notes and photographs. From these polygons, image statistics were collected to perform a supervised classification. Supervised classifications are based on a maximum likelihood decision rule containing a Bayesian classifier that uses probabilities to weight the classification toward particular classes. In this study, the probabilities were unknown, so the maximum likelihood equation (Equation 8) for each of the classes is given as:

$$D = [0.5\ln(cov_c)]-[0.5(X-M_c)T * (cov_c-1)*(X-M_c)] \quad \text{(Eq.8)}$$

where D is the weighted distance, cov_c is the covariance matrix for a particular class, X is the measurement vector of the pixel, M_c is the mean vector of the class and T is the matrix transpose function. Each pixel is then assigned to the class with the lowest weighted distance. This technique assumes the statistical signatures have a normal distribution. This decision rule is considered the most accurate because it not only uses a spectral distance as the minimum-distance decision rule, but also takes into account the variance of each of the signatures. The variance is important when comparing a pixel to a signature representing, for example, a woodland community, which can be fairly heterogeneous due to numerous canopies and non-canopy interspaces, as compared to a grassland community, which is more homogeneous.

Final map development

The final supervised raster classification was then used to classify the image polygons developed from the object-oriented classification based on the legend. The image objects (primitives) were imported as a feature of the dataset polygon layer in ESRI ArcGIS (v. 10.4; ESRI 2015), the file quality controlled, and a topology built. The image polygons were then overlaid onto the recoded raster classification and the majority map unit assigned to each polygon map unit to create the draft final map.

As a final step, the draft final map was subjected to a head-up screen digitizing edit using the most recent aerial photography (four-band NAIP 2014 and NAIP 2016). During the final edit, the thematic composition and number of Level 1 and 2 map units were finalized and the final map product produced using NPS cartographic standards. While the required minimum mapping requirements were at 1:24,000 scale with map unit delineations or polygons 0.5 ha (1.24 ac) or larger, most of the final line work was completed at an operational scale between 1:12,000 and 1:3,000. Hence, polygons down to 0.01 ha (0.025 ac) were often maintained. For final map production, adjacent polygons of the same class were merged and remaining polygons less than 0.1 ha (0.025 ac) were subsumed into neighboring polygons based on longest shared boundary. Final map products were compiles into geodatabase for NPS and poster maps produced at Level 1 and 2 following NPS cartographic standards.

Mapping Results

Vegetation map and map legend

The White Sands NM vegetation map is composed of nine Level 1 (L1) vegetation units that correspond to the group level of USNVC and one miscellaneous Other Land Cover Class (Figures 30 and 31; Tables 11 and 12A-12J). Within each L1 unit there are one or more Level 2 (L2) units defined in terms of component plant associations—primary components, secondary components, and inclusions and tied to the national vegetation classification in Tables 4A-4D. Conversely, in Table 4A-4D, the plant associations are cross-referenced to the Level 2 map units of Tables 11 and 12A-12J. A total of 22 L2 units were delineated. While some units are more heterogeneous than others, the attempt was made to keep the map units as monophyletic as possible; that is, to minimize the overlap of associations from one unit to the next. The map-unit name reflects the primary component associations of the unit. In addition, the component structure of most of the Level 2 units typically reflect the geomorphic context such as dune, interdune, basin, etc. A complete annotated legend with summary descriptions of the units, distribution maps, aerial photo examples of map unit polygons, and representative photos is provided in Appendix E. Full-size maps at 1:34,500-scale are available as both a PDF and a shape file for GIS use at http://biology.usgs.gov/npsveg/products/parkname.html.

Mapping Discussion

The complex combination geology and soils, along with wind and hydrological processes have likely shaped much of the vegetation pattern of White Sands NM. The high degree of thematic resolution provided in the Level 2 units was directed towards delineating variation among grasslands in the interdune zones and along the dunefield margins. The high thematic content was intended to inform our understanding of current vegetation patterns as they may reflect the ecological processes in and around the dunefield (many of which are described above in the context of the vegetation classification). Overall, the combination of the annotated legend (Appendix E) and the detailed floristic and site descriptions of individual plant associations (Appendix D) provide for a vegetation map that is rich in ecological information and one that can serve multiple purposes in the management of the park and the broader network of parks.

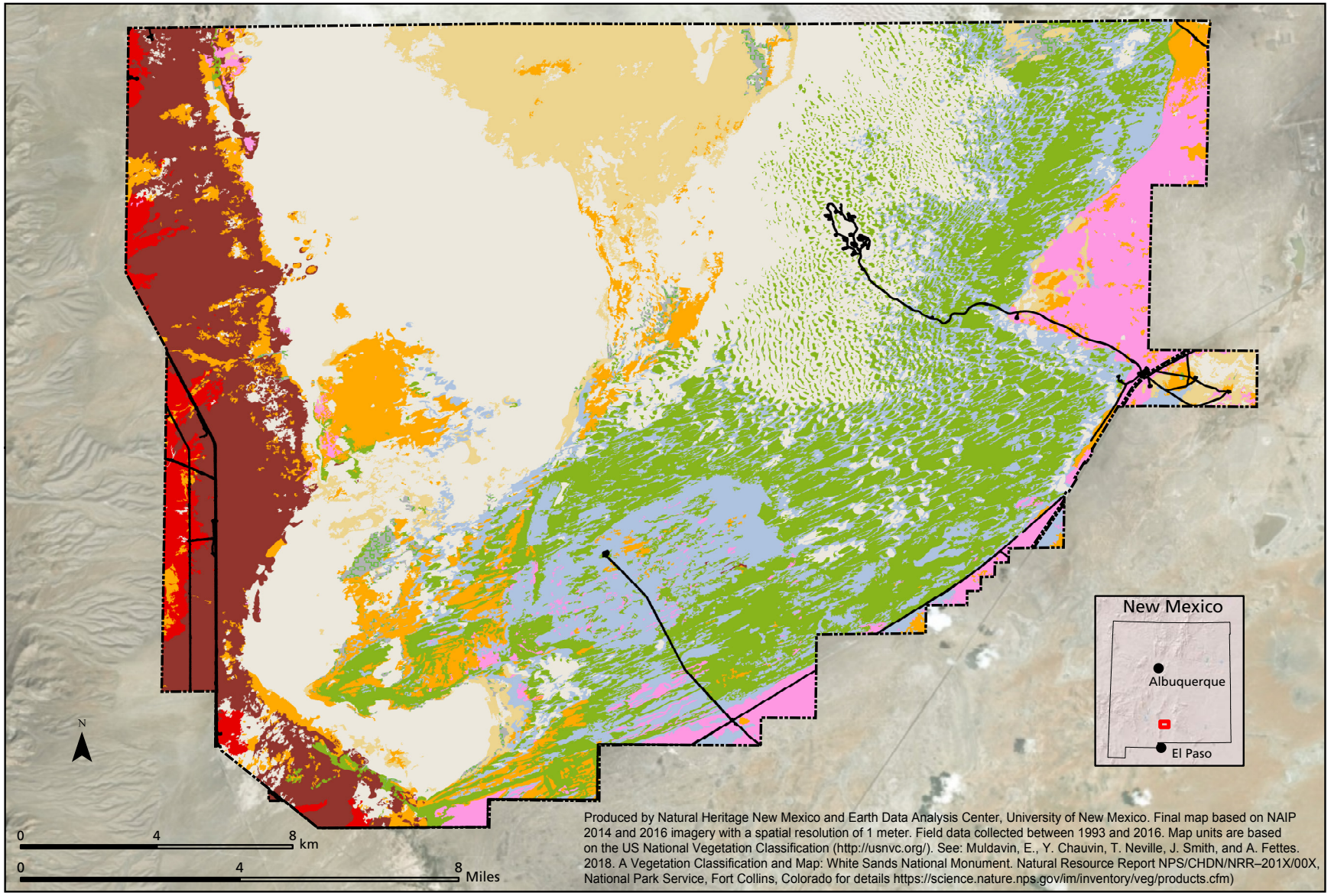
Table 11. Hierarchical map unit legend for the White Sands National Monument vegetation map. See text for definition of map unit Levels 1 and 2. "GIS Spectral Code" refers to the GIS spectral signature code for each Level 2 map unit. "# of polygons" refers to the number of polygon delineations for that map unit at that level. Total areas for the map units by level are given in hectares and acres.

Level 1 and Level 2 Map Units	GIS Spectral Code	# of Polygons	Area	
			Hectare	Acres
1 Chihuahuan Gypsophilous Scrub	–	**1994**	**8233**	**20344**
1A Frosted Mint - Skunkbush Sumac Dune Shrubland	11	1539	4874	12044
1B Fourwing Saltbush / Gyp Dropseed Interdune Shrubland	15	421	2262	5590
1C Fourwing Saltbush / Gyp Dropseed Interdune Shrubland with Honey Mesquite	17	34	1097	2710
2 Chihuahuan Gypsophilous Grassland	–	**4886**	**11229**	**27757**
2A Gypsum Grama - New Mexico Bluestem Interdune Grassland	12	733	1689	4173
2B Gypsum Grama / Torrey's Jointfir Interdune Grassland	18	636	1832	4537
2C Gyp Dropseed - Gypsum Grama / Hairy Coldenia Interdune Grassland	14	629	5369	13268
2D Alkali Sacaton - Gypsum Bluestem - Sand Verbena Interdune Grassland	13	1791	1056	2609
2E Alkali Sacaton - Gypsum Bluestem Interdune Grassland	16	978	1013	2503
2F Alkali Sacaton - James' Seaheath Interdune Grassland	19	119	270	667
3 Chihuahuan Semi-Desert Lowland Grassland	–	**848**	**3949**	**9757**
3A Alkali Sacaton Basin Grassland	22	848	3949	9757
4 North American Desert Alkaline-Saline Wet Scrub	–	**348**	**4822**	**11915**
4A Iodinebush Basin Shrubland	21	348	4822	11915
5 Chihuahuan Desert Lowland Basin Scrub	–	**467**	**2822**	**6972**
5A Fourwing Saltbush Basin Shrubland	32	433	1635	4039
5B Fourwing Saltbush Basin Shrubland and Alkali Sacaton Grassland	33	34	1187	2933
6 Chihuahuan Creosotebush - Mixed Desert Scrub	–	**46**	**947**	**2339**
6A Creosotebush Piedmont Shrubland	41	46	947	2339
7 Chihuahuan Desert Sand Scrub	–	**502**	**6183**	**15275**
7A Honey Mesquite Piedmont Shrubland	51	108	2822	6972
7B Honey Mesquite Basin Shrubland	52	234	2858	7062
8 Interior West Ruderal Riparian Forest & Scrub	–	**160**	**503**	**1241**
8A Saltcedar Alluvial Flat Shrubland	72	88	349	861
8B Saltcedar Dune Shrubland	73	72	154	380
9 Sparse Vegetation	–	**1211**	**21698**	**53618**
9A Sparse Vegetation / Dune	81	733	7139	17642
9B Sparse Vegetation / Alluvial Flat	82	273	14073	34775
9C Sparse Vegetation / Alluvial Fan	85	205	486	1201
10 Other Land Cover	–	**12**	**173**	**428**
10A Roads / Built-up Areas	90	12	173	428

White Sands National Monument
New Mexico

National Park Service
U.S. Department of the Interior

Vegetation of White Sands National Monument



Produced by Natural Heritage New Mexico and Earth Data Analysis Center, University of New Mexico. Final map based on NAIP 2014 and 2016 imagery with a spatial resolution of 1 meter. Field data collected between 1993 and 2016. Map units are based on the US National Vegetation Classification (http://usnvc.org/). See: Muldavin, E., Y. Chauvin, T. Neville, J. Smith, and A. Fettes. 2018. A Vegetation Classification and Map: White Sands National Monument. Natural Resource Report NPS/CHDN/NRR–201X/00X, National Park Service, Fort Collins, Colorado for details https://science.nature.nps.gov/im/inventory/veg/products.cfm)

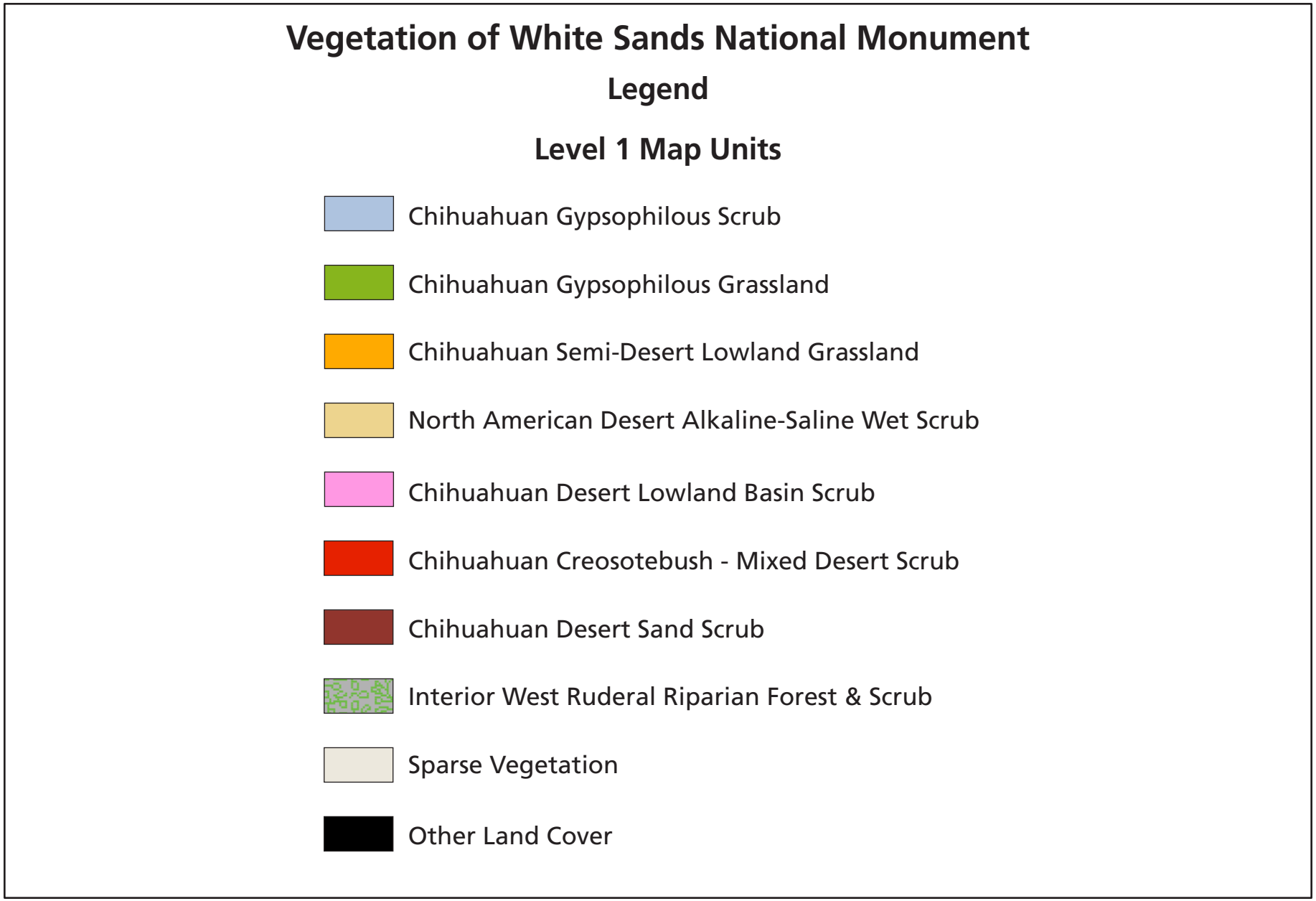
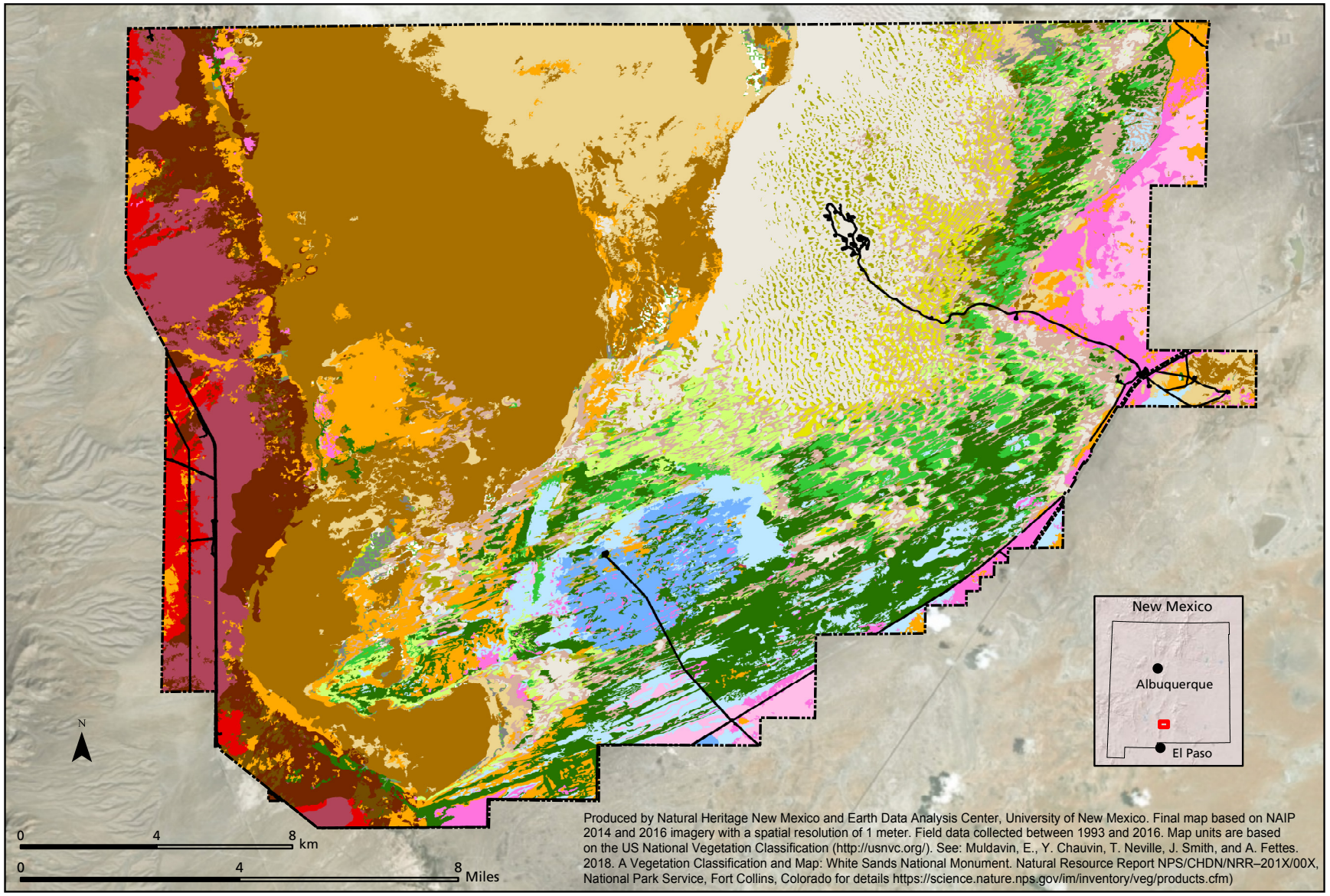


Figure 30. Vegetation map of White Sands National Monument portraying the Level 1 units (see Tables 11 &12A-12J for map unit definitions). A full-scale, 1:35,500 version is available at https://www.nps.gov/im/vmi-whsa.htm.

White Sands National Monument
New Mexico

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Vegetation of White Sands National Monument



Produced by Natural Heritage New Mexico and Earth Data Analysis Center, University of New Mexico. Final map based on NAIP 2014 and 2016 imagery with a spatial resolution of 1 meter. Field data collected between 1993 and 2016. Map units are based on the US National Vegetation Classification (http://usnvc.org/). See: Muldavin, E., Y. Chauvin, T. Neville, J. Smith, and A. Fettes. 2018. A Vegetation Classification and Map: White Sands National Monument. Natural Resource Report NPS/CHDN/NRR–201X/00X, National Park Service, Fort Collins, Colorado for details https://science.nature.nps.gov/im/inventory/veg/products.cfm)

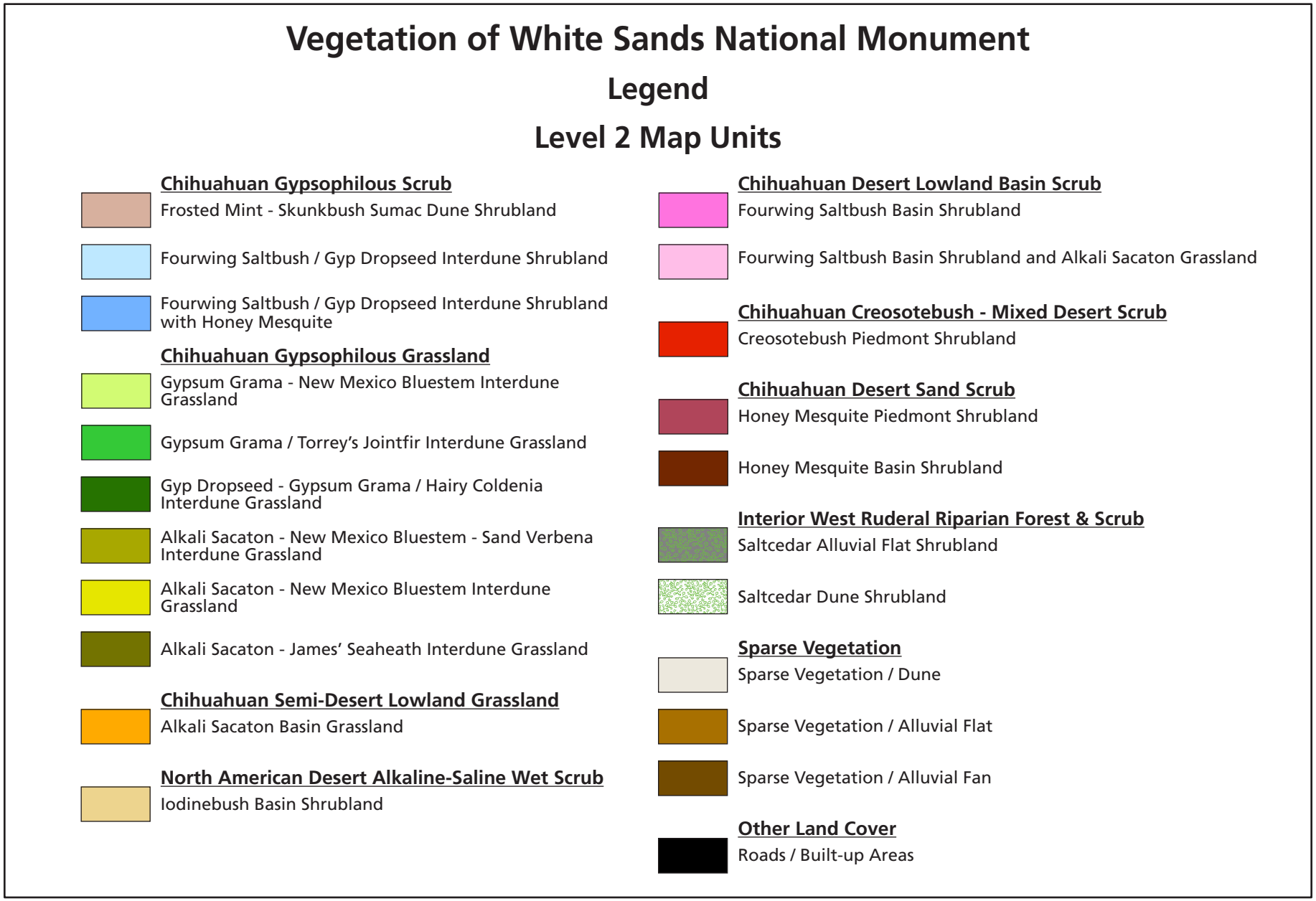


Figure 31. Vegetation map of White Sands National Monument portraying the Level 2 units (see Tables 11 &12A-12J and Appendix E for map unit definitions). A full-scale, 1:35,500 version is available at https://www.nps.gov/im/vmi-whsa.htm.

Table 12A. Plant associations of Level 1 Map Unit: 1 Chihuahuan Gypsophilous Scrub. "Component level" indicates that plant association is designated either as a primary (1), secondary component (2), or as an inclusion (3) (see text for detail).

Level 2 Map Unit	Association	Component Level	Code
1A Frosted Mint - Skunkbush Sumac Dune Shrubland	*Poliomintha incana* Gypsum Dune Shrubland	1	CEPP007391
	Poliomintha incana / *Muhlenbergia pungens* Gypsophilous Shrubland	1	CEGL002672
	Poliomintha incana / *Bouteloua breviseta* Gypsophilous Shrubland	1	CEPP007347
	Rhus trilobata / *Bouteloua breviseta* Gypsophilous Dune Shrubland	1	CEPP007400
	Rhus trilobata - *Poliomintha incana* Gypsophilous Dune Shrubland	1	CEPP007401
	Poliomintha incana / *Sporobolus flexuosus* Shrubland	2	NHNM000615
	Psorothamnus scoparius / *Sporobolus flexuosus* Shrubland	2	CEGL001695
	Yucca elata / *Sporobolus flexuosus* Shrub Grassland	2	CEPP007481
	Populus deltoides ssp. *wislizeni* / *Poliomintha incana* Forest	3	CEGL005972
	Populus deltoides ssp. *wislizeni* / *Schizachyrium scoparium* Woodland	3	CEGL005973
	Sparse Vegetation / Dune	3	NPS_NM096
1B Fourwing Saltbush / Gyp Dropseed Interdune Shrubland	*Atriplex canescens* / *Sporobolus nealleyi* Shrubland	1	CEPP007287
	Larrea tridentata / *Sporobolus nealleyi* Shrubland	2	CEPP007342
	Sparse Vegetation / Alluvial Flat	3	NPS_NM049
1C Fourwing Saltbush / Gyp Dropseed Interdune Shrubland with Honey Mesquite	*Atriplex canescens* / *Sporobolus nealleyi* Shrubland with *Prosopis glandulosa*	1	CEPP007287
	Tiquilia hispidissima / Sporobolus nealleyi Dwarf-shrubland with *Prosopis glandulosa*	2	CEGL001546
	Sparse Vegetation / Alluvial Flat	3	NPS_NM049

Table 12B. Plant associations of Level 1 Map Unit: 2 Chihuahuan Gypsophilous Grassland. "Component level" indicates that plant association is designated either as a primary (1), secondary component (2), or as an inclusion (3) (see text for detail).

Level 2 Map Unit	Association	Component Level	Code
2A Gypsum Grama - New Mexico Bluestem Interdune Grassland	*Bouteloua breviseta* - *Schizachyrium neomexicanum* Grassland	1	CEPP007423
	Ephedra torreyana / *Bouteloua breviseta* Dwarf-shrub Grassland	2	CEPP007425
	Populus deltoides ssp. *wislizeni* / *Poliomintha incana* Forest	3	CEGL005972
	Populus deltoides ssp. *wislizeni* / *Schizachyrium scoparium* Woodland	3	CEGL005973
	Sparse Vegetation / Alluvial Flat	3	NPS_NM049
2B Gypsum Grama / Torrey's Jointfir Interdune Grassland	*Ephedra torreyana* / *Bouteloua breviseta* Dwarf-shrub Grassland	1	CEPP007425
	Bouteloua breviseta - *Sporobolus airoides* Grassland	2	CEPP007424
	Sparse Vegetation / Alluvial Flat	3	NPS_NM049
2C Gyp Dropseed - Gypsum Grama / Hairy Coldenia Interdune Grassland	*Tiquilia hispidissima* / *Sporobolus nealleyi* Dwarf-shrub Grassland	1	CEGL001546
	Tiquilia hispidissima / *Bouteloua breviseta* - *Mentzelia humilis* Dwarf-shrub Grassland	1	CEGL004573
	Sporobolus nealleyi - *Sporobolus airoides* Grassland	2	CEPP007465
	Tiquilia hispidissima / *Acleisanthes lanceolata* Dwarf-shrubland	2	CEPP007479
	Sparse Vegetation / Alluvial Flat	3	NPS_NM049

Table 12B (continued). Plant associations of Level 1 Map Unit: 2 Chihuahuan Gypsophilous Grassland. "Component level" indicates that plant association is designated either as a primary (1), secondary component (2), or as an inclusion (3) (see text for detail).

Level 2 Map Unit	Association	Component Level	Code
2D Alkali Sacaton - Gypsum Bluestem - Sand Verbena Interdune Grassland	*Sporobolus airoides - Abronia angustifolia* Grassland	1	CEPP007453
	Sporobolus airoides - Schizachyrium neomexicanum Grassland	1	CEPP007463
	Schizachyrium neomexicanum - Abronia angustifolia Grassland	2	CEPP007448
	Ephedra torreyana / Sporobolus airoides Dwarf-shrub Grassland	3	CEPP007427
	Sparse Vegetation / Alluvial Flat	3	NPS_NM049
2E Alkali Sacaton - Gypsum Bluestem Interdune Grassland	*Sporobolus airoides - Schizachyrium neomexicanum* Grassland	1	CEPP007463
	Sparse Vegetation / Alluvial Flat	3	NPS_NM049
2F Alkali Sacaton - James' Seaheath Interdune Grassland	*Frankenia jamesii / Sporobolus airoides* Dwarf-shrub Grassland	1	CEPP007433
	Sparse Vegetation / Alluvial Flat	3	NPS_NM049

Table 12C. Plant associations of Level 1 Map Unit: 3 Chihuahuan Semi-Desert Lowland Grassland. "Component level" indicates that plant association is designated either as a primary (1), secondary component (2), or as an inclusion (3) (see text for detail).

Level 2 Map Unit	Association	Component Level	Code
3A Alkali Sacaton Basin Grassland	*Sporobolus airoides* Monotype Grassland	1	CEGL001688
	Pleuraphis mutica - Sporobolus airoides Grassland	2	CEPP007435
	Sporobolus nealleyi - Sporobolus airoides Grassland	2	CEPP007465
	Sporobolus airoides - Distichlis spicata Wet Meadow	2	CEGL001687
	Distichlis spicata Alkaline Wet Meadow	2	CEGL001770
	Sparse Vegetation / Alluvial Flat	3	NPS_NM049

Table 12D. Plant associations of Level 1 Map Unit: 4 North American Desert Alkaline-Saline Wet Scrub. "Component level" indicates that plant association is designated either as a primary (1), secondary component (2), or as an inclusion (3) (see text for detail).

Level 2 Map Unit	Association	Component Level	Code
4A Iodinebush Basin Shrubland	*Allenrolfea occidentalis* / Sparse Shrubland	1	CEPP007408
	Allenrolfea occidentalis - Atriplex canescens / Sporobolus airoides Shrubland	2	CEPP007404
	Allenrolfea occidentalis / Suaeda nigra Shrubland	2	CEPP005787
	Suaeda nigra Shrubland	2	CEGL001991
	Sparse Vegetation / Alluvial Flat	3	NPS_NM049

Table 12E. Plant associations of Level 1 Map Unit: 5 Chihuahuan Desert Lowland Basin Scrub. "Component level" indicates that plant association is designated either as a primary (1), secondary component (2), or as an inclusion (3) (see text for detail).

Level 2 Map Unit	Association	Component Level	Code
5A Fourwing Saltbush Basin Shrubland	*Atriplex canescens* / *Sporobolus airoides* Shrubland	1	CEGL001291
	Atriplex canescens / Sparse Shrubland	2	CEPP007413
	Atriplex canescens / *Suaeda nigra* Shrubland	2	CEPP007421
	Rhus trilobata / *Sporobolus airoides* Shrubland	3	CEPP007446
	Sparse Vegetation / Alluvial Flat	3	NPS_NM049
5B Fourwing Saltbush Basin Shrubland and Alkali Sacaton Grassland	*Atriplex canescens* / *Sporobolus airoides* Shrubland	1	CEGL001291
	Sporobolus airoides Monotype Grassland	1	CEGL001688
	Atriplex canescens / Sparse Shrubland	2	CEPP007413
	Sparse Vegetation / Alluvial Flat	3	NPS_NM049

Table 12F. Plant associations of Level 1 Map Unit: 6 Chihuahuan Creosotebush - Mixed Desert Scrub. "Component level" indicates that plant association is designated either as a primary (1), secondary component (2), or as an inclusion (3) (see text for detail).

Level 2 Map Unit	Association	Component Level	Code
6A Creosotebush Piedmont Shrubland	*Larrea tridentata* / Sparse Understory Shrubland	1	CEGL001276
	Larrea tridentata - *Parthenium incanum* Shrubland	1	CEGL001274
	Larrea tridentata / *Muhlenbergia porteri* Shrubland	2	CEGL001272
	Prosopis glandulosa / Sparse Shrubland, *Larrea tridentata* Phase	2	CEPP007442
	Sparse Vegetation / Alluvial Flat	3	NPS_NM049

Table 12G. Plant associations of Level 1 Map Unit: 7 Chihuahuan Desert Sand Scrub. "Component level" indicates that plant association is designated either as a primary (1), secondary component (2), or as an inclusion (3) (see text for detail).

Level 2 Map Unit	Association	Component Level	Code
7A Honey Mesquite Piedmont Shrubland	*Prosopis glandulosa* - *Atriplex canescens* Shrubland	1	CEGL001382
	Sparse Vegetation / Alluvial Flat	3	NPS_NM049
7B Honey Mesquite Basin Shrubland	*Prosopis glandulosa* / *Sporobolus airoides* Shrubland	1	CEGL001385
	Prosopis glandulosa / *Muhlenbergia porteri* Ruderal Shrubland	2	CEGL001511
	Larrea tridentata / Sparse Understory Shrubland	2	CEGL001276
	Flourensia cernua / *Sporobolus airoides* Shrubland	2	CEGL001337
	Flourensia cernua / *Muhlenbergia porteri* Shrubland	2	CEPP007428
	Sparse Vegetation / Alluvial Flat	3	NPS_NM049

Table 12H. Plant associations of Level 1 Map Unit: 8 Interior West Ruderal Riparian Forest & Scrub. "Component level" indicates that plant association is designated either as a primary (1), secondary component (2), or as an inclusion (3) (see text for detail).

Level 2 Map Unit	Association	Component Level	Code
8A Saltcedar Alluvial Flat Shrubland	*Tamarix chinensis* (*Allenrolfea occidentalis*) Alkali Flat Ruderal Shrubland	1	CEPP007468
	Tamarix chinensis / *Sporobolus airoides* Ruderal Shrubland	1	CEPP007475
	Tamarix chinensis / *Distichlis spicata* Ruderal Shrubland	2	CEPP007471
	Sparse Vegetation / Alluvial Flat	2	NPS_NM049
8B Saltcedar Dune Shrubland	*Tamarix chinensis* Gypsum Dune Ruderal Shrubland	1	CEPP007477
	Sparse Vegetation / Dune	2	NPS_NM096

Table 12I. Plant associations of Level 1 Map Unit: 9 Sparse Vegetation. "Component level" indicates that plant association is designated either as a primary (1), secondary component (2), or as an inclusion (3) (see text for detail).

Level 2 Map Unit	Association	Component Level	Code
9A Sparse Vegetation / Dune	Sparse Vegetation / Dune	1	NPS_NM096
9B Sparse Vegetation / Alluvial Flat	Sparse Vegetation / Alluvial Flat	1	NPS_NM049
	Allenrolfea occidentalis / Sparse Shrubland	2	CEPP007408
	Allenrolfea occidentalis / *Suaeda nigra* Shrubland	2	NPS_NM076
9C Sparse Vegetation / Alluvial Fan	Sparse Vegetation / Alluvial Fan	1	NPS_NM105

Table 12J. Plant associations of Level 1 Map Unit: 10 Other Land Cover. "Component level" indicates that plant association is designated either as a primary (1), secondary component (2), or as an inclusion (3) (see text for detail).

Level 2 Map Unit	Association	Component Level	Code
10A Roads / Built-up Areas	Disturbed / Developed	1	NHNM000395
	Disturbed / Road	1	NHNM000396
	Disturbed / Recreation Site	2	NPS_NM048
	Disturbed / Non-vegetated	2	NPS_NM047

Chapter 4: Accuracy Assessment

The thematic accuracy of the White Sands NM vegetation map was assessed following the USGS-NPS guidelines (Lea and Curtis 2010). Under these guidelines, the goal is to achieve overall and individual map unit accuracies greater than 80% from both producers' and users' perspectives. We tested both Level 1 (NVCS group) and Level 2 of the legend hierarchy, and also scaled up to broad physiognomic classes of forest/woodland, shrubland, and grassland. We report the results of the accuracy assessment here and make recommendations on the use of the map in the context of users' and producers' errors detected among the map units at various levels of the hierarchy.

Positional accuracy is usually omitted from USGS-NPS National Vegetation Mapping Program products because vegetation seldom splits along discrete edges that can be positively located in the field. The subjectivity involved in this effort, plus the high resolution and accuracy of the ortho-photo imagery, usually permits the assumption that all products derived from them are well within National Map Accuracy Standards for 1:12,000-scale maps (±10 m or ±33 ft). Qualitatively, minor deviations were seen from image to image date, but given that resources were limited, we did not assess the positional accuracy further.

Accuracy Assessment Methods

Sampling

All Level 2 vegetation map units were included as available for accuracy assessment but roads urban and built-up land units were excluded. In collaboration with CHDN, we created a sampling pool of 1,320 randomized points across that park and selected plots based on both individual map unit targets and logistics. During the Accuracy Assessment (AA) sampling campaigns, actual sampling tracks were developed to optimize effort between the target number of samples and what a field person could reasonably cover in a single ten-hour day (including vehicle travel). For units with a large aerial extent we targeted at least 30 sample points overall, but we also attempted to not fall below five for less common units. Following the NPS guidelines, multiple samples were allowed within any given delineated polygon and were considered independent samples. In effect, each sample is intended to represent a pseudo-polygon at the minimum map unit size of 0.5 ha (1.24 ac).

The AA sampling was conducted between October 15 and October 27, 2016. To support field sampling, paper maps were created at a 1:12,000 scale with target sample points and the underlying imagery and topography, and unlabeled polygon delineations. These were used by the field crew as guidance in developing optimal sampling strategies with respect to map-unit targets and logistics, and for reconnoitering in the field. In the field, crews would navigate to the point location and determine if the point was representative of the surrounding vegetation as a whole. If not, crews were allowed to move the point to a representative area and provide justification for the move. The key was to avoid sampling small patches or fragments of plant associations not typical of the target stand.

At the sample location, a validation plot was taken that included cover of the dominant species in each strata (trees, shrubs, subshrubs, grasses, and forbs), aspect (azimuth), slope (%), a brief description of the polygon landscape and composition relative to the sampling point, the GPS location (±10 m or ±33 ft precision), and four representative digital photos. A total of 678 accuracy assessment (AA) plots were used in the assessment (Figure 32).

Analysis methods

Initially, we classified each AA point into a plant association following the White Sands NM vegetation classification and dichotomous key (Tables 4A-4D and Appendix C). AA points were then assigned to a map unit, according to the plant-association composition of the unit as reflected in the map-unit descriptions (Tables 11 &12A-12J, Appendix E). In most cases, assignments were from either the primary or secondary components of the map units. Inclusions, even related ones, were considered errors when their estimated extent met or exceeded the minimum map-unit size of 0.5 ha (1.24 ac). When errors occurred, the sample point was assigned to either the adjacent polygon map unit that made thematic sense (spatial concordance) or, if not, to the most closely related map unit with respect to composition and environment based on the map-unit descriptions in Appendix E.

For each level of the map legend, we calculated both a users' and producers' accuracy (Congalton and Green 2008) for each map unit. Producers' accuracy reflects how well the map-unit delineations represent the vegetation type on the ground, and not some other vegetation type (e.g., that dune shrublands are mapped accurately based on the field-validation point locations). This provides the mapmaker with a measure of how well the mapping product meets specifications. In contrast, the users' accuracy demonstrates how well the map performs when used in the field, i.e., its reliability. For example, that a dune shrubland encountered on the ground is mapped as such and not as some other map unit. This provides the user, regardless of training, a level of confidence that what one sees on the ground is actually the element as indicated by the map. In addition, we calculated

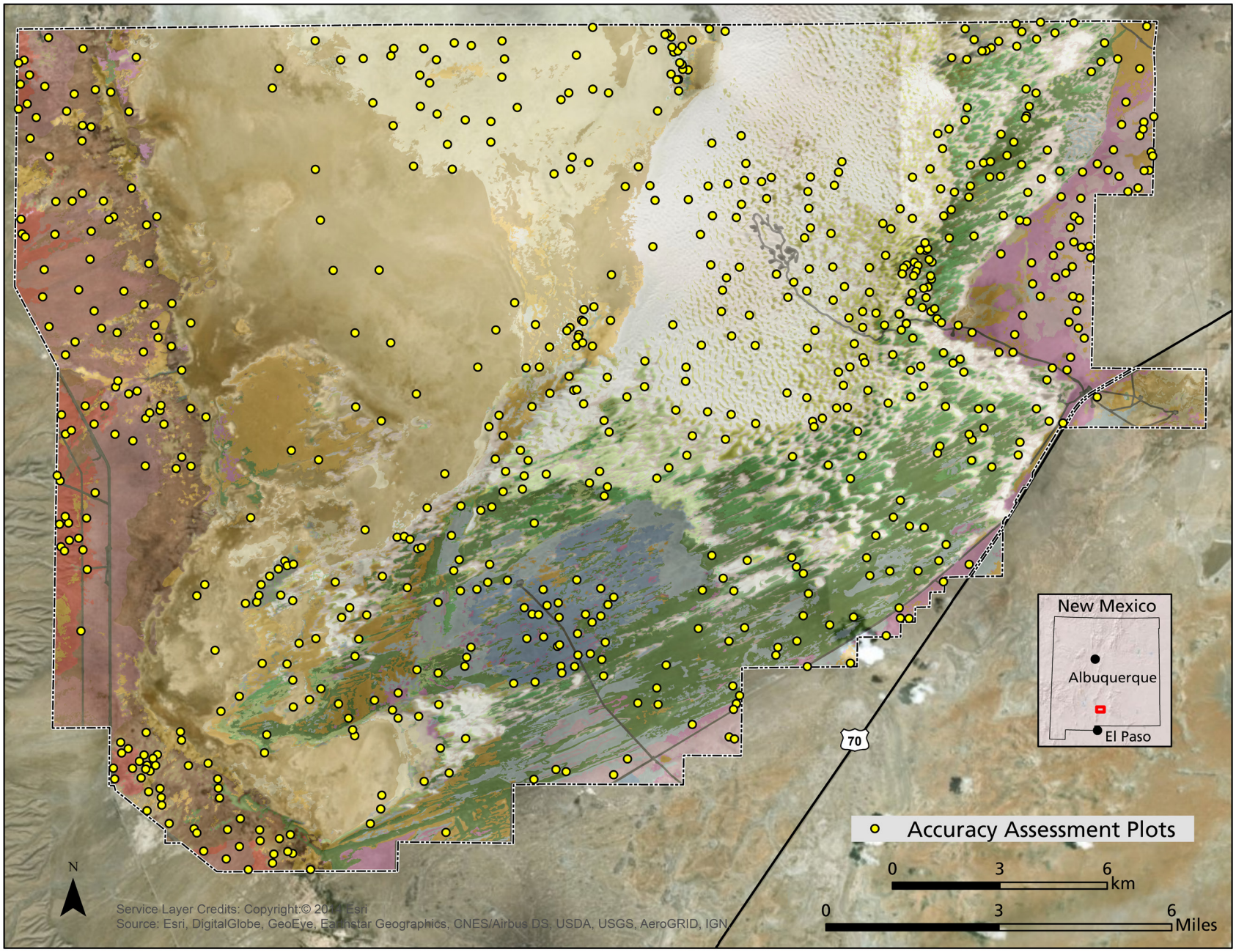


Figure 32. Distribution of the 677 accuracy assessment plots for the White Sands National Monument vegetation map.

the 90%-confidence interval by map unit for each type of error.

To quantify overall accuracy, we calculated both an overall accuracy and an estimate of kappa (kappa index) for each of the three map-unit levels in the legend. The overall accuracy is simply the total number of agreements between the map and reference data. The estimate of kappa is another measure of agreement or accuracy varying from 0 to 1 (often presented as a percentage), where higher values indicate better agreement. The kappa statistic—k-hat— is used to measure the difference between the actual agreement between the reference data and the map and the chance agreement between the reference data and a random map. k-hat indicates the extent to which the percentage-correct values of an error matrix are due to "true" agreement versus "chance" agreement (Congalton and Green 2008).

The results are presented in a series of contingency tables for each level of the legend, showing the producers' and users' errors by map unit with associated 90%-confidence intervals, and the overall accuracy and the kappa estimate for each level. These are also commonly referred to as "confusion" matrices.

The AA plots with their assigned plant association, map unit, and location were entered into NHNM Plot Database (MS Access-based) and then transferred to the NPS Plot_v4_BE relational database.

Accuracy Assessment Results

Map accuracies at Level 1 (the USNVC Group level) was high overall at 90% and 88% k-hat adjusted (Table 13). The weakest unit was Chihuahuan Semi-Desert Lowland Grassland (3) that was intended to map non-gypsiferous grasslands of the basin floor but was often confused with other non-gypsum shrublands or occasionally gypsiferous grasslands. This suggested the needed for enhanced imagery or LiDAR to detect the often diminutive shrubs.

At Level 2, results were more equivocal as overall accuracy dropped to 79% and 78% k-hat adjusted (Table 14). With respect to producer's accuracies, nine of the 22 units fell below the 80% accuracy standard, but only two of those were between 50% and 60%; none fell below 50%. For user's accuracy, ten were below 80%. The preponderance of errors was associated with cross-classifications within the Chihuahuan Gypsophilous Grassland (3). To mitigate these errors, some of the closely related units could have been combined, but upon consultation with White Sands NM staff it was agreed that the units, by in large, made spatial and ecological sense and the preference was to leave them intact pending future validation by the park. Similarly, map units 7A and B, the honey mesquite-dominated units, were closely related thematically and cross-classified but were maintained in the map by mutual agreement. Again, the detection of fourwing saltbush could be problematic between Alkali Sacaton Basin Grassland (3A) and Fourwing Saltbush Basin Shrubland (5A). The mixed unit—Fourwing Saltbush Basin Shrubland and Alkali Sacaton Grassland (5B)—was created to compensate for this but was not always successful.

Accuracy Assessment Discussion

The main sources of error discovered during the accuracy assessment process were primarily due to thematic content of the units and the associated limits of the image interpretation (fundamental error). Additional sources were the positional accuracy of the AA points (particularly with respect to narrow linear polygons) and the structure and accuracy of the classification key. With respect to the AA methodology itself, the randomized approach where AA points represent independent samples of the minimum mapping unit-size polygon is perhaps best from the point of view of user accuracy, but it may not address producer accuracy effectively because multiple samples within a polygon are not independent of the producers' call for the polygon at large. That is, a polygon that has multiple samples linked to a single map unit assignment decision by the mapper is effectively weighted more in the AA outcome for the producers' accuracy than polygons with less sampling. While likely analytically more complex, perhaps a method could be developed to consider this in future NPS AA procedures.

In summary, overall accuracies at each level met the 80% standard at Level 1 and are just shy of the standard at Level 2. Most errors were associated with the finer scale at Level 2, although the greater majority of these units also met the standard. Where they did not, the confusion was mostly explainable as fundamental error, or that the sample sizes were too small. The issues identified here can be resolved with future higher-resolution imagery combined with a small amount of supplemental sampling. Hence, at this time, we recommend that the units be retained as is pending future in-depth analysis at finer scales of specific target areas.

Table 13. Accuracy assessment contingency table for the White Sands National Monument vegetation map at Level 1. We provide the Producers' and Users' accuracies with 10% confidence intervals where n = number of sampling points per class used to calculate "% Correct" by class. Also presented is the overall accuracy based on the total n, and the associated adjusted accuracy kappa (k-hat) index. See Tables 12A-12J for map unit names associated with the map unit numbers.

Point Mapped as		Point Validated as Map Unit										User's				Producer's				
Map Unit	Map Unit Name	1	2	3	4	5	6	7	8	9	Total	Accuracy	90% CI	90% CI-	90% CI+	Total	Accuracy	90% CI	90% CI-	90% CI+
1	Chihuahuan Gypsophilous Scrub	75	8	–	–	1	–	2	–	–	86	0.87	0.07	0.81	0.94	86	0.87	0.07	0.81	0.94
2	Chihuahuan Gypsophilous Grassland	5	197	2	3	2	–	–	2	–	211	0.93	0.03	0.90	0.96	216	0.91	0.03	0.88	0.95
3	Chihuahuan Semi-Desert Lowland Grassland	1	6	14	–	5	–	5	–	–	31	0.45	0.16	0.29	0.61	26	0.54	0.18	0.36	0.72
4	North American Desert Alkaline-Saline Wet Scrub	–	–	–	39	–	–	–	–	–	39	1.00	0.01	0.99	1.01	44	0.89	0.09	0.80	0.98
5	Chihuahuan Lowland Basin Scrub	1	1	6	–	52	–	–	–	–	60	0.87	0.08	0.79	0.95	60	0.87	0.08	0.79	0.95
6	Chihuahuan Creosotebush Mixed Desert Scrub	–	–	–	–	–	31	2	–	–	33	0.94	0.08	0.86	1.02	34	0.91	0.09	0.82	1.01
7	Chihuahuan Desert Sand Scrub	–	–	1	–	–	2	69	–	–	72	0.96	0.05	0.91	1.00	78	0.88	0.07	0.82	0.95
8	Interior West Ruderal Riparian Forest & Scrub	4	3	3	2	–	–	–	53	–	65	0.82	0.09	0.73	0.90	55	0.96	0.05	0.91	1.01
9	Sparse Vegetation	–	1	–	–	–	1	0	–	77	79	0.97	0.04	0.94	1.01	77	1.00	0.01	0.99	1.01

Overall Accuracy: 0.90 (90% Confidence interval 0.88 - 0.92). Adjusted Accuracy: 0.88 (90% Confidence interval 0.86 - 0.90).

Table 14. Accuracy assessment contingency table for the White Sands National Monument vegetation map at Level 2. We provide the Producers' and Users' accuracies with 10% confidence intervals where n = number of sampling points per class used to calculate "% Correct" by class. Also presented is the overall accuracy based on the total n, and the associated adjusted accuracy kappa (k-hat) index. See Tables 12A-12J for map unit names associated with the map unit numbers. Outlined units are the grouping by Level 1 units.

Point Mapped as Map Unit	Point Validated as Map Unit																					Total	User's					Producer's				
	1A	1B	1C	2A	2B	2C	2D	2E	2F	3A	4A	5A	5B	6A	7A	7B	8A	8B	9A	9B	9C		Total	Accuracy	90% CI	90% CI-	90% CI+	Total	Accuracy	90% CI	90% CI-	90% CI+
1A	35	–	–	1	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	38	0.92	0.09	0.84	1.01	45	0.78	0.11	0.66	0.89
1B	1	11	–	–	1	4	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	18	0.61	0.22	0.39	0.83	13	0.85	0.2	0.64	1.05
1C	–	–	28	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–	–	30	0.93	0.09	0.84	1.02	28	1	0.02	0.98	1.02
2A	2	–	–	18	2	6	1	–	1	1	–	–	–	–	–	–	1	–	–	–	–	32	0.56	0.16	0.40	0.72	36	0.5	0.15	0.35	0.65
2B	–	–	–	3	18	8	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	30	0.60	0.16	0.44	0.76	25	0.72	0.17	0.55	0.89
2C	–	1	–	–	2	37	–	–	–	1	–	1	–	–	–	–	–	–	–	–	–	42	0.88	0.09	0.79	0.98	64	0.58	0.11	0.47	0.69
2D	1	–	–	3	–	1	21	–	2	–	–	–	–	–	–	–	1	–	2	–	–	31	0.68	0.15	0.52	0.83	28	0.75	0.15	0.6	0.9
2E	1	–	–	8	–	1	6	19	–	–	–	–	–	–	–	–	–	–	–	–	–	35	0.54	0.15	0.39	0.70	19	1	0.03	0.97	1.03
2F	–	–	–	1	1	2	–	–	35	–	3	–	–	–	–	–	–	–	–	–	–	42	0.83	0.11	0.73	0.94	43	0.81	0.11	0.7	0.92
3A	1	–	–	1	–	2	–	–	3	14	–	4	1	–	2	3	–	–	–	–	–	31	0.45	0.16	0.29	0.61	26	0.54	0.18	0.36	0.72
4A	–	–	–	–	–	–	–	–	–	–	39	–	–	–	–	–	–	–	–	–	–	39	1.00	0.01	0.99	1.01	44	0.89	0.09	0.8	0.98
5A	–	1	–	–	–	1	–	–	–	4	–	18	–	–	–	–	–	–	–	–	–	24	0.75	0.17	0.58	0.92	25	0.72	0.17	0.55	0.89
5B	–	–	–	–	–	–	–	–	–	2	–	–	34	–	–	–	–	–	–	–	–	36	0.94	0.08	0.87	1.02	35	0.97	0.06	0.91	1.03
6A	–	–	–	–	–	–	–	–	–	–	–	–	–	31	2	–	–	–	–	–	–	33	0.94	0.08	0.86	1.02	34	0.91	0.09	0.82	1.01
7A	–	–	–	–	–	–	–	–	–	–	–	–	–	2	31	2	–	–	–	–	–	35	0.89	0.10	0.78	0.99	44	0.7	0.12	0.58	0.83
7B	–	–	–	–	–	–	–	–	–	1	–	–	–	–	9	27	–	–	–	–	–	37	0.73	0.13	0.60	0.86	34	0.79	0.13	0.67	0.92
8A	–	–	–	–	–	1	–	–	2	3	2	–	–	–	–	–	24	2	–	–	–	34	0.71	0.14	0.56	0.85	28	0.86	0.13	0.73	0.98
8B	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	25	–	–	–	31	0.81	0.13	0.67	0.94	27	0.93	0.1	0.82	1.03
9A	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	28	1	–	30	0.93	0.09	0.84	1.02	30	0.93	0.09	0.84	1.02
9B	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	31	–	31	1.00	0.02	0.98	1.02	36	0.86	0.11	0.75	0.97
9C	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	4	13	18	0.72	0.20	0.52	0.92	13	1	0.04	0.96	1.04

Accuracy: 0.79 (90% Confidence interval 0.77 - 0.82). Adjusted Accuracy: 0.78 (90% Confidence interval 0.76 - 0.81).

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Appendix A: A Vegetation Classification and Map White Sands National Monument Field Handbook and Field Datasheets

The Natural Heritage New Mexico Vegetation Survey Handbook that was the guiding document for all vegetation plot data taken during the course of the White Sands National Monument Vegetation mapping project. The handbook and associated datasheets follow. While this is the 2008 version, there were no significant changes made to the protocol during the life of the project.

Vegetation Survey Handbook

Natural Heritage New Mexico
Department Of Biology
University Of New Mexico



2008

THE UNIVERSITY OF NEW MEXICO

NATURAL HERITAGE NEW MEXICO

Natural Heritage New Mexico Vegetation Survey Protocols

Plot Establishment Guidelines and Techniques (May 2002)

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

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

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

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

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

Monitoring plots are variable, but the general design is two parallel 30 m transects spaced 5 m apart within a 13.3 x 30 m macroplot (400 sq. meters). 1 m quadrat frames are placed at every third meter and cover estimated to the nearest 1% class and the median height measured to the nearest 1 cm. Since the exact spot is re-measured over time, the tapes must drawn tight, through shrubs not around¸ and as near the ground as possible. The quads should be aligned along one side of the tape with the inside of the corner of the frame at the position mark on the tape. Precision is key to good data in monitoring, particularly grasslands.

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

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

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

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

Instructions and Forms

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

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

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

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

- Example (lead surveyor): The 33rd plot sampled in 1991 by Hank Gleason would be entered as 91HG033.
- Example (project assignment): The 54th plot sampled in 2003 at Bandelier would be entered as 03BD054.

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

PLOT TYPE: [Required]

- **RP** = Releve or Reconnaissance plot. Full species list of both plot and stand are recorded and their abundance estimated, may also include Element Quality Ranking using the ranking form.
- **STP** = Standard plot where all species within the plot are recorded and their abundance estimated, and enough site information to provisionally rank the quality of the occurrence.
- **QP** = Quick plot where only the dominant and most common species recorded with their abundance to ensure proper identification of the type, and enough site information to provisionally rank the quality of the occurrence.
- **OPT** = Observation point with mostly qualitative data on an occurrence, including: dominant species recorded with their abundance, location, community type and size; and at least one photos.
- **AP** = Analytical plot. Full species list of both plot and stand with sub-sampling of abundance (usually quadrat based). May include Element Quality Ranking using the ranking form.
- **OVP** = Observation video plot; community type or size is interpreted from either video or aerial photography.
- **OSP** = Observation scope plot is used for surveys of plants growing on steep cliff faces that are otherwise inaccessible.
- **FSP** = Floristic survey plot is used for general plant inventories when site information is not required and location encompasses an area greater than a standard size plot. Quantitative data is not recorded.

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

SUBPROJECT: Subproject code if applicable

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

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

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

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

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

Naming guidelines:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

PHOTOGRAPHER: record the initials of the person taking the photographs

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

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

ELEV: Elevation in feet unless otherwise noted.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Igneous

- ANDE – andesite
- BASA – basalt (including obsidian)
- DIGA – diorite to gabbro
- GRBG – granite and biotite granite
- IFAL – igneous felsic(acid) alluvium
- IGTU – igneous type unknown
- IMAL – igneous mafic(basic) alluvium
- LATI – latite
- MIIG – mixed igneous
- PUMI – pumice
- QUMO – quartz monzonite
- RHYO – rhyolite
- SCOR – scoria (porcelanite), clinker
- TRSY – trachyte and syenite
- WETU – welded tuff (tufa)

Metamorphic

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

Sedimentary

- CACO – calcareous conglomerate
- CASA – calcareous sandstone
- CASH – calcareous shale
- CASI – calcareous siltstone
- CLAY – claystone
- CONG – conglomerate
- DOLO – dolomite

- LIME – limestone
- MISE – mixed sedimentary
- MUDS – mudstone
- RESH – red shale
- SAND – sandstone
- SCAL – sedimentary calcareous alluvium
- SETU – type unknown
- SHAL – shale
- SILT – siltstone
- SNCA – sedimentary non-calcareous alluvium

Miscellaneous

- ASHT – ash (of any origin)
- CLAL – clayey alluvium
- DUNE – sand dunes
- GLTI – glacial till, mixed origin
- GRAL – gravelly alluvium
- GYPS – gpysum
- LOES – loess
- MIAL – mixed alluvium (full range of textures)
- MIRT – mix of two or more rock types
- NONE – no surface rocks
- NORE – not recorded
- SAAL – sandy alluvium
- SIAL – silty alluvium

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

- **L/R:** Plot Radius or Length – enter plot radius (for circular plots) or length (for rectangular plots). Indicate units of measurement. Note: a 400 m squared plot has a radius of 11.3 m (37.1 ft); a 100 m squared plot has a radius of 5.6 m (18.5 ft)
- **PLOT W:** Enter width if a rectangular plot shape is used. Enter 0 (numeric) if a circular plot shape is used. Indicate units of measurement

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

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

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

FORMS CHECKOFF: please indicate if other forms were used besides those given (floristics, trees, soils, quadrants, point/line intercepts, EO assessments, site evaluation).

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

Floristic Inventory (Form 3)

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

BOTANIST: Name of person responsible for assessing the botany.

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

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

- **S** – exposed soil: particles < 1/16 in. (2 mm dia.)
- **G** – gravel: particles 1/16 to 3 in. dia. (2 mm to 7.5 cm dia.)
- **R** – rock as composed of cobbles, stones and bed rock: particles > 3 in. (>7.5 cm dia.)
- **L** – litter and duff. Litter includes dead and detached vegetation, freshly fallen leaves, needles, twigs < 2 in. (5cm), bark, fruits, seeds; duff is decomposed litter (fermentation layer and humus layer)
- **HCC** – herbaceous canopy cover is the total combined canopy cover of forbs and graminoids, including attached litter and current years standing dead annuals, and does not include overlapping cover where canopies interlock
- **WO** – woody, downed debris: > 2 in. (5 cm dia.)
- **M** – microphytic (cryptogams) crust cover; mosses, lichens and algae on soil surface (excludes cover found on logs, rocks and tree bases)
- **WA** – water, standing pools of water or streams if within the plot.

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

SPECIES NAME: Use the accepted acronyms from the current NMNHP species list or spell out the species scientific name.

Do not use common names. If the species is not on the list, spell it out.

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

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

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

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

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

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

Voucher Tag Format:

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

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

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

Data sheet from 05YC004:

```
|G1 MUHMON                    | @| 20 |  .4||                          |  |   |   ||
|G2 BROMUS - 05YC001-G5       |  |   5|  .2||                          |  |   |   ||
|G3                           |  |    |    ||                          |  |   |   ||
```

Circle G2

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

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

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

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

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

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

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

Percent Cover Estimation Precision Guidelines:

- +0 – species outside the plot, but within the stand
- + – for < .05% (trace <0.2m2/400m2)
- 0.1% – for .05 - < 0.5% (>0.2m2 - <2.0 m2 /400m2)
- 0.5% – For .5 - < 1% (>2.0 m2 - <4.0 m2 /400m2)
- 1-10% to the nearest 1% (each % equals 4m2/400m2)
- 10-30% to the nearest 5%
- 30-100% to nearest 10%

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

Scalar	Cover Range	Concept	Midpoint Value	Data Value	m^2 / $400m^2$
+0	N/A	Outside quadrat	0.001	.001	–
+	<0.05%	Solitary or very few	0.025	.025	<.2m2
1	0.05- 0.124%	very scattered	0.0875	0.1	0.2m2 - <.5m2
2	0.125- 0.99%	scattered	0.56	0.5	.5 m2 - <4 m2
3	1.0 - 4.9%	common	3.0	3.0	4m2 - <20m2
4	5.0 - 9.9%	well-represented	7.5	7.5	20m2 - <40m2
5	10.0- 24.9%	well-represented	17.5	17.5	40m2 - <100m2
6	25.0- 32.9%	abundant	29.0	29.0	100m2 - <132m2
7	33.0 - 49.9%	abundant	41.5	41.5	132m2 - <200m2
8	50.0 -74.9%	luxuriant	62.5	62.5	200m2 - < 300m2
9	75.0 - 94.9%	luxuriant	85.0	85.0	300m2 - <380m2
10	95.0 -100.0%	full cover	97.5	97.5	380m2 - 400m2

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

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

QUICK PLOT/OBSERVATION POINT FORM – This form is a condensed version of the Standard Data Form and has 3 observation points per page.

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

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

Lines are then used to connect the dots and cross from


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

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

TRANSECT POINT INTERCEPT FORM – This form documents point intercepts along transects.

Element Occurrence Condition Evaluation

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

Condition Factors

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

Landscape Context Factors

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

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

Size Factor

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

NHNM VEGETATION SURVEY - Standard Data Form – 2008

PLOT ID_____**PLOT TYPE**_____**PROJECT**_____**Subproject** _____ **MO**___**DAY**___**YEAR**____
EO/PA_____
EO/PA Comment_____
FIELD POINT ID_____**MONUMENT** ☐
_____**MU**_____
SURVEY SITE_____ **SURVEYORS**_____
COUNTY_____ **NM/**____ **MAP NAME**_____ - __ **MARGNUM**___ 10,10 __,__
DIRECTIONS_____
GPS Unit_____ **GPS File**_____ **PREC**____**m** **UTM:EASTING** __ __ __ __ __ __ **NORTHING** __ __ __ __ __ __ __
Zone_____ **Datum: NAD83** ☐ / **NAD27** ☐; **Other**_____; **Log#**_____D☐ / F☐ **Photographer**_____
PP1:Exp____**AZM**____**FocL**___ **Notes**_____ **PP3:Exp**____**AZM**____**FocL**___ **Notes**_____
PP2:Exp____**AZM**____**FocL**___ **Notes**_____ **PP4:Exp**____**AZM**____**FocL**___ **Notes**_____
Other Site Photos:_____
ELEV _____**ft., SLOPE** ____**%, ASPECT**____, **SLOPE SHAPE**_____/___, **Surface Rock Type**_____/_____
LANDFORM:_____/ __ __ __ __ __ __
Lndfrm/Geol/Soil Notes:_____
SUMMARY DESCRIPTION: ¨ **Site** ¨ **Veg** ¨ **Adjacent Com** ¨ **Disturb/Frag** ¨ **Animals** ¨ **Disease** ¨ **Management** ¨ **Condition**

PLOTDIM(M)L/R ____**W** ____ **EO Size**_____**Ha**__/**Ac**__ **Est**¨ **Map** ¨ **Condition**____ **Landscape Context**_____ ☐ **EOMapped**:_____
Comments:_____

Ground Surface Cover (%) Soil_____ Grav_____ Rock_____ Litter_____ HCC_____ Wood_____ Micro_____ Water_____=100%
Botanist:_____ *CIRCLE YOUR VOUCHER NUMBERS*
Phenology: * = Flowering; @ = fruiting; X = dead annual ☐ Cover Scale or ☐ Percent Cover

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

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

Cover Scale: **+0**=outside plot,in stand; **+**=solitary/very few(<0.2m²/400m²); **1**=very scattered (0.2m² -<.5m/400m²); **2**=scattered, <1% (.5m² & <4m²); **3**=1-<5% (>4m² & <20m²); **4**=5-<10%(>20m² & <40m²); **5**=10-<25%(40m² & <100m²); **6**=25-<33%(100m² & <132m²); **7**=33-<50%; **8**=50-<75%; **9**=75-<95%; **10**=95-100%

Percent Scale: **+0**=outside plot,in stand; **+**=solitary/very few(<0.2m²/400m²); **0.1%**=very scattered (0.2m² -<.5m/400m²); **0.5%**= scattered, <1% (.5m² & <4m²); **1-10%** to the nearest 1% (each % equals 4m²/400m²); **10-30%** to the nearest 5%; **30-100%** to nearest 10%

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

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

PLOT ID_____**PLOT TYPE**_____**PROJECT**_____**Subproject** _____ **MO**___**DAY**___**YEAR**_____
EO/PA_____
EO/PA Comment_____
FIELD POINT ID_____**MU**_____
SURVEY SITE_____ **SURVEYORS**_____
LOCATION/DIRECTIONS_____
_____
COUNTY_____ **NM/**_____ **MAP NAME**_____ - __
MARGNUM___ 10,10 __,__
GPS Unit_____ **GPS File**_____ **UTM: EASTING** _ _ _ _ _ _ **NORTHING** _ _ _ _ _ _ _
PREC_____ **Zone**_____ **Datum: NAD83** ☐ / **NAD27** ☐;
Other_____
☐ **Monument/:**_____
☐ **Photo Pt:**_____/**Cam Ht**_____ **Log#**___D☐ / F☐ **Photographer**_____
PP1:AZM___**FocL**___**Exp**___**Notes**_____**PP5:AZM**___**FocL**___**Exp**___**Notes**_____
PP2:AZM___FocL___Exp___Notes_____PP6:AZM___FocL___Exp___Notes_____
PP3:AZM___**FocL**___**Exp**___**Notes**_____**PP7:AZM**___**FocL**___**Exp**___**Notes**_____
PP4:AZM___**FocL**___**Exp**___**Notes**_____**PP8:AZM**___**FocL**___**Exp**___**Notes**_____
Other Site Photos/com:_____
_____
ELEV _____ **ft. SLOPE** _____**% ASPECT**_____ **SLOPE SHAPE**_____/_____
LANDFORM:_____/ _ _ _ _ _ _
Landform/Geology/Soil Comment_____
_____
SURFACE ROCK TYPE_____/_____
SITE / VEG SUMMARY:_____
_____
_____
_____
_____
_____
_____
_____
Adjacent Communities:_____
_____
_____
_____
Disease:_____
_____
Animal Use Evidence:_____
_____
Condition (Disturbance, Fragmentation, Erosion):_____
_____
_____
_____
_____
Distance in km to nearest human disturbance (roads, dam, clearcut, housing, mine, dump, etc.):_____**km**
Comments:_____
_____
PLOTDIM (m) L/R ____**W** ____ **Comments:**_____
_____**OCC Size** ☐**HA** ☐**AC,** ☐ **Ground Estimate** ☐ **Mapped Estimate Comments:**_____
_____
☐ **EO/PA Mapped:**_____
Management/Conservation/Other Comments:_____
_____
Forms: ☐ **Floristics** ☐ **Trees** ☐ **Soils** ☐ **Quadrats** ☐ **Point/Line Intercept** ☐ **EO Assessment** ☐ **Site Evaluation**

Appendix B: White Sands National Monument Vegetation Classification and Map: Plant Species List

A list of plant species recorded on vegetation plots at White Sands National Monument as part of the vegetation mapping project (includes species reported by Muldavin et al. 1994). Plant voucher specimens were collected to confirm field identifications as necessary and are housed at the University of New Mexico Herbarium. Specimens were identified by NHNM botanist Yvonne Chauvin to lowest level possible given the material at hand and names assigned according to the PLANTS database (USDA-NRCS 2002) and/or the Integrated Taxonomic Information System (ITIS), whichever was more recently updated. Suitable quality specimens were accessioned with both UNM accession numbers and NPS record numbers tied to the Herbarium and NPS databases. Table B.1 provides the list ordered by lifeform code (LFC) and scientific name and Table B.2 is ordered by lifeform and common name. NHNM Acronym refers to the Natural Heritage New Mexico database code for the species; PLANTS symbol is database code from the USDA PLANTS database. The last column indicates whether a voucher collection was made for the species.

Table B1. Species list for White Sands National Monument, ordered by lifeform and species name.

LFC	Species Name	Common Name	Family	PLANTS Code	NHNM Acronym	NPS Strata							Voucher
						H	S1	S2	T1	T2	T3	X	
1	*Juniperus monosperma*	oneseed juniper	Cupressaceae	JUMO	JUNMON	–	–	–	–	–	3	–	–
1	*Populus deltoides* ssp. *wislizeni*	Rio Grande cottonwood	Salicaceae	PODEW	POPDEL	–	2	1	3	26	–	–	–
1	*Salix gooddingii*	Goodding's willow	Salicaceae	SAGO	SALGOO	–	–	–	–	2	–	–	–
1	*Tamarix chinensis*	saltcedar	Tamaricaceae	TACH2	TAMCHI	–	144	1	11	43	–	3	Y
2	*Allenrolfea occidentalis*	iodinebush	Chenopodiaceae	ALOC2	ALLOCC	1	210	2	–	–	–	–	Y
2	*Aloysia wrightii*	Wright's beebrush	Verbenaceae	ALWR	ALOWRI	–	1	–	–	–	–	–	–
2	*Ambrosia monogyra*	singlewhorl burrobush	Asteraceae	AMMO6	AMBMON	–	2	–	–	–	–	–	–
2	*Artemisia filifolia*	sand sagebrush	Asteraceae	ARFI2	ARTFIL	–	4	–	–	–	–	–	–
2	*Atriplex canescens*	fourwing saltbush	Chenopodiaceae	ATCA2	ATRCAN	1	658	–	–	–	–	–	Y
2	*Baccharis bigelovii*	Bigelow's falsewillow	Asteraceae	BABI	BACBIG	–	1	–	–	–	–	–	–
2	*Baccharis pteronioides*	yerba de pasmo	Asteraceae	BAPT	BACPTE	–	1	–	–	–	–	–	–
2	*Baccharis salicina*	false willow	Asteraceae	BASA	BACSAL2	–	7	–	–	–	–	–	–
2	*Brickellia laciniata*	splitleaf brickellbush	Asteraceae	BRLA	BRILAC	–	2	–	–	–	–	–	–
2	*Condalia warnockii*	Warnock's snakewood	Rhamnaceae	COWA	CONWAR	–	4	–	–	–	–	–	–
2	*Cylindropuntia imbricata*	tree cholla	Cactaceae	CYIM2	CLYIMB	–	15	–	–	–	–	–	–
2	*Cylindropuntia leptocaulis*	Christmas cactus	Cactaceae	CYLE8	CYLLEP	–	54	3	–	–	–	–	–
2	*Ephedra torreyana*	Torrey's jointfir	Ephedraceae	EPTO	EPHTOR	–	609	2	–	–	–	–	Y
2	*Ephedra trifurca*	longleaf jointfir	Ephedraceae	EPTR	EPHTRI	–	3	–	–	–	–	–	–
2	*Ericameria nauseosa*	rubber rabbitbrush	Asteraceae	ERNA10	ERINAU	–	115	–	–	–	–	–	–
2	*Ericameria nauseosa* var. *latisquamea*	rubber rabbitbrush	Asteraceae	ERNAL2	ERINAU	–	1	–	–	–	–	–	Y
2	*Fallugia paradoxa*	Apacheplume	Rosaceae	FAPA	FALPAR	–	5	–	–	–	–	–	–
2	*Flourensia cernua*	tarbush	Asteraceae	FLCE	FLOCER	1	62	–	–	–	–	–	–
2	*Fouquieria splendens*	ocotillo	Fouquieriaceae	FOSP2	FOUSPL	–	1	–	–	–	–	–	–
2	*Koeberlinia spinosa*	crown of thorns	Koeberliniaceae	KOSP	KOESPI	–	32	–	–	–	–	–	–
2	*Larrea tridentata*	creosotebush	Zygophyllaceae	LATR2	LARTRI	1	123	–	–	–	–	–	–
2	*Lorandersonia pulchella*	southwestern rabbitbrush	Asteraceae	CHPU4	LORPUL	–	11	–	–	–	–	–	Y
2	*Lycium berlandieri*	Berlandier's wolfberry	Solanaceae	LYBE	LYCBER	–	117	–	–	–	–	–	–
2	*Lycium berlandieri* var. *parviflorum*	Berlandier's wolfberry	Solanaceae	LYBEP	LYCBER	–	2	–	–	–	–	–	Y
2	*Lycium pallidum*	pale wolfberry	Solanaceae	LYPA	LYCPAL	–	13	–	–	–	–	–	–
2	*Opuntia engelmannii*	cactus apple	Cactaceae	OPEN3	OPUENG	–	9	–	–	–	–	–	–
2	*Opuntia microdasys*	angel's-wings	Cactaceae	OPMI4	OPUMIC	–	–	1	–	–	–	–	–

LFC	Species Name	Common Name	Family	PLANTS Code	NHNM Acronym	NPS Strata							Voucher
						H	S1	S2	T1	T2	T3	X	
2	*Pluchea sericea*	arrowweed	Asteraceae	PLSE	PLUSER	–	4	–	–	–	–	–	–
2	*Poliomintha incana*	frosted mint	Lamiaceae	POIN3	POLINC	–	279	1	–	–	–	–	–
2	*Prosopis glandulosa*	honey mesquite	Fabaceae	PRGL2	PROGLA	–	258	–	–	–	–	–	–
2	*Pseudoclappia arenaria*	TransPecos false clapberry	Asteraceae	PSAR	PSEARE	–	90	76	–	–	–	–	Y
2	*Psorothamnus scoparius*	broom dalea	Fabaceae	PSSC6	PSOSCO	–	27	–	–	–	–	–	–
2	*Rhus microphylla*	littleleaf sumac	Anacardiaceae	RHMI3	RHUMIC	–	8	–	–	–	–	–	–
2	*Rhus trilobata*	skunkbush sumac	Anacardiaceae	RHTR	RHUTRI	–	77	–	–	–	–	–	–
2	*unidentified shrub*	unidentified shrub	unknown	2SHRUB	UNIDS	–	1	–	–	–	–	–	–
2	*Yucca elata*	soaptree yucca	Agavaceae	YUEL	YUCELA	–	395	2	–	–	–	–	–
2	*Yucca spp.*	yucca	Agavaceae	YUCCA	YUCCA	–	1	–	–	–	–	–	–
2.5	*Artemisia bigelovii*	Bigelow's sagebrush	Asteraceae	ARBI3	ARTBIG	–	–	1	–	–	–	–	–
2.5	*Coryphantha scheeri* var. *valida*	Scheer's beehive cactus	Cactaceae	COSCV	CORSCH	–	–	4	–	–	–	–	–
2.5	*Coryphantha* spp.	beehive cactus	Cactaceae	CORYP	CORYPH	–	1	1	–	–	–	–	–
2.5	*Dalea formosa*	featherplume	Fabaceae	DAFO	DALFOR	–	–	1	–	–	–	–	–
2.5	*Echinocactus horizonthalonius*	devilshead	Cactaceae	ECHO	ECHHOR	–	–	1	–	–	–	–	–
2.5	*Echinocereus coccineus*	scarlet hedgehog cactus	Cactaceae	ECCO5	ECHCOC	–	–	4	–	–	–	–	–
2.5	*Echinocereus* spp.	hedgehog cactus	Cactaceae	ECHIN3	ECHINO2	1	–	1	–	–	–	–	–
2.5	*Echinocereus triglochidiatus*	kingcup cactus	Cactaceae	ECTR	ECHTRI	–	1	41	–	–	–	–	–
2.5	*Escobaria vivipara*	spinystar	Cactaceae	ESVI2	ESCVIV	–	–	5	–	–	–	–	–
2.5	*Frankenia jamesii*	James' seaheath	Frankeniaceae	FRJA	FRAJAM	1	2	199	–	–	–	–	–
2.5	*Gutierrezia microcephala*	threadleaf snakeweed	Asteraceae	GUMI	GUTMIC	1	–	93	–	–	–	–	Y
2.5	*Gutierrezia sarothrae*	broom snakeweed	Asteraceae	GUSA2	GUTSAR	1	5	72	–	–	–	–	–
2.5	*Isocoma pluriflora*	southern jimmyweed	Asteraceae	ISPL	ISOPLU	–	49	74	–	–	–	–	Y
2.5	*Isocoma* spp.	goldenbush	Asteraceae	ISOCO	ISOCOM	–	1	–	–	–	–	–	–
2.5	*Mammillaria* spp.	nipple cactus	Cactaceae	MAMMI	MAMMIL	–	–	1	–	–	–	–	–
2.5	*Opuntia macrocentra*	purple pricklypear	Cactaceae	OPMA8	OPUMAC	2	3	33	–	–	–	–	–
2.5	*Opuntia phaeacantha*	tulip pricklypear	Cactaceae	OPPH	OPUPHA	–	–	22	–	–	–	–	–
2.5	*Opuntia* spp.	pricklypear	Cactaceae	OPUNT	OPUNTI	–	1	5	–	–	–	–	–
2.5	*Parthenium incanum*	mariola	Asteraceae	PAIN2	PARINC	–	2	18	–	–	–	–	–
2.5	*Suaeda nigra*	bush seepweed	Chenopodiaceae	SUNI	SUANIG	7	–	91	–	–	–	–	Y
2.5	*Thymophylla acerosa*	pricklyleaf dogweed	Asteraceae	THAC	THYACE	–	–	4	–	–	–	–	–
2.5	*Tiquilia canescens*	woody crinklemat	Boraginaceae	TICA3	TIQCAN	–	–	6	–	–	–	–	–
2.5	*Tiquilia hispidissima*	hairy crinklemat	Boraginaceae	TIHI	TIQHIS	–	2	385	–	–	–	–	Y

LFC	Species Name	Common Name	Family	PLANTS Code	NHNM Acronym	NPS Strata							Voucher
						H	S1	S2	T1	T2	T3	X	
3	*Achnatherum hymenoides*	Indian ricegrass	Poaceae	ACHY	ACHHYM	94	–	1	–	–	–	–	Y
3	*Aristida adscensionis*	sixweeks threeawn	Poaceae	ARAD	ARIADS	5	–	–	–	–	–	–	–
3	*Aristida purpurea*	purple threeawn	Poaceae	ARPU9	ARIPUR	17	–	–	–	–	–	–	–
3	*Aristida purpurea* var. *longiseta*	red threeawn	Poaceae	ARPUL	ARIPUR	2	–	–	–	–	–	–	Y
3	*Bothriochloa springfieldii*	Springfield's beardgrass	Poaceae	BOSP3	BOTSPR	1	–	–	–	–	–	–	–
3	*Bouteloua barbata*	sixweeks grama	Poaceae	BOBA2	BOUBAR	63	–	–	–	–	–	–	–
3	*Bouteloua breviseta*	gypsum grama	Poaceae	BOBR	BOUBRE	317	–	–	–	–	–	–	Y
3	*Bouteloua eriopoda*	black grama	Poaceae	BOER4	BOUERI	1	–	–	–	–	–	–	–
3	*Chloris verticillata*	tumble windmill grass	Poaceae	CHVE2	CHLVER	8	–	–	–	–	–	–	–
3	*Dasyochloa pulchella*	fluffgrass	Poaceae	DAPU7	DASPUL	11	–	–	–	–	–	–	–
3	*Distichlis spicata*	inland saltgrass	Poaceae	DISP	DISSPI	18	–	–	–	–	–	–	Y
3	*Enneapogon desvauxii*	nineawn pappusgrass	Poaceae	ENDE	ENNDES	15	–	–	–	–	–	–	–
3	*Eragrostis cilianensis*	stinkgrass	Poaceae	ERCI	ERACIL	1	–	–	–	–	–	–	–
3	*Juncus torreyi*	Torrey's rush	Juncaceae	JUTO	JUNTOR	1	–	–	–	–	–	–	–
3	*Kobresia* spp.	bog sedge	Cyperaceae	KOBRE	KOBRES	–	1	–	–	–	–	–	–
3	*Muhlenbergia arenacea*	ear muhly	Poaceae	MUAR	MUHARE	2	–	–	–	–	–	–	–
3	*Muhlenbergia arenicola*	sand muhly	Poaceae	MUAR2	MUHARE2	3	–	–	–	–	–	–	–
3	*Muhlenbergia porteri*	bush muhly	Poaceae	MUPO2	MUHPOR	132	–	–	–	–	–	–	–
3	*Muhlenbergia pungens*	sandhill muhly	Poaceae	MUPU2	MUHPUN	61	–	–	–	–	–	–	Y
3	*Panicum hallii*	Hall's panicgrass	Poaceae	PAHA	PANHAL	1	–	–	–	–	–	–	–
3	*Phragmites australis* ssp. *americanus*	common reed	Poaceae	PHAUA6	PHRAUS	1	–	–	–	–	–	–	Y
3	*Pleuraphis mutica*	tobosa	Poaceae	PLMU3	PLEMUT	11	–	–	–	–	–	–	–
3	*Schizachyrium neomexicanum*	New Mexico bluestem	Poaceae	SCSCN	SCHNEO	206	–	2	–	–	–	–	–
3	*Schizachyrium scoparium*	little bluestem	Poaceae	SCSC	SCHSCO	1	–	–	–	–	–	–	–
3	*Schoenoplectus americanus*	American bulrush	Cyperaceae	SCAM6	SCHAME	1	–	–	–	–	–	–	Y
3	*Scleropogon brevifolius*	burrograss	Poaceae	SCBR2	SCLBRE	17	–	–	–	–	–	–	–
3	*Setaria leucopila*	streambed bristlegrass	Poaceae	SELE6	SETLEU	12	–	–	–	–	–	–	–
3	*Setaria* spp.	bristlegrass	Poaceae	SETAR	SETARI	1	–	–	–	–	–	–	–
3	*Sporobolus airoides*	alkali sacaton	Poaceae	SPAI	SPOAIR	731	1	1	–	–	–	–	Y
3	*Sporobolus contractus*	spike dropseed	Poaceae	SPCO4	SPOCON	24	–	–	–	–	–	–	–
3	*Sporobolus cryptandrus*	sand dropseed	Poaceae	SPCR	SPOCRY	6	–	–	–	–	–	–	–
3	*Sporobolus flexuosus*	mesa dropseed	Poaceae	SPFL2	SPOFLE	71	–	–	–	–	–	–	–
3	*Sporobolus giganteus*	giant dropseed	Poaceae	SPGI	SPOGIG	11	–	–	–	–	–	–	–

LFC	Species Name	Common Name	Family	PLANTS Code	NHNM Acronym	NPS Strata							Voucher
						H	S1	S2	T1	T2	T3	X	
3	*Sporobolus nealleyi*	gyp dropseed	Poaceae	SPNE	SPONEA	291	1	1	–	–	–	–	Y
3	*Sporobolus wrightii*	big sacaton	Poaceae	SPWR2	SPOWRI	7	–	–	–	–	–	–	–
4	*Abronia angustifolia*	purple sand verbena	Nyctaginaceae	ABAN	ABRANG	180	–	–	–	–	–	–	Y
4	*Acleisanthes lanceolata*	gypsum moonpod	Nyctaginaceae	SELA3	SELLAN	187	–	9	–	–	–	–	Y
4	*Acleisanthes* spp.	trumpets	Nyctaginaceae	ACLEI	ACLEIS	1	–	–	–	–	–	–	–
4	*Acourtia nana*	desert holly	Asteraceae	ACNA2	ACONAN	9	–	–	–	–	–	–	–
4	*Acourtia wrightii*	brownfoot	Asteraceae	ACWR5	ACOWRI	1	–	–	–	–	–	–	–
4	*Allionia choisyi*	annual windmills	Nyctaginaceae	ALCH	ALLCHO	1	–	–	–	–	–	–	–
4	*Allionia incarnata*	trailing windmills	Nyctaginaceae	ALIN	ALLINC	34	–	–	–	–	–	–	–
4	*Amaranthus* spp.	amaranth	Amaranthaceae	AMARA	AMARAN	1	–	–	–	–	–	–	–
4	*Amsonia* spp.	bluestar	Apocynaceae	AMSON	AMSONI	4	–	–	–	–	–	–	–
4	*Amsonia tomentosa*	woolly bluestar	Apocynaceae	AMTO2	AMSTOM	–	–	3	–	–	–	–	–
4	*Amsonia tomentosa var. stenophylla*	woolly bluestar	Apocynaceae	AMTOS	AMSTOM	1	–	–	–	–	–	–	–
4	*Arida parviflora*	smallflower tansyaster	Asteraceae	MAPA	ARIPAR	48	–	–	–	–	–	–	Y
4	*Artemisia dracunculus*	wild tarragon	Asteraceae	ARDR4	ARTDRA	1	–	–	–	–	–	–	–
4	*Asclepias brachystephana*	bract milkweed	Asclepiadaceae	ASBR	ASCBRA	1	–	–	–	–	–	–	–
4	*Asclepias latifolia*	broadleaf milkweed	Asclepiadaceae	ASLA4	ASCLAT	1	–	–	–	–	–	–	–
4	*Asclepias subverticillata*	whorled milkweed	Asclepiadaceae	ASSU2	ASCSUB	4	–	–	–	–	–	–	–
4	*Aster* spp.	aster	Asteraceae	ASTER	ASTER	–	–	1	–	–	–	–	–
4	*Astragalus* spp.	milkvetch	Fabaceae	ASTRA	ASTRAG	1	–	–	–	–	–	–	–
4	*Bahia absinthifolia*	hairyseed bahia	Asteraceae	BAAB	BAHABS	9	–	–	–	–	–	–	–
4	*Bahia dissecta*	ragleaf bahia	Asteraceae	BADI	BAHDIS	1	–	–	–	–	–	–	–
4	*Baileya multiradiata*	desert marigold	Asteraceae	BAMU	BAIMUL	1	–	–	–	–	–	–	–
4	*Calylophus hartwegii*	Hartweg's sundrops	Onagraceae	CAHA14	CALHAR	91	–	4	–	–	–	–	–
4	*Calylophus hartwegii* ssp. *filifolius*	Hartweg's sundrops	Onagraceae	CAHAF2	CALHAR	7	–	–	–	–	–	–	Y
4	*Centaurea americana*	American basketflower	Asteraceae	CEAM2	CENAME	1	–	–	–	–	–	–	–
4	*Cevallia sinuata*	stinging serpent	Loasaceae	CESI	CEVSIN	12	–	–	–	–	–	–	Y
4	*Chamaesaracha* spp.	five eyes	Solanaceae	CHAMA8	CHAMAE	2	–	–	–	–	–	–	–
4	*Chamaesyce lata*	hoary sandmat	Euphorbiaceae	CHLA10	CHALAT	1	–	–	–	–	–	–	–
4	*Chamaesyce serpens*	matted sandmat	Euphorbiaceae	CHSE4	CHASER	1	–	–	–	–	–	–	–
4	*Chamaesyce serpyllifolia*	thymeleaf sandmat	Euphorbiaceae	CHSE6	CHASER2	5	–	–	–	–	–	–	–
4	*Chamaesyce serrula*	sawtooth sandmat	Euphorbiaceae	CHSE7	CHASER3	10	–	–	–	–	–	–	–
4	*Cirsium ochrocentrum*	yellowspine thistle	Asteraceae	CIOC2	CIROCH	10	–	–	–	–	–	–	–

LFC	Species Name	Common Name	Family	PLANTS Code	NHNM Acronym	NPS Strata							Voucher
						H	S1	S2	T1	T2	T3	X	
4	*Comandra umbellata*	bastard toadflax	Santalaceae	COUM	COMUMB	17	–	–	–	–	–	–	–
4	*Comandra umbellata* ssp. *pallida*	pale bastard toadflax	Santalaceae	COUMP	COMUMB	29	–	–	–	–	–	–	–
4	*Convolvulus* spp.	bindweed	Convolvulaceae	CONVO	CONVOL	1	–	–	–	–	–	–	–
4	*Conyza canadensis*	Canadian horseweed	Asteraceae	COCA5	CONCAN	3	–	–	–	–	–	–	–
4	*Corallorhiza maculata*	summer coralroot	Orchidaceae	COMA25	CORMAC	–	–	1	–	–	–	–	–
4	*Corispermum villosum*	hairy bugseed	Chenopodiaceae	COVI5	CORVIL	–	–	1	–	–	–	–	–
4	*Cressa truxillensis*	spreading alkaliweed	Convolvulaceae	CRTR5	CRETRU	8	–	–	–	–	–	–	Y
4	*Croton dioicus*	grassland croton	Euphorbiaceae	CRDI6	CRODIO	2	–	–	–	–	–	–	–
4	*Cryptantha fulvocanescens*	tawny cryptantha	Boraginaceae	CRFU	CRYFUL	15	–	–	–	–	–	–	–
4	*Cryptantha* spp.	catseye	Boraginaceae	CRYPT	CRYPTA	6	–	–	–	–	–	–	–
4	*Cyclospermum leptophyllum*	marsh parsley	Apiaceae	CYLE7	CYCLEP	–	1	–	–	–	–	–	–
4	*Dicranocarpus parviflorus*	pitchfork	Asteraceae	DIPA3	DICPAR	83	–	–	–	–	–	–	–
4	*Dimorphocarpa wislizeni*	spectacle pod	Brassicaceae	DIWI2	DIMWIS	3	–	–	–	–	–	–	–
4	*Erigeron bellidiastrum*	western daisy fleabane	Asteraceae	ERBE2	ERIBEL	1	–	–	–	–	–	–	–
4	*Eriogonum rotundifolium*	roundleaf buckwheat	Polygonaceae	ERRO2	ERIROT	2	–	–	–	–	–	–	–
4	*Eustoma exaltatum*	catchfly prairie gentian	Gentianaceae	EUEX5	EUSEXA	2	–	–	–	–	–	–	–
4	*Eustoma exaltatum ssp. russellianum*	catchfly prairie gentian	Gentianaceae	EUEXR	EUSEXA	1	–	–	–	–	–	–	Y
4	*Evolvulus sericeus*	silver dwarf morningglory	Convolvulaceae	EVSE	EVOSER	1	–	–	–	–	–	–	–
4	*Glandularia bipinnatifida*	Dakota mock vervain	Verbenaceae	GLBI2	GLABIP	3	–	–	–	–	–	–	–
4	*Glandularia bipinnatifida* var. *bipinnatifida*	Dakota mock vervain	Verbenaceae	GLBIB	GLABIP	1	–	–	–	–	–	–	–
4	*Heliotropium greggii*	fragrant heliotrope	Boraginaceae	HEGR6	HELGRE	32	–	–	–	–	–	–	–
4	*Hoffmannseggia drepanocarpa*	sickle-pod hog-potato	Fabaceae	HODR	HOFDRE	3	–	–	–	–	–	–	–
4	*Hoffmannseggia glauca*	Indian rushpea	Fabaceae	HOGL2	HOFGLA	7	–	–	–	–	–	–	Y
4	*Hymenopappus filifolius*	fineleaf hymenopappus	Asteraceae	HYFI	HYMFIL	81	–	–	–	–	–	–	–
4	*Hymenopappus filifolius* var. *cinereus*	fineleaf hymenopappus	Asteraceae	HYFIC	HYMFIL	1	–	–	–	–	–	–	Y
4	*Ibervillea tenuisecta*	slimlobe globeberry	Cucurbitaceae	IBTE2	IBETEN	1	–	–	–	–	–	–	–
4	*Kallstroemia parviflora*	warty caltrop	Zygophyllaceae	KAPA	KALPAR	5	–	–	–	–	–	–	–
4	*Kochia scoparia*	common kochia	Chenopodiaceae	BASC5	KOCSCO	1	–	–	–	–	–	–	–
4	*Laennecia coulteri*	conyza	Asteraceae	LACO13	LAECOU	10	–	–	–	–	–	–	Y
4	*Lepidium alyssoides*	mesa pepperweed	Brassicaceae	LEAL4	LEPALY	15	–	–	–	–	–	–	–
4	*Lepidium alyssoides* var. *angustifolium*	mountain pepperweed	Brassicaceae	LEALA4	LEPALY	35	–	–	–	–	–	–	Y
4	*Lepidium montanum*	mountain pepperweed	Brassicaceae	LEMO2	LEPMON	105	–	1	–	–	–	–	–
4	*Lepidium* spp.	pepperweed	Brassicaceae	LEPID	LEPIDI	1	–	–	–	–	–	–	–

LFC	Species Name	Common Name	Family	PLANTS Code	NHNM Acronym	NPS Strata							Voucher
						H	S1	S2	T1	T2	T3	X	
4	*Limonium limbatum*	Transpecos sealavender	Plumbaginaceae	LILI4	LIMLIM	7	–	–	–	–	–	–	–
4	*Lithospermum multiflorum*	manyflowered gromwell	Boraginaceae	LIMU3	LITMUL	2	–	–	–	–	–	–	–
4	*Machaeranthera canescens*	hoary aster	Asteraceae	MACA2	MACCAN	1	–	–	–	–	–	–	–
4	*Machaeranthera canescens* ssp. *canescens* var. *canescens*	hoary tansyaster	Asteraceae	MACAC3	MACCANC	21	–	–	–	–	–	–	–
4	*Machaeranthera canescens* ssp. *canescens* var. *incana*	hoary tansyaster	Asteraceae	MACAI2	DIECANI	4	–	–	–	–	–	–	–
4	*Machaeranthera* spp.	tansyaster	Asteraceae	MACHA	MACHAE	5	–	–	–	–	–	–	–
4	*Machaeranthera tanacetifolia*	tanseyleaf aster	Asteraceae	MATA2	MACTAN	13	–	–	–	–	–	–	Y
4	*Mentha* spp.	mint	Lamiaceae	MENTH	MENTHA	1	–	–	–	–	–	–	–
4	*Mentzelia humilis*	gypsum blazingstar	Loasaceae	MEHU	MENHUM	7	–	–	–	–	–	–	–
4	*Mentzelia multiflora*	manyflowered mentzelia	Loasaceae	MEMU3	MENMUL	63	–	–	–	–	–	–	–
4	*Mentzelia perennis*	perennial blazingstar	Loasaceae	MEPE6	MENPER	43	–	–	–	–	–	–	Y
4	*Mentzelia* spp.	mentzelia	Loasaceae	MENTZ	MENTZE	9	–	–	–	–	–	–	–
4	*Nama carnosum*	sand fiddleleaf	Hydrophyllaceae	NACA	NAMCAR	121	–	3	–	–	–	–	Y
4	*Nerisyrenia camporum*	mesa greggia	Brassicaceae	NECA3	NERCAM	7	–	–	–	–	–	–	–
4	*Nerisyrenia linearifolia*	White Sands fanmustard	Brassicaceae	NELI	NERLIN	91	–	–	–	–	–	–	Y
4	*Nyctaginaceae*	four o'clock family	Nyctaginaceae	NYCTAG	NYCTAG	1	–	–	–	–	–	–	–
4	*Oenothera pallida*	pale eveningprimrose	Onagraceae	OEPA	OENPAL	4	–	–	–	–	–	–	–
4	*Oenothera pallida* ssp. *runcinata*	pale eveningprimrose	Onagraceae	OEPAR	OENPAL	3	–	–	–	–	–	–	Y
4	*Oenothera* spp.	eveningprimrose	Onagraceae	OENOT	OENOTH	4	–	–	–	–	–	–	–
4	*Oenothera suffrutescens*	scarlet beeblossom	Onagraceae	OESU3	GAUCOC	4	–	–	–	–	–	–	–
4	*Pectis angustifolia*	narrowleaf pectis	Asteraceae	PEAN	PECANG	1	–	–	–	–	–	–	–
4	*Phacelia crenulata* var. *corrugata*	notched scorpion-weed	Hydrophyllaceae	PHCRC	PHACRE	5	–	–	–	–	–	–	–
4	*Phacelia integrifolia*	gypsum scorpionweed	Hydrophyllaceae	PHIN	PHAINT	27	–	–	–	–	–	–	–
4	*Phacelia integrifolia* var. *texana*	Texan phacelia	Hydrophyllaceae	PHINT	PHAINT	1	–	–	–	–	–	–	–
4	*Phacelia* spp.	phacelia	Hydrophyllaceae	PHACE	PHACEL	14	–	–	–	–	–	–	–
4	*Phemeranthus aurantiacus*	orange flameflower	Portulacaceae	PHAU13	PHEAUR	1	–	–	–	–	–	–	–
4	*Physaria fendleri*	Fendler's bladderpod	Brassicaceae	LEFE	PHYFEN	1	–	–	–	–	–	–	–
4	*Physaria* spp.	twinpod	Brassicaceae	PHYSA2	PHYSAR	1	–	–	–	–	–	–	–
4	*Portulaca oleracea*	common purslane	Portulacaceae	POOL	POROLE	2	–	–	–	–	–	–	–
4	*Portulaca pilosa*	kiss me quick	Portulacaceae	POPI3	PORPIL	2	–	–	–	–	–	–	–
4	*Proboscidea parviflora*	doubleclaw	Pedaliaceae	PRPA2	PROPAR	1	–	–	–	–	–	–	–

LFC	Species Name	Common Name	Family	PLANTS Code	NHNM Acronym	NPS Strata							Voucher
						H	S1	S2	T1	T2	T3	X	
4	*Psilostrophe* spp.	paperflower	Asteraceae	PSILO3	PSILOS	1	–	–	–	–	–	–	–
4	*Psilostrophe tagetina*	woolly paperflower	Asteraceae	PSTA	PSITAG	85	–	–	–	–	–	–	Y
4	*Rumex hymenosepalus*	canaigre dock	Polygonaceae	RUHY	RUMHYM	2	–	–	–	–	–	–	–
4	*Salsola tragus*	prickly Russian thistle	Chenopodiaceae	SATR12	SALTRA	61	–	–	–	–	–	–	Y
4	*Sanvitalia abertii*	Albert's creeping zinnia	Asteraceae	SAAB	SANABE	4	–	–	–	–	–	–	–
4	*Sartwellia flaveriae*	threadleaf glowwort	Asteraceae	SAFL5	SARFLA	53	–	–	–	–	–	–	Y
4	*Senecio flaccidus*	threadleaf ragwort	Asteraceae	SEFL3	SENFLA	65	–	–	–	–	–	–	–
4	*Senecio flaccidus* var. *flaccidus*	threadleaf ragwort	Asteraceae	SEFLF	SENFLA	1	–	–	–	–	–	–	–
4	*Senecio* spp.	groundsel	Asteraceae	SENEC	SENECI	2	–	3	–	–	–	–	–
4	*Solanum elaeagnifolium*	silverleaf nightshade	Solanaceae	SOEL	SOLELA	15	–	–	–	–	–	–	–
4	*Sphaeralcea angustifolia*	copper globemallow	Malvaceae	SPAN3	SPHANG	16	–	–	–	–	–	–	–
4	*Sphaeralcea hastulata*	spear globemallow	Malvaceae	SPHA	SPHHAS	42	–	–	–	–	–	–	–
4	*Sphaeralcea incana*	gray globemallow	Malvaceae	SPIN2	SPHINC	4	–	–	–	–	–	–	–
4	*Sphaeralcea* spp.	globemallow	Malvaceae	SPHAE	SPHAER	1	–	–	–	–	–	–	–
4	*Stephanomeria pauciflora*	brownplume wirelettuce	Asteraceae	STPA4	STEPAU	1	–	–	–	–	–	–	–
4	*Thelesperma megapotamicum*	Hopi tea greenthread	Asteraceae	THME	THEMEG	165	–	–	–	–	–	–	–
4	*Thymophylla pentachaeta*	fiveneedle pricklyleaf	Asteraceae	THPE4	THYPEN	4	–	–	–	–	–	–	–
4	*Tidestromia lanuginosa*	wooly tidestromia	Amaranthaceae	TILA2	TIDLAN	15	–	–	–	–	–	–	–
4	*Trianthema portulacastrum*	desert horsepurslane	Aizoaceae	TRPO2	TRIPOR	1	–	–	–	–	–	–	–
4	*Typha latifolia*	broadleaf cattail	Typhaceae	TYLA	TYPLAT	2	–	–	–	–	–	–	–
4	unidentified forb	unidentified forb	unknown	2FORB	UNIDF	21	–	–	–	–	–	–	–
4	unidentified forb - seedling	unidentified forb - seedling	unknown	2FA	UNIDF	3	–	–	–	–	–	–	–
4	*unidentified* spp.	unidentified plant	unknown	2PLANT	UNID	–	–	1	–	–	–	–	–
4	*Verbesina encelioides*	golden crownbeard	Asteraceae	VEEN	VERENC	82	–	–	–	–	–	–	–
4	*Xanthisma gracile*	slender goldenweed	Asteraceae	MAGR10	XANGRA	4	–	–	–	–	–	–	–
4	*Xanthisma spinulosum*	lacy tansyaster	Asteraceae	MAPI	XANSPI2	35	–	–	–	–	–	–	Y
4	*Xanthisma* spp.	sleepydaisy	Asteraceae	XANTH	XANTHI	1	–	–	–	–	–	–	–
4	*Xanthium spinosum*	spiny cockleburr	Asteraceae	XASP2	XANSPI	4	–	–	–	–	–	–	–
4	*Zeltnera arizonica*	Arizona centaury	Gentianaceae	CEAR12	CENARI	13	–	–	–	–	–	–	–
4	*Zeltnera maryanna*	gypsum centaury	Gentianaceae	CEMA19	CENMAR	40	–	–	–	–	–	–	Y

Lifeform code (LFC): 1 = tree, 2 = shrub, 2.5 = dwarf shrub, 3 = graminoid, 4 = forb. NPS strata: H = Herbaceous Layer, S1 = Tall Shrub, S2 = Short Shrub, T1 = Emergent Tree, T2 = Tree Canopy, T3 = Tree Sub Canopy, X = Tree Standing Dead.

Table B2. Species list for White Sands National Monument, ordered by lifeform and common name.

LFC	Common name	Species Name	Family	PLANTS Code	NHNM Acronym	NPS Strata							Voucher
						H	S1	S2	T1	T2	T3	X	
1	Goodding's willow	*Salix gooddingii*	Salicaceae	SAGO	SALGOO	–	–	–	–	2	–	–	–
1	oneseed juniper	*Juniperus monosperma*	Cupressaceae	JUMO	JUNMON	–	–	–	–	–	3	–	–
1	Rio Grande cottonwood	*Populus deltoides* ssp. *wislizeni*	Salicaceae	PODEW	POPDEL	–	2	1	3	26	–	–	–
1	saltcedar	*Tamarix chinensis*	Tamaricaceae	TACH2	TAMCHI	–	144	1	11	43	–	3	Y
2	angel's-wings	*Opuntia microdasys*	Cactaceae	OPMI4	OPUMIC	–	–	1	–	–	–	–	–
2	Apacheplume	*Fallugia paradoxa*	Rosaceae	FAPA	FALPAR	–	5	–	–	–	–	–	–
2	arrowweed	*Pluchea sericea*	Asteraceae	PLSE	PLUSER	–	4	–	–	–	–	–	–
2	Berlandier's wolfberry	*Lycium berlandieri*	Solanaceae	LYBE	LYCBER	–	117	–	–	–	–	–	–
2	Berlandier's wolfberry	*Lycium berlandieri* var. *parviflorum*	Solanaceae	LYBEP	LYCBER	–	2	–	–	–	–	–	Y
2	Bigelow's falsewillow	*Baccharis bigelovii*	Asteraceae	BABI	BACBIG	–	1	–	–	–	–	–	–
2	broom dalea	*Psorothamnus scoparius*	Fabaceae	PSSC6	PSOSCO	–	27	–	–	–	–	–	–
2	cactus apple	*Opuntia engelmannii*	Cactaceae	OPEN3	OPUENG	–	9	–	–	–	–	–	–
2	Christmas cactus	*Cylindropuntia leptocaulis*	Cactaceae	CYLE8	CYLLEP	–	54	3	–	–	–	–	–
2	creosotebush	*Larrea tridentata*	Zygophyllaceae	LATR2	LARTRI	1	123	–	–	–	–	–	–
2	crown of thorns	*Koeberlinia spinosa*	Koeberliniaceae	KOSP	KOESPI	–	32	–	–	–	–	–	–
2	false willow	*Baccharis salicina*	Asteraceae	BASA	BACSAL2	–	7	–	–	–	–	–	–
2	fourwing saltbush	*Atriplex canescens*	Chenopodiaceae	ATCA2	ATRCAN	1	658	–	–	–	–	–	Y
2	frosted mint	*Poliomintha incana*	Lamiaceae	POIN3	POLINC	–	279	1	–	–	–	–	–
2	honey mesquite	*Prosopis glandulosa*	Fabaceae	PRGL2	PROGLA	–	258	–	–	–	–	–	–
2	iodinebush	*Allenrolfea occidentalis*	Chenopodiaceae	ALOC2	ALLOCC	1	210	2	–	–	–	–	Y
2	littleleaf sumac	*Rhus microphylla*	Anacardiaceae	RHMI3	RHUMIC	–	8	–	–	–	–	–	–
2	longleaf jointfir	*Ephedra trifurca*	Ephedraceae	EPTR	EPHTRI	–	3	–	–	–	–	–	–
2	ocotillo	*Fouquieria splendens*	Fouquieriaceae	FOSP2	FOUSPL	–	1	–	–	–	–	–	–
2	pale wolfberry	*Lycium pallidum*	Solanaceae	LYPA	LYCPAL	–	13	–	–	–	–	–	–
2	rubber rabbitbrush	*Ericameria nauseosa*	Asteraceae	ERNA10	ERINAU	–	115	–	–	–	–	–	–
2	rubber rabbitbrush	*Ericameria nauseosa* var. *latisquamea*	Asteraceae	ERNAL2	ERINAU	–	1	–	–	–	–	–	Y
2	sand sagebrush	*Artemisia filifolia*	Asteraceae	ARFI2	ARTFIL	–	4	–	–	–	–	–	–
2	singlewhorl burrobush	*Ambrosia monogyra*	Asteraceae	AMMO6	AMBMON	–	2	–	–	–	–	–	–
2	skunkbush sumac	*Rhus trilobata*	Anacardiaceae	RHTR	RHUTRI	–	77	–	–	–	–	–	–
2	soaptree yucca	*Yucca elata*	Agavaceae	YUEL	YUCELA	–	395	2	–	–	–	–	–
2	southwestern rabbitbrush	*Lorandersonia pulchella*	Asteraceae	CHPU4	LORPUL	–	11	–	–	–	–	–	Y

LFC	Common name	Species Name	Family	PLANTS Code	NHNM Acronym	NPS Strata							Voucher
						H	S1	S2	T1	T2	T3	X	
2	splitleaf brickellbush	*Brickellia laciniata*	Asteraceae	BRLA	BRILAC	–	2	–	–	–	–	–	–
2	tarbush	*Flourensia cernua*	Asteraceae	FLCE	FLOCER	1	62	–	–	–	–	–	–
2	Torrey's jointfir	*Ephedra torreyana*	Ephedraceae	EPTO	EPHTOR	–	609	2	–	–	–	–	Y
2	TransPecos false clapberry	*Pseudoclappia arenaria*	Asteraceae	PSAR	PSEARE	–	90	76	–	–	–	–	Y
2	tree cholla	*Cylindropuntia imbricata*	Cactaceae	CYIM2	CLYIMB	–	15	–	–	–	–	–	–
2	unidentified shrub	unidentified shrub	unknown	2SHRUB	UNIDS	–	1	–	–	–	–	–	–
2	Warnock's snakewood	*Condalia warnockii*	Rhamnaceae	COWA	CONWAR	–	4	–	–	–	–	–	–
2	Wright's beebrush	*Aloysia wrightii*	Verbenaceae	ALWR	ALOWRI	–	1	–	–	–	–	–	–
2	yerba de pasmo	*Baccharis pteronioides*	Asteraceae	BAPT	BACPTE	–	1	–	–	–	–	–	–
2	yucca	*Yucca* spp.	Agavaceae	YUCCA	YUCCA	–	1	–	–	–	–	–	–
2.5	beehive cactus	*Coryphantha* spp.	Cactaceae	CORYP	CORYPH	–	1	1	–	–	–	–	–
2.5	Bigelow's sagebrush	*Artemisia bigelovii*	Asteraceae	ARBI3	ARTBIG	–	–	1	–	–	–	–	–
2.5	broom snakeweed	*Gutierrezia sarothrae*	Asteraceae	GUSA2	GUTSAR	1	5	72	–	–	–	–	–
2.5	bush seepweed	*Suaeda nigra*	Chenopodiaceae	SUNI	SUANIG	7	–	91	–	–	–	–	Y
2.5	devilshead	*Echinocactus horizonthalonius*	Cactaceae	ECHO	ECHHOR	–	–	1	–	–	–	–	–
2.5	featherplume	*Dalea formosa*	Fabaceae	DAFO	DALFOR	–	–	1	–	–	–	–	–
2.5	goldenbush	*Isocoma* spp.	Asteraceae	ISOCO	ISOCOM	–	1	–	–	–	–	–	–
2.5	hairy crinklemat	*Tiquilia hispidissima*	Boraginaceae	TIHI	TIQHIS	–	2	385	–	–	–	–	Y
2.5	hedgehog cactus	*Echinocereus* spp.	Cactaceae	ECHIN3	ECHINO2	1	–	1	–	–	–	–	–
2.5	James' seaheath	*Frankenia jamesii*	Frankeniaceae	FRJA	FRAJAM	1	2	199	–	–	–	–	–
2.5	kingcup cactus	*Echinocereus triglochidiatus*	Cactaceae	ECTR	ECHTRI	–	1	41	–	–	–	–	–
2.5	mariola	*Parthenium incanum*	Asteraceae	PAIN2	PARINC	–	2	18	–	–	–	–	–
2.5	nipple cactus	*Mammillaria* spp.	Cactaceae	MAMMI	MAMMIL	–	–	1	–	–	–	–	–
2.5	pricklyleaf dogweed	*Thymophylla acerosa*	Asteraceae	THAC	THYACE	–	–	4	–	–	–	–	–
2.5	pricklypear	*Opuntia* spp.	Cactaceae	OPUNT	OPUNTI	–	1	5	–	–	–	–	–
2.5	purple pricklypear	*Opuntia macrocentra*	Cactaceae	OPMA8	OPUMAC	2	3	33	–	–	–	–	–
2.5	scarlet hedgehog cactus	*Echinocereus coccineus*	Cactaceae	ECCO5	ECHCOC	–	–	4	–	–	–	–	–
2.5	Scheer's beehive cactus	*Coryphantha scheeri* var. *valida*	Cactaceae	COSCV	CORSCH	–	–	4	–	–	–	–	–
2.5	southern jimmyweed	*Isocoma pluriflora*	Asteraceae	ISPL	ISOPLU	–	49	74	–	–	–	–	Y
2.5	spinystar	*Escobaria vivipara*	Cactaceae	ESVI2	ESCVIV	–	–	5	–	–	–	–	–
2.5	threadleaf snakeweed	*Gutierrezia microcephala*	Asteraceae	GUMI	GUTMIC	1	–	93	–	–	–	–	Y
2.5	tulip pricklypear	*Opuntia phaeacantha*	Cactaceae	OPPH	OPUPHA	–	–	22	–	–	–	–	–
2.5	woody crinklemat	*Tiquilia canescens*	Boraginaceae	TICA3	TIQCAN	–	–	6	–	–	–	–	–

LFC	Common name	Species Name	Family	PLANTS Code	NHNM Acronym	NPS Strata							Voucher
						H	S1	S2	T1	T2	T3	X	
3	alkali sacaton	*Sporobolus airoides*	Poaceae	SPAI	SPOAIR	731	1	1	–	–	–	–	Y
3	American bulrush	*Schoenoplectus americanus*	Cyperaceae	SCAM6	SCHAME	1	–	–	–	–	–	–	Y
3	big sacaton	*Sporobolus wrightii*	Poaceae	SPWR2	SPOWRI	7	–	–	–	–	–	–	–
3	black grama	*Bouteloua eriopoda*	Poaceae	BOER4	BOUERI	1	–	–	–	–	–	–	–
3	bog sedge	*Kobresia spp.*	Cyperaceae	KOBRE	KOBRES	–	1	–	–	–	–	–	–
3	bristlegrass	*Setaria spp.*	Poaceae	SETAR	SETARI	1	–	–	–	–	–	–	–
3	burrograss	*Scleropogon brevifolius*	Poaceae	SCBR2	SCLBRE	17	–	–	–	–	–	–	–
3	bush muhly	*Muhlenbergia porteri*	Poaceae	MUPO2	MUHPOR	132	–	–	–	–	–	–	–
3	common reed	*Phragmites australis* ssp. *americanus*	Poaceae	PHAUA6	PHRAUS	1	–	–	–	–	–	–	Y
3	ear muhly	*Muhlenbergia arenacea*	Poaceae	MUAR	MUHARE	2	–	–	–	–	–	–	–
3	fluffgrass	*Dasyochloa pulchella*	Poaceae	DAPU7	DASPUL	11	–	–	–	–	–	–	–
3	giant dropseed	*Sporobolus giganteus*	Poaceae	SPGI	SPOGIG	11	–	–	–	–	–	–	–
3	gyp dropseed	*Sporobolus nealleyi*	Poaceae	SPNE	SPONEA	291	1	1	–	–	–	–	Y
3	gypsum grama	*Bouteloua breviseta*	Poaceae	BOBR	BOUBRE	317	–	–	–	–	–	–	Y
3	Hall's panicgrass	*Panicum hallii*	Poaceae	PAHA	PANHAL	1	–	–	–	–	–	–	–
3	Indian ricegrass	*Achnatherum hymenoides*	Poaceae	ACHY	ACHHYM	94	–	1	–	–	–	–	Y
3	inland saltgrass	*Distichlis spicata*	Poaceae	DISP	DISSPI	18	–	–	–	–	–	–	Y
3	little bluestem	*Schizachyrium scoparium*	Poaceae	SCSC	SCHSCO	1	–	–	–	–	–	–	–
3	mesa dropseed	*Sporobolus flexuosus*	Poaceae	SPFL2	SPOFLE	71	–	–	–	–	–	–	–
3	New Mexico bluestem	*Schizachyrium neomexicanum*	Poaceae	SCSCN	SCHNEO	206	–	2	–	–	–	–	–
3	nineawn pappusgrass	*Enneapogon desvauxii*	Poaceae	ENDE	ENNDES	15	–	–	–	–	–	–	–
3	purple threeawn	*Aristida purpurea*	Poaceae	ARPU9	ARIPUR	17	–	–	–	–	–	–	–
3	red threeawn	*Aristida purpurea* var. *longiseta*	Poaceae	ARPUL	ARIPUR	2	–	–	–	–	–	–	Y
3	sand dropseed	*Sporobolus cryptandrus*	Poaceae	SPCR	SPOCRY	6	–	–	–	–	–	–	–
3	sand muhly	*Muhlenbergia arenicola*	Poaceae	MUAR2	MUHARE2	3	–	–	–	–	–	–	–
3	sandhill muhly	*Muhlenbergia pungens*	Poaceae	MUPU2	MUHPUN	61	–	–	–	–	–	–	Y
3	sixweeks grama	*Bouteloua barbata*	Poaceae	BOBA2	BOUBAR	63	–	–	–	–	–	–	–
3	sixweeks threeawn	*Aristida adscensionis*	Poaceae	ARAD	ARIADS	5	–	–	–	–	–	–	–
3	spike dropseed	*Sporobolus contractus*	Poaceae	SPCO4	SPOCON	24	–	–	–	–	–	–	–
3	Springfield's beardgrass	*Bothriochloa springfieldii*	Poaceae	BOSP3	BOTSPR	1	–	–	–	–	–	–	–
3	stinkgrass	*Eragrostis cilianensis*	Poaceae	ERCI	ERACIL	1	–	–	–	–	–	–	–
3	streambed bristlegrass	*Setaria leucopila*	Poaceae	SELE6	SETLEU	12	–	–	–	–	–	–	–
3	tobosa	*Pleuraphis mutica*	Poaceae	PLMU3	PLEMUT	11	–	–	–	–	–	–	–

LFC	Common name	Species Name	Family	PLANTS Code	NHNM Acronym	NPS Strata							Voucher
						H	S1	S2	T1	T2	T3	X	
3	Torrey's rush	*Juncus torreyi*	Juncaceae	JUTO	JUNTOR	1	–	–	–	–	–	–	–
3	tumble windmill grass	*Chloris verticillata*	Poaceae	CHVE2	CHLVER	8	–	–	–	–	–	–	–
4	Albert's creeping zinnia	*Sanvitalia abertii*	Asteraceae	SAAB	SANABE	4	–	–	–	–	–	–	–
4	amaranth	*Amaranthus* spp.	Amaranthaceae	AMARA	AMARAN	1	–	–	–	–	–	–	–
4	American basketflower	*Centaurea americana*	Asteraceae	CEAM2	CENAME	1	–	–	–	–	–	–	–
4	annual windmills	*Allionia choisyi*	Nyctaginaceae	ALCH	ALLCHO	1	–	–	–	–	–	–	–
4	Arizona centaury	*Zeltnera arizonica*	Gentianaceae	CEAR12	CENARI	13	–	–	–	–	–	–	–
4	aster	*Aster* spp.	Asteraceae	ASTER	ASTER	–	–	1	–	–	–	–	–
4	bastard toadflax	*Comandra umbellata*	Santalaceae	COUM	COMUMB	17	–	–	–	–	–	–	–
4	bindweed	*Convolvulus* spp.	Convolvulaceae	CONVO	CONVOL	1	–	–	–	–	–	–	–
4	bluestar	*Amsonia* spp.	Apocynaceae	AMSON	AMSONI	4	–	–	–	–	–	–	–
4	bract milkweed	*Asclepias brachystephana*	Asclepiadaceae	ASBR	ASCBRA	1	–	–	–	–	–	–	–
4	broadleaf cattail	*Typha latifolia*	Typhaceae	TYLA	TYPLAT	2	–	–	–	–	–	–	–
4	broadleaf milkweed	*Asclepias latifolia*	Asclepiadaceae	ASLA4	ASCLAT	1	–	–	–	–	–	–	–
4	brownfoot	*Acourtia wrightii*	Asteraceae	ACWR5	ACOWRI	1	–	–	–	–	–	–	–
4	brownplume wirelettuce	*Stephanomeria pauciflora*	Asteraceae	STPA4	STEPAU	1	–	–	–	–	–	–	–
4	Canadian horseweed	*Conyza canadensis*	Asteraceae	COCA5	CONCAN	3	–	–	–	–	–	–	–
4	canaigre dock	*Rumex hymenosepalus*	Polygonaceae	RUHY	RUMHYM	2	–	–	–	–	–	–	–
4	catchfly prairie gentian	*Eustoma exaltatum*	Gentianaceae	EUEX5	EUSEXA	2	–	–	–	–	–	–	–
4	catchfly prairie gentian	*Eustoma exaltatum* ssp. *russellianum*	Gentianaceae	EUEXR	EUSEXA	1	–	–	–	–	–	–	Y
4	catseye	*Cryptantha* spp.	Boraginaceae	CRYPT	CRYPTA	6	–	–	–	–	–	–	–
4	common kochia	*Kochia scoparia*	Chenopodiaceae	BASC5	KOCSCO	1	–	–	–	–	–	–	–
4	common purslane	*Portulaca oleracea*	Portulacaceae	POOL	POROLE	2	–	–	–	–	–	–	–
4	conyza	*Laennecia coulteri*	Asteraceae	LACO13	LAECOU	10	–	–	–	–	–	–	Y
4	copper globemallow	*Sphaeralcea angustifolia*	Malvaceae	SPAN3	SPHANG	16	–	–	–	–	–	–	–
4	Dakota mock vervain	*Glandularia bipinnatifida*	Verbenaceae	GLBI2	GLABIP	3	–	–	–	–	–	–	–
4	Dakota mock vervain	*Glandularia bipinnatifida var. bipinnatifida*	Verbenaceae	GLBIB	GLABIP	1	–	–	–	–	–	–	–
4	desert holly	*Acourtia nana*	Asteraceae	ACNA2	ACONAN	9	–	–	–	–	–	–	–
4	desert horsepurslane	*Trianthema portulacastrum*	Aizoaceae	TRPO2	TRIPOR	1	–	–	–	–	–	–	–
4	desert marigold	*Baileya multiradiata*	Asteraceae	BAMU	BAIMUL	1	–	–	–	–	–	–	–
4	doubleclaw	*Proboscidea parviflora*	Pedaliaceae	PRPA2	PROPAR	1	–	–	–	–	–	–	–
4	eveningprimrose	*Oenothera* spp.	Onagraceae	OENOT	OENOTH	4	–	–	–	–	–	–	–
4	Fendler's bladderpod	*Physaria fendleri*	Brassicaceae	LEFE	PHYFEN	1	–	–	–	–	–	–	–

LFC	Common name	Species Name	Family	PLANTS Code	NHNM Acronym	NPS Strata							Voucher
						H	S1	S2	T1	T2	T3	X	
4	fineleaf hymenopappus	*Hymenopappus filifolius*	Asteraceae	HYFI	HYMFIL	81	–	–	–	–	–	–	–
4	fineleaf hymenopappus	*Hymenopappus filifolius* var. *cinereus*	Asteraceae	HYFIC	HYMFIL	1	–	–	–	–	–	–	Y
4	five eyes	*Chamaesaracha* spp.	Solanaceae	CHAMA8	CHAMAE	2	–	–	–	–	–	–	–
4	fiveneedle pricklyleaf	*Thymophylla pentachaeta*	Asteraceae	THPE4	THYPEN	4	–	–	–	–	–	–	–
4	four o'clock family	*Nyctaginaceae*	Nyctaginaceae	NYCTAG	NYCTAG	1	–	–	–	–	–	–	–
4	fragrant heliotrope	*Heliotropium greggii*	Boraginaceae	HEGR6	HELGRE	32	–	–	–	–	–	–	–
4	globemallow	*Sphaeralcea* spp.	Malvaceae	SPHAE	SPHAER	1	–	–	–	–	–	–	–
4	golden crownbeard	*Verbesina encelioides*	Asteraceae	VEEN	VERENC	82	–	–	–	–	–	–	–
4	grassland croton	*Croton dioicus*	Euphorbiaceae	CRDI6	CRODIO	2	–	–	–	–	–	–	–
4	gray globemallow	*Sphaeralcea incana*	Malvaceae	SPIN2	SPHINC	4	–	–	–	–	–	–	–
4	groundsel	*Senecio spp.*	Asteraceae	SENEC	SENECI	2	–	3	–	–	–	–	–
4	gypsum blazingstar	*Mentzelia humilis*	Loasaceae	MEHU	MENHUM	7	–	–	–	–	–	–	–
4	gypsum centaury	*Zeltnera maryanna*	Gentianaceae	CEMA19	CENMAR	40	–	–	–	–	–	–	Y
4	gypsum moonpod	*Acleisanthes lanceolata*	Nyctaginaceae	SELA3	SELLAN	187	–	9	–	–	–	–	Y
4	gypsum scorpionweed	*Phacelia integrifolia*	Hydrophyllaceae	PHIN	PHAINT	27	–	–	–	–	–	–	–
4	hairy bugseed	*Corispermum villosum*	Chenopodiaceae	COVI5	CORVIL	–	–	1	–	–	–	–	–
4	hairyseed bahia	*Bahia absinthifolia*	Asteraceae	BAAB	BAHABS	9	–	–	–	–	–	–	–
4	Hartweg's sundrops	*Calylophus hartwegii*	Onagraceae	CAHA14	CALHAR	91	–	4	–	–	–	–	–
4	Hartweg's sundrops	*Calylophus hartwegii* ssp. *filifolius*	Onagraceae	CAHAF2	CALHAR	7	–	–	–	–	–	–	Y
4	hoary aster	*Machaeranthera canescens*	Asteraceae	MACA2	MACCAN	1	–	–	–	–	–	–	–
4	hoary sandmat	*Chamaesyce lata*	Euphorbiaceae	CHLA10	CHALAT	1	–	–	–	–	–	–	–
4	hoary tansyaster	*Machaeranthera canescens* ssp. *canescens* var. *canescens*	Asteraceae	MACAC3	MACCANC	21	–	–	–	–	–	–	–
4	hoary tansyaster	*Machaeranthera canescens* ssp. *canescens* var. *incana*	Asteraceae	MACAI2	DIECANI	4	–	–	–	–	–	–	–
4	Hopi tea greenthread	*Thelesperma megapotamicum*	Asteraceae	THME	THEMEG	165	–	–	–	–	–	–	–
4	Indian rushpea	*Hoffmannseggia glauca*	Fabaceae	HOGL2	HOFGLA	7	–	–	–	–	–	–	Y
4	kiss me quick	*Portulaca pilosa*	Portulacaceae	POPI3	PORPIL	2	–	–	–	–	–	–	–
4	lacy tansyaster	*Xanthisma spinulosum*	Asteraceae	MAPI	XANSPI2	35	–	–	–	–	–	–	Y
4	manyflowered gromwell	*Lithospermum multiflorum*	Boraginaceae	LIMU3	LITMUL	2	–	–	–	–	–	–	–
4	manyflowered mentzelia	*Mentzelia multiflora*	Loasaceae	MEMU3	MENMUL	63	–	–	–	–	–	–	–
4	marsh parsley	*Cyclospermum leptophyllum*	Apiaceae	CYLE7	CYCLEP	–	1	–	–	–	–	–	–
4	matted sandmat	*Chamaesyce serpens*	Euphorbiaceae	CHSE4	CHASER	1	–	–	–	–	–	–	–

LFC	Common name	Species Name	Family	PLANTS Code	NHNM Acronym	NPS Strata							Voucher
						H	S1	S2	T1	T2	T3	X	
4	mentzelia	*Mentzelia* spp.	Loasaceae	MENTZ	MENTZE	9	–	–	–	–	–	–	–
4	mesa greggia	*Nerisyrenia camporum*	Brassicaceae	NECA3	NERCAM	7	–	–	–	–	–	–	–
4	mesa pepperweed	*Lepidium alyssoides*	Brassicaceae	LEAL4	LEPALY	15	–	–	–	–	–	–	–
4	milkvetch	*Astragalus* spp.	Fabaceae	ASTRA	ASTRAG	1	–	–	–	–	–	–	–
4	mint	*Mentha* spp.	Lamiaceae	MENTH	MENTHA	1	–	–	–	–	–	–	–
4	mountain pepperweed	*Lepidium alyssoides* var. *angustifolium*	Brassicaceae	LEALA4	LEPALY	35	–	–	–	–	–	–	Y
4	mountain pepperweed	*Lepidium montanum*	Brassicaceae	LEMO2	LEPMON	105	–	1	–	–	–	–	–
4	narrowleaf pectis	*Pectis angustifolia*	Asteraceae	PEAN	PECANG	1	–	–	–	–	–	–	–
4	notched scorpion-weed	*Phacelia crenulata* var. *corrugata*	Hydrophyllaceae	PHCRC	PHACRE	5	–	–	–	–	–	–	–
4	orange flameflower	*Phemeranthus aurantiacus*	Portulacaceae	PHAU13	PHEAUR	1	–	–	–	–	–	–	–
4	pale bastard toadflax	*Comandra umbellata* ssp. *pallida*	Santalaceae	COUMP	COMUMB	29	–	–	–	–	–	–	–
4	pale eveningprimrose	*Oenothera pallida*	Onagraceae	OEPA	OENPAL	4	–	–	–	–	–	–	–
4	pale eveningprimrose	*Oenothera pallida* ssp. *runcinata*	Onagraceae	OEPAR	OENPAL	3	–	–	–	–	–	–	Y
4	paperflower	*Psilostrophe* spp.	Asteraceae	PSILO3	PSILOS	1	–	–	–	–	–	–	–
4	pepperweed	*Lepidium* spp.	Brassicaceae	LEPID	LEPIDI	1	–	–	–	–	–	–	–
4	perennial blazingstar	*Mentzelia perennis*	Loasaceae	MEPE6	MENPER	43	–	–	–	–	–	–	Y
4	phacelia	*Phacelia* spp.	Hydrophyllaceae	PHACE	PHACEL	14	–	–	–	–	–	–	–
4	pitchfork	*Dicranocarpus parviflorus*	Asteraceae	DIPA3	DICPAR	83	–	–	–	–	–	–	–
4	prickly Russian thistle	*Salsola tragus*	Chenopodiaceae	SATR12	SALTRA	61	–	–	–	–	–	–	Y
4	purple sand verbena	*Abronia angustifolia*	Nyctaginaceae	ABAN	ABRANG	180	–	–	–	–	–	–	Y
4	ragleaf bahia	*Bahia dissecta*	Asteraceae	BADI	BAHDIS	1	–	–	–	–	–	–	–
4	roundleaf buckwheat	*Eriogonum rotundifolium*	Polygonaceae	ERRO2	ERIROT	2	–	–	–	–	–	–	–
4	sand fiddleleaf	*Nama carnosum*	Hydrophyllaceae	NACA	NAMCAR	121	–	3	–	–	–	–	Y
4	sawtooth sandmat	*Chamaesyce serrula*	Euphorbiaceae	CHSE7	CHASER3	10	–	–	–	–	–	–	–
4	scarlet beeblossom	*Oenothera suffrutescens*	Onagraceae	OESU3	GAUCOC	4	–	–	–	–	–	–	–
4	sickle-pod hog-potato	*Hoffmannseggia drepanocarpa*	Fabaceae	HODR	HOFDRE	3	–	–	–	–	–	–	–
4	silver dwarf morningglory	*Evolvulus sericeus*	Convolvulaceae	EVSE	EVOSER	1	–	–	–	–	–	–	–
4	silverleaf nightshade	*Solanum elaeagnifolium*	Solanaceae	SOEL	SOLELA	15	–	–	–	–	–	–	–
4	sleepydaisy	*Xanthisma* spp.	Asteraceae	XANTH	XANTHI	1	–	–	–	–	–	–	–
4	slender goldenweed	*Xanthisma gracile*	Asteraceae	MAGR10	XANGRA	4	–	–	–	–	–	–	–
4	slimlobe globeberry	*Ibervillea tenuisecta*	Cucurbitaceae	IBTE2	IBETEN	1	–	–	–	–	–	–	–
4	smallflower tansyaster	*Arida parviflora*	Asteraceae	MAPA	ARIPAR	48	–	–	–	–	–	–	Y
4	spear globemallow	*Sphaeralcea hastulata*	Malvaceae	SPHA	SPHHAS	42	–	–	–	–	–	–	–

LFC	Common name	Species Name	Family	PLANTS Code	NHNM Acronym	NPS Strata							Voucher
						H	S1	S2	T1	T2	T3	X	
4	spectacle pod	*Dimorphocarpa wislizeni*	Brassicaceae	DIWI2	DIMWIS	3	–	–	–	–	–	–	–
4	spiny cockleburr	*Xanthium spinosum*	Asteraceae	XASP2	XANSPI	4	–	–	–	–	–	–	–
4	spreading alkaliweed	*Cressa truxillensis*	Convolvulaceae	CRTR5	CRETRU	8	–	–	–	–	–	–	Y
4	stinging serpent	*Cevallia sinuata*	Loasaceae	CESI	CEVSIN	12	–	–	–	–	–	–	Y
4	summer coralroot	*Corallorhiza maculata*	Orchidaceae	COMA25	CORMAC	–	–	1	–	–	–	–	–
4	supine bean	*Macroptilium supinum*	Fabaceae	MASU18	MACSUP	1	–	–	–	–	–	–	–
4	tanseyleaf aster	*Machaeranthera tanacetifolia*	Asteraceae	MATA2	MACTAN	13	–	–	–	–	–	–	Y
4	tansyaster	*Machaeranthera* spp.	Asteraceae	MACHA	MACHAE	5	–	–	–	–	–	–	–
4	tawny cryptantha	*Cryptantha fulvocanescens*	Boraginaceae	CRFU	CRYFUL	15	–	–	–	–	–	–	–
4	Texan phacelia	*Phacelia integrifolia* var. *texana*	Hydrophyllaceae	PHINT	PHAINT	1	–	–	–	–	–	–	Y
4	threadleaf glowwort	*Sartwellia flaveriae*	Asteraceae	SAFL5	SARFLA	53	–	–	–	–	–	–	Y
4	threadleaf ragwort	*Senecio flaccidus*	Asteraceae	SEFL3	SENFLA	65	–	–	–	–	–	–	–
4	threadleaf ragwort	*Senecio flaccidus* var. *flaccidus*	Asteraceae	SEFLF	SENFLA	1	–	–	–	–	–	–	–
4	thymeleaf sandmat	*Chamaesyce serpyllifolia*	Euphorbiaceae	CHSE6	CHASER2	5	–	–	–	–	–	–	–
4	trailing windmills	*Allionia incarnata*	Nyctaginaceae	ALIN	ALLINC	34	–	–	–	–	–	–	–
4	Transpecos sealavender	*Limonium limbatum*	Plumbaginaceae	LILI4	LIMLIM	7	–	–	–	–	–	–	–
4	trumpets	*Acleisanthes* spp.	Nyctaginaceae	ACLEI	ACLEIS	1	–	–	–	–	–	–	–
4	twinpod	*Physaria* spp.	Brassicaceae	PHYSA2	PHYSAR	1	–	–	–	–	–	–	–
4	unidentified forb	unidentified forb	unknown	2FORB	UNIDF	21	–	–	–	–	–	–	–
4	unidentified forb - seedling	unidentified forb - seedling	unknown	2FA	UNIDF	3	–	–	–	–	–	–	–
4	unidentified plant	*unidentified spp.*	unknown	2PLANT	UNID	–	–	1	–	–	–	–	–
4	warty caltrop	*Kallstroemia parviflora*	Zygophyllaceae	KAPA	KALPAR	5	–	–	–	–	–	–	–
4	western daisy fleabane	*Erigeron bellidiastrum*	Asteraceae	ERBE2	ERIBEL	1	–	–	–	–	–	–	–
4	White Sands fanmustard	*Nerisyrenia linearifolia*	Brassicaceae	NELI	NERLIN	91	–	–	–	–	–	–	Y
4	whorled milkweed	*Asclepias subverticillata*	Asclepiadaceae	ASSU2	ASCSUB	4	–	–	–	–	–	–	–
4	wild tarragon	*Artemisia dracunculus*	Asteraceae	ARDR4	ARTDRA	1	–	–	–	–	–	–	–
4	woolly bluestar	*Amsonia tomentosa*	Apocynaceae	AMTO2	AMSTOM	–	–	3	–	–	–	–	–
4	woolly bluestar	*Amsonia tomentosa* var. *stenophylla*	Apocynaceae	AMTOS	AMSTOM	1	–	–	–	–	–	–	–
4	woolly paperflower	*Psilostrophe tagetina*	Asteraceae	PSTA	PSITAG	85	–	–	–	–	–	–	Y
4	wooly tidestromia	*Tidestromia lanuginosa*	Amaranthaceae	TILA2	TIDLAN	15	–	–	–	–	–	–	–
4	yellowspine thistle	*Cirsium ochrocentrum*	Asteraceae	CIOC2	CIROCH	10	–	–	–	–	–	–	–

Lifeform code (LFC): 1 = tree, 2 = shrub, 2.5 = dwarf shrub, 3 = graminoid, 4 = forb. NPS strata: H = Herbaceous Layer, S1 = Tall Shrub, S2 = Short Shrub, T1 = Emergent Tree, T2 = Tree Canopy, T3 = Tree Sub Canopy, X = Tree Standing Dead.

Appendix C: Keys to White Sands National Monument Plant Associations

The dichotomous keys to plant associations of White Sands National Monument (NM) provided below. Key steps use either explicitly specified cover values for indicator species as part of the decision rules in each step or specific adjectives that relate to species canopy cover as shown in Table C1. There are separate keys for the major classes (e.g., forests and woodlands, shrublands, etc.) as specified in the first key. Descriptions for each association can be found in Appendix D.

Table C1. Text descriptors for canopy cover and density with associated quantitative ranges definitions.

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

Key to Major Vegetation Types

1a Substrate of mostly barren soil, or gravels or rock with total vegetation cover <1% or dominated by lithomorphic species: . . . . . **KEY 4 – Lithomorphic Vegetation or sparse vegetation (page A36)**

1b Total vegetation cover >1%: **2**

2a (1b) Trees dominant, typically >10% canopy cover; or if <10%, clearly the dominant and/or the characteristic growth form: . . . . . **KEY 1 – Forests and Woodlands (page A30)**

2b Trees <10%, clearly not dominant or characteristic growth form: **3**

3a (2b) Shrubs or subshrubs >25%, or if <25%, clearly the dominant and/or the characteristic growth form: . . . . . **KEY 2 – Shrublands (page A31)**

3b Shrubs <25%, herbs clearly the dominant and/or characteristic growth-form: . . . . . **KEY 3 – Herbaceous Vegetation (page A34)**

KEY 1 – Forests and Woodlands

1a *Populus deltoide*s ssp. *wislizeni* dominant: **2**

1b *Populus deltoides* ssp. *wislizeni* poorly represented or absent, *Tamarix chinensis* dominant: **3**

2a (1a) *Poliomintha incan*a common to abundant, herbaceous cover low; associated with dunes: . . . . . ***Populus deltoides* ssp. *wislizeni* / *Poliomintha incana* Flooded Forest**

2b *Poliomintha incana* scattered to absent, *Schizachyrium neomexicanum* and other grasses common to abundant; associated with interdune areas: . . . . . ***Populus deltoides* ssp. *wislizeni* / *Schizachyrium scoparium* Flooded Woodland**

3a (1b) *Distichlis spicata* common to abundant: . . . . . ***Tamarix chinensis* / *Distichlis spicata Ruderal* Shrubland**

3b *Distichlis spicata* is scattered to absent: **4**

4a (3b) *Sporobolus airoides* common to abundant: . . . . . ***Tamarix chinensis* / *Sporobolus airoides* Ruderal Shrubland**

4b *Sporobolus airoides* scattered to absent: **5**

5a (4b) *Allenrolfea occidentalis* common to abundant; associated with alluvial flats and interdune areas: . . . . . ***Tamarix chinensis (Allenrolfea occidentalis)* Alkali Flat Ruderal Shrubland**

5b *Allenrolfea occidentalis* scattered to absent; associated with dunes: . . ***Tamarix chinensis* Dune - Ruderal Shrubland**

KEY 2 – Shrublands

1a *Larrea tridentata* dominant shrub, common to very abundant as dominant shrub; if sparse then dominant shrub:. . . **2**
1b *Larrea tridentata* uncommon to absent; if common to abundant then not dominant shrub: **5**

2a (1a) *Muhlenbergia porteri* well represented to abundant as a dominant or codominant graminoid: . . . . . ***Larrea tridentata* / *Muhlenbergia porteri* Shrubland**
2b *Muhlenbergia porteri* not dominant, poorly represented to absent:. **3**

3a (2b) *Sporobolus nealleyi* well represented as codominant graminoid: ***Larrea tridentata* / *Sporobolus nealleyi* Shrubland**
3b *Sporobolus nealleyi* poorly represented to absent: **4**

4a (3b) *Parthenium incanum* well represented:. . . . . ***Larrea tridentata - Parthenium incanum* Shrubland**
4b *Parthenium incanum* poorly represented and forbs scattered or absent: . . . . . ***Larrea tridentata* / Sparse Understory Shrubland**

5a (1b) *Flourensia cernua* dominant, common to abundant: **6**
5b *Flourensia cernua* scattered to absent, not dominant: **7**

6a (5a) *Muhlenbergia porteri* common to abundant:. . . . . ***Flourensia cernua* / *Muhlenbergia porteri* Shrubland**
6b *Muhlenbergia porteri* scattered to absent; *Sporobolus airoides* common to luxuriant: . . . . . ***Flourensia cernua* / *Sporobolus airoides* Shrubland**

7a (5b) *Prosopis glandulosa* common to abundant as dominant or codominant shrub:. **8**
7b *Prosopis glandulosa* uncommon to absent or not dominant or codominant shrub:. **10**

8a (7a) *Sporobolus airoides* common to luxuriant in cover: . . . . . ***Prosopis glandulosa* / *Sporobolus airoides* Shrubland**
8b *Sporobolus airoides* uncommon or absent; Intershrub spaces nonvegetated or with scattered dwarf-shrubs, grasses and forbs: **9**

9a (8b) *Larrea tridentata* is usually present to abundant and may codominate. *Atriplex canescens* uncommon or absent: . . . . . ***Prosopis glandulosa* / Sparse Shrubland, *Larrea tridentata* Phase**
9b *Atriplex canescens* common to well represented; *Larrea tridentata* uncommon or absent: . . . . . ***Prosopis glandulosa - Atriplex canescens* Ruderal Shrubland**

10a (7b) *Allenrolfea occidentalis* common to abundant; dominant or codominant shrub: **11**
10b *Allenrolfea occidentalis* scattered or absent, not dominant or codominant: **13**

11a (10a) *Suaeda nigra* common to abundant, often codominant: . . . . . ***Allenrolfea occidentalis* / *Suaeda nigra* Shrubland**
11b *Suaeda nigra* uncommon or absent: **12**

12a (11b) *Atriplex canescens* common to abundant, often codominant; *Sporobolus airoides* common to abundant: . . . . . ***Allenrolfea occidentalis - Atriplex canescens* / *Sporobolus airoides* Shrubland**
12b *Atriplex canescens* is uncommon or absent; herbaceous layer sparse: . . . . . ***Allenrolfea occidentalis* Sparse Shrubland**

13a (10b) *Atriplex canescens* common to very abundant as dominant or codominant shrub; *Rhus trilobata*, *Psorothamnus scoparius*, or *Poliomintha incana* uncommon or absent: **14**

13b *Atriplex canescens* uncommon or absent, not dominant or codominant: **17**

14a (13a) Graminoids are well represented to abundant: **15**

14b Graminoids are poorly represented or absent.. . . . . **16**

15a (14a) *Sporobolus airoides* is common to very abundant, the dominant graminoid: . . . . . ***Atriplex canescens* / *Sporobolus airoides* Shrubland**

15b *Sporobolus nealleyi* common to well represented; *Sporobolus airoides* is poorly represented or absent, not dominant: . . . . . ***Atriplex canescens* / *Sporobolus nealleyi* Shrubland**

16a (14b) *Suaeda nigra* well represented to abundant:. . . . . ***Atriplex canescens* / *Suaeda nigra* Shrubland**

16b Herbaceous layer is poorly represented or absent. . . . . ***Atriplex canescens* / Sparse Shrubland**

17a (13b) *Rhus trilobata* well represented to abundant; dominant or codominant with other shrubs: **18**

17b *Rhus trilobata* poorly represented or absent; not dominant or codominant: **20**

18a (17a) *Bouteloua breviseta* well represented, dominant or codominant:. . . . . ***Rhus trilobata* / *Bouteloua breviseta* Gypsophilous Dune Shrubland**

18b *Bouteloua breviseta* poorly represented or absent; not dominant or codominant: **19**

19a (18b) *Sporobolus airoides* well represented, dominant or codominant:. . . . . ***Rhus trilobata* / *Sporobolus airoides* Gypsophilous Shrubland**

19b *Sporobolus airoides* and other grasses poorly represented or absent; not dominant or codominant: . . . . . R***hus trilobata - Poliomintha incana* Gypsophilous Dune Shrubland**

20a (17b) *Psorothamnus scoparius* common to abundant; dominant shrub: . . . . . ***Psorothamnus scoparius* / *Sporobolus flexuosus* Shrubland**

20b *Psorothamnus scoparius* scattered to absent; not the dominant shrub: **21**

21a (20b) *Poliomintha incana* dominant or codominant shrub, usually common to abundant: **22**

21b *Poliomintha incana* not dominant; uncommon or absent:. **25**

22a (21a) Herbaceous layer is well represented to abundant:. **23**

22b Herbaceous layer is poorly represented to scattered: . . . . . ***Poliomintha incana* Gypsum Dune Shrubland**

23a (22a) *Muhlenbergia pungens* is common to abundant; dominant or codominant graminoid: . . . . . ***Poliomintha incana* / *Muhlenbergia pungens* Gypsophilous Shrubland**

23b *Muhlenbergia pungens* scattered to absent: **24**

24a (23b) *Bouteloua breviseta* common, dominant: . . . . ***Poliomintha incana* / *Bouteloua breviseta* Gypsophilous Shrubland**

24b *Bouteloua breviseta* uncommon or absent; *Sporobolus flexuosus* common:. . . . . ***Poliomintha incana* / *Sporobolus flexuosus* Shrubland**

25a (21b) *Tiquilia hispidissima* is common to abundant; dominant or codominant as a subshrub; Herbaceous layer is scattered to poorly represented. *Acleisanthes lanceolata* is often present:. . . . . ***Tiquilia hispidissima* / *Acleisanthes lanceolata* Dwarf-shrubland**

25b *Tiquilia hispidissima* scattered or absent:. **28**

26a (25b) *Suaeda nigra* is common and codominant: . . . . . ***Suaeda nigra* Wet Shrubland**

26b *Suaeda nigra* is scattered or absent **27**

27a (26b) Shrub, dwarf shrub, and herbaceous cover is sparse: . . . . . **See KEY 4 – Sparse Vegetation or barren.**

27b Other shrubs or dwarf shrubs co-dominant with grasses:. . . . . **Either unclassified shrub association or see KEY 3 – Herbaceous Vegetation.**

KEY 3 – Herbaceous Vegetation

1a *Bouteloua breviseta* common; dominant or codominant graminoid: **2**

1b *Bouteloua breviseta* is uncommon or absent. If common, then herbaceous layer is dominated by other species: **5**

2a (1a) *Schizachyrium neomexicanum* is common to abundant; dominant to codominant graminoid: . . . . . ***Bouteloua breviseta - Schizachyrium neomexicanum*** **Grassland**

2b *Schizachyrium neomexicanum* is absent or scarce: **3**

3a (2b) *Sporobolus airoides* is common to abundant codominant graminoid: . . . . . ***Bouteloua breviseta - Sporobolus airoides*** **Grassland**

3b *Sporobolus airoides* is uncommon or absent: **4**

4a (3b) T*iquilia hispidissima* common to abundant: . . . . . ***Tiquilia hispidissima / Bouteloua breviseta - Mentzelia humilis*** **Dwarf-shrub Grassland**

4b *Tiquilia hispidissima* uncommon or absent; Ephedra torreyana common: . . . . . ***Ephedra torreyana / Bouteloua breviseta*** **Dwarf-shrub Grassland**

5a (1b) *Sporobolus airoides* is common to abundant, dominant or codominant graminoid: **6**

5b *Sporobolus airoides* is scattered or absent: **13**

6a (5a) *Distichlis spicata* is common to abundant, codominant: . . . . . ***Sporobolus airoides - Distichlis spicata*** **Wet Meadow**

6b *Distichlis spicata* is scattered or absent: **7**

7a (6b) *Pleuraphis mutica* well represented to abundant, codominant; gypsophilous species usually absent: . . . . . ***Pleuraphis mutica - Sporobolus airoides*** **Grassland**

7b *Pleuraphis mutica* poorly represented or absent: **8**

8a (7b) *Schizachyrium neomexicanum* is common to abundant, codominant graminoid: . . . . . ***Sporobolus airoides - Schizachyrium neomexicanum*** **Grassland**

8b *Schizachyrium neomexicanum* is uncommon or absent: **9**

9a (8b) Gypsophilous subshrubs such as *Frankenia jamesii* and/or *Pseudoclappia arenaria* common; associated with gypsum interdune flats: . . . . . ***Frankenia jamesii / Sporobolus airoides*** **Shrubland**

9b Gypsophilous subshrubs such as *Frankenia jamesii* and/or *Pseudoclappia arenaria* uncommon or absent: **10**

10a (9b) *Sporobolus nealleyi* common: . . . . . ***Sporobolus nealleyi - Sporobolus airoides*** **Grassland**

10b *Sporobolus nealleyi* uncommon or absent: **11**

11a (10b) *Abronia angustifolia* common along other gypsophilous herbs: . . . . . ***Sporobolus airoides - Abronia angustifolia*** **Grassland**

11b *Abronia angustifolia* and other gypsophilous herbs and shrubs absent **12**

12a (11b) *Ephedra torreyana* is common to well represented as dominant shrub; *Sporobolus airoides* common to abundant, the dominant graminoid; hummocks in interdunal zones:. . . . . ***Ephedra torreyana* / *Sporobolus airoides* Dwarf-shrub Grassland**

12b *Sporobolus airoides* dominant, well represented to abundant; alluvial flats, often non-gypsic sites: . . . . . ***Sporobolus airoides* Monotype Grassland**

13a (5b) *Sporobolus flexuosus* and/or *Sporobolus contractu*s together common to well represented: . . . . . ***Yucca elata* / *Sporobolus flexuosus* Shrubland**

13b *Sporobolus flexuosus* and/or *Sporobolus contractus* uncommon or absent: **14**

14a (13b) *Distichlis spicata* is common to abundant, dominant, mostly monotypic stand:. . . . . ***Distichlis spicata* Alkaline Wet Meadow**

14b *Distichlis spicata* uncommon or absent: **15**

15a (14b) *Schizachyrium neomexicanum* common to abundant and the clear dominant: . . . . . S***chizachyrium neomexicanum* - *Abronia angustifolia* Grassland**

15b *Schizachyrium neomexicanum* is uncommon or absent: **4**

16a (15b) *Sporobolus nealleyi* common to well represented and the dominant grass: . . . . . ***Tiquilia hispidissima* / *Sporobolus nealleyi* Dwarf-shrub Grassland**

16b *Sporobolus nealleyi* is uncommon or absent: . . . . . **Unclassified**

KEY 4 – Lithomorphic Vegetation or Sparse Vegetation

1a *Allenrolfea occidentalis* or *Suaeda nigra* present: **2**
1b *Allenrolfea occidentalis* or *Suaeda nigra* absent: **3**

2a (1a) *Suaeda nigra* present, often codominant: . . . . . ***Allenrolfea occidentalis* / *Suaeda nigra* Shrubland**
2b *Suaeda nigra* absent: . . . . . ***Allenrolfea occidentalis* Sparse Shrubland**

3a (1b) Site is anthropogenically disturbed land such as old gravel pits, roadsides, parking lots, etc.: **Disturbed / Unclassified**
3b Site is natural/not anthropogenically disturbed land. **4**

4a (3b) Sparsely vegetated gypsum dunes: . . . . . **Sparse Vegetation / Dune**
4b Sparsely vegetated alluvial fans and flats, playas bottoms: **5**

5a (4b) Sparsely vegetated alluvial fans and piedmonts: . . . . . **Sparse Vegetation / Alluvial Fan**
5b Sparsely vegetated alluvial flats and playas bottoms: . . . . . **Sparse Vegetation / Alluvial Flat**

Appendix D: Local Plant Association Descriptions for White Sands National Monument

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As part of the White Sands National Monument (NM) vegetation classification and mapping project, local plant association descriptions were written for plant associations (PAs) identified for the park. Local descriptions provide information on the park-level distribution, level of acceptable physiognomic and compositional variation, and the key ecological process and environmental/abiotic factors that are associated with a type.

The arrangement of the plant associations follows the USNVC hierarchy in Table 4 of the main document. For accepted currently NVC plant associations, those with database codes beginning with "CEGL…", global descriptions are available from the USNVC webpage at http://usnvc.org/explore-classification/.

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Populus deltoides ssp. *wislizeni / Poliomintha incana* Flooded Forest

Rio Grande Cottonwood / Frosted Mint Flooded Forest

Identifier: CEGL005972

US National Vegetation Classification

Level	Unit
Class	Forest & Woodland (1)
Subclass	Temperate & Boreal Forest & Woodland (1.B)
Formation	Temperate Flooded & Swamp Forest (1.B.3)
Division	Western North American Interior Flooded Forest (1.B.3.Nd)
Macrogroup	Warm Mediterranean & Desert Riparian, Flooded & Swamp Forest (M036)
Group	Western Interior Riparian Forest & Woodland [G797]
Association	*Populus deltoides* ssp. *wislizeni* / *Poliomintha incana* Flooded Forest

Distribution

This association is known from the active dunes throughout the monument.

Environmental Description

This association occurs from 1,190 to 1,220 m (3,900 to 4,000 ft) in elevation on active transverse to parabolic gypsum dune formations. Dunes can be rolling, low to medium in height and comprised of fine-textured, gypsiferous sands. The ground surface is predominantly loose gypsum sands (50 – 80%) with scattered herbaceous cover along with cottonwood litter under the tree canopies.

Soils are mapped in the following five units: Lark-Transformer association, 0 to 40 percent slopes; Lark-Transformer association, 0 to 90 percent slopes, duneland; Astrobee-Lark association, 0 to 35 percent slopes; Lark-Astrobee-Nasa complex, 0 to 40 percent slopes; and Lark-Piedrablanca-Wulie complex, 0 to 25 percent slopes (USDA-NRCS 2017).

Vegetation Description

This open dune woodland is characterized by *Populus deltoides* ssp. *wislizeni*, a facultative wetland tree species which normally occurs in riverine riparian areas. Here it has been established in wet interdune areas with shallow water tables and then buried by shifting gypsum sands. While the boles of the trees are commonly buried, the stems extend above the dunes' surfaces, creating canopies between 20 and 40% in cover. *Poliomintha incana*, a tall shrub that is also tolerant of sand burial, also occurs on the dunes, is usually well represented in the intertree-canopy spaces, further stabilizing the dunes. Overall shrub diversity is high with 14 shrub and dwarf shrub species recorded. *Yucca elata*, *Ericameria nauseosa*, and *Lorandersonia pulchella* can all be frequent associates. The herbaceous layer is generally low in cover, however, grasses such as *Sporobolus airoides* and *Muhlenbergia pungens* may be common. Forbs are variable in composition and cover, and are most frequently represented by *Thelesperma megapotamicum* and *Hymenopappus filifolius*.

Most Abundant Species

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Populus deltoides* ssp. *wislizeni*
Shrub/sapling (tall & short)	Broad-leaved deciduous dwarf-shrub	*Poliomintha incana*

Other Noteworthy Species

Facultative wetland (FACW) indicator species: *Tamarix chinensis*, *Limonium limbatum*

New Mexico state-listed noxious weeds: (Class C) *Tamarix chinensis*

Classification Comments

Data are not available.

Classification Confidence

2

Element Sources
Inventory Notes: Data are not available.
Plots: 93MP113, 93MP145, 93MP213, 93MP148, 93MP150, 93MP077, 93MP079, 09YC323, 07WS031, 07WS021.

Local Description Authors: A. Fettes

Populus deltoides ssp. *wislizeni / Schizachyrium scoparium* Flooded Woodland

Rio Grande Cottonwood / Little Bluestem Flooded Woodland

Identifier: CEGL005973

US National Vegetation Classification

Level	Unit
Class	Forest & Woodland (1)
Subclass	Temperate & Boreal Forest & Woodland (1.B)
Formation	Temperate Flooded & Swamp Forest (1.B.3)
Division	Western North American Interior Flooded Forest (1.B.3.Nd)
Macrogroup	Warm Mediterranean & Desert Riparian, Flooded & Swamp Forest (M036)
Group	Western Interior Riparian Forest & Woodland [G797]
Association	*Populus deltoides* ssp. *wislizeni* / *Schizachyrium scoparium* Flooded Woodland

Distribution
This association is known from the active dunes throughout the monument.

Environmental Description
This association occurs from 1,190 to 1,230 m (3,905 to 4,035 ft) in elevation in interdune areas with relatively high soil moisture and shallow water tables. Soils are fine-textured to sandy and are derived from gypsum. The ground surface is characterized by up to 50% exposed gypsum sands scattered in herbaceous canopy and cottonwood litter.

Soils are mapped in the following two units: Lark-Transformer association, 0 to 40 percent slopes and Lark-Astrobee-Nasa complex, 0 to 40 percent slopes (USDA-NRCS 2017).

Vegetation Description
This open interdune woodland is characterized by *Populus deltoides* ssp. *wislizeni*, a facultative wetland tree species which normally occurs in riverine riparian areas. Here it has established in wet interdune areas with shallow water tables and can reach canopy cover of 40% in some stands. The understory is characteristically grassy and dominated by *Schizachyrium neomexicanum* (this is the gypsophilous equivalent to *Schizachyrium scoparium* and is considered by some to be only a variation the latter, e.g., *Schizachyrium scoparium* var. *neomexicanum*). *Bouteloua breviseta*, *Muhlenbergia arenicola*, and *Sporobolus airoides* may be well represented graminoid associates. Forbs are variable in composition and low in abundance with few representatives greater than 0.5% total cover. *Eustoma exaltatum* ssp. *russellianum*, an obligate wetland species, is often present.

Most Abundant Species

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Populus deltoides* ssp. *wislizeni*
Herb (field)	Graminoid	*Schizachyrium neomexicanum*

Other Noteworthy Species
Obligate wetland (OBL) indicator species: *Salix gooddingii*, *Eustoma exaltatum*, *Typha latifolia*
Facultative wetland (FACW) indicator species: *Tamarix chinensis*, *Distichlis spicata*, *Juncus torreyi*
New Mexico state-listed noxious weeds: (Class C) *Tamarix chinensis*

Classification Comments
Data are not available.

Classification Confidence
2

Element Sources
Inventory Notes: Data are not available.
Plots: 93MP168, 93MP186, 93JT002, 93MP154, 08CJ001.

Local Description Authors: A. Fettes

Tamarix chinensis (Allenrolfea occidentalis) Alkali Flat Ruderal Shrubland

Saltcedar (Iodinebush) Alkali Flat Ruderal Shrubland

Identifier: CEPP007468

US National Vegetation Classification

Level	Unit
Class	Forest & Woodland (1)
Subclass	Temperate & Boreal Forest & Woodland (1.B)
Formation	Temperate Flooded & Swamp Forest (1.B.3)
Division	Western North American Interior Flooded Forest (1.B.3.Nd)
Macrogroup	Interior West Ruderal Flooded & Swamp Forest & Woodland (M298)
Group	Interior West Ruderal Riparian Forest & Scrub [G510]
Association	*Tamarix chinensis - Allenrolfea occidentalis* Alkali Flat Ruderal Shrubland

Distribution
This association is known from flats and interdune areas throughout the entire monument.

This association is known from the eastern edge of the Lake Otero basin/western margin of the dunes, and isolated flats within the parabolic dune areas of the monument.

Environmental Description
This association occurs from 1,185 to 1,220 m (3,905 to 3,890 ft) in elevation on basin bottom sites that include alkali flats and playa margins, interdune flats, wide drainages, and occasional low-lying dunelands. Sites are typically flooded seasonally and the water table can be within 0.5 m of the surface. Soils are derived from gypsum sediments and occasionally are mixed alluvium. The ground surface is typically barren, exposed soil and gypsum sands along with microphytic crusts; herbaceous vegetation and litter cover is low.

Soils are mapped in the following six units: Astrobee-Lark association, 0 to 35 percent slopes; Corvus-Astrobee-Lark complex, 0 to 25 percent slopes; Lark-Andrecito association, 0 to 15 percent slopes; Mamtrack-Lark-Transformer complex, 0 to 15 percent slopes; Rioperdido-Harses association, 0 to 4 percent slopes; Salago-Llano complex, 0 to 2 percent slopes; and Torbellino-Lark association, 0 to 15 percent slopes (USDA-NRCS 2017).

Vegetation Description
This tall shrubland is characterized by the dominance of the exotic *Tamarix chinensis*, which can form canopies that range from very sparse (5 to 25% cover) to luxuriant (>80% cover). *Allenrolfea occidentalis* may also occur as a common shrub associate. Intershrub spaces are sparsely vegetated, with only two grasses and three forb species recorded for this association, but may occasionally be well represented, along with scattered individuals of the annual forb *Abronia angustifolia*.

Most Abundant Species

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Tamarix chinensis*
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Allenrolfea occidentalis*

Other Noteworthy Species
Facultative wetland (FACW) indicator species: *Tamarix chinensis*
New Mexico state-listed noxious weeds: (Class C) *Tamarix chinensis*

Classification Comments
Data are not available.

Classification Confidence
2

Element Sources
Inventory Notes: Data are not available.
Plots: 93MP081, 93MP050, 93MP054, 93JT020, 93MP165, 93MP099, 93MP101, 08CJ008, 08SS001, 09YC292, 08CJ003, 08SS016, 08SS011, 08SS008, 08SS005, 08SS003, 08SS002.

Local Description Authors: E. Muldavin and A. Fettes

Tamarix chinensis - Dune Ruderal Shrubland

Saltcedar - Dune Ruderal Shrubland

Identifier: CEPP007477

US National Vegetation Classification

Level	Unit
Class	Forest & Woodland (1)
Subclass	Temperate & Boreal Forest & Woodland (1.B)
Formation	Temperate Flooded & Swamp Forest (1.B.3)
Division	Western North American Interior Flooded Forest (1.B.3.Nd)
Macrogroup	Interior West Ruderal Flooded & Swamp Forest & Woodland (M298)
Group	Interior West Ruderal Riparian Forest & Scrub [G510]
Association	*Tamarix chinensis* - Dune Ruderal Shrubland

Distribution
This association is known from the eastern edge of the Lake Otero basin/western margin of the dunes in the monument.

Environmental Description
This association occurs from 1,185 to 1,210 m (3,905 to 3,970 ft) in elevation and typically on low gypsum dunes or forming coppice dunes around individuals or groups of shrubs. While the sites are now sandy, the shrubs likely were originally rooted in the basin bottom flats and then subsequently buried by sand or sand accumulated around the stems. In these basin bottom sites the water table is shallow, particularly during the rainy season. Wind erosion can also cause pedestal dune formation around shrub bases. The ground surface is typically bare or with only scattered litter and grass cover.

Soils are mapped in the following six units: Corvus-Astrobee-Lark complex, 0 to 25 percent slopes; Lacarreta-Salago-Ratscat complex, 0 to 3 percent slopes; Lark-Andrecito association, 0 to 15 percent slopes; Lark-Piedrablanca-Wulie complex, 0 to 25 percent slopes; Mamtrack-Lark-Transformer complex, 0 to 15 percent slopes; and Torbellino-Lark association, 0 to 15 percent slopes (USDA-NRCS 2017).

Vegetation Description
This tall shrubland is characterized by the dominance of the exotic *Tamarix chinensis*, which forms very open to moderate canopies (5 to 60% cover). Other shrubs such as *Atriplex canescens*, *Psorothamnus scoparius*, or *Allenrolfea occidentalis* may occur but they are scattered and clearly subordinate. Patches of *Sporobolus airoides* may be common in the intershrub spaces, while most other dwarf shrubs and herbaceous species are scattered and low in cover.

Most Abundant Species

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Tamarix chinensis*

Other Noteworthy Species
Facultative wetland (FACW) indicator species: *Tamarix chinensis*
New Mexico state-listed noxious weeds: (Class C) *Tamarix chinensis*

Classification Comments
Data are not available.

Classification Confidence
3

Element Sources
Inventory Notes: Data are not available.
Plots: 93MP055, 93MP096, 93MP100, 08CJ004, 08SS006, 08SS007, 08SS010, 08SS014, 09YC329, 08CJ005, 08CJ007, 08CJ013, 09YC316, 09YC317, 09YC318, 09YC324, 08SS013

Local Description Authors: E. Muldavin and A. Fettes

Tamarix chinensis / Distichlis spicata Ruderal Shrubland

Saltcedar / Inland Saltgrass Ruderal Shrubland

Identifier: CEPP007471

US National Vegetation Classification

Level	Unit
Class	Forest & Woodland (1)
Subclass	Temperate & Boreal Forest & Woodland (1.B)
Formation	Temperate Flooded & Swamp Forest (1.B.3)
Division	Western North American Interior Flooded Forest (1.B.3.Nd)
Macrogroup	Interior West Ruderal Flooded & Swamp Forest & Woodland (M298)
Group	Interior West Ruderal Riparian Forest & Scrub [G510]
Association	*Tamarix chinensis / Distichlis spicata* Ruderal Shrubland

Distribution
This widespread association is known from low-lying areas throughout the monument.

Environmental Description
This association occurs from 1,185 to 1,220 m (3,905 to 3,890 ft) in elevation along drainage bottoms and on alkali and interdune flats. Sites are typically flooded seasonally and the water table can be with 0.5 m of the surface. Slopes can be flat to gently rolling over fine soils derived from eolian, lacustrine, or alluvial deposits of clay or gypsum.

Soils are mapped in the following five units: Flake-Saltspring complex, 0 to 3 percent slopes; Lark-Andrecito association, 0 to 15 percent slopes; Lark-Transformer association, 0 to 40 percent slopes; MLRA-42 Gypsic Aquisalids and Gypsic Haplosalids soils, 0 to 1 percent slopes; and Rioperdido-Harses association, 0 to 4 percent slopes (USDA-NRCS 2017).

Vegetation Description
This tall shrubland is characterized by the dominance of the exotic *Tamarix chinensis*, which forms very open to moderate canopies (5 to 60% cover). Other shrubs such as *Allenrolfea occidentalis*, *Atriplex canescens*, *Baccharis biglovii*, *Baccharis salicina*, and *Suaeda nigra* may be common to well represented, sometimes codominating with *Tamarix chinensis*. The herbaceous layer is

dominated by *Distichlis spicata*, which can exceed 90% total cover. *Sporobolus airoides* may also occur as a codominant in some stands.

Most Abundant Species

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Tamarix chinensis*
Herb (field)	Graminoid	*Distichlis spicata, Sporobolus airoides*

Other Noteworthy Species
Obligate wetland (OBL) indicator species: *Typha latifolia*
Facultative wetland (FACW) indicator species: *Tamarix chinensis, Distichlis spicata*
New Mexico state-listed noxious weeds: (Class C) *Tamarix chinensis*

Classification Comments
Data are not available.

Classification Confidence
3

Element Sources
Inventory Notes: Data are not available.
Plots: 93MP061, 93MP206, 93MP204, 93MP185, 93JT004, 93MP103, 93MP095, 93MP184.

Local Description Authors: E. Muldavin and A. Fettes

Tamarix chinensis / Sporobolus airoides Ruderal Shrubland

Saltcedar / Alkali Sacaton Ruderal Shrubland

Identifier: CEPP007475

US National Vegetation Classification

Level	Unit
Class	Forest & Woodland (1)
Subclass	Temperate & Boreal Forest & Woodland (1.B)
Formation	Temperate Flooded & Swamp Forest (1.B.3)
Division	Western North American Interior Flooded Forest (1.B.3.Nd)
Macrogroup	Interior West Ruderal Flooded & Swamp Forest & Woodland (M298)
Group	Interior West Ruderal Riparian Forest & Scrub [G510]
Association	*Tamarix chinensis / Sporobolus airoides* Ruderal Shrubland

Distribution
This association is known from the eastern margins of Lake Lucero, Lost River, and interdune flats throughout the monument.

Environmental Description
This association occurs from 1,190 to 1,220 m (3,905 to 3,890 ft) in elevation along drainage bottoms and on alkali and interdune flats with occasional coppice dune formation. Sites are typically flooded seasonally and the water table can be with 0.5 m of the surface. Soils are typically derived from gypsum or clay alluvium. The ground surface is characterized by patchy vegetation cover with bare soil in the interspaces. Microphytic crusts can be common on the soil surface.

Soils are mapped in the following five units: Corvus-Astrobee-Lark complex, 0 to 25 percent slopes; Typic Petrogypsids-Oxyaquic Torriorthents complex, 0 to 8 percent slopes; Typic Torriorthents-Corvus complex, 0 to 6 percent slopes; Mamtrack-Lark-Transformer complex, 0 to 15 percent slopes; Rioperdido-Harses association, 0 to 4 percent slopes; Salago-Llano complex, 0 to 2

percent slopes; Torbellino-Lark association, 0 to 15 percent slopes; and Typic Torriorthents-Corvus complex, 0 to 6 percent slopes (USDA-NRCS 2017).

Vegetation Description
This tall shrubland is characterized by the dominance of the exotic *Tamarix chinensis*, which forms very open to moderate canopies (5 to 40% cover). Additional shrub species such as *Atriplex canescens*, *Isocoma pluriflora*, and *Allenrolfea occidentalis* may be common. *Sporobolus airoides* is typically well represented and the dominant grass. Forbs are variable in composition and typically low in cover.

Most Abundant Species

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Tamarix chinensis*
Herb (field)	Graminoid	*Sporobolus airoides*

Other Noteworthy Species
Facultative wetland (FACW) indicator species: *Tamarix chinensis, Distichlis spicata*
New Mexico state-listed noxious weeds: (Class C) *Tamarix chinensis*

Classification Comments
Data are not available.

Classification Confidence
3

Element Sources
Inventory Notes: Data are not available.
Plots: 93MP073, 09YC294, 08CJ009, 08CJ010, 08CJ011, 08CJ012, 08CJ014, 08SS004, 09YC293, 09YC326, 09YC295, 09YC314, 09YC315, 09YC319, 09YC320, 09YC321, 08CJ017.

Local Description Authors: A. Fettes

Allenrolfea occidentalis - Atriplex canescens / Sporobolus airoides Shrubland

Iodinebush - Fourwing Saltbush / Alkali Sacaton Shrubland

Identifier: CEPP007404

US National Vegetation Classification

Level	Unit
Class	Shrub & Herb Vegetation (2)
Subclass	Shrub & Herb Wetland (2.C)
Formation	Salt Marsh (2.C.5)
Division	North American Western Interior Brackish Marsh, Playa & Shrubland (2.C.5.Nd)
Macrogroup	Warm & Cool Desert Alkali-Saline Marsh, Playa & Shrubland (M082)
Group	North American Desert Alkaline-Saline Wet Scrub [G537]
Association	*Allenrolfea occidentalis - Atriplex canescens / Sporobolus airoides* Shrubland

Distribution
This association is known from the dune front on the basin flats east of the main dunefield and the alkali flat area to the west.

Environmental Description
This association occurs from 1,190 to 1,215 m (3,905 to 3,985 ft) in elevation and is associated with alluvial alkali flats and playas. Soils are typically fine-textured, eolian deposits of gypsiferous origin over lacustrine deposits. Coppice dunes may form around

established vegetation while areas of exposed soil characterize the intershrub spaces. Crystalline evaporates and/or microphytic crust may also occur on the soil surface.

Soils are mapped in the following five units: Lacarreta-Salago-Ratscat complex, 0 to 3 percent slopes; Lark-Andrecito association, 0 to 15 percent slopes; Nasa-Yesum complex, 0 to 6 percent slopes; Yesum gypsiferous fine sandy loam, saline, 0 to 3 percent slopes; and Yesum gypsiferous sandy loam, 0 to 9 percent slopes (USDA-NRCS 2017).

Vegetation Description
This tall desert shrubland forms a sparse to open canopy (10 to 30% cover) and is dominated by *Allenrolfea occidentalis* with *Atriplex canescens* as codominant shrub associate. The herbaceous layer is dominated by a nearly monotypic and often luxuriant grass cover of *Sporobolus airoides*. Forb diversity and cover is very low; the annual composites, *Arida parviflora* and *Dieteria canescens* were the most abundant representatives.

Most Abundant Species

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Succulent evergreen shrub	*Allenrolfea occidentalis*
Shrub/sapling (tall & short)	Broad-leaved evergreen shrub	*Atriplex canescens*
Herb (field)	Graminoid	*Sporobolus airoides*

Other Noteworthy Species
Facultative wetland (FACW) indicator species: *Tamarix chinensis*
New Mexico state-listed noxious weeds: (Class C) *Tamarix chinensis*

Classification Comments
Data are not available.

Classification Confidence
3

Element Sources
Inventory Notes: Data are not available.
Plots: 93MP106, 93MP003, 93MP093, 09YC298, 07WS033, 07WS009.

Local Description Authors: E. Muldavin and A. Fettes

Allenrolfea occidentalis Sparse Shrubland

Iodinebush Sparse Undergrowth Shrubland

Identifier: CEPP007408

US National Vegetation Classification

Level	Unit
Class	Shrub & Herb Vegetation (2)
Subclass	Shrub & Herb Wetland (2.C)
Formation	Salt Marsh (2.C.5)
Division	North American Western Interior Brackish Marsh, Playa & Shrubland (2.C.5.Nd)
Macrogroup	Warm & Cool Desert Alkali-Saline Marsh, Playa & Shrubland (M082)
Group	North American Desert Alkaline-Saline Wet Scrub [G537]
Association	*Allenrolfea occidentalis* Sparse Shrubland

Distribution
This association is known from alkali flats and playa edges throughout the monument.

Environmental Description
This community occurs from 1,190 to 1,215 m (3,905 to 3,985 ft) in elevation along playa edges and open alkali flats. Soils are typically derived from lacustrine deposits with the presence crystalline evaporates and fine-textured, eolian sands of gypsiferous origin. The soil surface is nearly barren except for occasional microphytic crusts.

Soils are mapped in the following seven units: Lacarreta-Salago-Ratscat complex, 0 to 3 percent slopes; Lark-Andrecito association, 0 to 15 percent slopes; Llano-Ratscat complex, 0 to 7 percent slopes; Mamtrack-Lark-Transformer complex, 0 to 15 percent slopes; Transformer gypsiferous sand, 0 to 5 percent slopes; Typic Petrogypsids-Oxyaquic Torriorthents complex, 0 to 8 percent slopes; and Yesum gypsiferous sandy loam, 0 to 9 percent slopes (USDA-NRCS 2017).

Vegetation Description
This tall desert shrubland is characterized by a very open canopy (1 to 10%) of *Allenrolfea occidentalis* with a sparse to non-vegetated understory. *Atriplex canescens* can be a common shrub associate along with the introduced shrub *Tamarix chinensis*. While the herbaceous layer is depauperate, scattered individuals of *Sporobolus airoides* may be present. Forbs are particularly scarce, e.g., scattered individuals of annual forbs such as *Abronia angustifolia* and *Machaeranthera tanacetifolia*.

Most Abundant Species

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Succulent evergreen shrub	*Allenrolfea occidentalis*

Other Noteworthy Species
Facultative wetland (FACW) indicator species: *Tamarix chinensis*
New Mexico state-listed noxious weeds: (Class C) *Tamarix chinensis*

Classification Comments
Data are not available.

Classification Confidence
3

Element Sources
Inventory Notes: Data are not available.
Plots: 93MP105, 93JT019, 93MP051, 93MP058, 93MP129, 93MP074, 93MP166, 09YC341, 09YC339, 09YC338, 08CJ006, 08CJ002.

Local Description Authors: A. Fettes

Allenrolfea occidentalis / Suaeda nigra Shrubland

Iodinebush / Bush Seepweed Shrubland

Identifier: CEPP005787

US National Vegetation Classification

Level	Unit
Class	Shrub & Herb Vegetation (2)
Subclass	Shrub & Herb Wetland (2.C)
Formation	Salt Marsh (2.C.5)
Division	North American Western Interior Brackish Marsh, Playa & Shrubland (2.C.5.Nd)
Macrogroup	Warm & Cool Desert Alkali-Saline Marsh, Playa & Shrubland (M082)
Group	North American Desert Alkaline-Saline Wet Scrub [G537]
Association	*Allenrolfea occidentalis / Suaeda nigra* Shrubland

Distribution
This association is known from the dune front near the Playa Trail and from east of the Visitor Center.

Environmental Description
This association occurs from 1,215 to 1,220 m (3,985 to 4,000 ft) in elevation along playa edges and open alkali flats. Soils are typically derived from lacustrine deposits with the presence of crystalline evaporates and fine-textured, eolian sands of gypsiferous origin. The soil surface is nearly barren except for occasional microphytic crusts.

Soils are mapped in the following six units: Flake-Saltspring complex, 0 to 3 percent slopes; Lacarreta-Salago-Ratscat complex, 0 to 3 percent slopes; Massasauga-Sabkha association, 0 to 2 percent slopes; MLRA-42 Gypsic Aquisalids and Gypsic Haplosalids soils, 0 to 1 percent slopes; Yesum gypsiferous fine sandy loam, saline, 0 to 3 percent slopes; and Yesum gypsiferous sandy loam, 0 to 9 percent slopes (USDA-NRCS 2017).

Vegetation Description
This tall desert shrubland is dominated by an open canopy of *Allenrolfea occidentalis*, with the dwarf shrub *Suaeda nigra* as an abundant codominant. *Atriplex canescens* may be common and total shrub cover may reach as high as 20%. Herbaceous cover can vary from sparse to abundant in the inter shrub spaces with *Sporobolus airoides* the most common graminoid representative. Forbs are variable in composition and cover, with annual and biennial species such as *Arida parviflora* and *Lepidium alyssoides* var. *angustifolium* the most prevalent.

Most Abundant Species

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Allenrolfea occidentalis*
Shrub/sapling (tall & short)	Broad-leaved deciduous dwarf-shrub	*Suaeda nigra*

Other Noteworthy Species
Facultative wetland (FACW) indicator species: *Tamarix chinensis*
New Mexico state-listed noxious weeds: (Class C) *Tamarix chinensis*

Classification Comments
Data are not available.

Classification Confidence
3

Element Sources
Inventory Notes: Data are not available.
Plots: 93MP203, 93MP209, 93MP010, 93MP107, 93MP012, 93MP207, 07WS043, 07WS042, 07WS041, 07WS040, 07WS002.

Local Description Authors: E. Muldavin and A. Fettes

Atriplex canescens / Suaeda nigra Shrubland

Fourwing Saltbush / Bush Seepweed Shrubland

Identifier: CEPP007421

US National Vegetation Classification

Level	Unit
Class	Shrub & Herb Vegetation (2)
Subclass	Shrub & Herb Wetland (2.C)
Formation	Salt Marsh (2.C.5)
Division	North American Western Interior Brackish Marsh, Playa & Shrubland (2.C.5.Nd)
Macrogroup	Warm & Cool Desert Alkali-Saline Marsh, Playa & Shrubland (M082)
Group	North American Desert Alkaline-Saline Wet Scrub [G537]
Association	*Atriplex canescens / Suaeda nigra* Shrubland

Distribution

This association is known from open flats north of the Visitor Center.

Environmental Description

This association occurs from 1,215 to 1,220 m (3,985 to 4,000 ft) in elevation on alkali alluvial flats and playas. Soils are derived from a mix of sandy, gypsiferous eolian and lacustrine deposits. The ground surface is characterized primarily by exposed soil and microphytic crusts.

Soils are mapped in the following two units: Yesum gypsiferous fine sandy loam, saline, 0 to 3 percent slopes and Yesum gypsiferous sandy loam, 0 to 9 percent slopes (USDA-NRCS 2017).

Vegetation Description

This tall desert shrubland is dominated by an open canopy of *Atriplex canescens*, with the dwarf-shrub *Suaeda nigra* as a well represented to abundant associate. Forbs are variable in composition and cover with annual and biennial species such as *Arida parviflora* and *Lepidium alyssoides* var. *angustifolium* the most prevalent.

Most Abundant Species

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved deciduous dwarf-shrub	*Atriplex canescens*
Shrub/sapling (tall & short)	Broad-leaved deciduous dwarf-shrub	*Suaeda nigra*

Other Noteworthy Species

Data are not available.

Classification Comments

Data are not available.

Classification Confidence

3

Element Sources

Inventory Notes: Data are not available.

Plots: 93JT003, 07WS022, 07WS012, 07WS010, 07WS008, 07WS003.

Local Description Authors: E. Muldavin and A. Fettes

Suaeda nigra Wet Shrubland

Shrubby Seepweed Wet Shrubland

Identifier: CEGL001991

US National Vegetation Classification

Level	Unit
Class	Shrub & Herb Vegetation (2)
Subclass	Shrub & Herb Wetland (2.C)
Formation	Salt Marsh (2.C.5)
Division	North American Western Interior Brackish Marsh, Playa & Shrubland (2.C.5.Nd)
Macrogroup	Warm & Cool Desert Alkali-Saline Marsh, Playa & Shrubland (M082)
Group	North American Desert Alkaline-Saline Wet Scrub [G537]
Association	*Suaeda nigra* Wet Shrubland

Distribution

This association is known from the northwestern corner of the monument.

Environmental Description

This association occurs from 1,190 to 1,200 m (3,905 to 3,935 ft) in elevation on alluvial flats and playa margins. Soils are derived from gypsum or mixed alluvium. The ground surface is characterized primarily by exposed soil with sparse herbaceous cover and occasional gravel or cobble.

Soils are mapped in the following two units: Mimbres-Chutum-Ybar complex, 0 to 5 percent slopes and Typic Petrogypsids-Oxyaquic Torriorthents complex, 0 to 8 percent slopes (USDA-NRCS 2017).

Vegetation Description

This alkaline scrub association is characterized by open canopies of *Suaeda nigra* with a sparse to non-vegetated understory. Diversity is low, with only eleven additional species recorded. The most common were the dwarf-shrub *Isocoma pluriflora* and the graminoid *Sporobolus airoides*.

Most Abundant Species

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved deciduous dwarf-shrub	*Suaeda nigra*

Other Noteworthy Species

Facultative wetland (FACW) indicator species: *Distichlis spicata*

Classification Comments

Data are not available.

Classification Confidence

2

Element Sources

Inventory Notes: Data are not available.

Plots: 93MP125, 93MP130.

Local Description Authors: E. Muldavin and A. Fettes

Distichlis spicata Alkaline Wet Meadow

Inland Saltgrass Alkaline Wet Meadow

Identifier: CEGL001770

US National Vegetation Classification

Level	Unit
Class	Shrub & Herb Vegetation (2)
Subclass	Shrub & Herb Wetland (2.C)
Formation	Salt Marsh (2.C.5)
Division	North American Western Interior Brackish Marsh, Playa & Shrubland (2.C.5.Nd)
Macrogroup	Warm & Cool Desert Alkali-Saline Marsh, Playa & Shrubland (M082)
Group	North American Desert Alkaline-Saline Marsh & Playa [G538]
Association	*Distichlis spicata* Alkaline Wet Meadow

Distribution

This association is known from the basin floor alluvial plain in the east-central portion of the monument (east of US Hwy 82).

Environmental Description

This association is known from a lowland site on an alluvial plain at 1,220 m (4,003 ft) in elevation with a low slope (3%) and NNE aspect. Exposed soil surface was relatively low with 21% cover. Soils are alkaline and sandy with high gypsum content and a shallow water table. This sandy site is stabilized by dense herbaceous vegetation. Geology is basin floor sediments (Holocene and late Pleistocene).

Soils are mapped in the MLRA-42 Gypsic Aquisalids and Gypsic Haplosalids soils, 0 to 1 percent slopes (USDA-NRCS 2017).

Vegetation Description

This warm desert, alkaline grassland is characterized by a luxuriant cover of *Distichlis spicata*. Total graminoid cover can be as high as 60%. Shrubs occur on the edge of the wetland and are low in diversity and abundance (<5% cover) with *Allenrolfea occidentalis* poorly represented and scattered *Suaeda nigra* and exotic *Tamarix chinensis*. *Schoenoplectus americanus* was present in stand but formed 10 meters wide patch on the upslope and outside of the plot. Forbs are low in diversity and abundance (<1% cover) and include *Arida parviflora*, *Laennecia coulteri*, *Lepidium alyssoides* var. *angustifolium*, *Mentzelia* spp., *Sphaeralcea angustifolia*, and exotic annuals *Kochia scoparia* and *Salsola tragus*.

Most Abundant Species

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Distichlis spicata*

Other Noteworthy Species

Facultative wetland (FACW) indicator species: *Tamarix chinensis*, *Distichlis spicata*

New Mexico state-listed noxious weeds: (Class C) *Tamarix chinensis*

Classification Comments

Data are not available.

Classification Confidence

2

Element Sources

Inventory Notes: Data are not available.

Plots: 07WS044.

Local Description Authors: K. Schulz

Sporobolus airoides - Distichlis spicata Wet Meadow

Alkali Sacaton - Inland Saltgrass Wet Meadow

Identifier: CEGL001687

US National Vegetation Classification

Level	Unit
Class	Shrub & Herb Vegetation (2)
Subclass	Shrub & Herb Wetland (2.C)
Formation	Salt Marsh (2.C.5)
Division	North American Western Interior Brackish Marsh, Playa & Shrubland (2.C.5.Nd)
Macrogroup	Warm & Cool Desert Alkali-Saline Marsh, Playa & Shrubland (M082)
Group	North American Desert Alkaline-Saline Marsh & Playa [G538]
Association	*Sporobolus airoides - Distichlis spicata* Wet Meadow

Distribution

This association is known from the basin floor alluvial plain in the southeastern portion of the park.

Environmental Description

This association is known from 1,215 m (3,985 ft) in elevation on an alluvial flat that abuts the upwind edge of the parabolic dunefield. In this basin bottom position against the dunes, water often accumulates during the rainy season and ground water may be near the surface. The soils are derived from gypsum and sediments of mixed mineralogy that lie on the basin floor. The ground surface is characterized by dense herbaceous cover and litter (90% average cover), with herbaceous litter containing patches of soil in the interplant spaces.

Soil mapped for this site is Yesum gypsiferous fine sandy loam, saline, 0 to 3 percent slopes (USDA-NRCS 2017).

Vegetation Description

This warm desert, alkaline grassland is characterized by a luxuriant cover of *Sporobolus airoides* and *Distichlis spicata*. Total graminoid cover can be as high as 90%. Shrubs and forbs are low in diversity and abundance (<1% cover).

Most Abundant Species

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Distichlis spicata, Sporobolus airoides*

Other Noteworthy Species
Facultative wetland (FACW) indicator species: *Distichlis spicata*, *Phragmites australis* ssp. *americanus*
Weed status (other states): *Phragmites australis* ssp. *americanus*

Classification Comments

Data are not available.

Classification Confidence

3

Element Sources

Inventory Notes: Data are not available.
Plots: 07WS016.

Local Description Authors: E. Muldavin and A. Fettes

Sporobolus airoides Monotype Grassland

Alkali Sacaton Monotype Grassland

Identifier: CEGL001688

US National Vegetation Classification

Level	Unit
Class	Shrub & Herb Vegetation (2)
Subclass	Shrub & Herb Wetland (2.C)
Formation	Salt Marsh (2.C.5)
Division	North American Western Interior Brackish Marsh, Playa & Shrubland (2.C.5.Nd)
Macrogroup	Warm & Cool Desert Alkali-Saline Marsh, Playa & Shrubland (M082)
Group	North American Desert Alkaline-Saline Marsh & Playa [G538]
Association	*Sporobolus airoides* Monotype Grassland

Distribution

This association is widespread throughout the monument.

Environmental Description

This association is known from 1,190 to 1,235 m (3,905 to 4,050 ft) in elevation and occurs on alluvial open flats, playas, and interdune areas. Sites are often low-lying areas or depressions where water tends to accumulate or where the water table likely close to the surface, particularly during the rainy season. Sites are typified by relatively high grass and litter cover with open soil between grass hummocks.

Soils are mapped in the following fourteen units: Astrobee-Lark-Nasa complex, 0 to 20 percent slopes; Corvus-Astrobee-Lark complex, 0 to 25 percent slopes; Lark-Andrecito association, 0 to 15 percent slopes; Lark-Astrobee-Nasa complex, 0 to 40 percent slopes; Lark-Transformer association, 0 to 90 percent slopes, duneland; Llano-Ratscat complex, 0 to 7 percent slopes; Nasa-Yesum complex, 0 to 6 percent slopes; Piedrablanca-Wulie-Nasa complex, 0 to 6 percent slopes; Queencreek-Agustin-Stagecoach complex, 0 to 14 percent slopes; Torbellino-Lark association, 0 to 15 percent slopes; Typic Petrogypsids-Oxyaquic Torriorthents complex, 0 to 8 percent slopes; Typic Torriorthents-Corvus complex, 0 to 6 percent slopes; Yesum gypsiferous fine sandy loam, saline, 0 to 3 percent slopes; and Yesum gypsiferous sandy loam, 0 to 9 percent slopes (USDA-NRCS 2017).

Vegetation Description

This semi-desert grassland is characterized by a nearly uniform and luxuriant cover of *Sporobolus airoides*. Total grass cover can be as high as 80%. Although more or less forming monotypic stands, there are other scattered graminoids and forbs (56 species recorded in this association). Among forbs, *Asclepias subverticillata*, *Arida parviflora*, *Lepidium alyssoides* var. *angustifolium*, and *Phacelia integrifolia* are the most prevalent. Shrub cover is limited to occasional *Allenrolfea occidentalis* or *Atriplex canescens*.

Most Abundant Species

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Sporobolus airoides*

Other Noteworthy Species

Facultative wetland (FACW) indicator species: *Tamarix chinensis, Limonium limbatum*

New Mexico state-listed noxious weeds: (Class C) *Tamarix chinensis*

Classification Comments

Data are not available.

Classification Confidence

2

Element Sources

Inventory Notes: Data are not available.

Plots: 93MP004, 93MP009, 93MP068, 93MP104, 93MP037, 93MP163, 93MP192, 93MP160, 93MP132, 93JT024, 93MP127, 93MP078, 93MP102, 93MP141, 93JT022, 93MP194, 07WS006, 07WS015, 07WS001, 09YC327, 07WS046, 09YC312, 09YC313, 07WS005, 07WS024.

Local Description Authors: E. Muldavin and A. Fettes

Larrea tridentata / Muhlenbergia porteri Shrubland

Creosotebush / Bush Muhly Shrubland

Identifier: CEGL001272

US National Vegetation Classification

Level	Unit
Class	Desert & Semi-Desert (3)
Subclass	Warm Desert & Semi-Desert Woodland, Scrub & Grassland (3.A)
Formation	Warm Desert & Semi-Desert Scrub & Grassland (3.A.2)
Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Chihuahuan Desert Scrub (M086)
Group	Chihuahuan Creosotebush - Mixed Desert Scrub [G288]
Association	*Larrea tridentata / Muhlenbergia porteri* Shrubland

Distribution
This association is known from an alluvial slope of the San Andreas Mountains in the southwestern corner of the monument.

Environmental Description
This association occurs on lower coalesced alluvial fan piedmont of mixed mineralogy.

Vegetation Description
This open shrubland is dominated by abundant *Larrea tridentata*, with *Prosopis glandulosa* as common shrub associate. *Muhlenbergia porteri* is often abundant, dominating underneath the shrub canopy. The inter shrub spaces are typically sparse with no other grasses or forbs greater than 0.05% cover.

Most Abundant Species

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Larrea tridentata*
Herb (field)	Graminoid	*Muhlenbergia porteri*

Other Noteworthy Species
Data are not available.

Classification Comments
Data are not available.

Classification Confidence
2

Element Sources
Inventory Notes: Data are not available.
Plots: 93MP198.

Local Description Authors: E. Muldavin and A. Fettes

Larrea tridentata - Parthenium incanum Shrubland

Creosotebush - Mariola Shrubland

Identifier: CEGL001274

US National Vegetation Classification

Level	Unit
Class	Desert & Semi-Desert (3)
Subclass	Warm Desert & Semi-Desert Woodland, Scrub & Grassland (3.A)
Formation	Warm Desert & Semi-Desert Scrub & Grassland (3.A.2)
Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Chihuahuan Desert Scrub (M086)
Group	Chihuahuan Creosotebush - Mixed Desert Scrub [G288]
Association	*Larrea tridentata - Parthenium incanum* Shrubland

Distribution

This association is known from two plots on alluvial fans below the San Andres Mountains along the western edge of the monument.

Environmental Description

This association occurs on the top and on an eroded side slope of upper bajada slopes below the San Andres Mountains. Elevations range from 1,263 to 1,276 m (4,144 to 4,186 ft). Slopes are gentle to moderate (4-14%) with north to northwest aspects. Sites have high gravel cover (75-80%) and low soil and rock cover. Geology is mapped older piedmont slope deposits.

Vegetation Description

This open shrubland is characterized by *Larrea tridentata* (18-29% cover) dominated short shrub layer and *Parthenium incanum* (8-18% cover) dominated dwarf-shrub layer. Other scattered woody associates may include *Prosopis glandulosa* and Condalia warnockii shrubs and diverse dwarf-shrubs such as *Echinocactus horizonthalonius*, *Echinocereus coccineus*, *Opuntia macrocentra*, *Thymophylla acerosa*, and *Tiquilia canescens*. Herbaceous cover is a typically a low diversity mixture perennial and annuals graminoids and forbs with one plot dominated by *Muhlenbergia porteri* with 9% cover.

Most Abundant Species

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Larrea tridentata*
Shrub/sapling (tall & short)	Broad-leaved dwarf-shrub	*Parthenium incanum*
Herb (field)	Graminoid	*Muhlenbergia porteri*

Other Noteworthy Species

Data are not available.

Classification Comments

Data are not available.

Classification Confidence

2

Element Sources

Inventory Notes: Data are not available.

Plots: 14WS116, 14WS117.

Local Description Authors: K. Schulz

Larrea tridentata / Sparse Understory Shrubland

Creosotebush / Sparse Understory Shrubland

Identifier: CEGL001276

US National Vegetation Classification

Level	Unit
Class	Desert & Semi-Desert (3)
Subclass	Warm Desert & Semi-Desert Woodland, Scrub & Grassland (3.A)
Formation	Warm Desert & Semi-Desert Scrub & Grassland (3.A.2)
Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Chihuahuan Desert Scrub (M086)
Group	Chihuahuan Creosotebush - Mixed Desert Scrub [G288]
Association	*Larrea tridentata* / Sparse Understory Shrubland

Distribution

This association is known from the alluvial slopes of the San Andreas Mountains in the southwestern corner of the monument.

Environmental Description

This association occurs from 1,200 to 1,235 m (3,935 to 4,050 ft) in elevation on coalesced alluvial fan piedmonts of mixed mineralogy. The ground surface is characterized by sparse herbaceous vegetation with intershrub spaces of barren soil mixed with gravel and cobble.

Soils are mapped in the following unit: Mimbres-Chutum-Ybar complex, 0 to 5 percent slopes (USDA-NRCS 2017).

Vegetation Description

This open shrubland is dominated by *Larrea tridentata* with *Prosopis glandulosa* and *Gutierrezia sarothrae* as common shrub associates. Grasses and forbs are poorly represented and species diversity low (five understory species were reported for the association on White Sands NM).

Most Abundant Species

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Larrea tridentata*

Other Noteworthy Species

Data are not available.

Classification Comments

Data are not available.

Classification Confidence

2

Element Sources

Inventory Notes: Data are not available.

Plots: 93MP199, 93JT014, 93MP047, 93MP046, 93MP187.

Local Description Authors: E. Muldavin and A. Fettes

Flourensia cernua / Muhlenbergia porteri Shrubland

Tarbush / Bush Muhly Shrubland

Identifier: CEPP007428

US National Vegetation Classification

Level	Unit
Class	Desert & Semi-Desert (3)
Subclass	Warm Desert & Semi-Desert Woodland, Scrub & Grassland (3.A)
Formation	Warm Desert & Semi-Desert Scrub & Grassland (3.A.2)
Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Chihuahuan Desert Scrub (M086)
Group	Chihuahuan Creosotebush - Mixed Desert Scrub [G288]
Association	*Flourensia cernua / Muhlenbergia porteri* Shrubland

Distribution

This association is known from the alluvial slopes of the San Andreas Mountains along the western edge of the monument.

Environmental Description

This association occurs from 1,205 to 1,235 m (3,955 to 4,050 ft) in elevation on coalesced alluvial fan piedmonts. The ground surface is characterized by exposed, sandy soils and gravels along with scattered herbaceous cover.

Soils are mapped in the following two units: Agustin-Vado-Riverwash complex, 1 to 10 percent slopes and Mimbres-Chutum-Ybar complex, 0 to 5 percent slopes (USDA-NRCS 2017).

Vegetation Description

This tall shrubland is characterized by a very open canopy of *Flourensia cernua*; *Atriplex canescens* may be a common to well represented shrub associate. *Muhlenbergia porteri* is abundant and the dominant grass. Forbs are generally low in cover and represented by a mix of weedy annuals and small native perennials such as *Bahia absinthifolia* and *Tidestromia lanuginosa*.

Most Abundant Species

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Allenrolfea occidentalis*
Shrub/sapling (tall & short)	Broad-leaved evergreen shrub	*Atriplex canescens*
Herb (field)	Graminoid	*Muhlenbergia porteri*

Other Noteworthy Species

Data are not available.

Classification Comments

Data are not available.

Classification Confidence

3

Element Sources

Inventory Notes: Data are not available.

Plots: 93MP197, 93JT017, 93MP049.

Local Description Authors: E. Muldavin and A. Fettes

Atriplex canescens / Sparse Shrubland

Fourwing Saltbush / Sparse Shrubland

Identifier: CEPP007413

US National Vegetation Classification

Level	Unit
Class	Desert & Semi-Desert (3)
Subclass	Warm Desert & Semi-Desert Woodland, Scrub & Grassland (3.A)
Formation	Warm Desert & Semi-Desert Scrub & Grassland (3.A.2)
Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Chihuahuan Desert Scrub (M086)
Group	Chihuahuan Desert Lowland Basin Scrub [G299]
Association	*Atriplex canescens* / Sparse Shrubland

Distribution

This association is known from basin flats and interdune areas scattered across the monument.

Environmental Description

This community occurs on alkali flats and in interdune areas and high cover of bare soil (40-82% cover). Soils are sandy with high gypsum content. Geology is largely gypsiferous lake deposits in the Tularosa Basin and Active gypsum dunes (Holocene and latest Pleistocene).

Vegetation Description

This vegetation is characterized by a sparse to open shrub canopy with 4-9% cover that is dominated by *Atriplex canescens*. Herbaceous cover is poorly represented to scarce (generally <5% cover). *Suaeda* spp. is absent. Other shrubs may be scattered such as *Cylindropuntia imbricata*, *Cylindropuntia leptocaulis*, *Ephedra torreyana*, *Echinocereus triglochidiatus* and *Tiquilia hispidissima*. There may be some scattered herbaceous species including *Sporobolus airoides*, *Sporobolus nealleyi* and *Aristida purpurea*.

Most Abundant Species

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Atriplex canescens*

Other Noteworthy Species

Data are not available.

Classification Comments

Data are not available.

Classification Confidence

3

Element Sources

Inventory Notes: Data are not available.

Plots: 16MP052, 16MP053, 16MP056, 16MP057.

Local Description Authors: K. Schulz

Flourensia cernua / Sporobolus airoides Shrubland

Tarbush / Alkali Sacaton Shrubland

Identifier: CEGL001337

US National Vegetation Classification

Level	Unit
Class	Desert & Semi-Desert (3)
Subclass	Warm Desert & Semi-Desert Woodland, Scrub & Grassland (3.A)
Formation	Warm Desert & Semi-Desert Scrub & Grassland (3.A.2)
Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Chihuahuan Desert Scrub (M086)
Group	Chihuahuan Desert Lowland Basin Scrub [G299]
Association	*Flourensia cernua / Sporobolus airoides* Shrubland

Distribution

This association is known from the alluvial plains in the southwest portion of the monument.

Environmental Description

This association occurs on alluvial plains and an alluvial toeslope that merges into the basin bottom. Elevations range from 1,200 to 1,208 m (3,938 to 4,064 ft). The ground surface is characterized by exposed, sandy soils and gravels up to 84% cover of bare soil along with scattered herbaceous cover. Soils are sandy gypsiferous outcrops. Geology is mapped as Younger piedmont-slope deposits (Holocene and latest Pleistocene).

Soils are mapped in the Mimbres-Chutum-Ybar complex, 0 to 5 percent slopes (USDA-NRCS 2017).

Vegetation Description

This shrubland is characterized by an open canopy of *Flourensia cernua* that ranges from common to abundant with a graminoid layer dominated by *Sporobolus airoides* that is well represented to abundant. *Muhlenbergia porteri* is typically scarce if present. Shrub associations may include common to scattered *Atriplex canescens* and scattered *Larrea tridentata*, Lycium berlandieri, *Gutierrezia sarothrae* or *Prosopis glandulosa*. Forbs are generally low in cover and represented by a mix of weedy annuals and small native perennials such as *Lepidium montanum* and *Salsola tragus*.

Most Abundant Species

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Flourensia cernua*
Herb (field)	Graminoid	*Sporobolus airoides*

Other Noteworthy Species

Facultative wetland (FACW) indicator species: *Tamarix chinensis*

New Mexico state-listed noxious weeds: (Class C) *Tamarix chinensis*

Classification Comments

Data are not available.

Classification Confidence

1

Element Sources

Inventory Notes: Data are not available.

Plots: 93MP040, 93MP069

Local Description Authors: K. Schulz

Prosopis glandulosa / Sporobolus airoides Shrubland

Honey Mesquite / Alkali Sacaton Shrubland

Identifier: CEGL001385

US National Vegetation Classification

Level	Unit
Class	Desert & Semi-Desert (3)
Subclass	Warm Desert & Semi-Desert Woodland, Scrub & Grassland (3.A)
Formation	Warm Desert & Semi-Desert Scrub & Grassland (3.A.2)
Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Chihuahuan Desert Scrub (M086)
Group	Chihuahuan Desert Lowland Basin Scrub [G299]
Association	*Prosopis glandulosa / Sporobolus airoides* Shrubland

Distribution

This association is known from the alluvial fan piedmont slopes of the San Andres Mountains along the western edge of the monument.

Environmental Description

This association is known from 1,190 to 1,210 m (3,905 to 3,970 ft) in elevation and occurs on lower alluvial fan aprons extending out on to alluvial flats. The surficial geologic substrates include mixed sedimentary calcareous alluvium, sandy alluvium, or gypsum. The ground cover is characterized by tussocks of grass with barren soil in the inter-grass spaces. Areas of crystalline gypsum evaporates are common, especially in the lowest areas along the Lake Lucero shoreline.

Soils are mapped in the following four units: Mimbres-Chutum-Ybar complex, 0 to 5 percent slopes; Salago-Typic Aquisalids-Petrogypsic Haplosalids complex, 0 to 5 percent slopes; Typic Petrogypsids-Oxyaquic Torriorthents complex, 0 to 8 percent slopes; and Typic Torriorthents-Corvus complex, 0 to 6 percent slopes (USDA-NRCS 2017).

Vegetation Description

This shrubland is characterized by an open canopy of invasive *Prosopis glandulosa* over a grassy understory dominated by *Sporobolus airoides*. *Sporobolus airoides* forms nearly monotypic stands that can exceed 60% in some areas. The shrub *Atriplex canescens* is often present but seldom exceeds 5% cover. Other forbs and grasses are few and of little cover.

Most Abundant Species

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Prosopis glandulosa*
Herb (field)	Graminoid	*Sporobolus airoides*

Other Noteworthy Species

None

Classification Comments

Data are not available.

Classification Confidence

1

Element Sources

Inventory Notes: Data are not available.

Plots: 93MP122, 93MP123, 93MP190, 93MP124, 93MP191, 93MP045, 93MP090, 93MP044, 93MP041, 93MP042, 93MP091, 93MP195, 93MP075, 93MP128.

Local Description Authors: E. Muldavin and A. Fettes

Rhus trilobata / Sporobolus airoides Shrubland

Skunkbush Sumac / Alkali Sacaton Shrubland

Identifier: CEPP007446

US National Vegetation Classification

Level	Unit
Class	Desert & Semi-Desert (3)
Subclass	Warm Desert & Semi-Desert Woodland, Scrub & Grassland (3.A)
Formation	Warm Desert & Semi-Desert Scrub & Grassland (3.A.2)
Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Chihuahuan Desert Scrub (M086)
Group	Chihuahuan Gypsophilous Scrub [G299]
Association	*Rhus trilobata / Sporobolus airoides* Shrubland

Distribution

This association occurs in a very narrow valley (arroyo) within the gypsum dunefield. Soil surfaces are characterized by patches of grasses across fine-textured to gypsum sand deposits.

Environmental Description

This dune shrubland is dominated by *Rhus trilobata* with over 25% cover with *Sporobolus airoides* diagnostic and abundant grass in the intershrub spaces. Other scattered shrubs may be present such as *Atriplex canescens*, *Baccharis salicina*, *Poliomintha incana*, and *Yucca elata*.

Vegetation Description

This active dune association occurs on large coppice mounds around very large *Rhus trilobata* with *Poliomintha incana* common to well represented, and scattered *Yucca elata* and *Atriplex canescens*. Other less consistent sparse shrubs may be present such as *Ephedra torreyana*, *Ericameria nauseosa* and *Psorothamnus scoparius*. Scattered *Populus deltoides* ssp. *wislizeni* may be present and exotic *Tamarix chinensis* occurred along the lake edge. Herbaceous species are poorly represented to scarce and may include scattered *Abronia angustifolia*, *Achnatherum hymenoides, Muhlenbergia pungens*, *Schizachyrium neomexicanum*, *Sporobolus airoides*, or *Sporobolus giganteus*.

Most Abundant Species

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Rhus trilobata*
Herb (field)	Graminoid	*Sporobolus airoides*

Other Noteworthy Species

Data are not available.

Classification Comments

Data are not available.

Classification Confidence

3

Element Sources

Inventory Notes: Data are not available.

Plots: 93MP008

Local Description Authors: K. Schulz

Poliomintha incana / Sporobolus flexuosus Shrubland

Frosted Mint / Mesa Dropseed Muhly Shrubland

Identifier: NHNM000615

US National Vegetation Classification

Level	Unit
Class	Desert & Semi-Desert (3)
Subclass	Warm Desert & Semi-Desert Woodland, Scrub & Grassland (3.A)
Formation	Warm Desert & Semi-Desert Scrub & Grassland (3.A.2)
Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Chihuahuan Desert Scrub (M086)
Group	Chihuahuan Desert Sand Scrub [G287]
Association	*Poliomintha incana / Sporobolus flexuosus* Shrubland

Distribution

This association is known from in the northeastern, west-central, and southwestern portions of the monument.

Environmental Description

This association is known from 1,189 to 1,232 m (3,901 to 4,042 ft) in elevation and typically occurs on marginal parabolic dunes, active small parabolic dunes, and vegetated small dunes. Substrates may include active quartz or gypsum sand dune often with patches of stabilized soil and crust especially at edges. Ground cover has is high cover of bare soil (83-94 %) and variable amounts of gravel (0-30%) and litter (10-15%). Geology is mostly mapped as active gypsum dunes (Holocene and latest Pleistocene) with one site one gypsiferous lake deposits in the Tularosa Basin (Holocene and latest Pleistocene) that has likely been covered by gypsum sand deposits.

Soils are mapped in the following three units: Astrobee-Lark association, 0 to 35 percent slopes; Lark-Andrecito association, 0 to 15 percent slopes; and Lark-Piedrablanca-Wulie complex, 0 to 25 percent slopes (USDA-NRCS 2017).

Vegetation Description

This open dune shrubland is characterized by dominance of *Poliomintha incana* that is well represented with the dominant grass, *Sporobolus flexuosus* common to well represented in the graminoid layer. *Ephedra torreyana*, conspicuous *Yucca elata*, and the dwarf-shrub *Tiquilia hispidissima* are scattered throughout the stands. Other shrubs may include *Atriplex canescens*, *Rhus trilobata* and *Psorothamnus scoparius*. Additional herbaceous species include a sparse, but diverse mixture of psammophilus and gypsophilous perennial and annual grasses and forbs with 20 species recorded. The most constant of these associates are *Abronia angustifolia*, *Achnatherum hymenoides*, *Calylophus hartwegii* ssp. *filifolius*, *Dicranocarpus parviflorus*, *Mentzelia perennis*, *Muhlenbergia pungens*, *Sphaeralcea angustifolia*, *Sporobolus airoides*, and *Thelesperma megapotamicum*. Less common gypsophilous species include *Bouteloua breviseta*, *Sartwellia flaveriae*, and *Sporobolus nealleyi*.

Most Abundant Species

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Poliomintha incana*
Herb (field)	Graminoid	*Sporobolus flexuosus*

Other Noteworthy Species

Data are not available.

Classification Comments

Data are not available.

Classification Confidence

3

Element Sources
Inventory Notes: Data are not available.
Plots: 14WS070, 14WS133, 14WS138, 14WS140, 14WS142.

Local Description Authors: K. Schulz

Psorothamnus scoparius / Sporobolus flexuosus Shrubland

Broom Smokebush / Mesa Dropseed Shrubland

Identifier: CEGL001695

US National Vegetation Classification

Level	Unit
Class	Desert & Semi-Desert (3)
Subclass	Warm Desert & Semi-Desert Woodland, Scrub & Grassland (3.A)
Formation	Warm Desert & Semi-Desert Scrub & Grassland (3.A.2)
Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Chihuahuan Desert Scrub (M086)
Group	Chihuahuan Desert Sand Scrub [G287]
Association	*Psorothamnus scoparius / Sporobolus flexuosus* Shrubland

Distribution
This association is known from the marginal dunes just east of Lake Lucero.

Environmental Description
This association occurs from 1,190 to 1,200 m (3,905 to 3,945 ft) in elevation and is associated with partially stabilized parabolic dune formations. Soils are fine-textured, eolian sand deposits of gypsiferous origin. The ground surface is characterized by sparse herbaceous vegetation with intershrub spaces of barren sands.

Soils are mapped in the following two units: Lark-Astrobee-Nasa complex, 0 to 40 percent slopes and Torbellino-Lark association, 0 to 15 percent slopes (USDA-NRCS 2017).

Vegetation Description
This open shrubland is dominated by *Psorothamnus scoparius*, with scattered grasses in the intershrub spaces that include *Sporobolus contractus*, *Sporobolus flexuosus*, and *Sporobolus airoides*. The shrub canopy can be intermixed with *Poliomintha incana*, *Yucca elata*, and *Atriplex canescens*, with total shrub cover as high as 20%. Forb diversity and cover is low, with only three species recorded for this association.

Most Abundant Species

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Psorothamnus scoparius*
Herb (field)	Graminoid	*Sporobolus airoides*

Other Noteworthy Species
None

Classification Comments
Data are not available.

Classification Confidence
2

Element Sources
Inventory Notes: Data are not available.
Plots: 93MP162, 93MP159, 09YC322.

Local Description Authors: E. Muldavin and A. Fettes

Atriplex canescens / Sporobolus nealleyi Shrubland

Fourwing Saltbush / Gyp Dropseed Shrubland

Identifier: CEPP007287

US National Vegetation Classification

Level	Unit
Class	Desert & Semi-Desert (3)
Subclass	Warm Desert & Semi-Desert Woodland, Scrub & Grassland (3.A)
Formation	Warm Desert & Semi-Desert Scrub & Grassland (3.A.2)
Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Chihuahuan Desert Scrub (M086)
Group	Chihuahuan Gypsophilous Scrub [G847]
Association	*Atriplex canescens* / *Sporobolus nealleyi* Shrubland

Distribution
This association is known from the dune front and marginal dune areas throughout the southeastern portions of the monument.

Environmental Description
This community is known from 1,205 to 1,240 m (3,955 to 4,070 ft) in elevation and occurs on alluvial plains, basin flats, and in interdune areas between active barchanoid or stabilized parabolic dunes. Soils are derived from fine-textured to sandy gypsum, eolian deposits and crystalline evaporates. The vegetation is associated with the summits of hummocks of gypsum outcrop that form micro-relief topography. Microphytic crusts are common.

Soils are mapped in the following eleven units: Astrobee-Lark association, 0 to 35 percent slopes; Astrobee-Lark-Nasa complex, 0 to 20 percent slopes; Corvus-Astrobee-Lark complex, 0 to 25 percent slopes; Corvus-Peligro-Nasa complex, 0 to 5 percent slopes; Lark-Astrobee-Nasa complex, 0 to 40 percent slopes; Lark-Transformer association, 0 to 40 percent slopes; Nasa-Yesum complex, 0 to 6 percent slopes; Peligro gypsiferous sandy loam, 0 to 15 percent slopes; Piedrablanca-Wulie-Nasa complex, 0 to 6 percent slopes; Yesum gypsiferous fine sandy loam, saline, 0 to 3 percent slopes; and Yesum gypsiferous sandy loam, 0 to 9 percent slopes (USDA-NRCS 2017).

Vegetation Description
This interdune shrubland is characterized by an open canopy of *Atriplex canescens*, with Sporobolus nealleyi abundant in the intershrub spaces. *Tiquilia hispidissima*, *Ephedra torreyana* and *Suaeda nigra* are common dwarf-shrub associates. While diverse (73 total species recorded for this association), composition and cover is variable. *Sartwellia flaveriae* is the most common and consistent forb.

Most Abundant Species

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Atriplex canescens*
Herb (field)	Graminoid	*Sporobolus nealleyi*

Other Noteworthy Species
None

Classification Comments
Data are not available.

Classification Confidence
2

Element Sources
Inventory Notes: Data are not available.
Plots: 93MP014, 93MP020, 93MP205, 93MP208, 93MP021, 93MP028, 93MP018, 93MP179, 93MP181, 93MP082, 93MP035, 93MP140, 93MP039, 93MP026, 93MP036, 93MP038, 93JT006, 93JT011, 93MP155, 93MP015, 09YC288, 09YC287, 09YC276, 09YC275, 07WS028, 07WS026, 07WS027, 09YC289, 07WS039.

Local Description Authors: E. Muldavin and A. Fettes

Larrea tridentata / Sporobolus nealleyi Shrubland

Creosotebush / Gyp Dropseed Shrubland

Identifier: CEPP007342

US National Vegetation Classification

Level	Unit
Class	Desert & Semi-Desert (3)
Subclass	Warm Desert & Semi-Desert Woodland, Scrub & Grassland (3.A)
Formation	Warm Desert & Semi-Desert Scrub & Grassland (3.A.2)
Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Chihuahuan Desert Scrub (M086)
Group	Chihuahuan Gypsophilous Scrub [G847]
Association	*Larrea tridentata / Sporobolus nealleyi* Shrubland

Distribution
This minor association is known from areas east of the Visitor Center.

Environmental Description
This association is known from 1,225 m (4,020 ft) in elevation and occurs on alluvial plains with discontinuous eolian gypsum deposits. The ground surface is characterized by scattered herbaceous vegetation and associated litter, with extensive intershrub spaces of a barren, exposed mix of soil and gravel.

Soils are mapped in the Corvus-Peligro complex, 0 to 10 percent slopes (USDA-NRCS 2017).

Vegetation Description
This shrubland is characterized by a sparse canopy of *Larrea tridentata* as the dominant shrub, with scattered *Ephedra torreyana* as a common dwarf-shrub associate along with *Tiquilia hispidissima*. In the herbaceous layer, the gypsophilous *Sporobolus nealleyi* is well represented to abundant, with *Sporobolus airoides* as a common associate. Forbs are few and scattered.

Most Abundant Species

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Larrea tridentata*
Herb (field)	Graminoid	*Sporobolus nealleyi*

Other Noteworthy Species
None

Classification Comments
Data are not available.

Classification Confidence
3

Element Sources
Inventory Notes: Data are not available.
Plots: 07WS045.

Local Description Authors: E. Muldavin and A. Fettes

Poliomintha incana / Bouteloua breviseta Gypsophilous Shrubland

Frosted Mint / Gypsum Grama Gypsophilous Shrubland

Identifier: CEPP007347

US National Vegetation Classification

Level	Unit
Class	Desert & Semi-Desert (3)
Subclass	Warm Desert & Semi-Desert Woodland, Scrub & Grassland (3.A)
Formation	Warm Desert & Semi-Desert Scrub & Grassland (3.A.2)
Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Chihuahuan Desert Scrub (M086)
Group	Chihuahuan Gypsophilous Scrub [G847]
Association	*Poliomintha incana / Bouteloua breviseta* Gypsophilous Shrubland

Distribution
This association is known from the eastern and southeastern dune periphery of the monument.

Environmental Description
This association is known from 1,210 to 1,225 m (3,970 to 4,020 ft) in elevation and occurs mostly on low, parabolic gypsum dunes, but it may extend into the active barchanoid dune areas as an initial stabilizer of shifting dunes. Soil surfaces are characterized by patches of grasses and litter distributed across fine-textured to gypsum sand deposits.

Soils are mapped in the following three units: Astrobee-Lark association, 0 to 35 percent slopes; Lark-Astrobee-Nasa complex, 0 to 40 percent slopes; and Lark-Transformer association, 0 to 40 percent slopes (USDA-NRCS 2017).

Vegetation Description
This open dune shrubland is dominated by *Poliomintha incana*, with the dwarf shrub, *Ephedra torreyana* usually present. *Bouteloua breviseta* is diagnostic as the well represented to abundant grass in the intershrub spaces. While scattered individuals of *Muhlenbergia pungens*, *Sporobolus airoides*, and *Schizachyrium neomexicanum* may be present, they are clearly subordinate. Forbs are variable in composition and scattered; the most consistent is *Heliotropium greggii*.

Most Abundant Species

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Poliomintha incana*
Herb (field)	Graminoid	*Bouteloua breviseta*

Other Noteworthy Species
Data are not available.

Classification Comments
Data are not available.

Classification Confidence
3

Element Sources
Inventory Notes: Data are not available.
Plots: 93MP001, 93MP147, 93MP175, 93MP180, 93MP083, 93MP027, 07WS018.

Local Description Authors: E. Muldavin and A. Fettes

Poliomintha incana / Muhlenbergia pungens Gypsophilous Shrubland

Frosted Mint / Sandhill Muhly Shrubland

Identifier: CEGL002672

US National Vegetation Classification

Level	Unit
Class	Desert & Semi-Desert (3)
Subclass	Warm Desert & Semi-Desert Woodland, Scrub & Grassland (3.A)
Formation	Warm Desert & Semi-Desert Scrub & Grassland (3.A.2)
Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Chihuahuan Desert Scrub (M086)
Group	Chihuahuan Gypsophilous Scrub [G847]
Association	*Poliomintha incana / Muhlenbergia pungens* Gypsophilous Shrubland

Distribution
This association is known from the eastern to southeastern dunefield periphery in the monument.

Environmental Description
This association is known from 1,200 to 1,235 m (3,935 to 4,050 ft) in elevation and typically occurs on partially stabilized parabolic gypsum dunes but can extend into the active barchanoid dunefield.

Soils are mapped in the following five units: Astrobee-Lark association, 0 to 35 percent slopes; Corvus-Astrobee-Lark complex, 0 to 25 percent slopes; Lark association, 0 to 60 percent slopes, duneland; Lark-Astrobee-Nasa complex, 0 to 40 percent slopes; and Lark-Transformer association, 0 to 40 percent slopes (USDA-NRCS 2017).

Vegetation Description
This open dune shrubland is dominated by *Poliomintha incana*, with conspicuous *Yucca elata* scattered throughout the stands. Other common shrubs include *Rhus trilobata* and *Atriplex canescens*. On these vegetated dunes, *Muhlenbergia pungens* is the dominant grass and is well represented to abundant in cover. Scattered individuals of *Achnatherum hymenoides*, along with other sand-tolerant grasses may occur, but they are clearly subordinate. Forbs are variable in composition and cover; of twelve species recorded, *Thelesperma megapotamicum* and *Dieteria canescens* are the most prevalent.

Most Abundant Species

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Poliomintha incana*
Herb (field)	Graminoid	*Muhlenbergia pungens*

Other Noteworthy Species
Data are not available.

Classification Comments
Data are not available.

Classification Confidence
3

Element Sources
Inventory Notes: Data are not available.
Plots: 93MP065, 93MP062, 93MP016, 93MP170, 93MP169, 93MP112, 93MP111, 93MP006, 93JT023, 93MP164, 07WS032, 07WS023.

Local Description Authors: E. Muldavin and A. Fettes

Poliomintha incana Gypsum Dune Shrubland

Frosted Mint Gypsum Dune Shrubland

Identifier: CEPP007391

US National Vegetation Classification

Level	Unit
Class	Desert & Semi-Desert (3)
Subclass	Warm Desert & Semi-Desert Woodland, Scrub & Grassland (3.A)
Formation	Warm Desert & Semi-Desert Scrub & Grassland (3.A.2)
Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Chihuahuan Desert Scrub (M086)
Group	Chihuahuan Gypsophilous Scrub [G847]
Association	*Poliomintha incana* Gypsum Dune Shrubland

Distribution
This association is known from the eastern and southeastern dune periphery of the monument.

Environmental Description
This association is known from 1,190 to 1,230 m (3,905 to 4,035 ft) in elevation and occurs on dunes that are transitional, from the stabilized parabolics to the shifting barchan and transverse dunes. The ground surface is characterized by bare gypsum sands with little no litter or herbaceous canopy.

Soils are mapped in the following seven units: Astrobee-Lark association, 0 to 35 percent slopes; Corvus-Astrobee-Lark complex, 0 to 25 percent slopes; Lark-Astrobee-Nasa complex, 0 to 40 percent slopes; Lark-Piedrablanca-Wulie complex, 0 to 25 percent slopes; Lark-Transformer association, 0 to 40 percent slopes; Lark-Transformer association, 0 to 90 percent slopes, duneland; and Torbellino-Lark association, 0 to 15 percent slopes (USDA-NRCS 2017).

Vegetation Description
This open dune shrubland is dominated by abundant *Poliomintha incana* with a sparse understory. Additional shrubs include *Rhus tri*lobata, *Ericameria nauseosa, Yucca elata*, *Atriplex canescens*, and E*phedra torreyana*. Although the herbaceous layer is low in total cover, scattered grasses such as *Achnatherum hymenoides, Sporobolus airoides, Schizachyrium neomexicanum*, and *Muhlenbergia pungens* may occur.

Most Abundant Species

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Poliomintha incana*

Other Noteworthy Species
Facultative wetland (FACW) indicator species: *Tamarix chinensis, Limonium limbatum*
New Mexico state-listed noxious weeds: (Class C) Tamarix chinensis

Classification Comments
Data are not available.

Classification Confidence
2

Element Sources
Inventory Notes: Data are not available.
Plots: 93MP120, 93MP033, 93MP214, 93MP167, 93MP080, 93MP143, 09YC291, 07WS017, 08SS012, 09YC301, 09YC304, 09YC277, 09YC279, 09YC336, 09YC305, 09YC306, 09YC309, 09YC310, 09YC311, 09YC328, 09YC330, 09YC331, 09YC334, 09YC335, 09YC278.

Local Description Authors: E. Muldavin and A. Fettes

Rhus trilobata / Bouteloua breviseta Gypsophilous Dune Shrubland

Skunkbush Sumac / Gypsum Grama Gypsophilous Dune Shrubland

Identifier: CEPP007400

US National Vegetation Classification

Level	Unit
Class	Desert & Semi-Desert (3)
Subclass	Warm Desert & Semi-Desert Woodland, Scrub & Grassland (3.A)
Formation	Warm Desert & Semi-Desert Scrub & Grassland (3.A.2)
Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Chihuahuan Desert Scrub (M086)
Group	Chihuahuan Gypsophilous Scrub [G847]
Association	*Rhus trilobata / Bouteloua breviseta* Gypsophilous Dune Shrubland

Distribution
This association is known from the parabolic dune area in northeastern portion of the monument.

Environmental Description
This shrubland association occurs mostly on marginal parabolic dunes (leading active ridge of parabolic gypsum dunes). Stands also occur in depressions inside of relatively stable interdune areas were grass cover may be well represented to abundant. Elevations range from 1,221 to 1,223 m (4,007 to 4,013 ft). Soil surfaces are largely bare (72%) and characterized by patches of grasses and litter distributed across fine-textured to gypsum sand deposits. Geology is mapped as active gypsum dunes (Holocene and latest Pleistocene).

Soils are mapped in the Lark-Transformer association, 0 to 40 percent slopes (USDA-NRCS 2017).

Vegetation Description
This open dune shrubland is characterized by large *Rhus trilobata* that are well represented with other scattered constant shrubs such as *Ephedra torreyana*, the conspicuous *Yucca elata* and *Atriplex canescens*. The dwarf shrub, *Tiquilia hispidissima* usually present. *Bouteloua breviseta* is diagnostic as the well represented to abundant grass in the intershrub spaces. While scattered individuals of *Sporobolus nealleyi*, *Sporobolus airoides*, *Sporobolus contractus* and *Sporobolus flexuosus* may be present, they are clearly subordinate. Forbs are variable in composition and scattered; the most consistent is *Psilostrophe tagetina*, *Xanthisma spinulosum*, *Lepidium montanum* and gypsophilous species such as *Nerisyrenia linearifolia*, *Sartwellia flaveriae*, and *Acleisanthes lanceolata*. *Comandra umbellata ssp. pallida* was abundant on one site.

Most Abundant Species

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Rhus trilobata*
Herb (field)	Graminoid	*Bouteloua breviseta*

Other Noteworthy Species
Data are not available.

Classification Comments
Data are not available.

Classification Confidence
3

Element Sources
Inventory Notes: Data are not available.
Plots: 14WS094, 93MP085, 93MP087

Local Description Authors: K. Schulz

Rhus trilobata - Poliomintha incana Gypsophilous Dune Shrubland

Skunkbush Sumac / Frosted Mint Gypsophilous Dune Shrubland

Identifier: CEPP007401

US National Vegetation Classification

Level	Unit
Class	Desert & Semi-Desert (3)
Subclass	Warm Desert & Semi-Desert Woodland, Scrub & Grassland (3.A)
Formation	Warm Desert & Semi-Desert Scrub & Grassland (3.A.2)
Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Chihuahuan Desert Scrub (M086)
Group	Chihuahuan Gypsophilous Scrub [G847]
Association	*Rhus trilobata - Poliomintha incana* Gypsophilous Dune Shrubland

Distribution
This association is known from the marginal parabolic dune area in eastern portion of the monument.

Environmental Description
This association occurs on active dunes forming large coppice mounds around very large shrubs with scattered smaller shrubs. Stands occur mostly on marginal parabolic dunes (leading active ridge of parabolic dunes). Elevations range from 1,193 to 1,219 m (3,914 to 4,000 ft). Soil surfaces are characterized by barren gypsum sand deposits (90-98% cover). Geology is mapped as active gypsum dunes (Holocene and latest Pleistocene).

Soils are mapped in the following two units: Corvus-Astrobee-Lark complex, 0 to 25 percent slopes and Lark-Transformer association, 0 to 40 percent slopes (USDA-NRCS 2017).

Vegetation Description
This active dune association occurs on large coppice mounds around very large *Rhus trilobata* with *Poliomintha incana* common to well represented, and scattered *Yucca elata* and *Atriplex canescens*. Other less consistent sparse shrubs may be present such as *Ephedra torreyana*, *Ericameria nauseosa* and *Psorothamnus scoparius*. Scattered *Populus deltoides* ssp. *wislizeni* may be present and exotic *Tamarix chinensis* occurred along the lake edge. Herbaceous species are poorly represented to scarce and may include

scattered *Abronia angustifolia*, *Achnatherum hymenoides*, *Muhlenbergia pungens*, *Schizachyrium neomexicanum*, *Sporobolus airoides*, or *Sporobolus giganteus.*

Most Abundant Species

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Rhus trilobata, Poliomintha incana*

Other Noteworthy Species
Facultative wetland (FACW) indicator species: *Tamarix chinensis*
New Mexico state-listed noxious weeds: (Class C) *Tamarix chinensis*

Classification Comments
Data are not available.

Classification Confidence
3

Element Sources
Inventory Notes: Data are not available.
Plots: 14WS093, 14WS103, 16TP026.

Local Description Authors: K. Schulz

Pleuraphis mutica - Sporobolus airoides Grassland

Tobosa - Alkali Sacaton Grassland

Identifier: CEPP007435

US National Vegetation Classification

Level	Unit
Class	Desert & Semi-Desert (3)
Subclass	Warm Desert & Semi-Desert Woodland, Scrub & Grassland (3.A)
Formation	Warm Desert & Semi-Desert Scrub & Grassland (3.A.2)
Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Chihuahuan Semi-Desert Grassland (M087)
Group	Chihuahuan Semi-Desert Lowland Grassland [G489]
Association	*Pleuraphis mutica - Sporobolus airoides* Grassland

Distribution
This grassland association is occur was sampled in a swale along the southwestern edge of the monument.

Environmental Description
This association is known from 1,198 m (3,930 ft) in elevation and occurs in a swale. There is low bare soil and moderately high cover of litter. Geology is mapped at edge of inactive gypsum dunes (late and middle Pleistocene) and the younger piedmont slope deposits (Holocene and latest Pleistocene.

Soils are mapped in the Mimbres-Chutum-Ybar complex, 0 to 5 percent slopes (USDA-NRCS 2017).

Vegetation Description
This lush semi-desert grassland is characterized by dense *Pleuraphis mutica* (88% cover) with *Sporobolus airoides* well represented. Total grass cover can be as high as 95%. Shrubs are scattered and overall cover is low; *Atriplex canescens*, *Flourensia cernua*, *Prosopis glandulosa* are the most consistent and abundant. Forbs are also typically low in cover and variable in composition. *Hoffmannseggia glauca* and *Scabrethia* spp. were most common.

Most Abundant Species

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Pleuraphis mutica, Sporobolus airoides*

Other Noteworthy Species
Data not available.

Classification Comments
Data are not available.

Classification Confidence
3

Element Sources
Inventory Notes: Data are not available.
Plots: 14WS058.

Local Description Authors: K. Schulz

Yucca elata / Sporobolus flexuosus Shrubland

Soaptree Yucca / Mesa Dropseed Muhly Shrubland

Identifier: CEPP007481

US National Vegetation Classification

Level	Unit
Class	Desert & Semi-Desert (3)
Subclass	Warm Desert & Semi-Desert Woodland, Scrub & Grassland (3.A)
Formation	Warm Desert & Semi-Desert Scrub & Grassland (3.A.2)
Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Chihuahuan Semi-Desert Grassland (M087)
Group	Chihuahuan Sandy Plains Semi-Desert Grassland [G491]
Association	*Yucca elata* / *Sporobolus flexuosus* Shrubland

Distribution
This association is known from the Holocene lake basins region in central portion of the monument.

Environmental Description
This association is known from a single plot in partially stabilized, small coppice gypsum dunes on an active playa within the Holocene Lake Basins. Elevation is 1,190 m (3,905 ft) on slight (2%) north aspect slope. It likely is more common in sand dune systems. Substrates are gypsum sand. Water table may be relatively shallow as evidenced by the presence of widely scattered Tamarix chinensis. Geology is mapped as gypsiferous lake deposits in the Tularosa Basin (Holocene and latest Pleistocene) near boundary with active gypsum dunes.

Soils are mapped in the Lark-Andrecito association, 0 to 15 percent slopes (USDA-NRCS 2017).

Vegetation Description
This vegetated dune shrubland is characterized by conspicuous tall shrub *Yucca elata* scattered throughout the stands and graminoid cover dominated or codominated by *Sporobolus flexuosus*. Species diversity is low with only 9 total species with both shrubs and grasses well represented. Other common shrubs include *Atriplex canescens*, *Ericameria nauseosa*, and *Isocoma pluriflora*. Other sand-tolerant grasses may occur such as *Sporobolus airoides* and *Sporobolus contractus* with *Dieteria canescens* the only forb recorded. Widely scattered *Tamarix chinensis* are present in this stand.

Most Abundant Species

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Yucca elata*
Herb (field)	Graminoid	*Sporobolus flexuosus*

Other Noteworthy Species
Facultative wetland (FACW) indicator species: *Tamarix chinensis*
New Mexico state-listed noxious weeds: (Class C) *Tamarix chinensis*

Classification Comments
Data are not available.

Classification Confidence
2

Element Sources
Inventory Notes: Data are not available.
Plots: 09YC297.

Local Description Authors: K. Schulz

Tiquilia hispidissima / Bouteloua breviseta - Mentzelia humilis Dwarf-shrub Grassland

Rough Tiquilia / Gypsum Grama - Gypsum Blazingstar Dwarf-shrub Grassland

Identifier: CEGL004573

US National Vegetation Classification

Level	Unit
Class	Desert & Semi-Desert (3)
Subclass	Warm Desert & Semi-Desert Woodland, Scrub & Grassland (3.A)
Formation	Warm Desert & Semi-Desert Scrub & Grassland (3.A.2)
Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Chihuahuan Semi-Desert Grassland (M087)
Group	Chihuahuan Gypsophilous Grassland [G492]
Association	*Tiquilia hispidissima / Bouteloua breviseta - Mentzelia humilis* Dwarf-shrub Grassland

Distribution
This association is known from the marginal parabolic dunefield of the monument.

Environmental Description
This association is known from 1,215 to 1,220 m (3,985 to 4,000 ft) in elevation and occurs on flat to hummocky interdune areas. Surrounding dunes can vary from active to stabilized parabolic formations composed of gypsum sands. The ground surface is typically dominated by a mosaic of vegetation cover and barren inter-spaces consisting of eolian gypsum deposits along with evaporates and microphytic crusts.

Soils are mapped in the following three units: primarily Astrobee-Lark association, 0 to 35 percent slopes; and Lark-Astrobee-Nasa complex, 0 to 40 percent slopes and Lark-Transformer association, 0 to 40 percent slopes (USDA-NRCS 2017).

Vegetation Description
This interdune dwarf-shrubland is characterized by the dominance of the gypsophilous dwarf-shrub, *Tiquilia hispidissima* and the gypsophilous grass *Bouteloua breviseta*. Both can be well represented to abundant. Other shrubs and grasses such as *Poliomintha incana*, *Ephedra torreyana*, *Atriplex canescens* and *Achnatherum hymenoides* can occur but are scattered and clearly subordinate.

Forbs are variable in composition and cover. Of the 17 species recorded for this association, gypsophilous species are most prevalent and include *Acleisanthes lanceolata*, *Mentzelia humilis*, and *Sartwellia flaveriae*.

Most Abundant Species

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved dwarf-shrub	*Tiquilia hispidissima*
Herb (field)	Graminoid	*Bouteloua breviseta*

Other Noteworthy Species
Data not available.

Classification Comments
Data are not available.

Classification Confidence
3

Element Sources
Inventory Notes: Data are not available.
Plots: 93MP030, 93MP108, 93MP178, 93MP172, 07WS025, 07WS020, 07WS019.

Local Description Authors: E. Muldavin and A. Fettes

Tiquilia hispidissima / Sporobolus nealleyi Dwarf-shrub Grassland

Hairy Coldenia / Gyp Dropseed Dwarf-shrub Grassland

Identifier: CEGL001546

US National Vegetation Classification

Level	Unit
Class	Desert & Semi-Desert (3)
Subclass	Warm Desert & Semi-Desert Woodland, Scrub & Grassland (3.A)
Formation	Warm Desert & Semi-Desert Scrub & Grassland (3.A.2)
Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Chihuahuan Semi-Desert Grassland (M087)
Group	Chihuahuan Gypsophilous Grassland [G492]
Association	*Tiquilia hispidissima* / *Sporobolus nealleyi* Dwarf-shrub Grassland

Distribution
This association is known from the marginal parabolic dunefield of the monument.

Environmental Description
This association is known from 1,195 to 1,235 m (3,920 to 4,050 ft) in elevation and occurs on flats and interdune areas among the parabolic dunes. The ground surface is often hummocky, with gypsum outcrops and microphytic crusts. Vegetation typically forms on the summits of small hummocks that are perhaps the remnants of old dunes.

Soils are mapped in the following seven units: Astrobee-Lark association, 0 to 35 percent slopes; Astrobee-Lark-Nasa complex, 0 to 20 percent slopes; Corvus-Peligro-Nasa complex, 0 to 5 percent slopes; Lark-Astrobee-Nasa complex, 0 to 40 percent slopes; Lark-Transformer association, 0 to 40 percent slopes; Peligro gypsiferous sandy loam, 0 to 15 percent slopes; and Typic Torriorthents-Corvus complex, 0 to 6 percent slopes (USDA-NRCS 2017).

Vegetation Description
This dwarf-shrubland is characterized by sparse canopies of the gypsophilous *Tiquilia hispidissima* along with *Sporobolus nealleyi* as a graminoid associate. Total cover seldom exceeds 10%. While *Atriplex canescens, Ephedra torreyana*, and *Cylindropuntia leptocaulis* may be common shrub associates, they are not conspicuous. Overall diversity is moderate, with 43 species recorded. However, composition and cover is variable across stands. Gypsophilous species are most prevalent and include *Acleisanthes lanceolata, Mentzelia humilis, Nerisyrenia linearifolia*, and *Sartwellia flaveriae*.

Most Abundant Species

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved deciduous dwarf-shrub	*Tiquilia hispidissima*
Herbaceous	Graminoid	*Sporobolus nealleyi*

Other Noteworthy Species
None

Classification Comments
Data are not available.

Classification Confidence
3

Element Sources
Inventory Notes: Data are not available.
Plots: 93MP019, 93MP032, 93MP139, 93JT009, 93MP174, 93MP029, 93MP121, 93MP086, 93MP022, 93MP126, 93MP142, 09YC290, 07WS029.

Local Description Authors: E. Muldavin and A. Fettes

Schizachyrium neomexicanum - Abronia angustifolia Grassland

New Mexico Bluestem - Purple Sand-verbena Grassland

Identifier: CEPP007448

US National Vegetation Classification

Level	Unit
Class	Desert & Semi-Desert (3)
Subclass	Warm Desert & Semi-Desert Woodland, Scrub & Grassland (3.A)
Formation	Warm Desert & Semi-Desert Scrub & Grassland (3.A.2)
Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Chihuahuan Semi-Desert Grassland (M087)
Group	Chihuahuan Gypsophilous Grassland [G492]
Association	*Schizachyrium neomexicanum - Abronia angustifolia* Grassland

Distribution
This association is known from interdune areas in the “Heart of the Sands” in the eastern portion of the monument.

Environmental Description
This association is known near 1,216m (3,991 ft) elevation and occurs in interdune areas among partially stabilized parabolic gypsum dunes and in the active barchanoid dunefield. The ground surface is characterized by abundant bare soil (to 68% cover) in the inter-plant spaces. The substrate is gypsum sand.

Vegetation Description
This open, semi-desert grassland is characterized by the dominance or codominance of *Schizachyrium neomexicanum* with gypsophilous *Abronia angustifolia* or other gypsum indicator species. Total herbaceous cover is well represented to abundant. Shrubs are scattered and overall cover is poorly represented; *Ephedra torreyana*, *Lorandersonia pulchella*, *Poliomintha incana*, and *Yucca elata* are the most consistent or abundant. Forbs are also typically low in cover and variable in composition. The gypsophilous *Zeltnera maryanna*, *Comandra umbellata ssp. pallida*, *Heliotropium greggii*, *Mentzelia pumila* and *Thelesperma megapotamicum*, were the most frequent or abundant forb species. *Sporobolus airoides* is scarce or absent. The exotic shrub *Tamarix chinensis* was present in one plot.

Most Abundant Species

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Schizachyrium neomexicanum*
Herb (field)	Forb	*Abronia angustifolia*

Other Noteworthy Species
Facultative wetland (FACW) indicator species: *Tamarix chinensis*
New Mexico state-listed noxious weeds: (Class C) *Tamarix chinensis*

Classification Comments
Data are not available.

Classification Confidence
3

Element Sources
Inventory Notes: Data are not available.
Plots: 08CJ016, 16SB058, 16SB064, 93MP216.

Local Description Authors: K. Schulz

Bouteloua breviseta - Schizachyrium neomexicanum Grassland

Gypsum Grama - New Mexico Bluestem Grassland

Identifier: CEPP007423

US National Vegetation Classification

Level	Unit
Class	Desert & Semi-Desert (3)
Subclass	Warm Desert & Semi-Desert Woodland, Scrub & Grassland (3.A)
Formation	Warm Desert & Semi-Desert Scrub & Grassland (3.A.2)
Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Chihuahuan Semi-Desert Grassland (M087)
Group	Chihuahuan Gypsophilous Grassland [G492]
Association	*Bouteloua breviseta - Schizachyrium neomexicanum* Grassland

Distribution
This association is known from the marginal parabolic dunefield of the monument.

Environmental Description
This association occurs from 1,205 to 1,285 m (3,955 to 4,215 ft) in elevation on low, rolling dunes associated with stabilized parabolic dune formations. Sites are characterized by large patches of grasses and associated litter with open areas of sand.

Soils are mapped in the following four units: Astrobee-Lark association, 0 to 35 percent slopes; Lark-Astrobee-Nasa complex, 0 to 40 percent slopes; Lark-Transformer association, 0 to 40 percent slopes; and Lark-Transformer association, 0 to 90 percent slopes, duneland (USDA-NRCS 2017).

Vegetation Description

This interdune grassland is characterized by the dominance of the gypsophilous grasses *Bouteloua breviseta* and *Schizachyrium neomexicanum*. Grass cover can be abundant to luxuriant on some sites. Overall diversity is moderate, with 36 species recorded for this association. *Yucca elata* and *Ephedra torreyana* are common shrub and dwarf-shrub associates, respectively. Forbs are variable in composition and cover. Of the 17 species recorded for this association, *Thelesperma megapotamicum*, *Comandra umbellata* ssp. *pallida*, and *Heliotropium greggii* were the most frequent and abundant representatives.

Most Abundant Species

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Bouteloua breviseta, Schizachyrium neomexicanum*

Other Noteworthy Species
Facultative wetland (FACW) indicator species: *Tamarix chinensis*
New Mexico state-listed noxious weeds: (Class C) *Tamarix chinensis*

Classification Comments

Data are not available.

Classification Confidence

2

Element Sources

Inventory Notes: Data are not available.
Plots: 93MP007, 93MP066, 93MP171, 93MP134, 93MP115, 93JT015, 93MP136, 93MP138, 93MP183, 93MP013, 93MP216, 93MP151, 93MP152, 93MP149, 93MP153.

Local Description Authors: E. Muldavin and A. Fettes

Bouteloua breviseta - Sporobolus airoides Grassland

Gypsum Grama - Alkali Sacaton Grassland

Identifier: CEPP007424

US National Vegetation Classification

Level	Unit
Class	Desert & Semi-Desert (3)
Subclass	Warm Desert & Semi-Desert Woodland, Scrub & Grassland (3.A)
Formation	Warm Desert & Semi-Desert Scrub & Grassland (3.A.2)
Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Chihuahuan Semi-Desert Grassland (M087)
Group	Chihuahuan Gypsophilous Grassland [G492]
Association	*Bouteloua breviseta - Sporobolus airoides* Grassland

Distribution

This association is known from the marginal parabolic dunefield in the eastern portion corner of the monument.

Environmental Description
This association occurs from 1,215 to 1,220 m (3,985 to 4,000 ft) in elevation in flat to rolling dune areas associated with stabilized parabolic dune formations and extending into the interdune deflation plains of the active barchanoid due fields. Sites are characterized by large patches of grasses and litter with open areas of eolian gypsum sands. Gypsum and microphytic crusts can be common on exposed soils.

Soils are mapped in the following two units: Astrobee-Lark association, 0 to 35 percent slopes and Lark-Transformer association, 0 to 40 percent slopes (USDA-NRCS 2017).

Vegetation Description
This interdune grassland is characterized by the dominance of the gypsophilous *Bouteloua breviseta* along with *Sporobolus airoides* as an often abundant and codominant associate. *Ephedra torreyana*, *Tiquilia hispidissima*, and *Frankenia jamesii* are often common shrub and dwarf-shrub associates, but seldom exceed 5% cover. Forbs are poorly represented and variable in composition.

Most Abundant Species

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Bouteloua breviseta, Sporobolus airoides*

Other Noteworthy Species
Data are not available.

Classification Comments
Data are not available.

Classification Confidence
3

Element Sources
Inventory Notes: Data are not available.
Plots: 93JT013, 93MP064, 93MP060, 93JT005.

Local Description Authors: E. Muldavin and A. Fettes

Ephedra torreyana / Bouteloua breviseta Dwarf-shrub Grassland

Torrey's Jointfir / Gypsum Grama Dwarf-shrub Grassland

Identifier: CEPP007425

US National Vegetation Classification

Level	Unit
Class	Desert & Semi-Desert (3)
Subclass	Warm Desert & Semi-Desert Woodland, Scrub & Grassland (3.A)
Formation	Warm Desert & Semi-Desert Scrub & Grassland (3.A.2)
Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Chihuahuan Semi-Desert Grassland (M087)
Group	Chihuahuan Gypsophilous Grassland [G492]
Association	*Ephedra torreyana / Bouteloua breviseta* Dwarf-shrub Grassland

Distribution
This association is known from the marginal parabolic dunefield of the monument.

Environmental Description
This association occurs from 1,215 to 1,225 m (3,985 to 4,020 ft) in elevation in elevation in flat to rolling gypsum dune areas associated with stabilized parabolic dune formations. Sites are characterized by large patches of grasses and litter with open areas of eolian gypsum sands.

Soils are mapped in the following six units: Astrobee-Lark association, 0 to 35 percent slopes; Corvus-Astrobee-Lark complex, 0 to 25 percent slopes; Corvus-Peligro-Nasa complex, 0 to 5 percent slopes; Lark-Astrobee-Nasa complex, 0 to 40 percent slopes; Lark-Transformer association, 0 to 40 percent slopes; and Lark-Transformer association, 0 to 90 percent slopes, duneland (USDA-NRCS 2017).

Vegetation Description
This low dune grassland is dominated by the gypsophilous grass *Bouteloua breviseta*, with scattered *Ephedra torreyana* and *Yucca elat*a as characteristic shrub associates. Other shrubs such as *Poliomintha incana*, *Tiquilia hispidissima*, and *Rhus trilobata* may be present but clearly not dominant. Overall diversity of this association is moderate, with 40 species recorded. Forbs are variable in composition and cover. Among the species recorded, *Thelesperma megapotamicum*, *Acleisanthes lanceolata*, and *Heliotropium greggii* were the most frequent and abundant representatives.

Most Abundant Species

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Ephedra torreyana, Yucca elata*
Herb (field)	Graminoid	*Bouteloua breviseta*

Other Noteworthy Species
Data are not available.

Classification Comments
Data are not available.

Classification Confidence
2

Element Sources
Inventory Notes: Data are not available.
Plots: 93MP059, 93MP063, 93MP017, 93MP031, 93MP114, 93MP119, 93MP116, 93JT010, 93MP135, 93MP177, 93MP133, 93MP118, 93MP085, 93MP182, 93MP087, 93MP025, 93MP173.

Local Description Authors: E. Muldavin and A. Fettes

Ephedra torreyana / Sporobolus airoides Dwarf-shrub Grassland

Torrey's Jointfir / Alkali Sacaton Dwarf-shrub Grassland

Identifier: CEPP007427

US National Vegetation Classification

Level	Unit
Class	Desert & Semi-Desert (3)
Subclass	Warm Desert & Semi-Desert Woodland, Scrub & Grassland (3.A)
Formation	Warm Desert & Semi-Desert Scrub & Grassland (3.A.2)
Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Chihuahuan Semi-Desert Grassland (M087)
Group	Chihuahuan Gypsophilous Grassland [G492]
Association	*Ephedra torreyana / Sporobolus airoides* Dwarf-shrub Grassland

Distribution

This association is known from the active dunefield near the loop road.

Environmental Description

This grassland community occurs on interdunal zones within an area that experiences intensive dune movement. Soils are gypsum sand.

Vegetation Description

The vegetation is dominated by *Sporobolus airoides* which is well represented and grows on small hummocks with *Ephedra torreyana*. *Yucca elata* is present and *Tamarix chinensis* is invasive in swales. Diversity is low with only scattered *Achnatherum hymenoides*, *Pseudoclappia arenaria*, and *Thelesperma megapotamicum* present.

Most Abundant Species

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Ephedra torreyana, Yucca elata*
Herb (field)	Graminoid	*Sporobolus airoides*

Other Noteworthy Species

Facultative wetland (FACW) indicator species: *Tamarix chinensis*

New Mexico state-listed noxious weeds: (Class C) *Tamarix chinensis*

Classification Comments

Data are not available.

Classification Confidence

3

Element Sources

Inventory Notes: Data are not available.

Plots: 93JT022

Local Description Authors: K. Schulz

Tiquilia hispidissima / Acleisanthes lanceolata Dwarf-shrubland

Hairy Coldenia / Gypsum Moonpod Dwarf-shrubland

Identifier: CEPP007479

US National Vegetation Classification

Level	Unit
Class	Desert & Semi-Desert (3)
Subclass	Warm Desert & Semi-Desert Woodland, Scrub & Grassland (3.A)
Formation	Warm Desert & Semi-Desert Scrub & Grassland (3.A.2)
Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Chihuahuan Semi-Desert Grassland (M087)
Group	Chihuahuan Gypsophilous Grassland [G492]
Association	*Tiquilia hispidissima / Acleisanthes lanceolata* Dwarf-shrubland

Distribution

This association is known from east of North Lake Lucero along the western margin the dunes.

Environmental Description

This association is known from around 1,190 m (3,905 ft) in elevation and occurs on gypsum outcrops and crusts along the western margin of the dunes. The ground surface is characterized by sparse vegetation with considerable barren soil.

Soils are mapped in the Lark-Andrecito association, 0 to 15 percent slopes (USDA-NRCS 2017).

Vegetation Description

This dwarf-shrubland is characterized by the presence of the gypsophilous dwarf-shrub *Tiquilia hispidissima*, with *Acleisanthes lanceolata* as a common and diagnostic forb associate. Overall diversity and abundance of vegetation is low on what are often sites that are predominantly open ground.

Most Abundant Species

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved deciduous dwarf shrub	*Tiquilia hispidissima*
Herbaceous	Perennial forb	*Acleisanthes lanceolata*

Other Noteworthy Species

Data not available.

Classification Comments

Data are not available.

Classification Confidence

3

Element Sources

Inventory Notes: Data are not available.

Plots: 93MP097.

Local Description Authors: E. Muldavin and A. Fettes

Frankenia jamesii / Sporobolus airoides Grassland

James' Sea-heath / Alkali Sacaton Shrubland

Identifier: CEPP007433

US National Vegetation Classification

Level	Unit
Class	Desert & Semi-Desert (3)
Subclass	Warm Desert & Semi-Desert Woodland, Scrub & Grassland (3.A)
Formation	Warm Desert & Semi-Desert Scrub & Grassland (3.A.2)
Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Chihuahuan Semi-Desert Grassland (M087)
Group	Chihuahuan Gypsophilous Grassland [G492]
Association	*Frankenia jamesii / Sporobolus airoides* Shrubland

Distribution

This association is known from the interdune areas in gypsum duneland areas within the northeast portion of the monument.

Environmental Description

This association occurs alluvial flats often with a few low gypsum ridges/outcrops, interdune flats with stable soils, and marginal parabolic dunes ranging from 1,217 to 1,222 m (3,992 to 4,009 ft) in elevation. The ground surface is variable ranging from low to high exposed, sandy soils depending on the cover of the herbaceous layer. Soil crusts are common.

Soils are mapped in the following three units: primarily Astrobee-Lark association, 0 to 35 percent slopes; and Lark-Transformer association, 0 to 40 percent slopes and Lark-Transformer association, 0 to 90 percent slopes, duneland (USDA-NRCS 2017).

Vegetation Description

This grassland is characterized by the dominance of *Sporobolus airoides*, which is well represented to abundant, intermixed with the subshrub *Frankenia jamesii* that is usually well represented. Other shrub and dwarf-shrub associates that may be common to codominant include *Atriplex canescens*, *Ephedra torreyana*, *Pseudoclappia arenaria*, *Yucca elata*, and *Tiquilia hispidissima*. Other graminoids may be present with lower cover with *Bouteloua breviseta*, *Sporobolus nealleyi*, and *Muhlenbergia pungens* being most constant. Forbs are generally low in cover and represented by a mix of annuals and small native perennials such as *Arida parviflora*, *Zeltnera maryanna*, *Nerisyrenia linearifolia*, *Sartwellia flaveriae*, *Acleisanthes lanceolata*, *Senecio flaccidus*, and *Thelesperma megapotamicum* being most constant. Introduced shrub *Tamarix chinensis* is present in some stands.

Most Abundant Species

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Frankenia jamesii*
Shrub/sapling (tall & short)	Broad-leaved evergreen shrub	*Atriplex canescens*
Herb (field)	Graminoid	*Sporobolus airoides*

Other Noteworthy Species

Data are not available.

Classification Comments

There is high species diversity and quite a bit of variation in this type.

Classification Confidence

3

Element Sources

Inventory Notes: Data are not available.

Plots: 14WS029, 14WS032, 14WS035, 14WS036, 14WS037, 14WS038, 14WS042, 14WS047, 14WS048, 16MP009, 16MP015, 16MP035, 16MP036, 16MP037, 16MP038, 16MP039, 16SB023, 16SB024, 16SB025, 16SB027, 16SB029, 16SB032, 16SB043, 16TP019, 16TP023, 16TP025, 93MP060, 93MP068, 93MP117.

Local Description Authors: K. Schulz

Sporobolus airoides - Abronia angustifolia Grassland

Alkali Sacaton - Purple Sand-verbena Grassland

Identifier: CEPP007453

US National Vegetation Classification

Level	Unit
Class	Desert & Semi-Desert (3)
Subclass	Warm Desert & Semi-Desert Woodland, Scrub & Grassland (3.A)
Formation	Warm Desert & Semi-Desert Scrub & Grassland (3.A.2)
Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Chihuahuan Semi-Desert Grassland (M087)
Group	Chihuahuan Gypsophilous Grassland [G492]
Association	*Sporobolus airoides - Abronia angustifolia* Grassland

Distribution
This widespread association is known from interdune areas in the"Heart of the Sands" of the entire monument.

Environmental Description
This association is known from 1,210 to 1,219m (3,971 to 3,999 ft) in elevation and occurs in interdune areas among partially stabilized parabolic gypsum dunes and in the active barchanoid dunefield. The ground surface is characterized by abundant bare soil (84% average cover) in the inter-plant spaces. Substrate is gypsum sand mostly forming low coppicing around base of vegetation (10-30 cm tall) forming an uneven surface. There may be patches of stabilized soils often by soil crust with fair amount microphytic growth.

Soils are mapped in the following two units: primarily Lark-Transformer association, 0 to 90 percent slopes, duneland and Lark association, 5 to 90 percent slopes, duneland (USDA-NRCS 2017).

Vegetation Description
This semi-desert grassland is characterized by the dominance or codominance of *Sporobolus airoides* and gypsophilous *Abronia angustifolia*, and other gypsum indicator species such as *Zeltnera maryanna*, *Mentzelia humilis*, or *Nama carnosum*. Total herbaceous cover is well represented to abundant. Total grass cover can be as high as 20%. Other herbaceous species with higher constancy, but poorly represented are *Achnatherum hymenoides*, *Schizachyrium neomexicanum*, and *Thelesperma megapotamicum*. The exotic shrub *Tamarix chinensis* was present with low cover in or near a few plots on mesic depressional areas and along drainages.

Most Abundant Species

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Sporobolus airoides*
Herb (field)	Forb	*Abronia angustifolia*

Other Noteworthy Species
Facultative wetland (FACW) indicator species: *Tamarix chinensis*
New Mexico state-listed noxious weeds: (Class C) *Tamarix chinensis*

Classification Comments
Data are not available.

Classification Confidence
3

Element Sources
Inventory Notes: Data are not available.
Plots: 09YC312, 14WS001, 14WS002, 14WS004, 14WS005, 14WS006, 14WS007, 14WS008, 14WS009, 14WS010, 14WS011, 14WS012, 14WS013, 14WS015, 14WS016, 14WS018, 14WS024, 14WS027, 14WS028.

Local Description Authors: K. Schulz

Sporobolus airoides - Schizachyrium neomexicanum Grassland

Alkali Sacaton - New Mexico Bluestem Grassland

Identifier: CEPP007463

US National Vegetation Classification

Level	Unit
Class	Desert & Semi-Desert (3)
Subclass	Warm Desert & Semi-Desert Woodland, Scrub & Grassland (3.A)
Formation	Warm Desert & Semi-Desert Scrub & Grassland (3.A.2)
Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Chihuahuan Semi-Desert Grassland (M087)
Group	Chihuahuan Gypsophilous Grassland [G492]
Association	*Sporobolus airoides - Schizachyrium neomexicanum* Grassland

Distribution
This widespread association is known from interdune areas throughout the entire monument.

Environmental Description
This association is known from 1,190 to 1,220 m (3,905 to 4,000 ft) in elevation and occurs in interdune areas among partially stabilized parabolic gypsum dunes and in the active barchanoid dunefield. A thin sheet of loose sand may occur on the surface, but dunning is limited. The ground surface is characterized by abundant herbaceous cover litter with bare soil in the inter-plant spaces.

Soils are mapped in the following three units: Astrobee-Lark association, 0 to 35 percent slopes; Lark-Andrecito association, 0 to 15 percent slopes; and primarily Lark-Transformer association, 0 to 90 percent slopes, duneland (USDA-NRCS 2017).

Vegetation Description
This semi-desert grassland is characterized by the codominance of *Sporobolus airoides* and gypsophilous *Schizachyrium neomexicanum*, both of which can be well represented to abundant. Total grass cover can be as high as 25%. Shrubs are scattered and overall cover is low; *Ephedra torreyana* and *Yucca elata* are the most consistent and abundant. Forbs are also typically low in cover and variable in composition. The gypsophilous *Zeltnera maryanna* and *Calylophus hartwegii* were the most frequent representatives.

Most Abundant Species

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Sporobolus airoides, Schizachyrium neomexicanum*

Other Noteworthy Species
Facultative wetland (FACW) indicator species: *Tamarix chinensis*
New Mexico state-listed noxious weeds: (Class C) *Tamarix chinensis*

Classification Comments
Data are not available.

Classification Confidence
3

Element Sources
Inventory Notes: Data are not available.
Plots: 93MP176, 93MP011, 93MP210, 93MP218, 93MP211, 93MP217, 93MP215, 93JT018, 09YC300, 09YC299, 09YC337, 09YC302, 09YC303, 09YC274, 09YC307, 09YC308, 09YC332, 09YC333, 08CJ016.

Local Description Authors: E. Muldavin and A. Fettes

Sporobolus nealleyi - Sporobolus airoides Grassland

Gyp Dropseed - Alkali Sacaton Grassland

Identifier: CEPP007465

US National Vegetation Classification

Level	Unit
Class	Desert & Semi-Desert (3)
Subclass	Warm Desert & Semi-Desert Woodland, Scrub & Grassland (3.A)
Formation	Warm Desert & Semi-Desert Scrub & Grassland (3.A.2)
Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Chihuahuan Semi-Desert Grassland (M087)
Group	Chihuahuan Gypsophilous Grassland [G492]
Association	*Sporobolus nealleyi - Sporobolus airoides* Grassland

Distribution
This association is known from the marginal parabolic dunefield in the central and east-central portions of the monument.

Environmental Description
This association occurs on flats and interdune areas among the parabolic dunes near 1,221 m (4,005 ft) in elevation. Site geology is variable and includes active Holocene lake basins with few active parabolic dunes, marginal parabolic dunes (leading active ridge of parabolic dunes), areas with quartz clastic input to dune system, and vegetated small dunes. One site occurs on a bench at lake edge with crusty soils and dense grass patches. The ground surface is largely barren, often hummocky with gypsum outcrops and patches of well-established microphytic cover. Soils are sandy with high gypsum content. Geology is mapped as gypsiferous lake deposits in the Tularosa Basin (Holocene and latest Pleistocene) near active dunes with eastern plot mapped as active gypsum dunes.

Soils are mapped in the following four units: Lark-Andrecito association, 0 to 15 percent slopes; Lark-Transformer association, 0 to 40 percent slopes; Piedrablanca-Wulie-Nasa complex, 0 to 6 percent slopes; and Typic Torriorthents-Corvus complex, 0 to 6 percent slopes (USDA-NRCS 2017).

Vegetation Description
This grassland is characterized by patchy canopies dominated or codominated by *Sporobolus airoides* and the gypsophilous *Sporobolus nealleyi*. Total graminoid cover ranges from 3-50% but is typically well represented to abundant. Overall diversity is moderate, with 31 species recorded. However, composition and cover is variable across stands. A diverse mix of 15 species of scattered shrubs and dwarf-shrubs may be present but is scarce to poorly represented. *Atriplex canescens, Ephedra torreyana, Allenrolfea occidentalis leptocaulis, Tiquilia hispidissima* and *Yucca elata* are most consistent. Forb cover is sparse to well represented with gypsophilous species most prevalent such as *Abronia angustifolia, Mentzelia humilis, Nerisyrenia linearifolia, Phacelia integrifolia*, and *Sartwellia flaveriae*.

Most Abundant Species

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Sporobolus nealleyi, Sporobolus airoides*

Other Noteworthy Species
None

Classification Comments
Data are not available.

Classification Confidence
3

Element Sources
Inventory Notes: Data are not available.
Plots: 07WS024, 14WS123, 14WS132, 14WS135. 16TP042, 16MP049

Local Description Authors: K. Schulz

Prosopis glandulosa - Atriplex canescens Ruderal Shrubland

Honey Mesquite - Fourwing Saltbush Ruderal Shrubland

Identifier: CEGL001382

US National Vegetation Classification

Level	Unit
Class	Desert & Semi-Desert (3)
Subclass	Warm Desert & Semi-Desert Woodland, Scrub & Grassland (3.A)
Formation	Warm Desert & Semi-Desert Scrub & Grassland (3.A.2)
Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	North American Warm Desert Ruderal Scrub & Grassland (M512)
Group	North American Warm Desert Ruderal Scrub [G819]
Association	*Prosopis glandulosa - Atriplex canescens* Ruderal Shrubland

Distribution
This association is known from the alluvial slopes of the San Andreas Mountains along the western edge of the monument.

Environmental Description
This association occurs from 1,205 to 1,235 m (3,950 to 4,050 ft) in elevation on alluvial plains and lower depositional piedmonts. Soils are derived from sedimentary calcareous alluvium. The ground surface is characterized by sparse herbaceous vegetation, with intershrub spaces of barren soil mixed with gravel and cobble.

Soils are mapped in the following two units: Agustin-Vado-Riverwash complex, 1 to 10 percent slopes and Mimbres-Chutum-Ybar complex, 0 to 5 percent slopes (USDA-NRCS 2017).

Vegetation Description
This shrubland is characterized by an open canopy of *Prosopis glandulosa* with *Atriplex canescens* as a common to abundant shrub associate. Overall species diversity is low. However, stands may include the dwarf shrub *Gutierrezia sarothrae*. Additional species in the herbaceous layer are typically low in cover, with grasses being largely absent from this association.

Most Abundant Species

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Prosopis glandulosa*
Shrub/sapling (tall & short)	Broad-leaved evergreen shrub	*Atriplex canescens*
Shrub/sapling (tall & short)	Broad-leaved deciduous dwarf-shrub	*Gutierrezia sarothrae*

Other Noteworthy Species
None.

Classification Comments
Data are not available.

Classification Confidence
3

Element Sources
Inventory Notes: Data are not available.
Plots: 93MP200, 93MP088, 93MP188, 93MP201, 93MP189, 93MP089, 93JT016.

Local Description Authors: E. Muldavin and A. Fettes

Prosopis glandulosa / Sparse Shrubland

Honey Mesquite / Sparse Shrubland

Identifier: CEPP007442

US National Vegetation Classification

Level	Unit
Class	Desert & Semi-Desert (3)
Subclass	Warm Desert & Semi-Desert Woodland, Scrub & Grassland (3.A)
Formation	Warm Desert & Semi-Desert Scrub & Grassland (3.A.2)
Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	North American Warm Desert Ruderal Scrub & Grassland (M512)
Group	North American Warm Desert Ruderal Scrub [G819]
Association	*Prosopis glandulosa* / Sparse Shrubland

Distribution
This association is known from the alluvial slopes of the San Andreas Mountains along the western edge of the monument.

Environmental Description
This mesquite duneland association occurs on larger (2-3m) dunes with deeper cuts in the interdune arc. Elevation is around 1,219 m (4,001 ft). The ground surface is characterized by sparse herbaceous vegetation, with intershrub spaces of barren soil mixed with gravel.

Soils are mapped in the Agustin-Vado-Riverwash complex, 1 to 10 percent slopes (USDA-NRCS 2017).

Vegetation Description
This shrubland is characterized by an open canopy of *Prosopis glandulosa* with *Larrea tridentata* as a common to well represented shrub associate. Total shrub canopy ranges from 7-30%. Overall species diversity is moderate with the dwarf shrub *Gutierrezia sarothrae* present in over half the plots. Other associated shrubs include *Atriplex canescens* and *Flourensia cernua*. Herbaceous cover is sparse with scattered perennial grasses and forbs.

Most Abundant Species

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Prosopis glandulosa*
Shrub/sapling (tall & short)	Broad-leaved evergreen shrub	*Atriplex canescens*
Shrub/sapling (tall & short)	Broad-leaved deciduous dwarf-shrub	*Gutierrezia sarothrae*

Other Noteworthy Species
None.

Classification Comments
Prosopis glandulosa / Sparse Shrubland in White Sands NM all occurs in the Larrea tridentata phase.
Some of these plots are adjacent to *Prosopis glandulosa - Larrea tridentata* shrublands and may have higher cover of *Larrea tridentata* than typical.

Classification Confidence
3

Element Sources
Inventory Notes: Data are not available.
Plots: 16MP028, 16MP029, 16MP030, 16MP031, 16TP047, 93MP220.

Local Description Authors: K. Schulz

Sparse Vegetation / Alluvial Flat

Sparse Vegetation / Alluvial Flat

Identifier: NPS_NM049

US National Vegetation Classification

Level	Unit
Class	Desert & Semi-Desert (3)
Subclass	Warm Desert & Semi-Desert Woodland, Scrub & Grassland (3.A)
Formation	Warm Desert & Semi-Desert Scrub & Grassland (3.A.2)
Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	North American Warm Semi-Desert Cliff, Scree & Rock Vegetation (M117)
Group	North American Warm Semi-Desert Cliff, Scree & Pavement Sparse Vegetation [G569]
Association	Sparse Vegetation / Alluvial Flat

Distribution
This widespread alluvial flat type is most common in active playas in Holocene Lake Basins and Scour Platform and Lake Otero outcrops in the western portion of the monument and an older basin (late to middle Pleistocene) in the northeastern portion of the monument.

Environmental Description
This widespread lowland type is known from (1,186 to 1,236 m (3,880 to 4,055 ft) on alluvial flats, old lake beds and active playas mostly in the western portion of the monument. Sites are mostly flat with a few low slopes (to 5%). The ground surface is characterized by scattered shrub and herbaceous cover with very high cover of exposed alluvial soils. Soils are often composed of gypsiferous sand with some finer textured soils in basin areas but are quite diverse derived from lake deposits.

Soils are mapped in the following eleven units: Lacarreta-Salago-Ratscat complex, 0 to 3 percent slopes; Lark-Andrecito association, 0 to 15 percent slopes; Lark-Astrobee-Nasa complex, 0 to 40 percent slopes; Lark-Transformer association, 0 to 90 percent slopes, duneland; Llano-Ratscat complex, 0 to 7 percent slopes; Mamtrack-Lark-Transformer complex, 0 to 15 percent

slopes; Massasauga-Sabkha association, 0 to 2 percent slopes; Mimbres-Chutum-Ybar complex, 0 to 5 percent slopes; Salago-Llano complex, 0 to 2 percent slopes; Salago-Sabkha association, 0 to 3 percent slopes; and Transformer gypsiferous sand, 0 to 5 percent slopes (USDA-NRCS 2017).

Vegetation Description

This sparsely vegetated alluvial flat type is characterized by variable, sparse vegetation. Frequently *Allenrolfea occidentalis* is often present with *Sporobolus airoides, Abronia angustifolia*, *Achnatherum hymenoides*, and *Suaeda nigra* most constant. *Poliomintha incana*, *Ephedra torreyana*, *Bouteloua breviseta*, *Scleropogon brevifolius* and exotic annual *Salsola tragus* are less consistent. The exotic shrub, *Tamarix chinensis* has moderately high constancy (25%) and is scarce to poorly represented. Herbaceous diversity is moderate with 20 of the 30 total species listed being forbs or grasses.

Most Abundant Species

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Succulent evergreen shrub	*Allenrolfea occidentalis*
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Tamarix chinensis*
Herb (field)	Graminoid	*Sporobolus airoides*
Herb (field)	Forb	*Abronia angustifolia*

Other Noteworthy Species
Facultative wetland (FACW) indicator species: *Tamarix chinensis*
New Mexico state-listed noxious weeds: (Class C) *Tamarix chinensis*

Classification Comments

Data are not available.

Classification Confidence

3

Element Sources

Inventory Notes: Data are not available.
Plots: 07WS004, 07WS007, 09YC296, 09YC340, 14WS053, 14WS054, 14WS056, 14WS060, 14WS061, 14WS120, 14WS126, 14WS129, 14WS134, 93MP023, 93MP043, 93MP048, 93MP052, 93MP056, 93MP057, 93MP070, 93MP071, 93MP072, 93MP092, 93MP094, 93MP219.

Local Description Authors: K. Schulz

Sparse Vegetation / Dune

Sparse Vegetation / Dune

Identifier: NPS_NM096

US National Vegetation Classification

Level	Unit
Class	Desert & Semi-Desert (3)
Subclass	Warm Desert & Semi-Desert Woodland, Scrub & Grassland (3.A)
Formation	Warm Desert & Semi-Desert Scrub & Grassland (3.A.2)
Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	North American Warm Semi-Desert Cliff, Scree & Rock Vegetation (M117)
Group	North American Warm Semi-Desert Cliff, Scree & Pavement Sparse Vegetation [G569]
Association	Sparse Vegetation / Dune

Distribution

This association is largely known from the "Heart of the Sands" in the eastern portion of the monument with some smaller areas in the western and southern portions of the monument.

Environmental Description

This barren and sparsely vegetated type is known from small to large gypsum dunes ranging (1,213 to 1,236 m (3,981 to 4,056 ft) elevation. Slopes were gentle (up to 5%). Aspect are variable.

Soils are mapped in the following three units: Lark association, 5 to 90 percent slopes, duneland; Lark-Astrobee-Nasa complex, 0 to 40 percent slopes; and Lark-Transformer association, 0 to 90 percent slopes, duneland (USDA-NRCS 2017).

Vegetation Description

This sparsely vegetated dune type is characterized by a few scattered shrub species. *Poliomintha incana*, *Ericameria nauseosa*, and *Yucca elata* are most constant. Less consistent are *Ephedra torreyana*, *Rhus trilobata*, *Scleropogon brevifolius* and *Achnatherum hymenoides*, the only grass listed. Very Scattered *Populus deltoides* ssp. *wislizeni* trees are occasionally present.

Most Abundant Species

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Poliomintha incana, Ericameria nauseosa*

Other Noteworthy Species

Data are not available

Classification Comments

Data are not available.

Classification Confidence

3

Element Sources

Inventory Notes: Data are not available.
Plots: 09YC301, 09YC310, 93MP024, 93MP137, 93MP146, 93MP212.

Local Description Authors: K. Schulz

Sparse Vegetation / Alluvial Fan

Sparse Vegetation / Alluvial Fan

Identifier: NPS_NM105

US National Vegetation Classification

Level	Unit
Class	Desert & Semi-Desert (3)
Subclass	Warm Desert & Semi-Desert Woodland, Scrub & Grassland (3.A)
Formation	Warm Desert & Semi-Desert Scrub & Grassland (3.A.2)
Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	North American Warm Semi-Desert Cliff, Scree & Rock Vegetation (M117)
Group	North American Warm Semi-Desert Cliff, Scree & Pavement Sparse Vegetation [G569]
Association	Sparse Vegetation / Alluvial Fan

Atriplex canescens / Sporobolus airoides Shrubland

Fourwing Saltbush / Alkali Sacaton Shrubland

Identifier: CEGL001291

US National Vegetation Classification

Level	Unit
Class	Desert & Semi-Desert (3)
Subclass	Cool Semi-Desert Scrub & Grassland (3.B)
Formation	Cool Semi-Desert Scrub & Grassland (3.B.1)
Division	Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup	Great Basin Saltbush Scrub (M093)
Group	Intermountain Shadscale - Saltbush Scrub [G300]
Association	*Atriplex canescens* / *Sporobolus airoides* Shrubland

Distribution

This association is known from basin flats and interdune areas throughout the monument.

Environmental Description

This community is known from 1,185 to 1,220 m (3,885 to 4,000 ft) in elevation and occurs on alkali flats and in interdune areas. Sites are often low-lying areas or depressions where water tends to accumulate or where the water table likely close to the surface, particularly during the rainy season. Sites are typified by relatively high grass and litter cover with open soil between grass hummocks and shrubs.

Soils are mapped in the following fourteen units: Astrobee-Lark association, 0 to 35 percent slopes; Corvus-Astrobee-Lark complex, 0 to 25 percent slopes; Corvus-Peligro-Nasa complex, 0 to 5 percent slopes; Mimbres-Chutum-Ybar complex, 0 to 5 percent slopes; Nasa-Yesum complex, 0 to 6 percent slopes; Piedrablanca-Wulie-Nasa complex, 0 to 6 percent slopes; Torbellino-Lark association, 0 to 15 percent slopes; Typic Petrogypsids-Oxyaquic Torriorthents complex, 0 to 8 percent slopes; Yesum gypsiferous fine sandy loam, saline, 0 to 3 percent slopes; and Yesum gypsiferous sandy loam, 0 to 9 percent slopes (USDA-NRCS 2017).

Vegetation Description

This shrubland is dominated by *Atriplex canescens* with canopies covers that approach 50%. High grass cover occurs beneath the shrubs and in the intershrub spaces and is dominated by *Sporobolus airoides*. Although total diversity within this association was moderately high (58 species recorded), composition and cover of individual species was variable among stands. The dwarf-shrub

Suaeda nigra and the graminoid *Sporobolus nealleyi* may be common associates, but both are typically less than 5% total cover. Common forbs include *Arida parviflora*, *Sartwellia flaveriae*, *Lepidium alyssoides* var. *angustifolium*, and *Phacelia integrifolia*.

Most Abundant Species

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Atriplex canescens, Pluchea sericea*
Herb (field)	Graminoid	*Sporobolus airoides*

Other Noteworthy Species
Facultative wetland (FACW) indicator species: *Tamarix chinensis*
New Mexico state-listed noxious weeds: (Class C) *Tamarix chinensis*

Classification Comments
Data are not available.

Classification Confidence
1

Element Sources
Inventory Notes: Data are not available.
Plots: 93MP110, 93MP034, 93MP109, 93MP117, 93JT001, 93JT012, 93MP202, 93JT007, 93MP196, 93MP161, 93MP156, 93MP131, 93MP158, 93MP098, 93MP076, 07WS034, 07WS030, 07WS014, 09YC286, 07WS011, 07WS036, 07WS013, 07WS037, 07WS038, 08SS009, 08CJ015, 07WS035.

Local Description Authors: E. Muldavin and A. Fettes

Literature Cited

USDA, Natural Resources Conservation Service (NRCS) and USDI National Park Service. 2017. Soil Survey of White Sands National Monument, New Mexico. (Accessible online at: http://soils.usda.gov/survey/printed_surveys).

Appendix E: A Vegetation Classification and Map: White Sands National Monument: Annotated Vegetation Map Legend

This annotated map legend for the vegetation map of White Sands National Monument (NM) is based on Tables 12A-12J of the main report. For each Level 2 unit, we provide a description with the following:

- A list of component plant associations by prevalence: Primary (collectively representing more than 50% of the map unit distribution); Secondary (collectively less than 50% of the area); and Inclusions (occupying less than 10% of the unit);
- Elevation range derived from the GIS;
- A summary of the distribution, environment, and floristic composition of the unit;
- A representative ground photograph;
- A distribution map of the unit with black polygons shown for each unit;
- An image map showing the delineation of a representative polygon(s) in the 2016 color aerial photography (Photo Map Detail);
- The total hectares and acres of the unit and number of polygons as derived from the GIS.

Scientific names for plant species in map unit descriptions are found in Appendix B.

Contents

1 Chihuahuan Gypsophilous Scrub A96

2 Chihuahuan Gypsophilous Grassland A99

3 Chihuahuan Semi-Desert Lowland Grassland A105

4 North American Desert Alkaline-Saline Wet Scrub A106

5 Chihuahuan Desert Lowland Basin Scrub A107

6 Chihuahuan Creosotebush - Mixed Desert Scrub A109

7 Chihuahuan Desert Sand Scrub A110

8 Interior West Ruderal Riparian Forest & Scrub A112

9 Sparse Vegetation A114

10 Other Land Cover A117

1 Chihuahuan Gypsophilous Scrub

1A Frosted Mint - Skunkbush Sumac Dune Shrubland

GIS Spectral Code: 11
Area: 4874 Ha; 12044 Acres
Polygons: 1539



Elev.: 3891 to 4078 ft (1186 to 1243 m)

Primary Component Associations

Poliomintha incana Gypsum Dune Shrubland
Poliomintha incana / *Muhlenbergia pungens* Gypsophilous Shrubland
Poliomintha incana / *Bouteloua breviseta* Gypsophilous Shrubland
Rhus trilobata / *Bouteloua breviseta* Gypsophilous Dune Shrubland
Rhus trilobata - *Poliomintha incana* Gypsophilous Dune Shrubland

Secondary Component Associations

Poliomintha incana / *Sporobolus flexuosus* Shrubland
Psorothamnus scoparius / *Sporobolus flexuosus* Shrubland
Yucca elata / *Sporobolus flexuosus* Shrubland

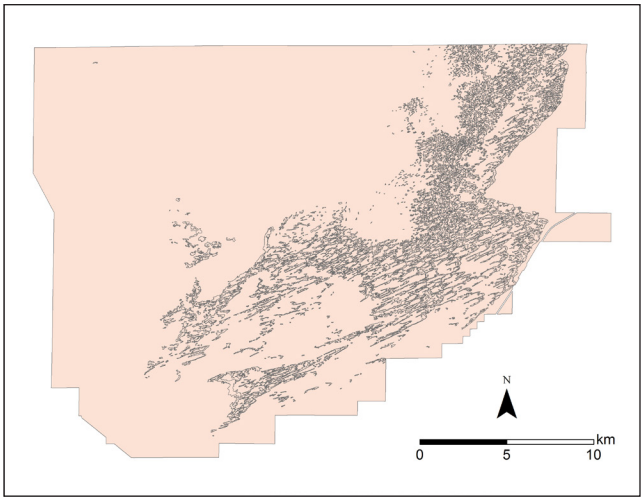
Inclusion Component Associations

Populus deltoides ssp. *wislizeni* / *Poliomintha incana* Flooded Forest
Populus deltoides ssp. *wislizeni* / *Schizachyrium scoparium* Flooded Woodland
Sparse Vegetation / Dune

Summary

These shrublands primarily occur on partially stabilized parabolic dunes that occur around the periphery of the main barchanoid shifting dune system. The shrubs with their roots anchored in the basin floor can tolerate being buried by sands, and, in fact, they serve to anchor the shifting sands into stabilized, well-vegetated parabolic dunes depending on the amount of windblown sands and their source. Shrub cover typically ranges from 10 to 25% or canopy cover and is usually dominated by frosted mint or skunkbush sumac with scattered broom dalea, soaptree yucca, and Torrey's jointfir. Grass cover can be sparse to abundant and is typically dominated by gypsum grama or sandhill muhly with scattered Indian ricegrass or mesa dropseed. Forbs are variable and low in cover; the most common are fragrant heliotrope, Hopi tea greenthread, and hoary aster.

On occasion, Rio Grande cottonwoods can be seen extending out of the dune tops and extending back into the interdune plains behind the dune fronts. As with the shrubs, they are rooted in the basin floor where they have access the shallow groundwater table, but can tolerate being buried by moving sand.



Distribution

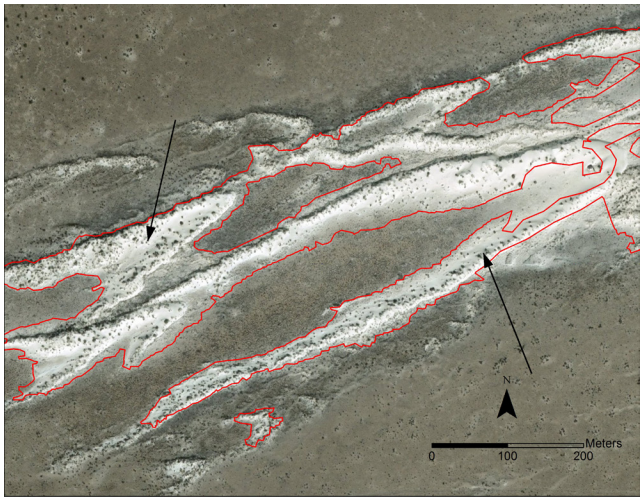


Photo Map Detail

1B Fourwing Saltbush / Gyp Dropseed Interdune Shrubland

GIS Spectral Code: 15
Area: 2262 Ha; 5590 Acres
Polygons: 421



Elev.: 3894 to 4075 ft (1187 to 1242 m)

Primary Component Associations

Atriplex canescens / *Sporobolus nealleyi* Shrubland

Secondary Component Associations

Larrea tridentata / *Sporobolus nealleyi* Shrubland

Inclusion Component Associations

Sparse Vegetation / Alluvial Flat

Summary

This shrubland occurs on gypsic basin flats, the scour platform, and interdune areas of the stabilized parabolic dunes that lie on the periphery of the main barchanoid dunefield. Sites have been scoured by wind, creating a crusty, rough soil surface that appears to limit the stature of the shrubs and cover provided by grasses and forbs. Fourwing saltbush is the dominant, but occasionally creosotebush may be dominant or codominant. Hairy crinklemat and pricklyleaf dogweed are common subshrubs. Among grasses, gyp dropseed can be abundant in the intershrub spaces. Forbs are scattered among the grass bunches with threadleaf glowwort, gypsum moonpod, and gypsum scorpionweed typically present.



Distribution

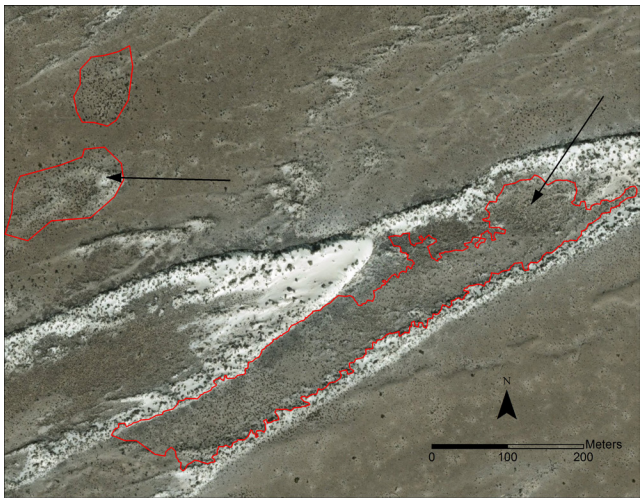


Photo Map Detail

1C Fourwing Saltbush / Gyp Dropseed Interdune Shrubland with Honey Mesquite

GIS Spectral Code: 17
Area: 1097 Ha; 2710 Acres
Polygons:34



Elev.: 3967 to 4088 ft (1209 to 1246 m)

Primary Component Associations

Atriplex canescens / *Sporobolus nealleyi* Shrubland with *Prosopis glandulosa*

Secondary Component Associations

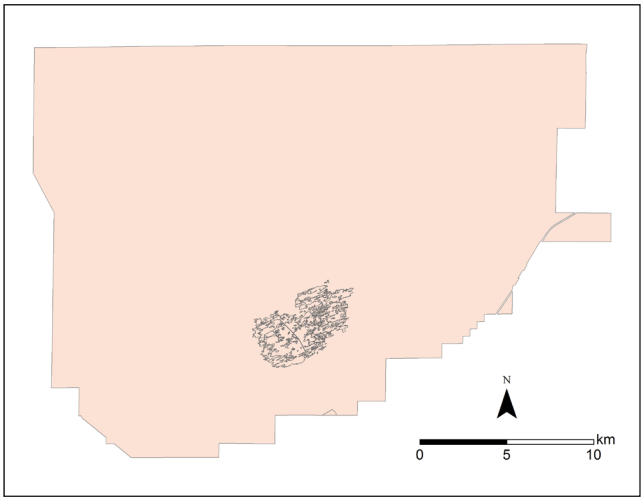
Tiquilia hispidissima / *Sporobolus nealleyi* Dwarf-shrub Grassland with *Prosopis glandulosa*

Inclusion Component Associations

Sparse Vegetation / Alluvial Flat

Summary

This shrubland is restricted to the elevated anticline dome of the scour platform in the south-central portion of the monument. Sites have been scoured by wind, creating a crusty, rough soil surface and often barren intershrub spaces. Honey mesquite is a conspicuous codominant with fourwing saltbush. Hairy crinklemat and pricklyleaf dogweed are common subshrubs. Among grasses, gyp dropseed can be abundant in the intershrub spaces. Forbs are scattered among the grass bunches with threadleaf glowwort, gypsum moonpod, and gypsum scorpionweed typically present.



Distribution

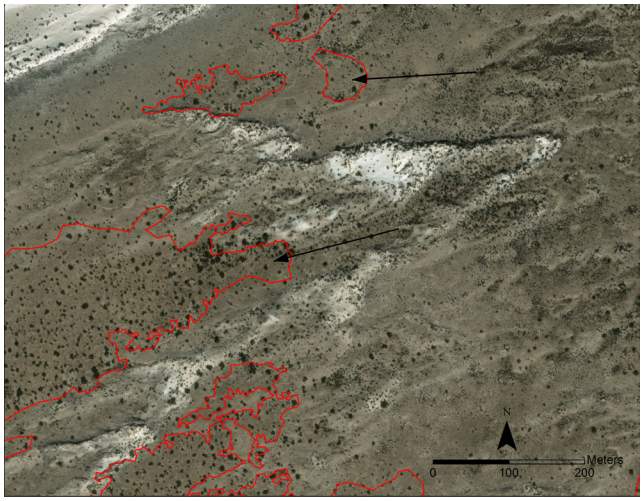


Photo Map Detail

2 Chihuahuan Gypsophilous Grassland

2A Gypsum Grama - New Mexico Bluestem Interdune Grassland

GIS Spectral Code: 12
Area: 1689 Ha; 4173 Acres
Polygons: 733



Elev.: 3891 to 4062 ft (1186 to 1238 m)

Primary Component Associations

Bouteloua breviseta - Schizachyrium neomexicanum Grassland

Secondary Component Associations

Ephedra torreyana / *Bouteloua breviseta* Dwarf-shrub Grassland

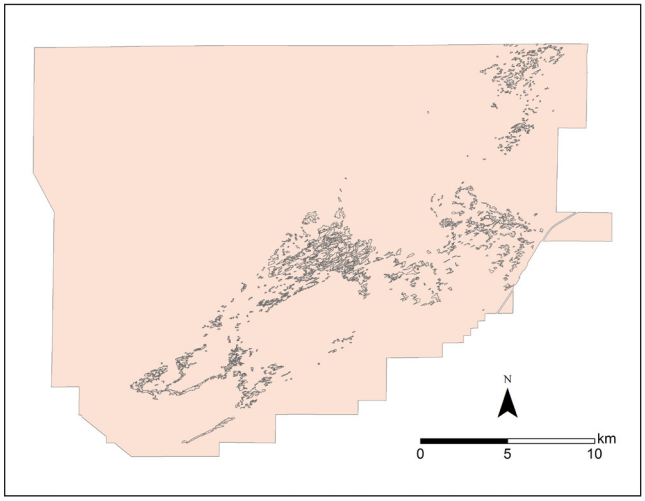
Inclusion Component Associations

Populus deltoides ssp. *wislizeni* / *Poliomintha incana* Flooded Forest
Populus deltoides ssp. *wislizeni* / *Schizachyrium scoparium* Flooded Woodland
Sparse Vegetation / Alluvial Flat

Summary

This grassland is associated with the scoured interdune areas that lie immediately behind the parabolic dune crests. Grasses are common to abundant and dominated by New Mexico bluestem and gypsum grama. Shrubs typically associated with desert grasslands such as Torrey's jointfir and soaptree yucca are common but scattered and not dominant. Forbs can be diverse and include gypsophiles such as Hartweg's sundrops, fragrant heliotrope, and gypsum centaury.

On occasion, remnant Rio Grande cottonwoods that once were buried by advancing dune are now exposed as short trees and shrubs.



Distribution

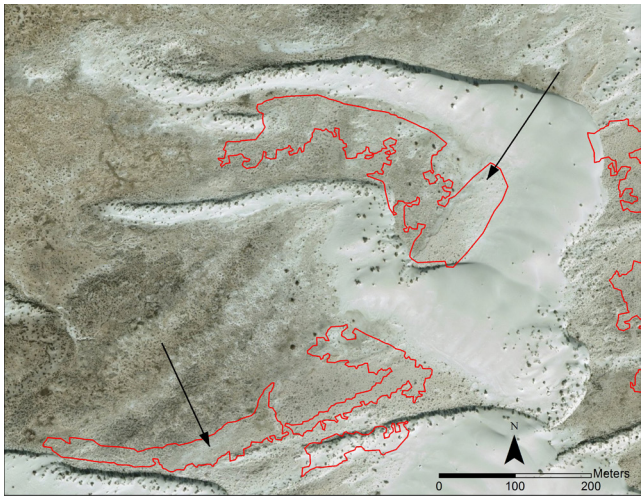


Photo Map Detail

2B Gypsum Grama / Torrey's Jointfir Interdune Grassland

GIS Spectral Code: 18
Area: 1832 Ha; 4537 Acres
Polygons: 636



Elev.: 3894 to 4058 ft (1187 to 1237 m)

Primary Component Associations

Ephedra torreyana / *Bouteloua breviseta* Dwarf-shrub Grassland

Secondary Component Associations

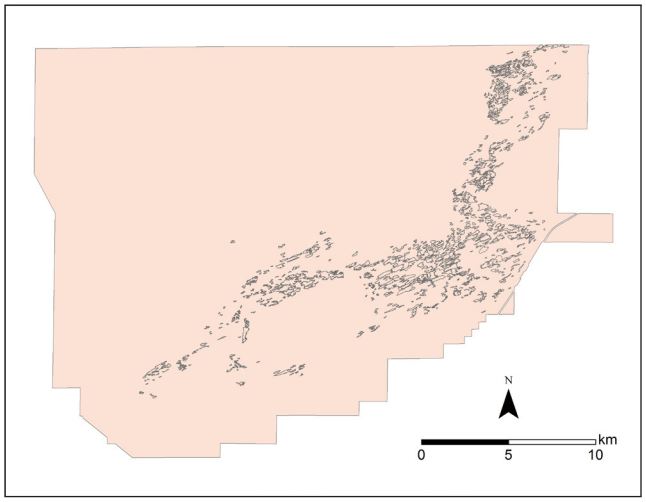
Bouteloua breviseta - *Sporobolus airoides* Grassland

Inclusion Component Associations

Sparse Vegetation / Alluvial Flat

Summary

This grassland is associated with the central portions of the scoured interdune areas that lie between parabolic dune crests. Grass cover can by luxuriant and dominated by gypsum grama and alkali sacaton. Shrubs typically associated with desert grasslands such as Torrey's jointfir and soaptree yucca are common but scattered and not dominant. In addition, gypsophilic subshrubs can be common, such as hairy crinklemat and James' seaheath. Forbs can be diverse and typically include gypsophiles such as White Sands fanmustard, and gypsum moonpod.



Distribution

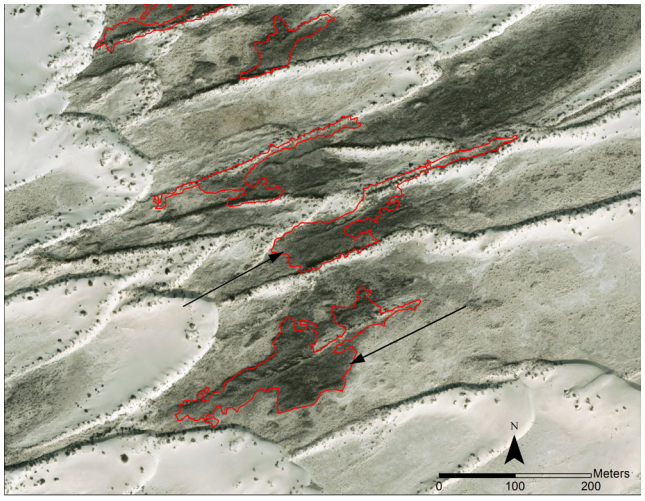


Photo Map Detail

2C Gyp Dropseed - Gypsum Grama / Hairy Coldenia Interdune Grassland

GIS Spectral Code: 14
Area: 5369 Ha; 13268 Acres
Polygons: 629



Elev.: 3888 to 4085 ft (1185 to 1245 m)

Primary Component Associations

Tiquilia hispidissima / *Sporobolus nealleyi* Dwarf-shrub Grassland
Tiquilia hispidissima / *Bouteloua breviseta - Mentzelia humilis* Dwarf-shrub Grassland

Secondary Component Associations

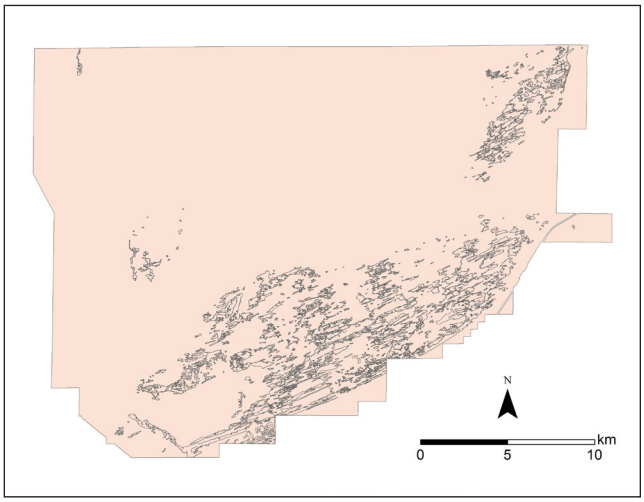
Sporobolus nealleyi - Sporobolus airoides Grassland
Tiquilia hispidissima / *Acleisanthes lanceolata* Dwarf-shrubland

Inclusion Component Associations

Sparse Vegetation / Alluvial Flat

Summary

This grassland occurs on gypsic scour platform and interdune areas of the stabilized parabolic dunes which lie on the periphery of the main barchanoid dunefield. Sites have been scoured by wind, creating a crusty, rough soil surface that appears to limit the stature of cover provided by grasses and forbs. The subshrub hairy crinklemat, along with bunches of short-statured gyp dropseed and gypsum grama typify the sites; alkali sacaton may also be abundant on occasion. Shrubs such as Torrey's jointfir and soaptree yucca may be present but are generally uncommon. Forbs are scattered among the grass bunches with White Sands fanmustard, perennial blazingstar, threadleaf glowwort, and gypsum moonpod typically present.



Distribution

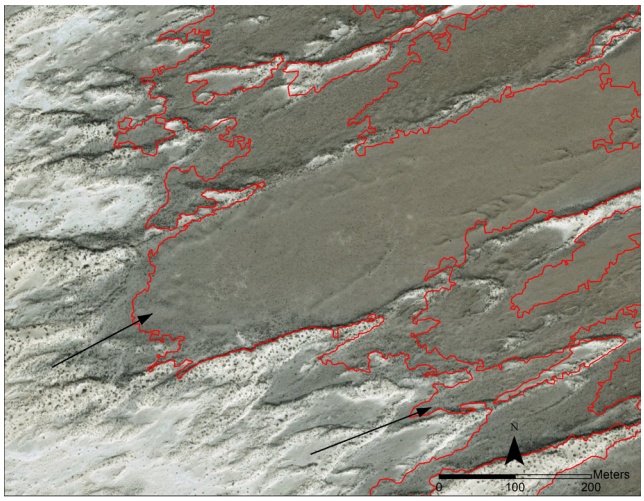


Photo Map Detail

2D Alkali Sacaton - New Mexico Bluestem - Sand Verbena Interdune Grassland

GIS Spectral Code: 13
Area: 1056 Ha; 2609 Acres
Polygons: 1791



Elev.: 3891 to 4101 ft (1186 to 1250 m)

Primary Component Associations

Sporobolus airoides - Abronia angustifolia Grassland
Sporobolus airoides - Schizachyrium neomexicanum Grassland

Secondary Component Associations

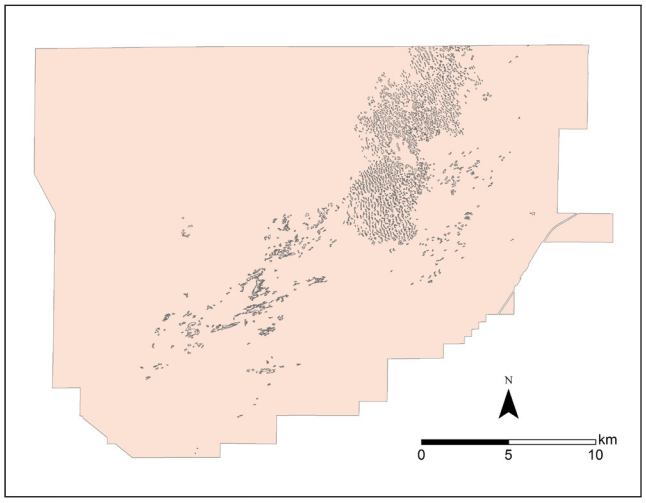
Schizachyrium neomexicanum - Abronia angustifolia Grassland

Inclusion Component Associations

Sparse Vegetation / Alluvial Flat

Summary

This grassland is associated with both scoured interdune areas that lie between parabolic dune crests, and interdune flats of the main barchan dunefield. Grass cover ranges from very sparse to luxuriant and is dominated by alkali sacaton and New Mexico bluestem. Shrubs typically associated with desert grasslands such as Torrey's jointfir and soaptree yucca are common but scattered and not dominant. In addition, gypsophilic subshrubs can be common, such as James' seaheath. Forbs can be diverse and typically include gypsophiles such as purple sand verbena, perennial blazingstar, gypsum centaury, Hartweg's sundrops, and fragrant heliotrope.



Distribution

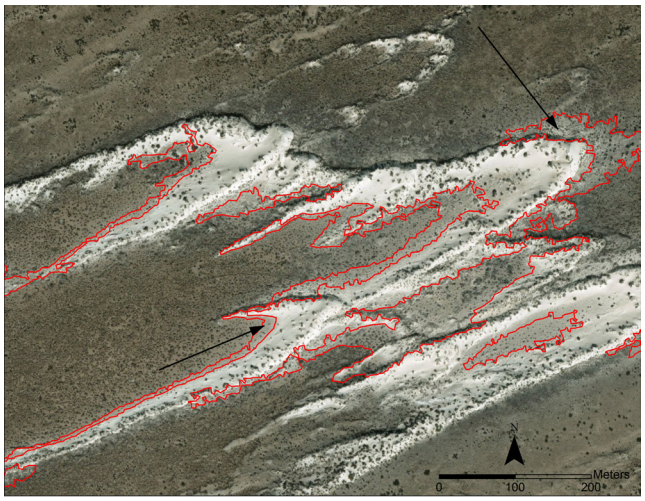


Photo Map Detail

2E Alkali Sacaton - New Mexico Bluestem Interdune Grassland

GIS Spectral Code: 16
Area: 1013 Ha; 2503 Acres
Polygons: 978



Elev.: 3891 to 4052 ft (1186 to 1235 m)

Primary Component Associations

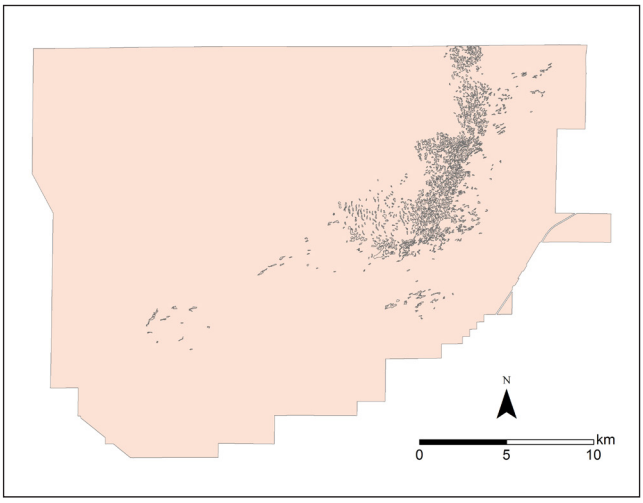
Sporobolus airoides - Schizachyrium neomexicanum Grassland

Inclusion Component Associations

Sparse Vegetation / Alluvial Flat

Summary

This grassland is primarily associated with interdune flats along the eastern margin of the main barchan dunefield. Grass cover ranges from very sparse to luxuriant and is dominated by alkali sacaton and New Mexico bluestem. Shrubs typically associated with desert grasslands such as Torrey's jointfir and soaptree yucca are common but scattered and not dominant. In addition, gypsophilic subshrubs can be common, such as James' seaheath. Forbs can be diverse and typically include gypsophiles such as purple sand verbena, perennial blazingstar, gypsum centaury, Hartweg's sundrops, and fragrant heliotrope.



Distribution

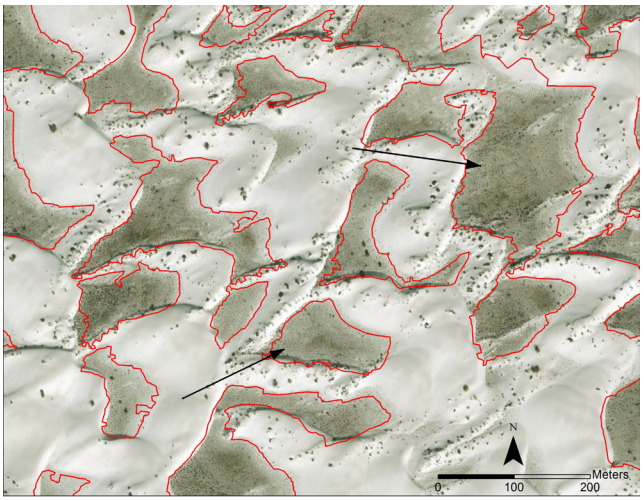


Photo Map Detail

2F Alkali Sacaton - James' Seaheath Interdune Grassland

GIS Spectral Code: 19
Area: 270 Ha; 667 Acres
Polygons: 119



Elev.: 3996 to 4029 ft (1218 to 1228 m)

Primary Component Associations

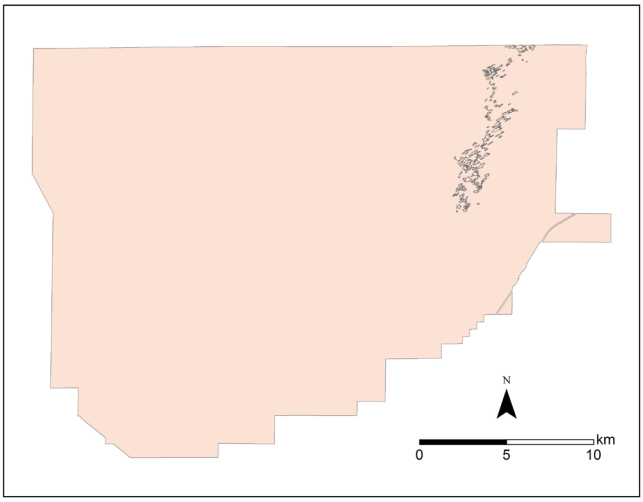
Frankenia jamesii / *Sporobolus airoides* Shrubland

Inclusion Component Associations

Sparse Vegetation / Alluvial Flat

Summary

This grassland is associated with both scoured interdune areas that lie between parabolic dune crests, and in interdune flats along the eastern margin of the main barchan dunefield. Grass cover ranges from very sparse to luxuriant and is dominated by alkali sacaton. Shrubs typically associated with desert grasslands such as Torrey's jointfir and soaptree yucca are common but scattered and not dominant. In addition, gypsophilic subshrubs can be common, such as James' seaheath. Forbs can be diverse and typically include gypsophiles such as gypsum centaury, threadleaf glowwort, and gypsum moonpod.



Distribution

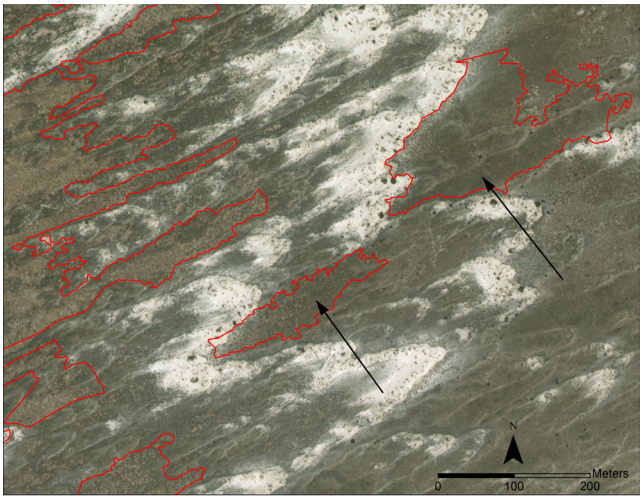


Photo Map Detail

3 Chihuahuan Semi-Desert Lowland Grassland

3A Alkali Sacaton Basin Grassland

GIS Spectral Code: 22
Area: 3949 Ha; 9757 Acres
Polygons: 848



Elev.: 3891 to 4183 ft (1186 to 1275 m)

Primary Component Associations

Sporobolus airoides Monotype Grassland

Secondary Component Associations

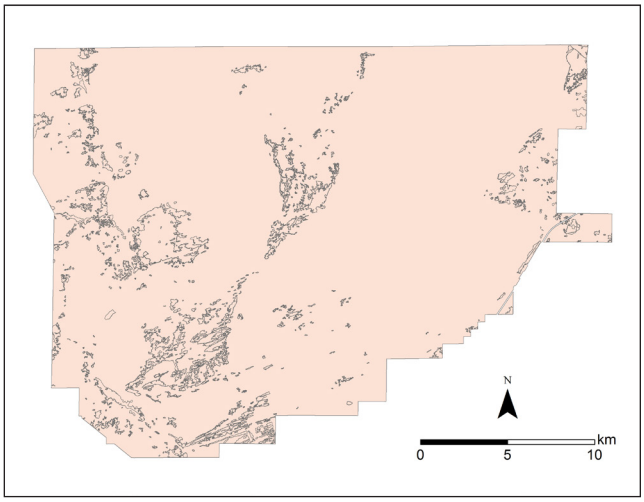
Pleuraphis mutica - Sporobolus airoides Grassland
Sporobolus nealleyi - Sporobolus airoides Grassland
Sporobolus airoides - Distichlis spicata Wet Meadow
Distichlis spicata Alkaline Wet Meadow

Inclusion Component Associations

Sparse Vegetation / Alluvial Flat

Summary

This grassland is very prevalent on alluvial flats, plains, and playas around dunefields that are not strongly gypsic, but can also occur sporadically in the interdune areas among parabolic dunes. These are often low-lying areas with more water accumulation and/or a shallow water table. Grass cover can be luxuriant and is dominated by alkali sacaton along with tobosa, and, on occasion, inland saltgrass. Among shrubs, iodinebush, fourwing saltbush, or tarbush may be present but low in cover. Forbs are variable and limited in diversity. Typical representatives include mountain pepperweed, Indian rushpea, and hoary aster.



Distribution

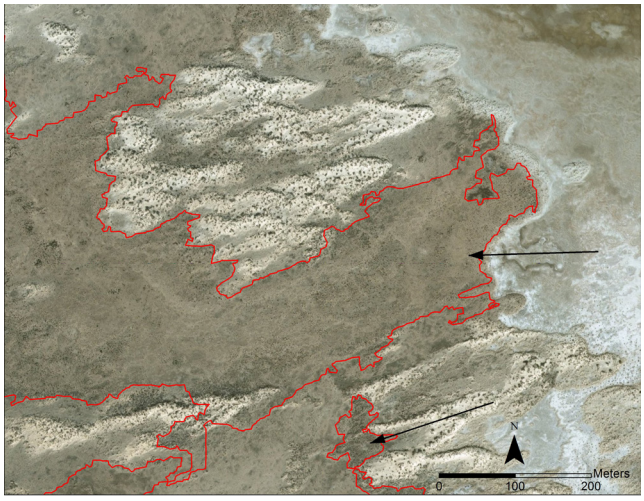


Photo Map Detail

4 North American Desert Alkaline-Saline Wet Scrub

4A Iodinebush Basin Shrubland

GIS Spectral Code: 21
Area: 4822 Ha; 11915 Acres
Polygons: 733



Elev.: 3888 to 4012 ft (1185 to 1223 m)

Primary Component Associations

Allenrolfea occidentalis Sparse Shrubland

Secondary Component Associations

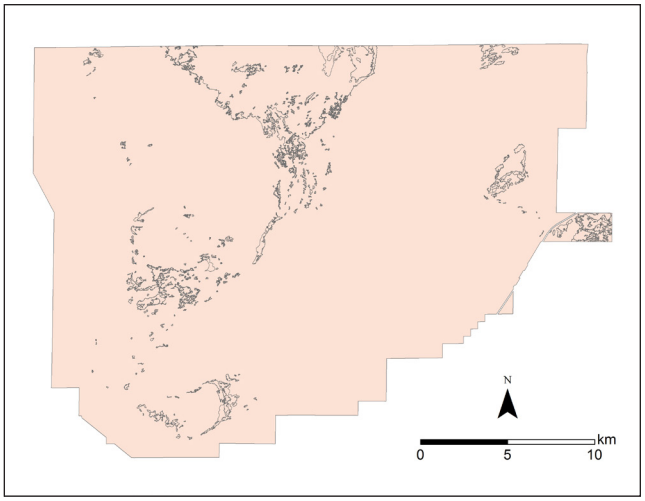
Allenrolfea occidentalis - Atriplex canescens / Sporobolus airoides Shrubland
Allenrolfea occidentalis / Suaeda nigra Shrubland
Suaeda nigra Wet Shrubland

Inclusion Component Associations

Sparse Vegetation / Alluvial Flat

Summary

This shrubland occurs on playa floors and alluvial flats associated with ancient Lake Otero deposits and Lake Lucero, along with the basin floor extending eastward from the dune complex. It is dominated by the succulent and salt-tolerant iodinebush and bush seepweed, species that also prefer shallow water tables as facultative and obligate wetland species, respectively. Fourwing saltbush may be common, along with the introduced shrub saltcedar. Herbaceous cover varies from nonvegetated to abundant; alkali sacaton is the most common graminoid. Forbs are scarce to variable, with annual and biennial species such as smallflower tansyaster, gypsum moonpod, and lacy tansyaster.



Distribution

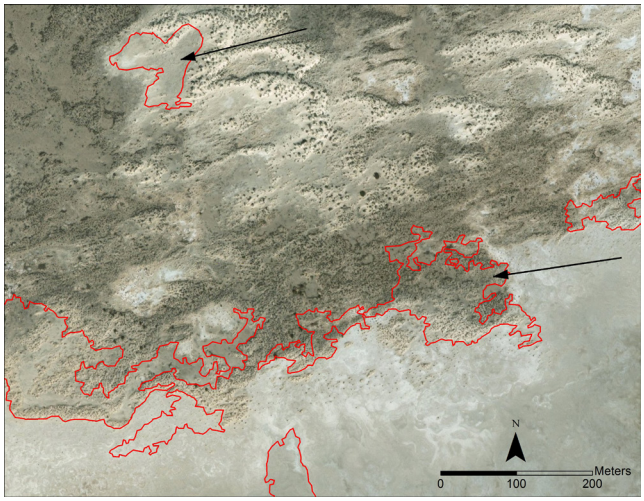


Photo Map Detail

5 Chihuahuan Desert Lowland Basin Scrub

5A Fourwing Saltbush Basin Shrubland

GIS Spectral Code: 32
Area: 1635 Ha; 4039 Acres
Polygons: 433



Elev.: 3891 to 4072 ft (1186 to 1241 m)

Primary Component Associations

Atriplex canescens / *Sporobolus airoides* Shrubland

Secondary Component Associations

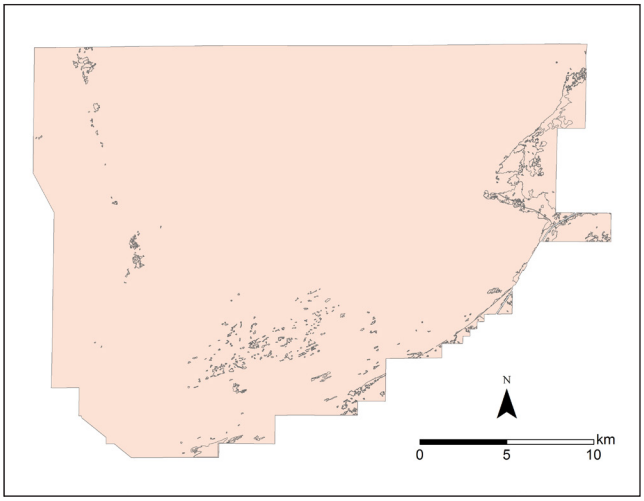
Atriplex canescens / Sparse Shrubland
Atriplex canescens / *Suaeda nigra* Shrubland

Inclusion Component Associations

Rhus trilobata / *Sporobolus airoides* Shrubland
Sparse Vegetation / Alluvial Flat

Summary

Occurs on alkali flats, interdune areas, playa fringes, and areas where water accumulates or there is a shallow water table. Fourwing saltbush dominates and grass cover may be high and dominated by alkali sacaton; other sites are sparse with scattered iodinebush and bush seepweed, along with Christmas cactus, Torrey's jointfir, and occasionally frosted mint. Forbs are variable and limited in diversity and may include gypsum scorpionweed, smallflower tansyaster, and mountain pepperweed.



Distribution

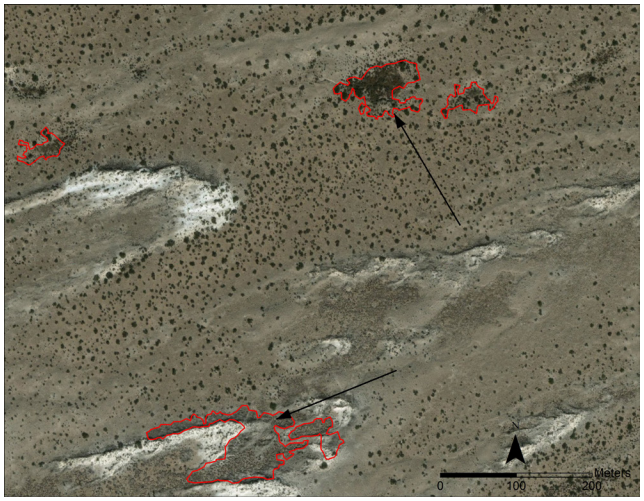


Photo Map Detail

5B Fourwing Saltbush Basin Shrubland and Alkali Sacaton Grassland

GIS Spectral Code: 33
Area: 1187 Ha; 2933 Acres
Polygons: 34



Elev.: 3944 to 4081 ft (1202 to 1244 m)

Primary Component Associations

Atriplex canescens / *Sporobolus airoides* Shrubland
Sporobolus airoides Monotype Grassland

Secondary Component Associations

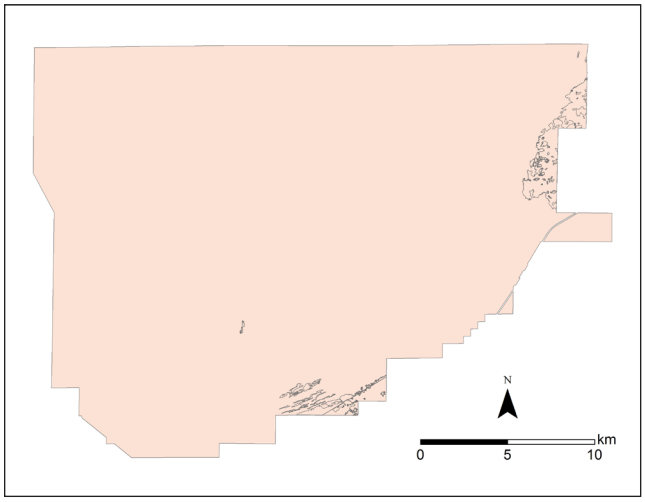
Atriplex canescens / Sparse Shrubland

Inclusion Component Associations

Sparse Vegetation / Alluvial Flat

Summary

This unit is a complex of fourwing saltbush shrublands intermixed with patches of alkali sacaton grasslands. It occurs on the basin floor of alluvial flats along the eastern and southeastern borders of the monument. Shrub, grass, and litter cover can be very high, with open soil between grass hummocks and shrubs. Bush seepweed and gyp dropseed may be common. Other shrubs that may occur are iodinebush, tree cholla, Christmas cactus, Torrey's jointfir, longleaf jointfir, and hairy crinklemat. The herbaceous layer is generally low in diversity and may include purple threeawn grass, along with forbs such as smallflower tansyaster or mountain pepperweed.



Distribution

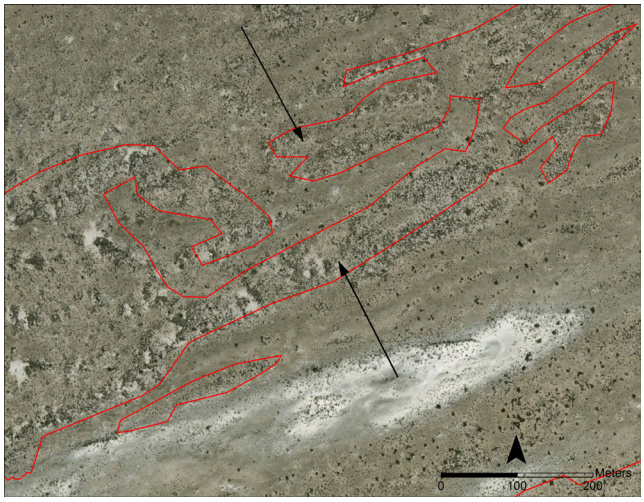


Photo Map Detail

6 Chihuahuan Creosotebush - Mixed Desert Scrub

6A Creosotebush Piedmont Shrubland

GIS Spectral Code: 41
Area: 947 Ha; 2339 Acres
Polygons: 46



Elev.: 3914 to 4226 ft (1193 to 1288 m)

Primary Component Associations

Larrea tridentata / Sparse Understory Shrubland
Larrea tridentata - Parthenium incanum Shrubland

Secondary Component Associations

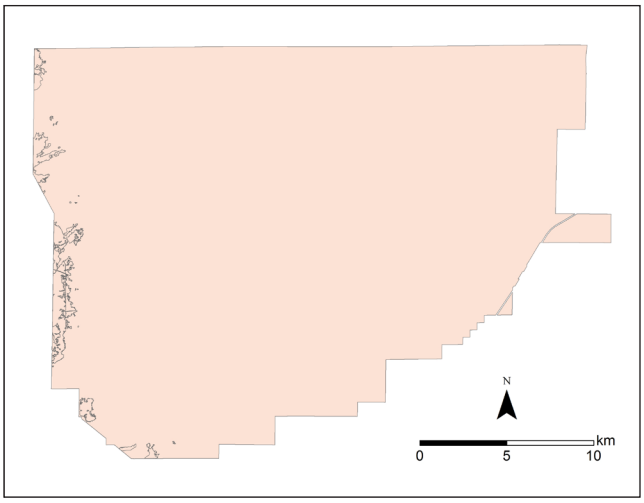
Larrea tridentata / *Muhlenbergia porteri* Shrubland
Prosopis glandulosa / Sparse Shrubland, *Larrea tridentata* Phase

Inclusion Component Associations

Sparse Vegetation / Alluvial Flat

Summary

This is a Chihuahuan Desert scrub unit that occurs on gravelly alluvial fan piedmonts that extend out from the foothills of the San Andres Mountains onto the monument along its western border. It is dominated by creosotebush with honey mesquite as a common co-dominant; tarbush may also be present but not dominant. Intershub spaces tend to be sparse but subshrubs and succulents such as boom snakeweed, mariola, and purple pricklypear may be common, along with grasses such as bush muhly and streambed bristlegrass. Forbs can include desert holly, hairyseed bahia, and copper globemallow.



Distribution

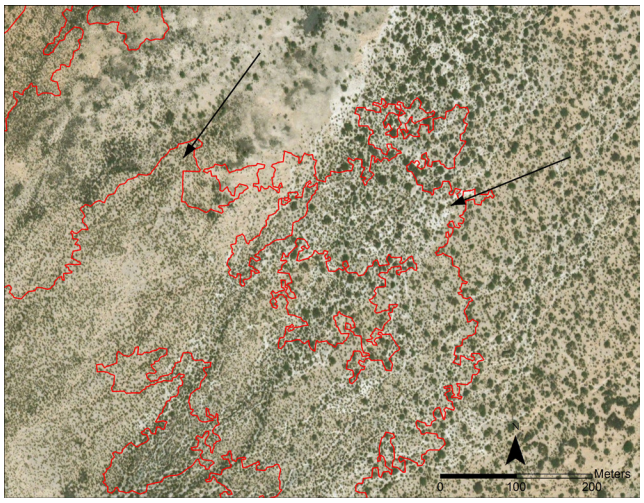


Photo Map Detail

7 Chihuahuan Desert Sand Scrub

7A Honey Mesquite Piedmont Shrubland

GIS Spectral Code: 51
Area: 2822 Ha; 6972 Acres
Polygons: 108



Elev.: 3891 to 4131 ft (1186 to 1259 m)

Primary Component Associations

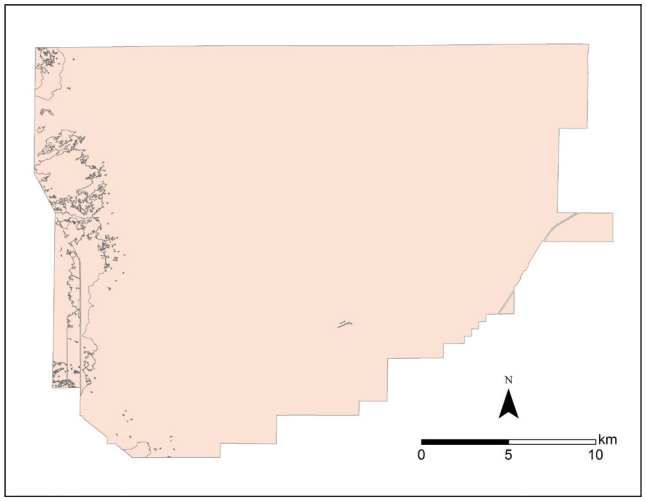
Prosopis glandulosa - Atriplex canescens Ruderal Shrubland

Inclusion Component Associations

Sparse Vegetation / Alluvial Flat

Summary

This is a Chihuahuan Desert scrub unit that occurs on lower alluvial fan piedmonts along the western border of the monument. Honey mesquite is the dominant and forms coppice dunes along the margins of Lake Lucero and Alkali Flat. Fourwing saltbush is typically present within the coppice dunes and occasionally in the sparse interdune spaces, along with broom snakeweed. Grass and forb diversity is very limited.



Distribution

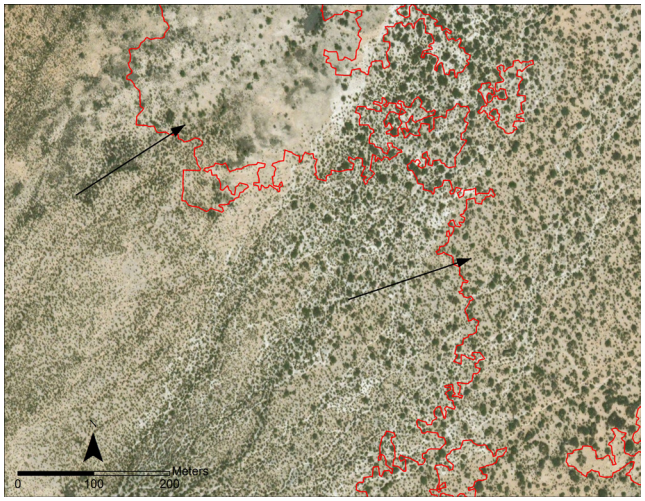


Photo Map Detail

7B Honey Mesquite Basin Shrubland

GIS Spectral Code: 52
Area: 2858 Ha; 7062 Acres
Polygons: 234

Primary Component Associations

Prosopis glandulosa / *Sporobolus airoides* Shrubland

Secondary Component Associations

Larrea tridentata / *Sparse Understory* Shrubland
Flourensia cernua / *Sporobolus airoides* Shrubland
Flourensia cernua / *Muhlenbergia porteri* Shrubland

Inclusion Component Associations

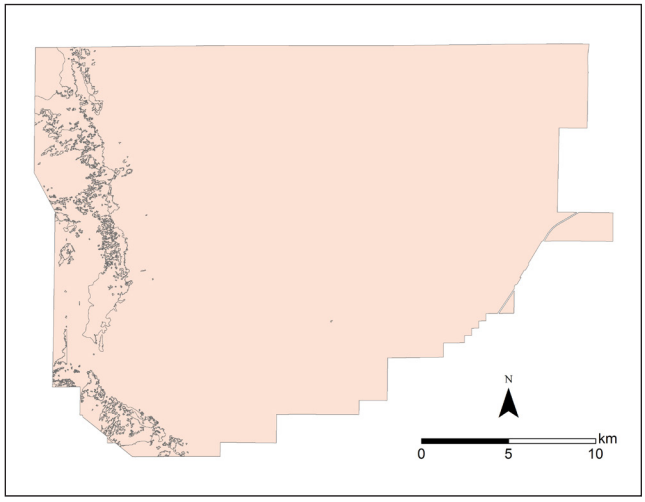
Sparse Vegetation / Alluvial Flat



Elev.: 3891 to 4137 ft (1186 to 1261 m)

Summary

This is a Chihuahuan Desert scrub complex that occurs on alluvial flats along the western margins of Lake Lucero and Alkali Flat (ancient Lake Otero deposits). Most stands are dominated by honey mesquite with intershrub spaces dominated by alkali sacaton. Some sites are codominated by tarbush or creosotebush. Other common grasses include bush muhly, tobosa, and burrograss. Forbs are limited in diversity and can include mountain pepperweed, copper globemallow, and desert holly.



Distribution

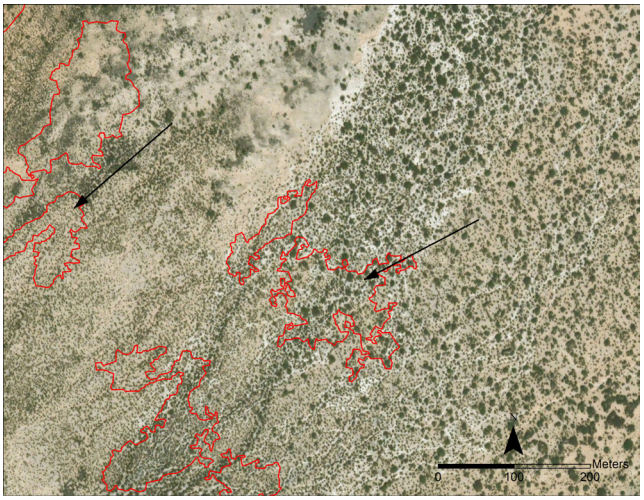


Photo Map Detail

8 Interior West Ruderal Riparian Forest & Scrub

8A Saltcedar Alluvial Flat Shrubland

GIS Spectral Code: 72
Area: 349 Ha; 861 Acres
Polygons: 88



Elev.: 3891 to 4032 ft (1186 to 1229 m)

Primary Component Associations

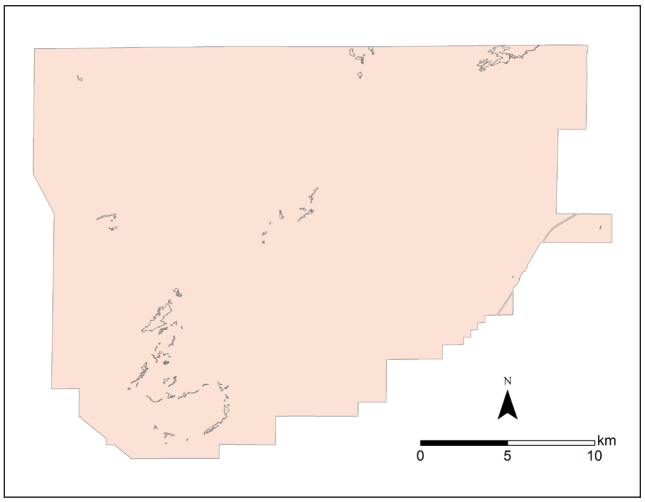
Tamarix chinensis (Allenrolfea occidentalis) Alkali Flat Ruderal Shrubland
Tamarix chinensis / *Sporobolus airoides* Ruderal Shrubland

Secondary Component Associations

Tamarix chinensis / *Distichlis spicata* Ruderal Shrubland
Sparse Vegetation / Alluvial Flat

Summary

This invasive riparian/wetland shrubland is scattered along the playa margin of Lake Lucero and Alkali Flat (ancient Lake Otero deposits), and along the drainage way of Lost Creek on the eastern side of the monument. Saltcedar dominates but iodinebush and false willow can be common. While the understory is commonly sparse, the intershrub spaces may support alkali sacaton or saltgrass patches. Forbs are uncommon and low in diversity.



Distribution

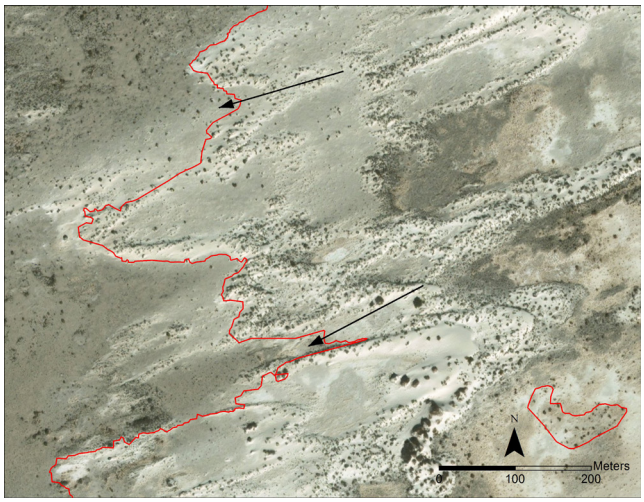


Photo Map Detail

8B Saltcedar Dune Shrubland

GIS Spectral Code: 73
Area: 154 Ha; 380 Acres
Polygons: 72



Elev.: 3891 to 4016 ft (1186 to 1224 m)

Primary Component Associations

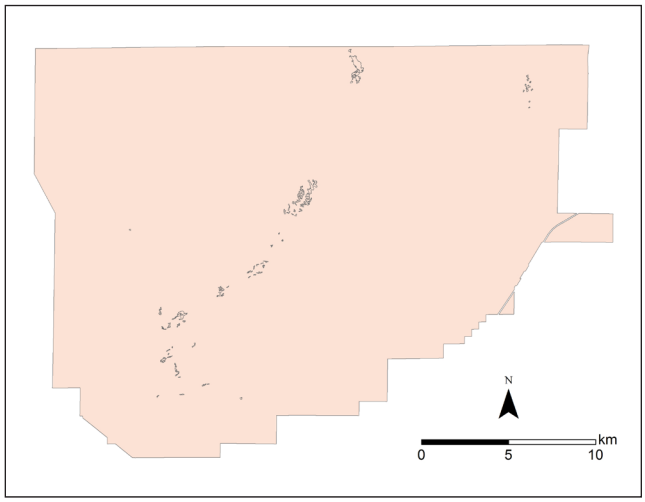
Tamarix chinensis - Dune Ruderal Shrubland

Secondary Component Associations

Sparse Vegetation / Dune

Summary

This invasive riparian/wetland shrubland is scattered along the eastern playa margin of Lake Lucero and Alkali Flat (ancient Lake Otero deposits) where coppice dunes and incipient gypsum dunelands form, anchored by saltcedar. Iodinebush and fourwing saltbush may be present but the intershrub spaces are typically barren. Forbs are uncommon and low in diversity, but may include purple sand verbena, gypsum moonpod, and other gypsophiles.



Distribution

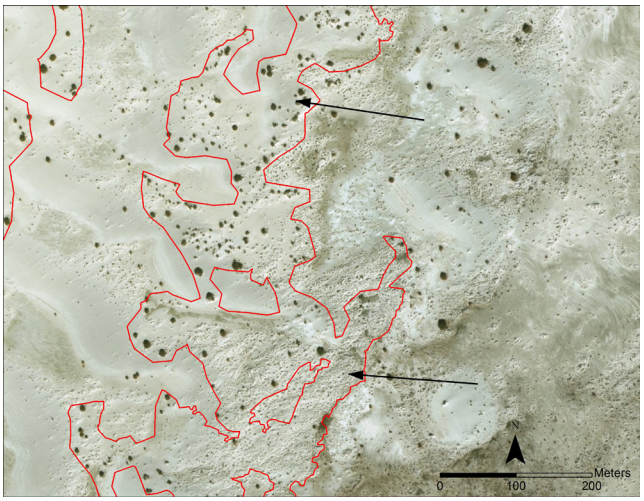


Photo Map Detail

9 Sparse Vegetation

9A Sparse Vegetation / Dune

GIS Spectral Code: 81
Area: 7139 Ha; 17642 Acres
Polygons: 733

Primary Component Associations

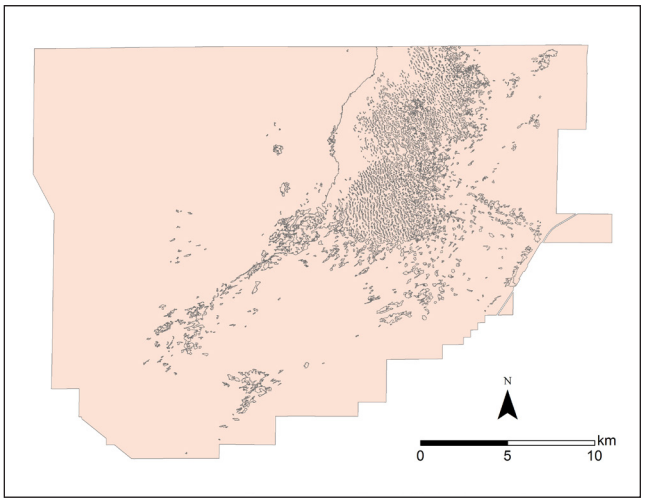
Sparse Vegetation / Dune

Summary

Shifting, non-vegetated gypsum dunes found within the interior regions of the main barchan duneland and scattered among parabolic dunes form this unit.



Elev.: 3891 to 4055 ft (1186 to 1236 m)



Distribution

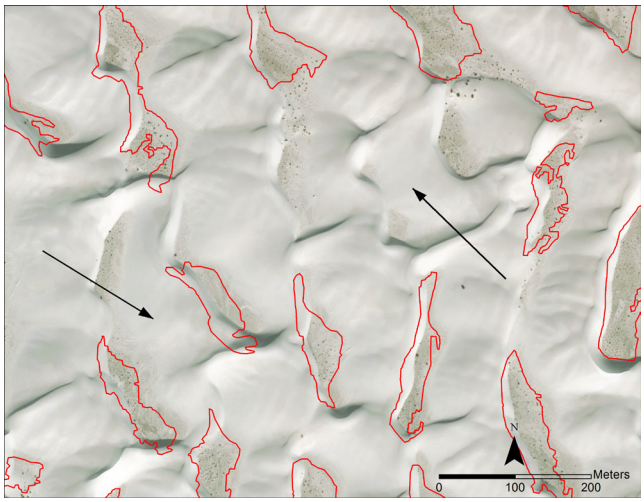


Photo Map Detail

9B Sparse Vegetation / Alluvial Flat

GIS Spectral Code: 82
Area: 14073 Ha; 34775 Acres
Polygons: 273



Elev.: 3888 to 4068 ft (1185 to 1240 m)

Primary Component Associations

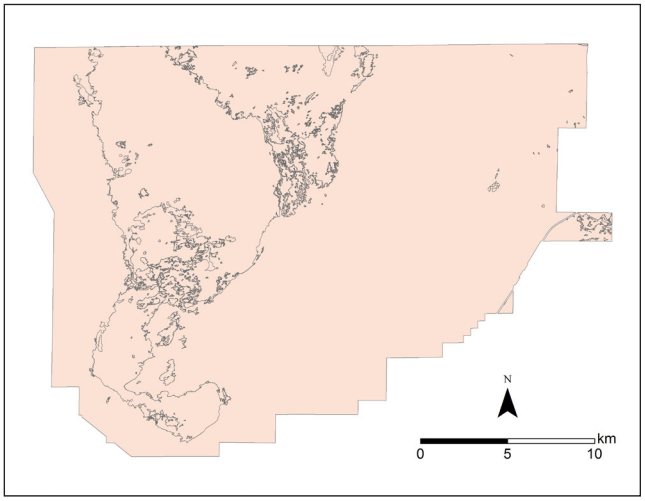
Sparse Vegetation / Alluvial Flat

Secondary Component Associations

Allenrolfea occidentalis / Sparse Shrubland
Allenrolfea occidentalis / *Suaeda nigra* Shrubland

Summary

These are non-vegetated playa and alkaline flats associated with Lake Lucero and Alkali Flat (ancient Lake Otero deposits) which are periodically inundated.



Distribution

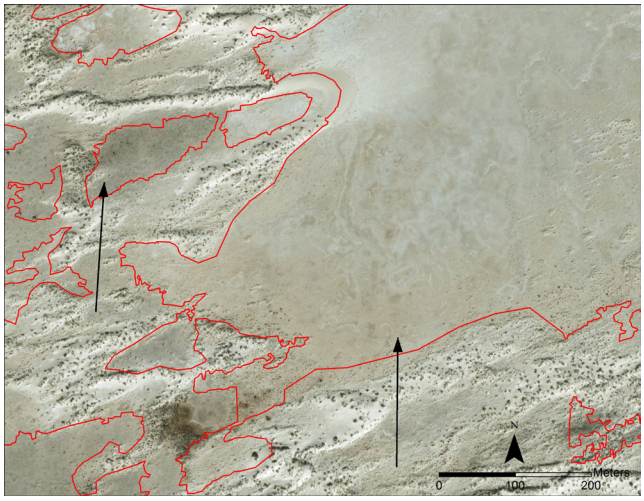


Photo Map Detail

9C Sparse Vegetation / Alluvial Fan

GIS Spectral Code: 85
Area: 486 Ha; 1201 Acres
Polygons: 205

Primary Component Associations

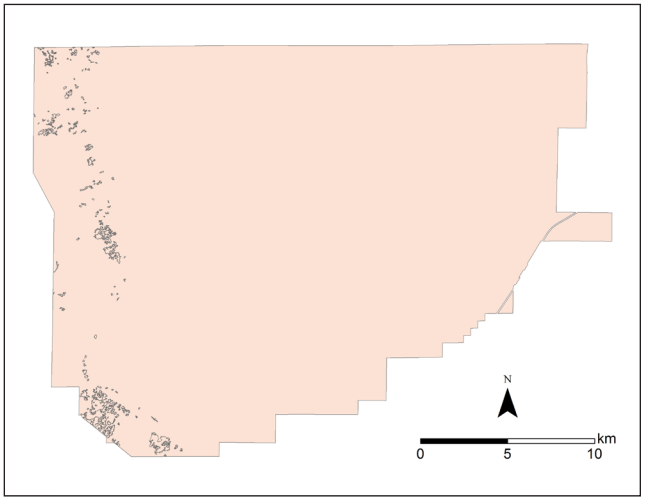
Sparse Vegetation / Alluvial Fan

Summary

Non-vegetated alluvial fan drainage ways and lower alluvial fans found on the western margin of Lake Lucero and Alkali Flat (ancient Lake Otero deposits) form this unit. They are periodically inundated by summer storm waters.



Elev.:3891 to 4180 ft (1186 to 1274 m)



Distribution

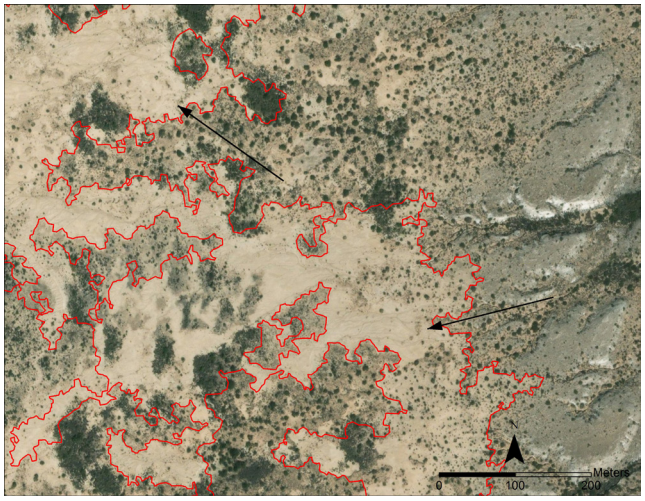


Photo Map Detail

10 Other Land Cover

10A Roads / Built-up Areas

GIS Spectral Code: 90
Area: 173 Ha; 428 Acres
Polygons: 12



Elev.: 3930 to 4180 ft (1198 to 1274 m)

Primary Component Associations

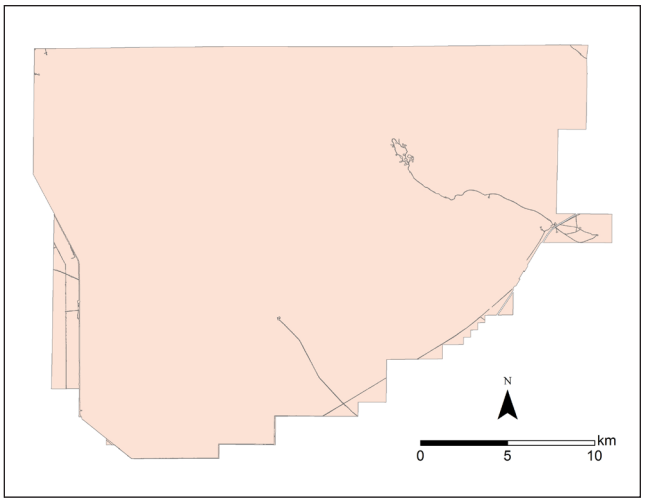
Disturbed / Developed
Disturbed / Road

Secondary Component Associations

Disturbed / Recreation Site
Disturbed / Non-vegetated

Summary

This unit is comprised of roads and built-up areas including buildings, shelters and miscellaneous development.



Distribution

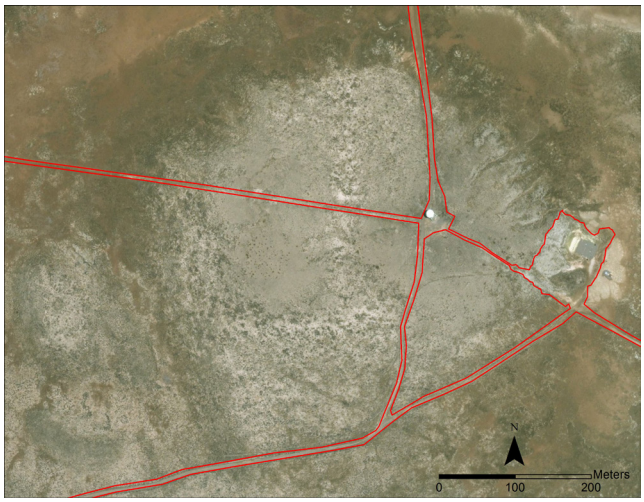


Photo Map Detail

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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National Park Service
U.S. Department of the Interior



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