



Vegetation Inventory, Mapping, and Characterization Report, Coronado National Memorial

Natural Resource Report NPS/SODN/NRR—2018/1818



ON THE COVER

Clockwise from top left: Common sotol / Sideoats grama - Tanglehead Shrubland Association; (Velvet mesquite - Desertbroom) / Lehmann lovegrass Herbaceous Association; Mexican blue oak / Mixed perennial grass Tree Savanna Association; view of Coronado Peak from the summit of Montezuma Peak. NPS photos.

Vegetation Inventory, Mapping, and Characterization Report, Coronado National Memorial

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November 2018

U.S. Department of the Interior

National Park Service

Natural Resource Stewardship and Science

Fort Collins, Colorado

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Please cite this publication as:

Studd, S. E., J. Galvin, and J. A. Hubbard. 2018. Vegetation inventory, mapping, and characterization report, Coronado National Memorial. Natural Resource Report NPS/SODN/NRR—2018/1818. National Park Service, Fort Collins, Colorado.

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Acronyms and Abbreviations

AA: accuracy assessment
ac: acres
CEGL: Community Element Code–Global
CES: NatureServe ecological system
cm: centimeter
CORO: Coronado National Memorial
DOQQ: digital orthophoto quarter quadrangle
ERDAS: Earth Resources Data Analysis System
ESA: Ecological Society of America
ESRI: Environmental Systems Research Institute
FGDC: Federal Geographic Data Committee
ft: foot/feet
GCP: ground control point
GIS: geographic information system
GPS: global positioning system
ha: hectares
I&M: Inventory and Monitoring
IRMA: Integrated Resource Management Applications
ITIS: Integrated Taxonomic Information System
km: kilometers
m: meters
mi: miles
MMU: minimum mapping unit
NA: not applicable
NAD83: North American Datum of 1983
NHS: National Historic Site
NM: National Monument
NMEM: National Memorial
NMAS: National Map Accuracy Standards
NP: national park
NPS: National Park Service
NS: NatureServe
NVCS: National Vegetation Classification Standard (or System)
NVC: National Vegetation Classification
OALS: Office of Arid Lands Studies
P: proposed
PS: park special
RMSE: root mean square error
RRQRR: Reversed Randomized Quadrant-Recursive Raster
SODN: Sonoran Desert Network (National Park Service)
sp.: species (singular)
spp.: species (plural)
TNC: The Nature Conservancy
UNESCO: United Nations Education, Science, and Cultural Organization
USDA: U.S. Department of Agriculture
USFS: U.S. Forest Service
USGS: U.S. Geological Survey
UTM: Universal Transverse Mercator

Executive Summary

The Sonoran Desert Network conducted a vegetation mapping and characterization effort at Coronado National Memorial (NMEM) from 2010 to 2016. This project was completed under the National Park Service (NPS) Vegetation Inventory Program, which aims to complete baseline mapping and classification inventories at more than 270 national park units. The goal of the project was to provide park managers with a digital map product that meets national standards of spatial and thematic accuracy, while also placing park vegetation into a regional and national context. The data standard was designed to facilitate the production of uniform statistics about vegetation across the nation; enable the translation of data collected at various scales; and allow data sharing, aggregation, and comparison across regions.

Vegetation mapping and characterization comprised three major field phases: (1) concurrent, field-based data collection and mapping from aerial imagery (map unit delineation), (2) development of vegetation community types at the National Vegetation Classification association level, and (3) map accuracy assessment. The majority of Phase 1 (sampling of all classification plots and 60% of the classification polygons) was completed during fall 2010. In summer 2011, the project was placed on hold due to the Monument Fire. Sampling of classification polygons was eventually completed in 2013 and 2014, and incorporated the effects of the Monument Fire. All map units (polygons) were delineated by hand, using printed satellite imagery and other spatial data in the field to guide the process.

Twenty-five new community type descriptions were drafted within the National Vegetation Classification System (NVCS) standard and applied to each of the mapped areas. The park-based vegetation community classification was developed from both plot data and field-census polygon data (map units). An accuracy assessment was completed in 2016. Following accuracy assessment, final products were developed, including this report, a digital map, and full vegetation community (“association”) descriptions.

Coronado National Memorial covers 1,922 hectares (4,750 ac) along the border between the U.S. and Mexico. Elevations range from 1,447 meters (4,750 ft) along the southeast boundary to 2,377 meters (7,800 ft) in the northeast corner. A total of 25 distinct communities were described and mapped at the park, ranging from dense, non-native grasslands dominated by Lehmann lovegrass (*Eragrostis lehmanniana*) to steep expanses of exposed bedrock dominated by mountain mahogany (*Cercocarpus montanus*) and evergreen sumac (*Rhus virens*). Four of the 25 vegetation types were existing, “accepted” types within the National Vegetation Classification (NVC). The others are new and specific to Coronado National Memorial, and are currently proposed for formal status within the NVC. Ten species were observed that have a global rarity rank of G3 (see Table 4-1), defined as “Vulnerable—at moderate risk of extinction due to a restricted range, relatively few populations, recent or widespread declines, or other factors” (natureserve.org). Of these, two species also had comparable state rankings: one S3 (“uncommon or restricted”) ranking for dentate falsepennyroyal (*Hedeoma dentate*) and one S1 (“very rare”) ranking for Arizona yellowhood (*Nissolia wislizeni*).

The project products are designed to facilitate ecologically based natural resource management and research. The vector (polygon) map is in digital format within a geodatabase structure that allows for complex relationships to be established between spatial and tabular data, and allows much of the data to be accessed concurrently. The Geographic Information System (GIS) format allows user flexibility and will also enable updates to be made as new information becomes available (such as revised NVC codes or vegetation type names) or in the event of major disturbance events that could impact the vegetation.

Acknowledgements

The authors would like to extend thanks to the staff of Coronado National Memorial for their support of this project and assistance with logistics. In particular, park law enforcement rangers were very supportive throughout all phases of this effort and assisted our crews with planning safe working practices. Sonoran Desert Network data manager Kristen Bonebrake helped with database design and management. Many people collected and managed the field data, including Natalie Wilson, Shannon Henke, Jesper Devantier, Beth Fallon, Dan Winkler, Greg Goodrum, and Daniel Stauning. Accuracy assessments were conducted by NPS Next Generation Rangers Ethan Sandoval and Nicole Gonzalez. Finally, we would like to thank Dennis Odion (Southern Oregon University and the Klamath Network) and E. William Schweiger (Rocky Mountain Network) for their review and helpful comments.

1 Introduction

1.1 Background

Vegetation is a primary resource of natural areas, and description of vegetation composition, structure, and distribution is fundamental to effective land management. The term “vegetation” encompasses plants at multiple scales, from the most refined floristic levels (referred to as “plant communities” in this report) to the broadest physiognomic or lifeform levels, such as “tropical rainforest” or “savanna.” This report describes the methods and results of a multi-year project (2010–2016) to classify, describe, and map vegetation at Coronado National Memorial (Coronado NMEM), located in Cochise County, in southeastern Arizona (Figure 1-1).

The Sonoran Desert Network (SODN), part of the National Park Service (NPS) Inventory and Monitoring (I&M) Division, organized and coordinated vegetation inventory, classification, and mapping at Coronado NMEM. A goal of the NPS I&M program is to complete baseline inventories of biological and geophysical resources for each NPS unit. Vegetation classification and mapping products are one of these mandated inventories. For Coronado NMEM and other network parks, SODN needed baseline vegetation data upon which to develop and implement specific monitoring programs. Park managers needed baseline data and information on park vegetation resources for management purposes.

The current effort to create a vegetation map for Coronado NMEM is part of the NPS Vegetation Mapping Inventory (<https://www.nps.gov/im/vegetation-mapping-inventory.htm>), in cooperation with SODN and the University of Arizona’s Office of Arid Lands Studies. The map is required to meet the standards of the NPS Vegetation Mapping Inventory, including a minimum mapping unit of 0.5 hectares, 80% thematic accuracy per class, and spatial accuracy meeting the U.S. National Map Accuracy Standards developed by the Federal Geographic Data Committee (FGDC). In addition to meeting the program standards, every effort was made to provide the mapping and classifica-

tion data to the park in a manner best suited to their specific management objectives and needs, as identified in a scoping meeting with park staff in 2007, and again after the Monument Fire in 2011.

1.2 Scope and products

The aim of this project was to create a vegetation map at the National Vegetation Classification System (NVCS) association level for a study area of about 1,934 hectares (4,750 acres) (see Figure 1-1).

Products developed for Coronado NMEM as part of this project included:

- A final report, including a dichotomous vegetation key and full vegetation community-type descriptions;
- Digital reference photos of each vegetation type (four per polygon mapped);
- A geodatabase containing mapped vegetation data, plot data and location, permanent photo point locations, and satellite imagery;
- Printable digital graphics of final map polygons;
- Federal Geographic Data Committee-compliant metadata for all spatial database files and field data; and
- A park-specific plant field guide with annotated checklist and voucher specimen list (not a program requirement; rather, an additional product developed by SODN).

1.3 The NPS Vegetation Mapping Inventory

The NPS Vegetation Mapping Inventory is an effort to “classify, describe and map detailed vegetation communities in more than 270 national parks across the United States” (NPS 2012). In its earlier years, starting in 1992, the program was administered as a collaboration between the U.S. Geological Survey (USGS) Center for Biological Informatics and the NPS. More recently, the NPS assumed the role as the primary funding agency, providing



Vegetation Mapping Inventory Project Area

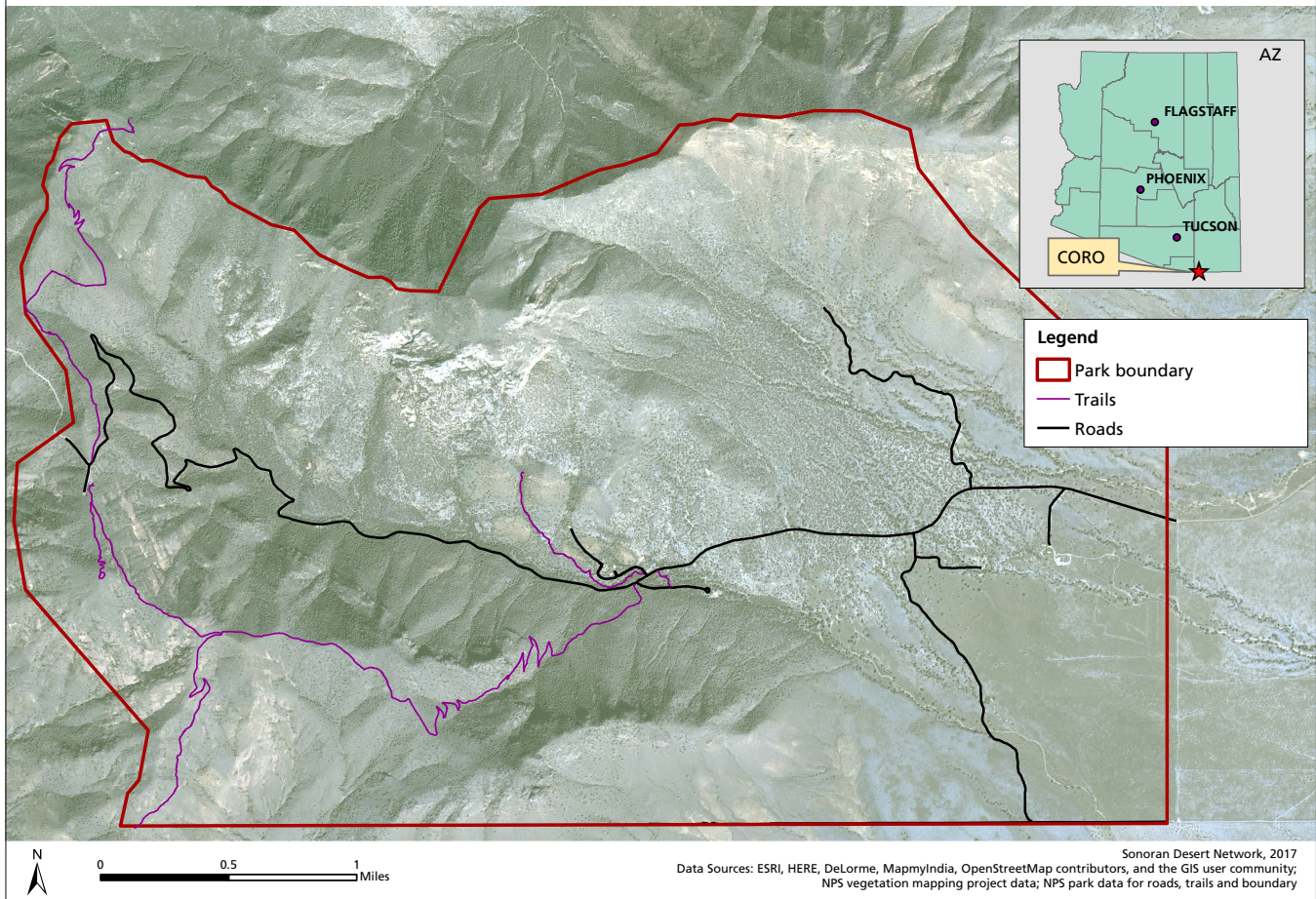


Figure 1-1. Map showing the project area and relative location of Coronado National Memorial in southeastern Arizona.

parks support through Inventory and Monitoring Division base funds. The program serves the data products through download from the inventory website (<https://www.nps.gov/im/vegetation-mapping-inventory.htm>). They can also be searched and downloaded via the Integrated Resource Management Applications (IRMA) portal (<https://irma.nps.gov/App/Portal/Home>).

The Vegetation Mapping Inventory supports consistent vegetation classification, mapping, and accuracy-assessment protocols and standards across all park mapping projects. The program has established guidance for all vegetation-mapping projects in four documents:

- Classification Guidance (Natural Resource Report NPS/NRPC/

NRR—2011/374)

- Methodology for Assessing the Utility of Existing Data for Vegetation Mapping (TNC and ESRI 1994a; NPS edited 2009 version)
- FGDC National Vegetation Classification Standard, v.2 (2008)
- Accuracy Assessment Guidance (Natural Resource Report NPS/NRPC/NRR—2010/204).

In addition, the program has defined national standards for all park vegetation classification and mapping projects:

- Vegetation classification follows the Federal Geographic Data Committee (FGDC) standard for vegetation classifi-

cation, the National Vegetation Classification Standard.

- Spatial data formatting follows FGDC standards for spatial data transfer.
- Metadata for each spatial dataset use the FGDC metadata standard.
- Spatial data are provided with a horizontal positional accuracy that meets National Map Accuracy Standards at the 1:24,000 scale. Each well-defined object within the spatial database is within 1/50 of an inch display scale, or 12.2 meters (40 ft) of its actual location.
- All plant names used in the classification are consistent with the Integrated Taxonomic Information System (ITIS).
- Each vegetated map class will try to meet or exceed 80% accuracy at the 90% confidence level.
- The minimum mapping unit (MMU) is 0.5 hectares (1.24 ac).

1.4 The National Vegetation Classification Standard

Patterns of vegetation vary continuously over landscapes. Classification systems attempt to categorize those patterns by identifying and describing assemblages of plants that repeat under similar environmental conditions. The National Vegetation Classification Standard (NVCS) provides a classification framework that is the standard for all NPS vegetation mapping projects (Comer et al. 2003; TNC and ESRI 1994a). In 1997, the FGDC formally adopted the NVCS version 1 (FGDC 1997). It was recognized as incomplete at the time of its adoption, and work to refine and further develop it began immediately. In October 2007, the FGDC vegetation subcommittee released the NVCS Version 2-Working draft (FGDC 2007), which was formally endorsed in February 2008.

The NVCS evolved from vegetation classification primarily conducted over more than two decades by The Nature Conservancy (TNC), NatureServe, and the Natural Heritage Program network (Grossman et al. 1998). It derives in part from earlier vegetation classification frameworks produced by the United Nations Educational, Cultural, and Scientific Organization (UNESCO 1973;

Driscoll et al. 1984). Use of this standardized classification system helps ensure data compatibility throughout the National Park Service and other agencies. The NVCS was designed to facilitate the production of uniform statistics about vegetation across the nation, enable the translation of data collected at various scales, and allow data sharing, aggregation, and comparison across regions.

The NVCS is a hierarchical system that allows vegetation classification to occur at multiple scales. Existing vegetation is classified on the basis of both physiognomic and floristic criteria. The upper three levels are physiognomic, based primarily on growth form, structure, and cover, indicating characteristics that reflect geographically widespread (global) topographic factors, such as soils and landscape physical properties. The middle three levels focus on largely biogeographic and habitat factors along very broad, continental-to-regional topographic, edaphic, and disturbance gradients. The lower two levels are floristic, based primarily on species composition and abundance. Tables 1-1 to 1-3 show the revised version 2, under which this project was conducted and which is currently being utilized by NatureServe and the Ecological Society of America (ESA) vegetation panel to substantially update the structure and content of the NVCS.

The NVCS also distinguishes between natural and cultural vegetation, the former being determined primarily by ecological processes and the latter by regular human activity. Vegetated areas intermediate between the two, such as those influenced by both human activity (e.g., logging, fire, and grazing) and ecological processes, are defined as semi-natural.

1.5 The National Vegetation Classification

The NVCS provides a framework for levels of classification but does not provide descriptions of all existing vegetation types at all levels. Those descriptions comprise the National Vegetation Classification (NVC), which is being populated by data from various completed vegetation inventory projects (such as the present one) and other sources. The NVC, which is predominantly main-

tained by NatureServe and used by many federal agencies, including the NPS, includes the plant communities (associations and alliances) defined for the United States.

NatureServe manages a database of NVC plant community entities. Their online database, NatureServe Explorer (<http://www.natureserve.org/explorer/>), provides public access to regularly updated versions of NVC plant community listings and descriptions. Until recently, NatureServe's documentation of associations (and in some cases, alliances) was the most accessible listing currently available. However, the plant community listings within the NVC are not yet complete. They are currently being revised to fall within version 2 of the FGDC hierarchy.

A newer website, www.usnvc.org, which posts all new descriptions as well as information on the changes to the hierarchy and displays these vegetation type descriptions in the new hierarchy, is now available (see Tables 1-1 to 1-3). Most vegetation associations listed on this site link to a full and updated description on the NatureServe explorer site. As of 2017, the alliance level of the system was still incomplete/undescribed.

As such, there were few alliances formally accepted at that time. After review of the upper and mid-levels is completed by NatureServe and the ESA vegetation panel, and associations have been peer-reviewed, the effort to revise the alliance concepts will begin. Therefore, all classes have been developed and reported here at the association level, with group membership noted when known. This project has utilized information available through usnvc.org and NatureServe to describe and classify the vegetation types within the broader system of known types. Where information is lacking or incomplete, classification of vegetation sampled at Coronado NMEM is based solely on data collected during this effort, and naming conventions were developed as fitting.

For more information on the NVC, see the NPS Vegetation Mapping Inventory website (<https://www.nps.gov/im/vegetation-mapping-inventory.htm>) or Grossman and others (1998).

1.6 Terminology and naming conventions

Alliances and associations are based on both the dominant (greatest-canopy-cover) species in the upper stratum of a contiguous vegetation unit and on diagnostic species (those consistently found in some land-cover types but not others). Associations, which describe and identify the two or three dominant species of a community, are the most specific classification, and are hierarchically subsumed in alliances. Typically, each association is included in only one alliance, while each alliance may include many associations.

Associations define distinct plant compositions that repeat across the landscape. They are generally named using both the dominant species in the uppermost stratum of the vegetation and one or more dominant species in lower strata (or a diagnostic species in any stratum). Associations are defined as having consistent species composition, uniform physiognomy, and similar habitat conditions.

Naming conventions and syntax for all NVC names are as follows:

- A hyphen with a space on either side (-) separates names of species occurring in the same stratum.
- A slash with a space on either side (/) separates names of species occurring in different strata.
- Species that occur in the uppermost stratum are listed first, followed successively by those in lower strata.
- Order of species names generally reflects decreasing levels of dominance, constancy, or indicator value. (Indicator species are those restricted to certain environments, so that while not dominant, they are indicative of, or can represent certain communities.)
- Parentheses () around a species name indicates the species is less consistently found either in all associations of an alliance, or in all occurrences of an association.
- Square brackets [] around two species names indicate that the species are co-dominant, with either being dominant in a given stand.

Table 1-1. Example of the National Vegetation Classification Standard (version 2) hierarchy: Upper levels.

Level	Level name	Criteria	Example
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)

Table 1-2. Example of the National Vegetation Classification Standard (version 2) hierarchy: Mid levels.

Level	Level name	Criteria	Example
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.	<i>Andropogon - Stipa - Bouteloua</i> 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.	<i>Andropogon gerardii - Schizachyrium scoparium - Sorghastrum nutans</i> 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.	<i>Andropogon gerardii - Sporobolus heterolepis</i> Grassland Group (Great Plains Mesic Tallgrass Prairie)

Table 1-3. Example of the National Vegetation Classification Standard (version 2) hierarchy: Lower levels.

Level	Level name	Criteria	Example
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.	<i>Andropogon gerardii - Calamagrostis canadensis - Panicum virgatum</i> 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.	<i>Andropogon gerardii - Panicum virgatum - Helianthus grosseserratus</i> Herbaceous Vegetation (Central Wet-mesic Tallgrass Prairie)

- Association names include the dominant species of the significant strata, followed by the structural class in which they are classified (e.g., Forest, Woodland, or Herbaceous).
- Alliance names also include the structural class in which they are classified (e.g., Forest, Woodland, or Herbaceous), but are followed by the word “Alliance” to distinguish them from associations (alliances are not used in this report).
- A “(P)” at the end of an alliance or association name implies that the type is proposed only and is not yet a formally accepted vegetation type within the NVC. These proposed types are reviewed on an ongoing basis and are added to the NVCS when sufficient data have been collected to support their addition.
- A “(PS)” at the end of an association name implies that the type is a “park special,” meaning it has been described as a unique community only been found

in the given park unit to date. This typically occurs when an area has a unique disturbance or management history.

The species nomenclature for all associations follows Kartesz (1999). Examples of association names from Coronado NMEM include the following:

- [*Aloysia wrightii* - *Parthenium incanum*] Shrubland Association (P) and
- *Pinus discolor* (*Quercus emoryi*) / (*Quercus toumeyi*) Woodland Association (P).

1.7 Project area description

1.7.1 Location and setting

Coronado National Memorial is located in Cochise County, Arizona, at the southern end of the Huachuca Mountains between the San Pedro Valley to the east and the San Raphael Valley to the west. The park’s total area is 1,922 hectares (4,750 ac), with a roughly rectangular shape that is about 7.2 kilometers (5.5 mi) east/west and 4.4 kilometers (2.7 mi) north/south (Figure 1-2).



Figure 1-2. Map of Coronado National Memorial, showing major topographic features and nearby U.S. Forest Service lands.

The southern boundary runs along 6.5 kilometers (4 mi) of the U.S./Mexico international border. Of that stretch, the eastern 2.7 kilometers (2.3 mi) is bound by a 9.1-meter (30-ft) tall pedestrian barrier. The western 3.8-kilometer (2.4-mi) portion, which runs through more rugged terrain, is bound by a barbed-wire fence. The northern boundary runs along the ridgeline that connects Bob Thompson Peak to Montezuma Peak, and continues west to the Arizona Trail. The western boundary runs along an unnamed ridge south to Montezuma Pass, then around the slopes of Coronado Peak and Yaqui Ridge. Both the western and northern boundaries abut the Sierra Vista District of the Coronado National Forest. The eastern boundary runs from the high slopes of Bob Thompson Peak south to the U.S./Mexico border. This boundary is shared with private land holdings and state trust lands. There are two small, active residential inholdings located in the eastern portion of the park, just south of Montezuma Canyon Road.

Coronado National Memorial falls within the Apache Highlands ecoregion, a transition zone between the Sonoran and Chihuahuan deserts (Gori and Enquist 2003). This region exhibits high biological diversity, as it contains a mix of temperate species associated with higher latitudes and subtropical species associated with Mexico and Central America (Gori and Enquist 2003). The park encompasses the low- to mid-elevation range of the Huachuca Mountains “sky island” associated with nearby Miller Peak. Elevation ranges from 1,448 meters (4,750 ft) in the grasslands dominating the southeast corner of the park to 2,377 meters (7,800 ft) in the pine and oak woodlands/savannas dominating the northwest corner. Larger conifers, including ponderosa pine (*Pinus ponderosa*), begin to occur just outside the northern boundary.

The Southwest is one of the fastest-growing population regions in the United States. The closest city, Sierra Vista, sits roughly 20 miles north of the park, along the western edge of the San Pedro Valley. As of the 2010 census, this city was home to roughly 58,685 people, about a 10% increase since the 2000 census, where a population of 52,159 was documented. The number of housing units and

households has also increased, with more than 22,714 households and 25,000 housing units estimated from 2010 to 2014, up from 19,588 and 21,542 in 2000. Dimmit and others (2011) provide a detailed overview of the park setting and regional biogeography.

1.7.2 *Park establishment and purpose*

From 1539 to 1543, numerous Spanish expeditions occurred in lands then unknown to Europeans (NPS 2004). One of these expeditions, led by Francisco Vázquez de Coronado, journeyed throughout northern Mexico and what is now the southwestern United States. While there is no evidence to pinpoint the exact route of Coronado’s journey, it is believed that the expedition entered the U.S. by way of the San Pedro Valley, just to the east of today’s Coronado National Memorial (NPS 2004).

In 1941, by presidential proclamation, Franklin D. Roosevelt used the Antiquities Act to create Coronado International Memorial, with the express purpose of “permanently commemorating the explorations of Francisco Vázquez de Coronado.” Other noted purposes were to honor the connection the U.S. has to Mexico and Spain, to reinforce international goodwill and cultural understanding, and to interpret and symbolize the entrance of Coronado to the U.S. (NPS 2004). The site was first named “Coronado International Memorial,” in the hope that a comparable area would one day be set aside in Mexico (NPS 2017). However, such an area has not been established.

The original proclamation set aside 1,165 hectares (2,878 ac) that started along the border and ran north to Montezuma Canyon Road. In 1952, President Harry S Truman redesignated the land as a national memorial. In 1978, additional acres were added, creating the current area of 1,922 hectares (4,750 ac) (Schmidt et. al 2007). The 1978 expansion involved a land swap that moved the northern boundary from Montezuma Canyon Road to the ridgeline between Montezuma and Bob Thompson peaks.

In 2015, Coronado NMEM received around 132,000 visitors, up 35% since 2005 (<https://irma.nps.gov/Stats/>). Popular activities in-

clude exploring the Coronado Cave, taking in the views from Montezuma Pass, and hiking the short interpretive trail to Coronado Peak.

1.7.3 Climate and hydrology

Coronado NMEM experiences climate typical of the Apache Highlands Ecoregion: a distinct bimodal precipitation regime characterized by violent summer thunderstorms from the North American monsoon and frequent, low-intensity Pacific frontal precipitation in the winter months. At Coronado NMEM, recent (1985–2015; Figure 1-3) average annual precipitation is 21.5 inches (95% confidence interval [CI]: 19.7–23.4 in), with nearly half (48.5%) of yearly rainfall occurring during the height of the monsoon season (July and August) and around a quarter (25.2%) during the winter and early spring (December–March). In general, April and May are the driest months, each contributing less than 1% (<1 in) to the total annual rainfall. Within the last 30 years, 1989 was the driest year on record, with only 9.97 inches of rainfall, while 2000 was the wettest, with 30.6. Average maximum temperature in summer (June–August) is 88.7°F (95% CI: 88.3–89.0°F). Average minimum temperature in winter (December–February) is 33.6°F (95% CI: 33.3–33.9°F) (www.climateanalyzer.org). In general, June is the hottest month, with an average high temperatures of 91.1°F (95% CI: 90.3–92.0°F). December is the coolest, with an average low temperature of 32.9°F

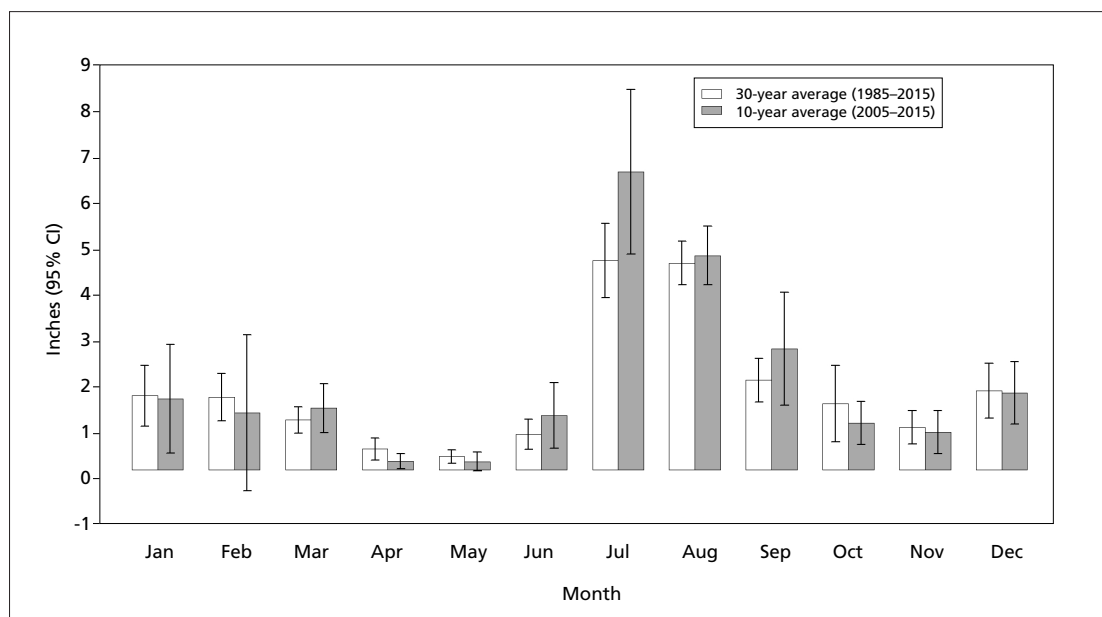
(95% CI: 32.3–33.5°F). While not common, significant snowfall (>1 in) does occasionally occur.

The park encompasses a number of substantial drainages and washes with seasonal water flow that is dependent on major precipitation events. It contains the majority of the Montezuma Canyon watershed, which originates at Montezuma Pass, flows through the canyon, out the through the international border, and eventually into the San Pedro River. In addition, SODN is monitoring numerous springs and seeps throughout the park.

1.7.4 Geology and soils

Coronado National Memorial sits within the Montezuma Caldera, a Jurassic-era (201–145 million years ago) feature created by a catastrophic volcanic eruption in the southern portion of the Huachuca Mountains (Graham 2011). Since then, park lands have been subjected to “mountain-building processes, igneous intrusions in the Paleogene (65.5 to 23 million years ago), and tectonic extension” (Graham 2011) that have shaped this geologically diverse area. At its finest classification, the geology of the park is far too complex to discuss. However, at the formation level, only six types dominate (Figure 1-4). The authors of this report have interpreted the following information, using GIS overlays, on where and to what extent each formation occurs. Based on our location as-

Figure 1-3. Monthly precipitation in inches, averaged over the 30-year period from 1985 to 2015, versus the most recent 10-year period of 2005 to 2015.





Overview of Major Geologic Groups

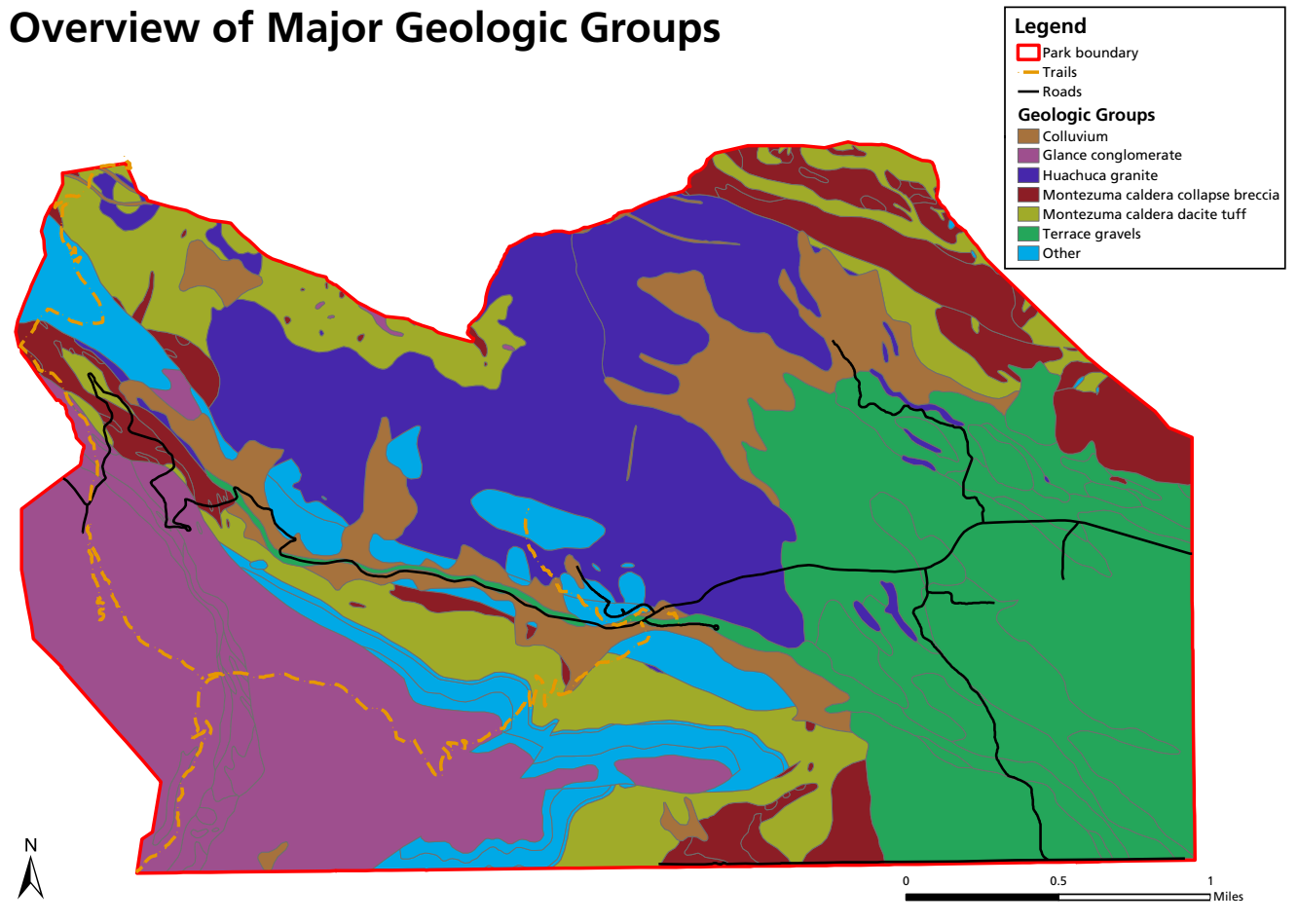


Figure 1-4. Geologic map of Coronado National Memorial.

assessments of the geological survey (Graham 2011), the dominant (>8% of the total area) geological formations include the following:

Terrace gravels: Holocene and Pleistocene stream terrace deposits of cobbles, gravel, sand, and silt. Covering 25% of the park, this formation is primarily found on the alluvial fan in its southeastern corner.

Huachuca granite: Pink-to-gray, medium-to-coarse-grained granite. Covering 20% of the park, this formation is found on the slopes of Montezuma Peak and the saddle joining it to Bob Thompson Peak.

Glance conglomerate: Volcaniclastic conglomerates, landslide deposits, and basaltic andesite sill and flows. Covering 18% of the park, this formation is mainly found around Montezuma Pass, Coronado Peak, and Yaqui Ridge.

Montezuma Caldera dacite tuff: Red-brown to dark-green dacite tuff, a porous rock formed from volcanic ash. Covering 12% of the park, this formation is mainly on the southern slopes of Montezuma Canyon, on Bob Thompson Peak, and on the ridgeline west of Montezuma Peak.

Montezuma Caldera collapse breccia: Chaotic blocks and scattered masses of pre-caldera rocks. Covering around 9% of the park, this formation is found primarily on the slopes of Bob Thompson Peak and scattered along Montezuma Canyon.

Colluvium: Alluvial fan deposits of gravelly sand. Covering 9% of the park, this formation is found on the low slopes as they drop into the upper Montezuma Canyon drainage and on the low slopes of Bob Thompson Peak.

In 2000, the USGS Sonoran Desert Field Station published a detailed soil inventory of Coronado National Memorial (Denny and Peacock 2000). Their surveys identified a total of 23 soil series across the park. Due to the complex distribution of these series, the park's soil map was delineated using 20 soil complexes (groups that contain two or more series). These series ranged from "garden-can," a very deep, well-drained soil type that dominates the alluvial fan in the southeast corner of the park, to large expanses of exposed bedrock that are common around Bob Thompson and Montezuma peaks.

1.7.5 Vegetation

The broad elevational range, varied geology, and extreme topography of Coronado National Memorial produce unique and diverse biological communities. Low-elevation alluvial fans and slopes are characterized by widespread grasslands and shrub savannas most commonly dominated by Lehmann lovegrass (*Eragrostis lehmanniana*) and a diverse mix of shrubs and succulents. At higher elevations and on more sheltered slopes, the vegetation transitions to oak savannas and

woodlands that eventually become intermixed with small conifers. Throughout the park, a total of 702 vascular plant species, subspecies, and varieties have been documented that represent 87 families. The majority of that diversity is composed of forbs ($n = 377$), graminoids ($n = 141$), and shrubs/subshrubs ($n = 135$). Several species that may be near their northern range are strongly associated with subtropical habitats found farther south, in Mexico. Some of these species include Tahitian kidneywood (*Eysenhardtia orthocarpa*), coralbean (*Erythrina flabeliformis*), anil falso (*Coursetia caribea*), and spreading snakeherb (*Dyschoriste schideana*). Other species are reaching the southern limit of their range, and are more strongly associated with Colorado Plateau and Rocky Mountains. Some of these species include Gambel oak (*Quercus gambelii*), Stansbury cliffrose (*Purshia stansburiana*) (Figure 1-5), and rubber rabbitbrush (*Ericameria nauseosa*).

1.7.6 Previous vegetation studies

Prior to the start of this project, two other vegetation mapping projects were completed at Coronado NMEM. The first was conduct-

Figure 1-5. Stansbury cliffrose (*Purshia stansburiana*).



ed by Ruffner Associates, who completed a classification and mapping effort using the Brown, Lowe, and Pace classification system (Ruffner and Johnson 1991). Using this generalized system, four plant associations were identified throughout the park, including:

- *Quercus* ssp. - *Pinus discolor* - *Juniperus* ssp. Association,
- *Bouteloua* ssp. Mixed Grass and Shrub Association,
- *Platanus* ssp. - *Juglans* ssp. - *Quercus* ssp. Association, and
- *Prosopis glandulosa* - Mixed Short Tree Association.

In 2002, a study was completed in cooperation with SODN and the Arizona Remote Sensing Center to compare vegetation mapping techniques (Drake et al. 2002). This project used Coronado NMEM as a study site to compare two types of high-elevation aerial photography: digital orthophoto quarter quadrangles (DOQQs), a three-band, publicly available product, and IKONOS, a four-band product created by and purchased from Space Imaging, Inc. In addition, two types of final products were compared: a raster/pixel-based map and a vector/polygon-based map. While some fieldwork was completed (mainly for initial and accuracy assessments) the majority of classification was completed using image processing in ERDAS Imagine 8.4 and vegetation classification software, or with manual imagery interpretation by a skilled observer. Similar to our mapping effort, pixels and polygons were placed within the NVC whenever possible and new alliances/associations were created when a similar accepted type was unavailable. In the end, a total of 20 alliances were identified between the IKONOS and DOQQ imagery analyses. Of those, six alliances accounted for roughly 75% of the park:

- *Quercus emoryi* - *Quercus arizonica* / *Arctostaphylos pungens* - *Agave palmeri* Woodland Alliance,
- *Quercus emoryi* - *Quercus arizonica* - (*Prosopis velutina* / *Agave palmeri*) / *Eragrostis lehmanniana* - Mixed Grass Tree Savanna Alliance,
- *Bouteloua* ssp. - Mixed Grass Herba-

ceous Alliance,

- *Eragrostis lehmanniana* - (*Eragrostis curvula* / *Agave palmeri*) Herbaceous Alliance,
- *Quercus emoryi* (*Quercus arizonica* - Mixed Broadleaf Deciduous) Intermittently Flooded Woodland Association, and
- *Nolina microcarpa* - *Agave palmeri* - *Arc-tostaphylos pungens* - Mixed Shrubland Alliance.

While there is notable agreement between 2002 mapping comparison study and the current effort, the classification we conducted described vegetation at the association level, which is the finest level of the NVCS and below the alliance level used by Drake and others (2002). Also, the NVC has been considerably revised since that time, especially at the alliance level. Some of the differences between communities identified within the two projects may be due to different classification and naming methodologies. It is also possible that the vegetation structure has changed in the intervening years (partly due to invasive grass spread and wildfire).

Starting in the fall of 2009, SODN began to establish long-term vegetation and soils monitoring plots throughout the park. During the following four years, SODN permanently marked and sampled 2–6 plots every fall, for a total of 29 plots. These plots will be re-sampled every five years in order to monitor change in species cover and composition over time. A report detailing the status of the vegetation based on these data is available at <https://www.nps.gov/im/sodn/coro.htm>. Data from these plots were referenced in addition to other vegetation-mapping data in developing the vegetation classification for Coronado NMEM.

1.7.7 Exotic (non-native) plants

Long-term anthropogenic disturbance in the San Pedro Valley has contributed to the introduction and spread of non-native flora and fauna, a significant challenge to natural resource managers. Following the Monument Fire of 2011, SODN completed two rounds of exotic-plant surveys throughout the park.

These surveys were vector-based and focused on roads, trails, and areas cut for fire breaks. Overall, crews documented 19 exotic species. Lehmann lovegrass (*Eragrostis lehmanniana*) and weeping lovegrass (*Eragrostis curvula*) were the most common exotic species observed (Table 1-4). During the classification phase of the vegetation mapping project, staff documented nine exotic species (Table 1-4) while surveying classification plot and polygons. Some of these species are also considered highly invasive (Lehmann lovegrass, *Tamarix* sp.), meaning they have the potential to outcompete native species for resources and to eventually alter ecosystem processes (such as fire).

In addition, during the accuracy-assessment phase of this vegetation inventory, we decided to take advantage of the numerous and thoroughly distributed assessment locations (see Section 3.1) by having the field crew collect presence and cover data for Lehmann lovegrass (*E. lehmanniana*) at each of the 366 plots sampled. Cover was estimated using Daubenmire cover classes. These data and a map are presented in more detail in Appendix A. Lehmann lovegrass is by far the most firmly established non-native plant species at Coronado NMEM, with widespread distribution. It is the dominant species in the grasslands at lower elevations. Recent data indicate that its abundance may be increasing at higher elevations, as a result of both drought conditions and recent fire disturbance (Hubbard unpublished data).

1.7.8 Disturbance history

Coronado NMEM has been subjected to significant recent and historic disturbance, including mining (e.g., lead, zinc), livestock grazing, wildfire, and border traffic/protection. Prior to park establishment, the U.S.

Forest Service managed grazing allotments (NPS 2004) in park lands, all of which have since been retired. Except for livestock intrusions from adjacent grazing lands, no active/official grazing occurs within park boundaries.

There are numerous mines spread throughout the park, with around 62 documented shafts, adits (horizontal mine entrances), and test pits (NPS 2007). The largest of these are part of the State of Texas Mine, located around one kilometer west of Coronado Cave. Despite the numerous remnants of mining activity, impacts are relatively low, due to the low-quality ores present and the presence of better mining claims outside the park (NPS 2007). The NPS, along with partner agencies, has closed open shafts, adits, and pits with bat-friendly gates or signed them appropriately to minimize risk to park visitors. The most conspicuous evidence of mining is in the northwest corner of the park, where several closed mine shafts are present along the Crest Trail.

Since 1988, fire has played a major role in altering the park's vegetation. Starting in Mexico, the human-caused Peak Fire burned over the majority of the park in 1988, excluding areas dominated by exposed bedrock or close to park facilities and roads. Severely burned areas included the northeast slopes of Coronado Peak and the steep slopes in the northwest corner of the park. The next major fire event didn't occur until the Monument Fire, in summer 2011. Starting along the park's southern boundary, this fire spread northeast, eventually burning the vast majority of the park. Areas most affected included the north-facing slopes of Montezuma Canyon, the northeast slope of Montezuma Peak, and the alluvial fan in the southeast corner of the park.

Table 1-4. Non-native plants observed during exotics plant early detection monitoring and during mapping classification surveys.

Scientific name	Common name	Family	Growth habit	Duration	Exotic plant monitoring (n=19)	Mapping & classification surveys (n = 9)
<i>Bothriochloa ischaemum</i>	yellow bluestem	Poaceae	Graminoid	Perennial	X	–
<i>Cenchrus spinifex</i>	coastal sandbur	Poaceae	Graminoid	Annual	X	–
<i>Cynodon dactylon</i>	Bermudagrass	Poaceae	Graminoid	Perennial	X	X
<i>Descurainia sophia</i>	herb sophia	Brassicaceae	Forb/Herb	Annual	X	–
<i>Eragrostis cilianensis</i>	stinkgrass	Poaceae	Graminoid	Annual	X	X
<i>Eragrostis curvula</i>	weeping lovegrass	Poaceae	Graminoid	Perennial	X	X
<i>Eragrostis lehmanniana</i>	Lehmann lovegrass	Poaceae	Graminoid	Perennial	X	X
<i>Eragrostis superba</i>	Wilman lovegrass	Poaceae	Graminoid	Perennial	X	X
<i>Erodium cicutarium</i>	redstem stork's bill	Geraniaceae	Forb/Herb	Annual	X	–
<i>Ipomoea hederacea</i>	ivyleaf morning-glory	Convolvulaceae	Vine	Annual	X	–
<i>Lactuca serriola</i>	prickly lettuce	Asteraceae	Forb/Herb	Annual	X	–
<i>Macroptilium gibbosifolium</i>	variableleaf bushbean	Fabaceae	Forb/Herb	Perennial	X	–
<i>Melinis repens</i>	rose natal grass	Poaceae	Graminoid	Annual	X	X
<i>Salsola</i> sp.	Russian thistle	Chenopodiaceae	Forb/Herb	Annual	X	X
<i>Sida abutifolia</i>	spreading fanpetals	Malvaceae	Forb/Herb	Perennial	X	X
<i>Sisymbrium irio</i>	London rocket	Brassicaceae	Forb/Herb	Annual	X	–
<i>Sonchus asper</i>	spiny sowthistle	Asteraceae	Forb/Herb	Annual	X	–
<i>Sorghum halepense</i>	Johnsongrass	Poaceae	Graminoid	Perennial	–	X
<i>Tamarix</i> sp.	tamarisk	Tamaricaceae	Shrub	Perennial	X	–
<i>Verbascum thapsus</i>	common mullein	Scrophulariaceae	Forb/Herb	Biennial	X	–

2 Classification and Mapping of Plant Communities

2.1 Methods

2.1.1 Planning and scoping

A general planning and scoping meeting was held on September 27, 2007, at the U.S. Forest Service (USFS) office in Sierra Vista, Arizona. Scoping was conducted simultaneously for all three NPS units managed under the Southeast Arizona Group, which includes Coronado National Memorial, Chiricahua National Monument, and Fort Bowie National Historic Site. These three parks are managed by one leadership team, headed by a superintendent. The superintendent, along with resource staff from each park and officials from surrounding USFS lands, was invited to attend this one-day meeting. Attending members of the project team included:

- Andy Hubbard, coordinator, Sonoran Desert Network,
- Sarah Studd, Vegetation Mapping Inventory project manager, Sonoran Desert Network
- Sam Drake (assistant research scientist) and Miguel Villarreal (PhD student), Office of Arid Lands Studies, University of Arizona, and
- Kathryn Thomas, USGS Sonoran Desert Research Station, University of Arizona—with whom we were consulting and who provided invaluable insights and practical considerations based on her experience managing other Vegetation Mapping Inventory projects elsewhere in Arizona.

The goal of the scoping was to identify site-specific needs or modifications to the standard mapping process, and to determine the safety and logistics details of the effort. A site-specific goal for Coronado NMEM was to map the occurrence of agaves, so staff could later conduct plot-based counts. Park staff monitor and actively restore agave populations to help provide a food source for endangered (delisted due to recovery in 2018) lesser long-nosed bats (*Leptonycteris curasoae yerbabuenae*). To meet this request, agave presence data were derived from our classification plot data and provided in the spatial

data tables of the final geodatabase. A second site-specific goal was to document rare plant species with limited distributions. The final goal was to provide a more precise map of the herbaceous-dominated areas, both to inform restoration efforts and due to their inherent importance as habitat. Every reasonable effort was made to observe and record all perennial species present in survey plots, especially when project crews worked in less-visited areas of the park. This increased species observations in unique communities. All communities (including herbaceous-dominated) were classified and mapped at the finest scale possible within the NVCS.

Coronado NMEM has long been used as an entry point for migrants and smugglers travelling north from Mexico into Arizona. Some of these border activities are potentially dangerous. NPS law-enforcement staff were consulted and heavily involved in planning for field-work activities at all stages of this project, from early classification work through the final accuracy-assessment phase. Although some park areas were considered “off-limits” to field crews without a law-enforcement escort, crews worked freely in groups of two or more throughout most of the park. While these considerations required additional planning, they did not hamper field work, with about 95% of the project area available for access under existing safety criteria.

This project was conducted primarily by the NPS Sonoran Desert Network and the University of Arizona Office of Arid Land Studies (OALS). Coronado NMEM personnel provided logistical support for all field-based components of the project. OALS completed the core technical preparation of the satellite-imagery mosaic, printed maps, and assisted with some field work. SODN staff conducted or oversaw all other project aspects, including data collection for classification, groundmapping of vegetation, classifying and drafting the local vegetation association descriptions, validation and accuracy assessment, and preparation of the final spatial database with relevant attributes for mapped polygons and vegetation plots.

2.1.2 Data collection overview

The methods used to classify and map vegetation generally followed the guidelines outlined in the NPS technical guidance and support documents found at <https://www.nps.gov/im/technical-guidance.htm>. However, our approach was more integrated than the traditional practice, because relevant NVC types for our area were generally lacking before our study. Rather than have ecologists collect plot data to develop a classification, then have photo interpreters delineate polygons solely using imagery, we used an integrated team of observers who concurrently collected plot- and polygon-scale data for classification while creating map polygons in the field. Map polygons were drawn based on imagery, topographic relief, and field observations.

2.1.3 Digital imagery acquisition and processing

All imagery (aerial photographs) for Coronado NMEM was acquired without cost from The National Map program (<https://nationalmap.gov/>). The imagery was originally acquired via the USGS High Resolution Orthoimagery project, for use in work related to border safety/border impacts. Images were

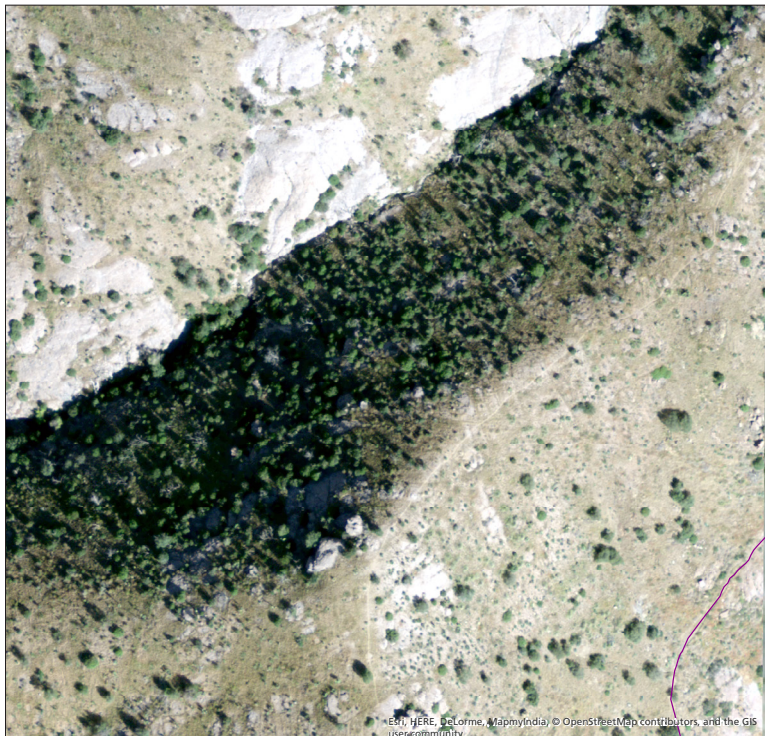


Figure 2-1. Example of high-resolution imagery used in groundmapping.

flown in October 2008, and have a 0.30-meter resolution. The 15 tiles covering the park were obtained at no cost and then processed (mosaicked) by OALS for use in this project. Minimal processing was required, as the tiles were already georeferenced. The final image set was used to create printed field maps that crews used while conducting field assessments and on which they drew draft polygon boundaries (Figure 2-1).

2.1.4 Field data collection

2.1.4.1 Classification plots

The 2009 “Standards for associations and alliances of the U.S. National Vegetation Classification” (Jennings et al. 2009) stated the need for vegetation units to be sampled and described through the use of plot data. They recommended that plots be distributed in homogenous areas to minimize sampling in areas with high physiognomic, floristic, and environmental variation—complications that would make interpretation of plot data difficult. Plot locations can be determined via subjective or objective means. The former method necessitates prior knowledge of the various types to be sampled. The latter can provide a less-biased set of plots but may miss rare or unusual vegetation types. We decided to objectively locate plots but to allow plots to be subjectively placed to account for any under or un-sampled areas. Six subjective plots were sampled.

Prior to commencing fieldwork, plot locations were randomly distributed using the “create random points” tool in the Hawth’s Analysis Tools add-on in ArcMap 9.x. We did not use the Reversed Randomized Quadrant-Recursive Raster (RRQRR) tool (Theobald 2007) to create both randomly located and spatially balanced plots at this stage. They were not entirely necessary for this project phase, in which our objective was to capture all potential vegetation types found at the park. That objective could also have been completed using a solely subjective means.

Plots had a minimum distance between points of 50 meters and were distributed within two strata: upland vegetation (upland) and areas associated with ephemeral drainages and washes (hydro). These strata were

delineated by generating a 50-meter buffer around all drainages and washes within the park, creating a 496-hectare (33% of the park) hydro stratum and a 1,468-hectare (67% of the park) upland stratum. A total of 100 points were distributed in the upland stratum and 50 in the hydro stratum (Figure 2-2).

All data collection was conducted by an NPS crew of 4–6 people, typically working in teams of two for safety and consistency. Crew leads had previously worked on vegetation mapping at other SODN parks (e.g., Chiricahua and Tonto national monuments) for several months prior to this field effort and had proficiency in all mapping and classification methodologies. Field-based mapping and data collection for classification was conducted over the course of three work tours of 6–7 days each during fall 2010.

During this time, crews visited and sampled 76 of the 100 classification plots that were randomly assigned to the upland stratum, and 20 of 50 plots that were randomly assigned to the hydro stratum (Figure 2-3). An additional 54 randomly distributed plot locations were drawn but not sampled due to dangerous terrain or because they overlapped with the footprints of park facilities or roads.

The random points served as one corner of a 1,000-m² classification plot. Ideally, the plot represented the surrounding community. When it did not, the protocol allowed for crews to evaluate the surrounding vegetation and move the point as far as 50 meters if necessary. Crews oriented and shaped the plots to best capture the sampled community. Various shapes were employed to capture the targeted community, but the preponderance of the plots were square, with sides measuring 31.6 meters. Within these plots, the crews collected semi-quantitative data on absolute canopy cover for all perennial plant species and non-native annuals in four height strata: field (0–0.5 m), subcanopy (0.5–2 m), lower canopy (2–5 m), and upper canopy (>5 m). For these strata, crewmembers placed each documented species into one of nine cover classes: 1 (< 1%), 2 (1–5%), 3 (6–10%), 4 (11–25%), 5 (26–33%), 6 (34–50%), 7 (51–75%), 8 (76–95%), and 9 (96–100%).

In general, crews only included perennial species and non-native annual species. Cover estimates of native annuals were occasionally documented when they provided a noteworthy amount of cover and/or were diagnostic of the community. Up to three species per stratum were assigned a dominance rank based on their cover class and/or importance to the sampled vegetation community. Additionally, crews recorded the average plant height (low and upper canopy only), lifeform (excluding the field stratum), disturbance types, total absolute cover by stratum, and a range of soil and landscape characteristics (see Appendix B). A single photograph was taken at a 45-degree angle into the plot from one of the corners. Two brief narratives were written to describe the preliminary community type of the polygon that was concurrently delineated at the time of plot sampling (see Section 2.1.4.2). Crews noted the ways in which this association/area differed from the adjacent areas, and any topographic features contributing to the divisions of floristic similarities.

2.1.4.2 Polygons

Concurrent with plot-based data collection, and assisted by hardcopy prints of imagery and GPS units, crews created polygons to define the extent of each vegetation association. Crews walked some portion of the boundary and much of the interior of each proposed polygon while hand-drawing its extent onto the printed imagery. This polygon-delineation process relied on field observations but also was strongly guided by visual interpretation of the printed imagery and other materials showing topographic features. Very large areas were often mapped in multiple units and later combined during digitization.

Within each of these polygons, crews conducted ocular cover estimates on the dominant and commonly associated species that defined the captured association. In addition, brief narratives were drafted to describe the vegetation community, differences from the surrounding vegetation, defining landscape features, and features used to delimit the polygon. The data collected were the same as those collected in the classification plots, differing only in the scale of observa-

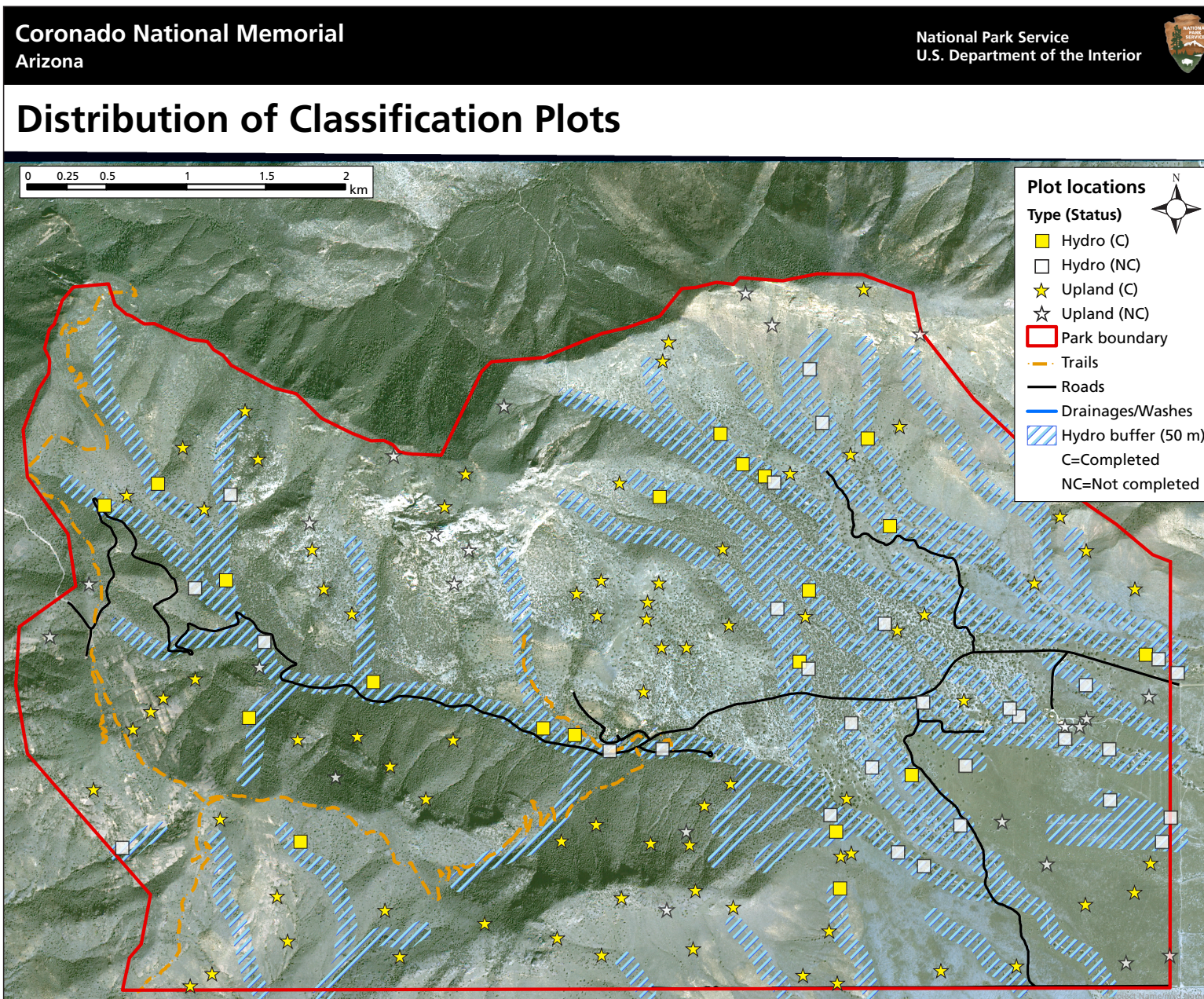


Figure 2-2. Distribution of classification plots at Coronado National Memorial. Plots were distributed within upland and hydro (riparian or drainage sites) strata. Yellow symbols indicate that data were collected. White symbols indicate the plot was not sampled due to safety or other concerns.



Figure 2-3. A crew member collects classification data on a plot.

tion (size of area). A sequence of four representative photographs was taken in the four cardinal directions from near the center of the polygon, which was marked with a GPS point for future repeat photography.

At the end of each field day, crews transferred all edits made to field maps to a set of master paper maps that did not go into the field. These were archived with the data-sheets. Upon completion of the mapping effort, polygon boundaries were transferred from the master maps into a digital format using ArcMap GIS software (ESRI 2011). The dataset is housed in a file geodatabase structure (.gdb), enabling establishment of topology rules and relationships. Strict nomenclature was enforced for polygons and a unique name was assigned to each polygon. These reflected the verified physiognomic formation type by a prefix of representative letters (e.g., W = Woodland, SS = shrub savanna), followed by a number.

In fall 2010, field crews mapped a total of 100 polygons, accounting for roughly 62% (1,222 ha) of the park. Then, due to crew-

member turnover, the occurrence and effects of the 2011 Monument Fire, and other ongoing projects, field mapping was placed on hold for two years. This allowed for new crewmembers to become proficient with all protocols and species and gave the vegetation communities within the park some time to rebound from the fire. In the meantime, classification of the vegetation for 62% of the park was completed. In fall 2013 and spring 2014, a crew of four mapped additional polygons in previously unmapped areas of an additional 37% (722 ha) of the park. These polygon data were used during the classification. No additional classification plots were sampled during this period. Due to safety concerns along the U.S./Mexico border, a small portion remained unmapped following this field effort. The remaining 1% (18 ha) was finally mapped during the validation phase, which occurred during winter 2016. Examples of polygon datasheets are provided in Appendix B.

The 2011 fire was unfortunate timing for this project, occurring over halfway through mapping efforts and forcing the team to make

a decision about how to proceed. Budgetary restraints made it impossible for us to start over. With over 60% of the park mapped and the classification drafted, we decided to complete the map to represent the pre-fire communities that had initially been sampled, and to address any lasting effects the fire may have on vegetation communities within the classification descriptions. The predominantly low-to-moderate severity of the fire allowed us to still reliably identify vegetation communities based on a mixture of remaining live—but often scorched—plants, resprouting snags (mostly oaks), and fallen dead individuals (e.g., ocotillos that died but weren't consumed). The prevalence and dominance of oak species in the majority of these wooded vegetation types, and the oaks' rapid sprouting response to fire, greatly facilitated our ability to identify these communities, even when burned. Shrub- or herbaceous-dominated burned communities also did not pose difficulty, as plant biomass either remained after the fire or recovered adequately, often vigorously. Pre-fire printed imagery also helped guide these efforts.

2.1.5 Data management

All plot and polygon data were entered into a Microsoft Access (2007) database developed and managed by the SODN data manager. The digital data were quality-checked for accuracy against the original datasheets, and any transcription errors were rectified prior to analysis. Data were also validated by an alternate mapping-team member for logical errors or unusual species entries. These processes followed the quality standards outlined in the global operating standards written by the SODN data management program. All datasheets were copied and stored separately from the original set.

Each polygon was edited to reflect any boundary changes and was attributed to reflect changed polygon identification numbers and tentative alliance names. Hard-copy maps were archived at SODN. Photographs were verified to be present for each polygon and plot, and for correct naming conventions. Photopoint locations (shapefiles) were similarly quality-checked for spatial accuracy and attribute completeness. After all data

checks were completed, the entire project team reviewed the field data.

2.2 Vegetation classification analysis

2.2.1 Methods

Using the software, Plymouth Routines In Multivariate Ecological Research version 7 (PRIMER) (Clark 2006 and 2015), we employed a multivariate approach to delineate vegetation communities using our classification plots ($n=96$). After the quality assessment was complete, midpoint cover-class values for all species at all plot locations were exported from the Access database and imported into PRIMER. We employed cluster analysis and similarity percentages (SIMPER) to assign plots to groupings based on the similarity/dissimilarity of the documented species and their associated cover values. Species cover was summed across all height strata to give one cover value per species per plot. Prior to analysis, all cover values were square-root transformed to help normalize values.

Using the Bray-Curtis Coefficient, a set of coefficients wherein plots with nothing in common receive a value of 0 and identical plots a value of 1, we created a dendrogram of plots. In addition, a similarity profile analysis (SIMPROF) was calculated to help identify groupings of similar plots. This profile provides a user-defined gauge of the statistical relevance of groups and graphically identifies the point where, statistically, groupings can no longer be differentiated from one another. We further assessed our data using non-metric MDS (multidimensional scaling).

2.2.2 Results

2.2.2.1 Identification of macro groups

Based on initial results, we determined that the park's diverse and highly variable composition of perennial grasses was contributing to a large number of groups that weren't necessarily ecologically meaningful. It made sense to simplify the dataset so perennial grasses were merged into groups based on their nativity; native perennial (38 species) and non-native perennial (4 species). In ad-

dition, we changed all values of 0.5 (<1%) to 0 to minimize the influence of less-abundant species. With this updated dataset, the resulting dendrogram and SIMPROF test were evaluated initially at a subjective within-group similarity of 35%, where plots were easily lumped into five distinct macro groups (Figure 2-4). These groups were primarily defined by the dominance of 1–3 species:

- **Macro Group A:** Three plots defined by the dominance of Wright’s beebush (*Aloysia wrightii*), native perennial grasses, and common sotol (*Dasyllirion wheeleri*), accounting for 52% of the cumulative group similarity.
- **Macro Group B:** Twenty-three plots defined by the dominance of non-native and native perennial grasses with limited shrub and tree cover, accounting for 70% of the cumulative group similarity.
- **Macro Group C:** Four plots defined by the dominance of border pinyon (*Pinus discolor*), native perennial grasses, and Emory oak (*Quercus emoryi*), accounting for 50% of the cumulative group similarity.
- **Macro Group D:** Thirty-seven plots defined by the dominance of Emory oak (*Q. emoryi*) and native perennial grasses,

accounting for 52% of the cumulative group similarity.

- **Macro Group E:** Twenty-nine plots defined by the dominance of Arizona white oak (*Quercus arizonica*) and native perennial grasses, accounting for 45% of the cumulative group similarity.

The MDS analysis (Figure 2-5) indicated that there was a clear similarity gradient from the grassland communities (Macro Group B), to savannas and woodlands dominated by Emory oak (*Q. emoryi*) (Macro Group D), to Arizona white oak (*Q. arizonica*) savannas and woodlands (Macro Group E), to communities with dominant border pinyon (*P. discolor*) and associate oaks (Macro Group C). Macro Group A was the most dissimilar from the other four macro groups, and the first branch to split off in the dendrogram.

Upon confirming that this grouping made sense and aligned with field observations, we began to look at the finer groupings present within each macro group. We identified 14 associations from the classification plot data within these five macro groups.

2.2.2.2 Macrogroup associations

Macro Group A (2 associations)—. Macro Group A, the Wright’s beebush group, split

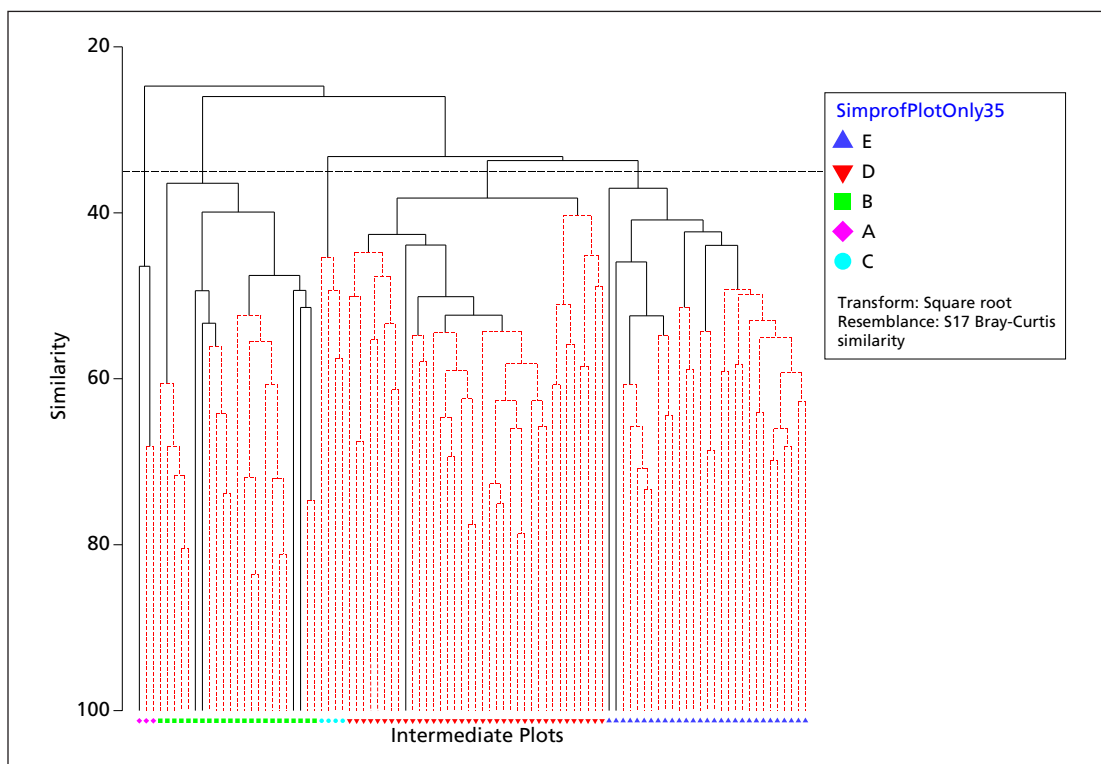
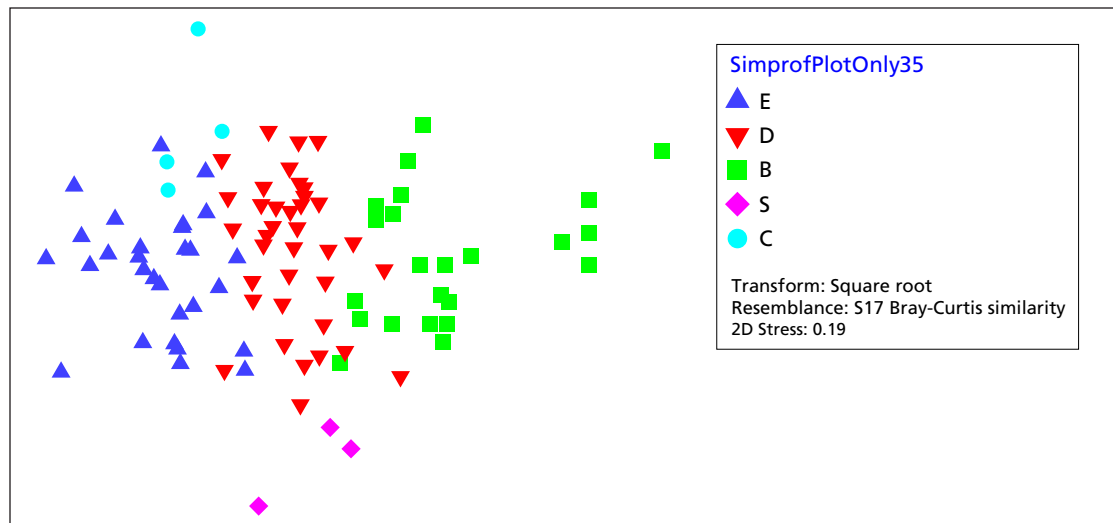


Figure 2-4. Dendrogram from the cluster analysis, showing five distinct macro groups (A–E) defined at a 35% similarity level, as indicated by the dashed line.

Figure 2-5. MDS diagram showing the five macro groups relative to one another. Groups closer together were more similar than those farther apart. From right to left, the plot map illustrates a similarity gradient from grass-land communities at lower elevations through mid-elevation oak savannas to upper-elevation pine woodlands.



into two associations using a SIMPROF test: one association represented by one plot, and another represented by two plots. While small, the legitimacy of these groups was confirmed through a review of plot data and photographs. Due to the small sample size, a meaningful MDS analysis was not possible. The two associations were:

Aa. Association Aa ($n = 1$) was designated a (*Quercus* spp.) / [*Rhus virens* - *Garrya wrightii* - *Eysenhardtia orthocarpa* - *Aloysia wrightii*] Intermittently Flooded Shrubland Association.

Ab. Final Association Ab ($n = 2$) was designated an [*Aloysia wrightii* - *Parthenium incanum*] Shrubland Association, with an average similarity of 68% among member plots.

Macro Group B (3 associations)—. Macro Group B, the perennial-grass dominant group, split into three distinct groups at a similarity of 45% (Figure 2-6). While the SIMPROF groups were finer, upon review of plot data and photographs, we determined that only these three final groups were distinguishable from one another. These three final associations were:

Ba. Association Ba ($n = 5$) was designated a (*Prosopis velutina* - *Baccharis sarothroides*) / *Eragrostis lehmanniana* Herbaceous Association, with an average similarity of 67% among member plots.

Bb. Association Bb ($n = 6$) was designated a heavily disturbed variation of a *Quercus emoryi* / Mixed Perennial Grass Tree Savanna Association, with an average similarity of 55% among member plots.

Bc. Association Bc ($n = 12$), the largest in terms of the number of plots, was designated an (*Agave palmeri* - *Mimosa aculeaticarpa*) / Mixed Perennial Grass (*Calliandra eriophylla*) Herbaceous Association, with an average similarity of 53% among member plots.

Macro Group C (1 association)—. Macro Group C, the border pinyon (*Pinus discolor*) macro group, contained only one SIMPROF group of four plots.

Ca. Association Ca ($n = 4$) aligned with our interpretation of plots and was designated a *Pinus discolor* (*Quercus emoryi*) / (*Quercus toumeyii*) / Mixed Perennial Grass Woodland and Wooded Shrubland Association, with an average similarity among member plots of 49%.

Macro Group D (4 associations)—. Macro Group D, the Emory oak (*Q. emoryi*) macro group, split into five SIMPROF groups and one solitary plot. The stress coefficient value (0.21) for the MDS was high, indicating less-than-ideal representation of the data within the ordination, resulting in increased difficulty in visual interpretation of the patterns. Upon a closer examination of plot-level data,

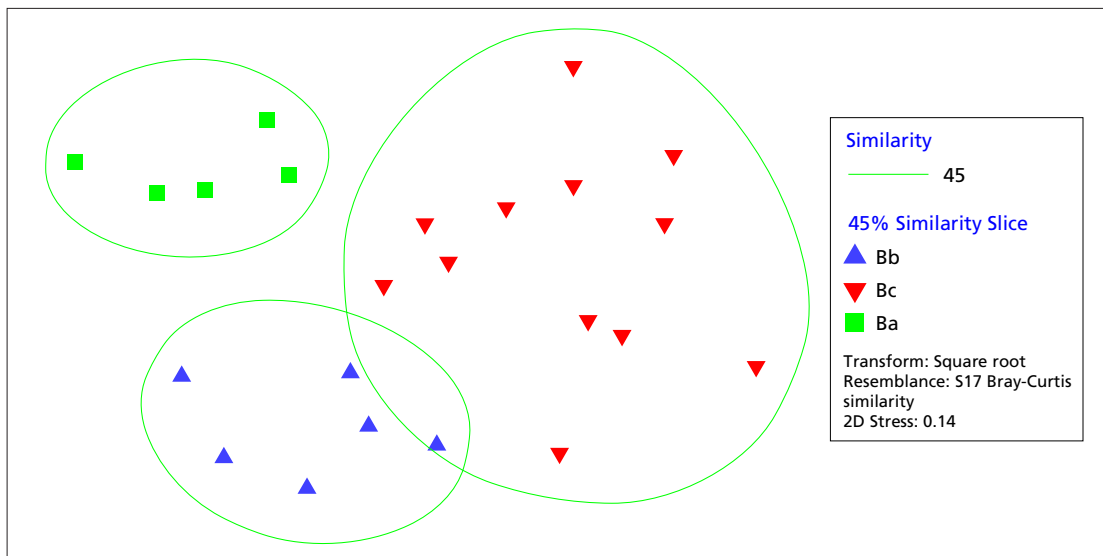


Figure 2-6. Non-metric MDS of Macro Group B. Green line denotes 45% similarity.

we determined that only four distinguishable associations (Figure 2-7) were included in this macro group:

Dl. Association Dl ($n = 8$) was designated a *Quercus emoryi* / Mixed Perennial Grass Tree Savanna Association, with an average similarity among member plots of 49%.

Do. Association group Do ($n = 11$) was designated a *Quercus emoryi* / *Bouteloua curtipendula* Scrub Woodland Association, with an average similarity among

member plots of 53%.

Dp. Association Dp ($n = 10$) was designated a *Quercus emoryi* / *Arctostaphylos pungens* / Mixed Perennial Grass Wooded Shrubland Association, with an average similarity of 60% among member plots.

Dq. Association Dq ($n = 8$) was designated a *Quercus oblongifolia* / Mixed Perennial Grass Tree Savanna Association, with an average similarity of 45% among member plots.

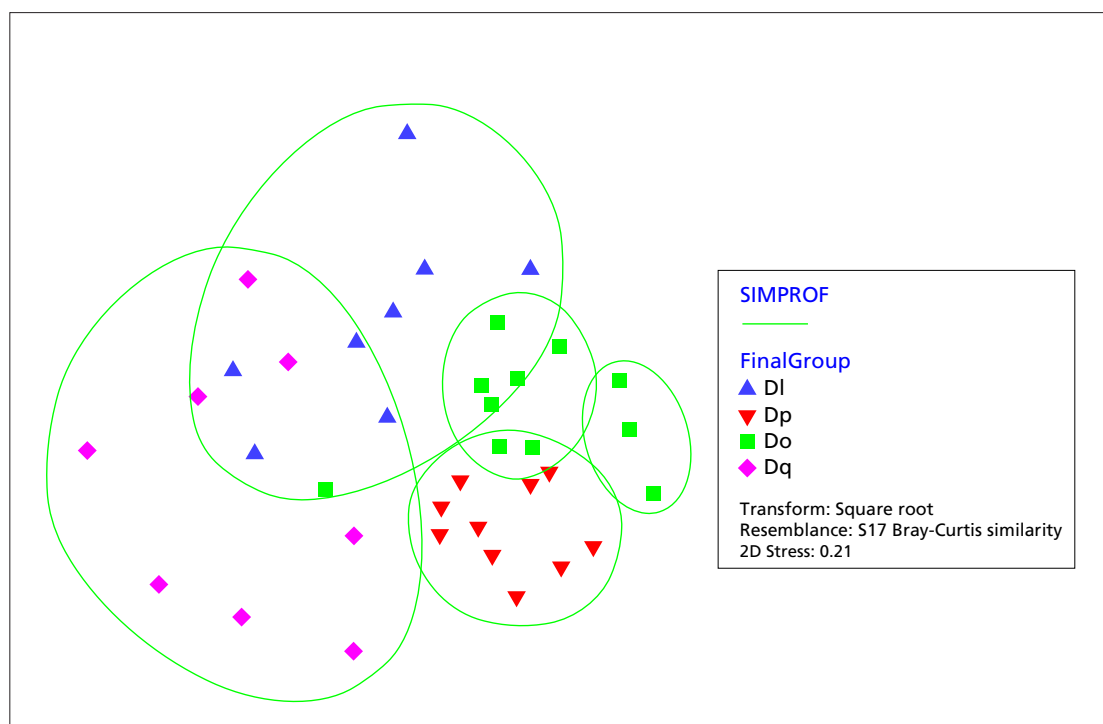


Figure 2-7. Non-metric MDS of Macro Group D, showing the four final subgroups. Green lines show the SIMPROF-derived groupings.

Macro Group E (4 associations)—. Macro Group E, the Arizona white oak (*Quercus arizonica*) group, split into five SIMPROF groups. The MDS stress coefficient was high (0.21), but the distribution of plots was fairly straightforward to interpret. In the end, the groups created using a 45% within-group similarity cut-off agreed with our interpretation of the plot data. This created four association groups (Figure 2-8):

Es. Association Es ($n = 9$) was designated a [*Cercocarpus montanus* - *Garrya wrightii*] / Mixed Perennial Grass Wooded Shrub Savanna Association, with an average similarity of 55% among member plots. This group was a combination of two SIMPROF groups and the solitary plot group, Er.

Ev. Association Ev ($n = 3$) was designated a *Quercus arizonica* - *Quercus emoryi* Intermittently Flooded Woodland Association, with an average similarity of 54% among member plots.

Ew. Association Ew ($n = 3$) was designated a *Pinus (discolor - cembroides)* / *Quercus arizonica* / *Muhlenbergia emersleyi* Woodland Association, with an average similarity of 59% among

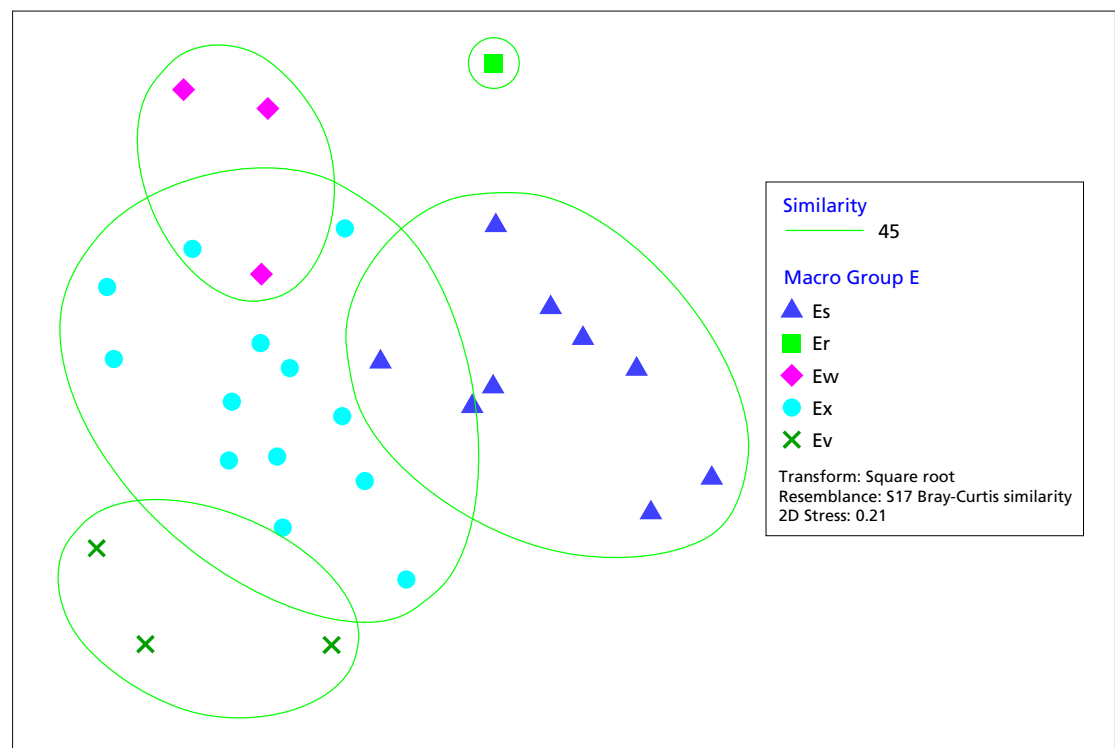
member plots.

Ex. Association Ex ($n = 13$) was designated a *Quercus arizonica* - *Quercus emoryi* / Mixed Perennial Grass Woodland Association, with an average similarity of 54% among member plots.

2.2.2.3 Associations derived from polygon data

From the field-mapping polygon data (November 2013 and March–April 2014) and the field reconnaissance (February 2016), an additional 11 associations were identified that were either entirely unrepresented by the types derived from the intermediate plots or were poorly characterized by 1,000-m² plots. The first five of these associations occurred only as small (or singular) stands and/or were found only in restricted locations at the very top of rigelines or under cliff bands. As such, they had been either missed or swept into larger polygons, as inclusions in the first round of mapping. We decided to map these separately, as they met the minimum mapping unit size. Two associations represented solitary stands of unique vegetation: *Quercus gambelii* (*Quercus rugosa*) Shrubland and *Baccharis sarothroides* / *Bothriochloa barbinodis* (*Eragrostis lehmanniana*) Shrub Savanna.

Figure 2-8. Non-metric MDS of Macro Group E. Green line denotes 45% within-group similarity.



The latter six associations were subdivided from other associations on the basis of the dominant oak species (e.g., *Quercus arizonica* Scrub Woodland Association separated out from a former *Quercus emoryi* - *Quercus arizonica* Scrub Woodland Association) or simply on the basis of finer-scale field mapping, where we were able to identify these smaller associations that would otherwise have been lumped into the few wide-ranging herbaceous and shrub-savanna types. These polygon data provided the same detailed species-dominance rankings, cover-class estimates, associated species listings, and landscape characterizations as the classification plots, differing only in scale, allowing us to develop detailed association descriptions (as with the plots) for the following types:

- *Quercus gambelii* (*Quercus rugosa*) Shrubland Association
- *Quercus rugosa* (*Quercus hypoleucoides*) Shrubland Association
- [*Quercus turbinella* - *Quercus rugosa* - *Quercus hypoleucoides*] Shrubland Association
- *Quercus arizonica* - *Quercus hypoleucoides* Shrubland Association
- [*Aloysia wrightii* - *Eysenhardtia orthocarpa*] / Mixed Perennial Grass Shrub Savanna and Shrubland Association
- *Baccharis sarothroides* / *Bothriochloa barbinodis* (*Eragrostis lehmanniana*) Shrub Savanna Association (Park special association - highly disturbed area)
- *Dasyllirion wheeleri* / *Bouteloua curtipendula* - *Heteropogon contortus* Shrubland Association
- *Dasyllirion wheeleri* / *Bouteloua curtipendula* Shrub Grassland Association
- *Quercus arizonica* / *Bouteloua curtipendula* Scrub Woodland Association
- *Quercus arizonica* / Mixed Shrub / Mixed Perennial Grass Tree Savanna Association
- *Quercus emoryi* / Mixed Shrub Intermittently Flooded Tree Savanna Association

In all, a total of 25 associations were identified from field-data observations.

2.2.2.4 Associations identified following validation sampling

In an effort to further describe differences between pre-fire and post-fire communities, and to evaluate and confirm the validity of drafted association types, we completed a brief qualitative validation effort. This field effort was split across two trips to Coronado NMEM—one during summer 2015 and one in February 2016. During these trips, a crew of two observers visited sites throughout the park. The primary focus of the first trip was to hike to pre-selected vantage points and assess polygon boundaries using a spotting scope. In addition, we assessed the associated vegetation communities of these polygons and those on the way to the vantage points. On the second trip, we visited areas identified as potentially under-mapped, meaning they were not mapped to the same scale as the rest of the park or to the association level. We focused primarily on the slopes and summit of Bob Thompson Peak, the ridgeline to the west of Montezuma Peak, and the shrub-by transition zones between the grasslands and tree savannas.

Based on the results of this thematic validation assessment, we made numerous refinements to both the association descriptions and a few polygon boundaries. Edits made to polygon boundaries were primarily a product of the second trip, after which Bob Thompson Peak and the ridge west of Montezuma Peak were split into a series of smaller polygons. Data collected during this trip also helped us identify two additional associations that were not previously defined, primarily due to their position in remote areas: *Fouquieria splendens* / *Aloysia wrightii* - *Eysenhardtia orthocarpa* / Mixed Perennial Grass Shrub Savanna Association and [*Cercocarpus montanus* - *Rhus virens*] Shrubby Rock Outcrop Association.

The addition of these associations brought the total number of identified and described associations at Coronado NMEM to 27. These were attributed to the digital map and were the basis of the later accuracy assessment (see Table 3-1). However, as a result of the accuracy assessment, two associations were completely combined into other, highly similar associations (see Section 3.3), as they

were insignificantly differentiated in the field and the mapping team decided that our decision to separate them in the first place was in error. This brought the total number back down to 25 associations attributed to 198

polygons, not including those associated with park facilities and barren expanses of bedrock. For the final list of types, see Table 4-1.

3 Accuracy Assessment

3.1 Methods

The protocol used for the accuracy assessment (AA) phase of this project was based on the Thematic Accuracy Assessment Procedures outlined in Lea and Curtis (2010). However, some modifications were required—primarily, to accommodate the small and often linear nature of many map classes and to accommodate crew size and availability.

Due to potential border issues and unsafe terrain, the inference area of this accuracy assessment was only 1,573 hectares (80%) of the park. Using ArcMap (ESRI 2011), we created the AA inference/project area by buffering and removing a number of features throughout the park. All roads (dirt and paved), facilities, and inholdings were buffered 10 meters and eliminated from the AA sampling frame, to remove the edge effect that areas close to these features may have. Additionally, we buffered all roads and trails by 800 meters to create an accessibility layer. Anything located beyond that distance was removed. The portion of the international border without a pedestrian fence was buffered 300 meters and removed. Finally, conspicuous bedrock outcrops were manually removed for crew-safety considerations, mainly on the slopes of Montezuma Peak.

Prior to the allocation of assessment points via a sample design (see below) within the inference area, individual polygons attributed as the same association were merged together to allow calculation of the total area for each association (Table 3-1). Random points were distributed based on the total area covered by each association. For classes covering more than 50 hectares, a total of 20 plots were distributed. For classes covering an area greater than 8.33 and less than 50 hectares, a plot was distributed for every 2.5 hectares. For classes covering less than 8.33 hectares, we distributed a minimum of five plots. These values are roughly 2/3 of the recommended sample size outlined in Lea and Curtis (2010). This decrease resulted from an assessment of crew availability and time requirements for differing sample sizes. For two associations, we did not distribute any

points because all or the majority of the community occurred outside the AA inference area. These points served as the centroid of a circular assessment plot.

A total of 366 plots were sampled across 25 associations (Figure 3-1; two associations were inaccessible for safety reasons). The area covered by each plot varied based on the size and shape of the polygons within each map class. The recommended size, equivalent to the MMU (0.5 ha), was too large for 14 of the map classes. Due to the linear nature of these map classes and/or the limited area they covered, plot sizes were reduced to avoid removing large portions of the park from the inference area. Plot size was determined on a class-by-class basis, taking into account the ratio of polygon widths to lengths and the area buffered out at different plot sizes. Based on this assessment, we used four different-sized plots: 10-m radius = 0.03 ha ($n = 5$), 18-m radius = 0.1 ha ($n = 38$), 28-m radius = 0.25 ha ($n = 103$), and 40-m radius = 0.5 ha ($n = 220$).

Using ArcMap, polygon boundaries were buffered and excluded based on the distance equal to the radius of the selected plot size, positional accuracy of the map, and positional error of the GPS to be used by the assessment crew (Lea and Curtis 2010). The resulting polygons were converted to raster format and points were distributed using the “distribute spatially balanced points” function in ArcToolbox. This function uses the RRQRR algorithm (Theobald et al. 2007) to distribute spatially balanced points throughout the raster. Next, each point was buffered using the radius of the assigned plot size to create a circular area (see Figure 3-1) that was later used as a visual aid to delineate the survey area. These circular plot areas (polygons, essentially) and the plot centroids for all map classes were merged and assigned a unique identifier. All information was removed that could give an assessor any indication as to which class it belonged.

In the field, assessors, with the aid of a Juno GPS unit, walked throughout each plot until they determined the dominant and/or diag-

Table 3-1. The 27 associations originally identified and described at Coronado National Memorial.

	Association	Abbreviation	AA area (ha)	% of total area	Plot radius (m)	# of plots
1	<i>Pinus (discolor - cembroides) / Quercus arizonica / Muhlenbergia emersleyi</i> Woodland Association	PIN(DIS-CEM) / QUEARI / MUHEME W	70.6	91.7%	28	20
2	<i>Pinus discolor (Quercus emoryi) / (Quercus toumeyi) / Mixed Perennial Grass Woodland and Wooded Shrubland Association</i>	PINDIS (QUEEMO) / (QUETOU) / MPG W&WS	45.8	63.7%	28	20
3	<i>Quercus emoryi / Mixed Perennial Grass Tree Savanna Association</i> ¹	QUEEMO / MPG TS	137.6	88.3%	40	20
4	<i>Quercus arizonica / Mixed Shrub / Mixed Perennial Grass Tree Savanna Association</i> ¹	QUEARI / MS / MPG TS	85.9	72.8%	40	20
5	<i>Quercus arizonica - Quercus emoryi / Mixed Perennial Grass Woodland Association</i> ²	QUEARI - QUEEMO / MPG W	54.7	91.8%	40	20
6	<i>Quercus arizonica / Bouteloua curtipendula</i> Scrub Woodland Association ²	QUEARI / BOUCUR SW	70.7	82.6%	40	20
7	<i>Quercus emoryi / Bouteloua curtipendula</i> Scrub Woodland Association	QUEEMO / BOUCUR SW	159.3	71.4%	40	20
8	<i>Quercus emoryi / Arctostaphylos pungens / Mixed Perennial Grass Wooded Shrubland Association</i>	QUEEMO / ARCPUN / MPG WS	155.7	97.5%	40	20
9	<i>Quercus emoryi / Mixed Shrub Intermittently Flooded Tree Savanna Association</i>	QUEEMO / MS IFTS	45.2	97.3%	18	18
10	<i>Quercus oblongifolia / Mixed Perennial Grass Tree Savanna Association</i>	QUEOBL / MPG TS	81.8	86.0%	40	20
11	<i>Quercus arizonica - Quercus emoryi</i> Intermittently Flooded Woodland Association	QUEARI - QUEEMO IFW	52.1	83.7%	28	20
12	<i>Quercus arizonica - Quercus hypoleucoides</i> Shrubland Association	QUEARI - QUEHYP S	22.0	71.3%	28	9
13	<i>Quercus rugosa (Quercus hypoleucoides)</i> Shrubland Association	QUERUG (QUEHYP) S	3.5	14.6%	18	5
14	[<i>Quercus turbinella - Quercus rugosa - Quercus hypoleucoides</i>] Shrubland Association	[QUETUR - QUERUG - QUEHYP] S	4.8	71.4%	18	5
15	* <i>Quercus gambelii (Quercus rugosa)</i> Shrubland Association	QUEGAM (QUERUG) S	0.0	0.0%	N/A	0
16	<i>Dasyilirion wheeleri / Bouteloua curtipendula - Heteropogon contortus</i> Shrubland Association	DASWHE / BOUCUR - HETCON S	17.8	94.9%	28	7

Table 3-1. The 27 associations originally identified and described at Coronado National Memorial, cont.

	Association	Abbreviation	AA area (ha)	% of total area	Plot radius (m)	# of plots
17	<i>Dasyllirion wheeleri</i> / <i>Bouteloua curtipendula</i> Shrub Grassland Association ³	DASWHE / BOUCUR SG	43.4	77.2%	28	17
18	[<i>Cercocarpus montanus</i> - <i>Garrya wrightii</i>] / Mixed Perennial Grass Wooded Shrub Savanna Association ³	[CERMON - GARWRI] / MPG WSS	74.0	62.2%	40	20
19	*[<i>Cercocarpus montanus</i> - <i>Rhus virens</i>] Shrubby Rock Outcrop Association	[CERMON - RHUVIR] SHRO	1.6	5.0%	N/A	0
20	[<i>Aloysia wrightii</i> - <i>Eysenhardtia orthocarpa</i>] / Mixed Perennial Grass Shrub Savanna Association	[ALLOWRI - EYSORT] / MPG SS	75.5	73.4%	40	20
21	[<i>Aloysia wrightii</i> - <i>Parthenium incanum</i>] Shrubland Association	[ALLOWRI - PARINC] S	8.6	50.8%	28	5
22	(<i>Quercus</i>) / [<i>Rhus virens</i> - <i>Garrya wrightii</i> - <i>Eysenhardtia orthocarpa</i> - <i>Aloysia wrightii</i>] Intermittently Flooded Shrubland Association	(QUERC) / [RHUVIR - GARWRI - EYSORT - ALLOWRI] IFS	12.4	75.8%	10	5
23	(<i>Prosopis velutina</i> - <i>Baccharis sarothroides</i>) / <i>Eragrostis lehmanniana</i> Herbaceous Association	(PROVEL - BACSAR) / ERALEH H	177.0	97.2%	40	20
24	(<i>Agave palmeri</i> - <i>Mimosa aculeaticarpa</i>) / Mixed Perennial Grass (<i>Calliandra eriophylla</i>) Herbaceous Association	(AGAPAL - MIMACU) / MPG (CALERI) H	158.4	91.6%	40	20
25	<i>Baccharis sarothroides</i> / <i>Bothriochloa barbinodis</i> (<i>Eragrostis lehmanniana</i>) Shrub Savanna Association	BACSAR / BOTBAR (ERALEH) SS	3.7	96.6%	28	5
26	<i>Fouquieria splendens</i> / <i>Cercocarpus montanus</i> Shrubland Association ⁴	FOUSPL / CERMON S	5.7	99.4%	18	5
27	<i>Fouquieria splendens</i> / [<i>Aloysia wrightii</i> - <i>Eysenhardtia orthocarpa</i>] / Mixed Perennial Grass Shrub Savanna Association ⁴	FOUSPL / [ALLOWRI - EYSORT] / MPG SS	4.0	100.0%	18	5

*Associations without any AA plots due to access limitations

¹ These associations became the [*Q. arizonica* - *Q. emoryi*] / Mixed Perennial Grass Tree Savanna map class.

² These associations became the *Q. arizonica* (*Q. emoryi*) / Mixed Perennial Grass Woodland map class.

³ These associations became the [*Cercocarpus montanus* - *Garrya wrightii* - *Dasyllirion wheeleri* - *Nolina microcarpa*] Wooded Shrub Savanna map class.

⁴ These associations were dissolved into the [*Aloysia wrightii* - *Eysenhardtia orthocarpa*] / Mixed Perennial Grass Shrub Savanna Association.

Each association was assigned AA plots based on the total hectares it covered. Plot size was determined by evaluating the available area for plot placement. 366 plots were sampled.

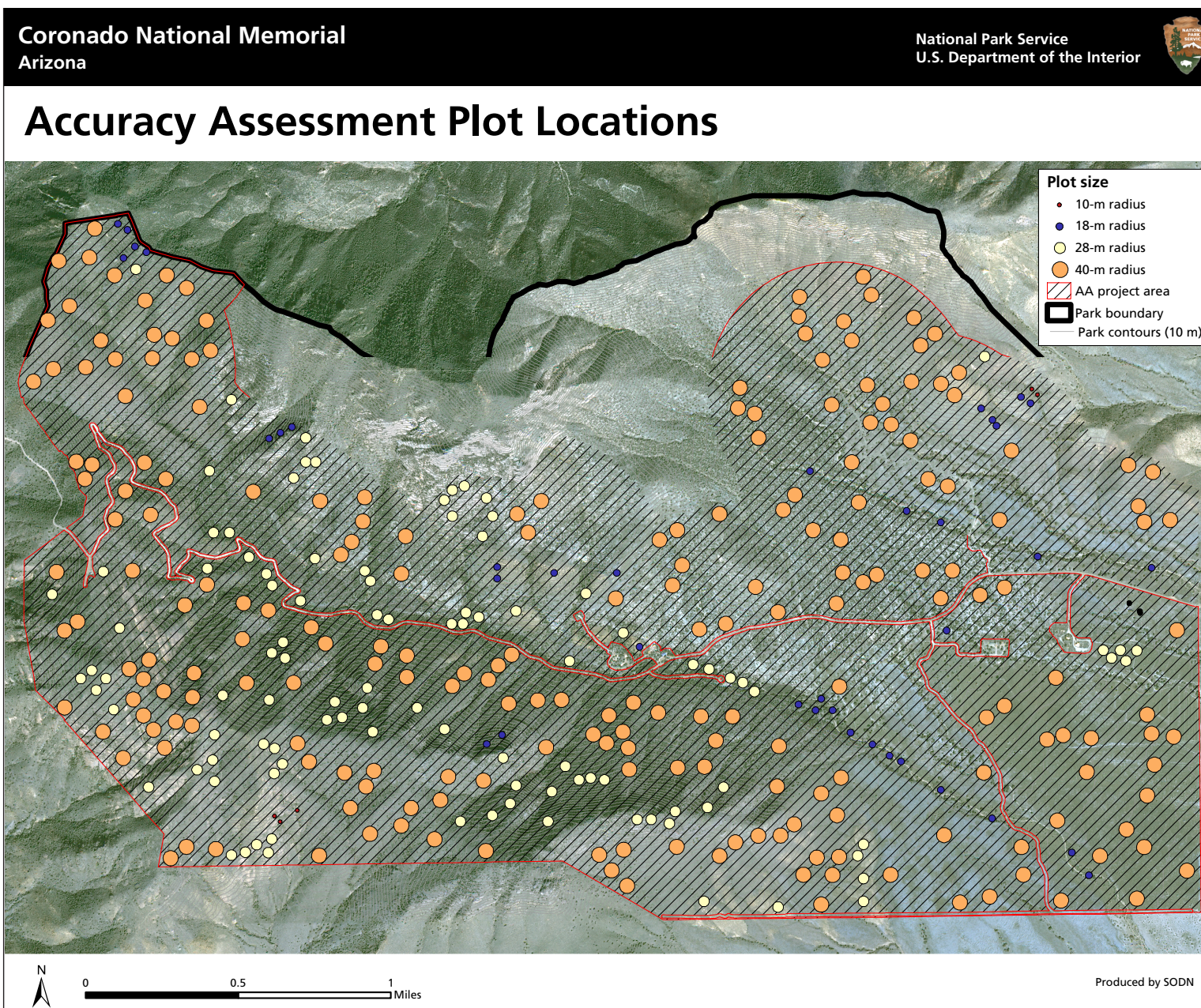


Figure 3-1. Plot locations for accuracy assessment were distributed across 25 of the 27 associations based on access and safety considerations. Plot size (radius) was determined in GIS and was reduced from 40 meters in some sites to better fit within the smaller or more linear feature polygons.

nostic species present and their approximate canopy cover. Using the association key (see Appendix C) and short descriptions, they determined which association provided the best match to the community present within the plot. The crew was instructed to assess the severity of fire disturbance and account for its influence on the current community. If no association was applicable, the assessors labeled it “unplaced” and assigned a new association name. All plots were assigned a level of “fit” for their assigned association: excellent, good, fair, or poor (see below). This was not used to assign agreement or disagreement between the map and the field data. It was used to further illustrate the accuracy of the map after the accuracy assessment.

Excellent: The composition of dominant species (taking into account listed variations within the type) and cover values within the plot match the type description.

Good: The composition of dominant species (taking into account listed variations within the type) within the plot matches the type description, but cover values are outside the values or ranges listed in the type description.

Fair: The composition of the minority of dominant species (taking into account listed variations within the type) does not match the type description (e.g., a dominant species is not listed in the description or a listed dominant is not in the plot), but the plot is clearly best suited for the type.

Poor: The composition of the majority of dominant species (taking into account listed variations within the type) does not match the type description (e.g., a dominant species is not listed in the description or a listed dominant is not in the plot). This indicates that the plot is similar enough to a description to assign a type, but there are major discrepancies between the two.

3.2 Field effort

Over the course of four tours of eight days each, running from mid-April through the

end of May 2016, a crew of two SODN field staff acted as assessors who sampled all plots distributed across the monument ($n = 366$). Prior to data collection, assessors were thoroughly briefed on the assessment protocol and vegetation associations. The assessors were provided with keys to the vegetation associations, detailed descriptions of each, and a field guide to aid in plant identification. Within all plots, assessors collected a GPS point attributed with the plot ID, assigned association, and level of fit. This served as a check on plot ID transcription errors and allowed for quicker analysis. For plots with a fair or poor fit, assessors also described the discrepancies between the plot and its assigned association and acquired four pictures of the plot (one in each cardinal direction) from a representative location. A seasoned crew lead was present for the first two tours to answer questions and ensure accurate plant identification and adherence to protocol. This person did not collect data or contribute to any discussions relating to assigning AA plots to associations.

3.3 Results

We assessed every discrepancy between assessor and producer ($n = 103$) to determine their validity. Based on AA datasheets, plot photos, and imagery, we determined that 15 plots were incorrectly assessed and should be in agreement with the producers’ designation. The most common issue was assessors’ not fully considering pre-Monument Fire species composition and abundance. Most associations disturbed by the fire were described with both pre- and post-fire variations. Some of the post-fire variations superficially resembled other similar types, leading to confusion when fire severity was not considered. This was especially true in areas once dominated by pointleaf manzanita (*Arctostaphylos pungens*) or border pinyon (*Pinus discolor*), two species that are easily consumed during fire events (although *A. pungens* is also an obligate post-fire seeder, and can have mass recruitment events after fires).

We also assessed the AA results to determine if certain associations were being confused on a consistent basis due to their similar structure and composition and may need

to be merged. We identified one instance in which two associations should be dissolved into another, and three cases in which two associations were merged to create new map classes (Table 3-2).

In Case 4, where the two *Fouquieria* associations were dissolved into the [*Aloysia wrightii* - *Eysenhardtia orthocarpa*] / Mixed Perennial Grass Shrub Savanna, the original description was expanded to account for the variations originally described by the dissolved types. In Cases 1–3, where two associations were grouped into new map classes, their separate descriptions were maintained, but their mapped polygons were merged. Following these changes, 64 discrepancies or mismatches remained between map assignments and AA field classes.

Table 3-3 is a contingency table showing the results of the AA after the three new map classes were created (cases 1–3 above), and another map class was expanded by incorporating two associations (case 4 above), for a total of 22 map classes. Values that occur within a shaded cell indicate agreement (A) between the assessor and map producer. Values in unshaded cells indicate disagreement (D). Column totals equal the total number of plots placed within that class by the assessors. Row totals are the number of plots as-

signed to that class by the producer. While no points were distributed within the [*Cercocarpus montanus* - *Rhus virens*] Shrubby Rock Outcrop association, it is included in the AA results because assessors placed one plot in this type. *Quercus gambelii* (*Quercus rugosa*) Shrubland was omitted from the AA process, as the entire single polygon fell outside the AA sampling frame.

In addition, we generated a population contingency table (Table 3-4) that includes user's and producer's accuracy per class; overall accuracy for all classes (81.4%, with 90% CI of 78.1%, 84.7%); and Kappa (81.2%, with 90% CI of 77.6%, 84.7%). Producer's accuracy indicates the likelihood that a class identified in the field matched the class attributed to the map (error of omission). User's accuracy is the reverse, indicating the likelihood that a class attributed to the map matched the class attributed in the field (error of commission). Kappa is a measure of overall accuracy minus chance agreement. Shaded cells indicate agreement (A). Unshaded cells show disagreement (D).

Values in each cell of Table 3-4 were transformed to show the “proportion of the [inference] area in the corresponding true and mapped vegetation classes” (Lea and Curtis 2010). The estimated true-area values in-

Table 3-2. Associations modified as a result of accuracy assessment.

Case	Association	Modification
1	<i>Quercus arizonica</i> / Mixed Shrub / Mixed Perennial Grass Tree Savanna Association AND <i>Quercus emoryi</i> / Mixed Perennial Grass Tree Savanna Association	Due to the considerable (25%) mixing of these two associations during AA, we decided to merge them into a new map class: [<i>Q. arizonica</i> - <i>Q. emoryi</i>] / Mixed Perennial Grass Tree Savanna Association.
2	[<i>Cercocarpus montanus</i> - <i>Garrya wrightii</i>] / Mixed Perennial Grass Wooded Shrub Savanna AND <i>Dasyllirion wheeleri</i> / <i>Bouteloua curtipendula</i> Shrub Savanna	Due to the considerable (22%) mixing of these two associations during AA, we decided to merge them into a new map class: [<i>Cercocarpus montanus</i> - <i>Garrya wrightii</i> - <i>Dasyllirion wheeleri</i> - <i>Nolina microcarpa</i>] Wooded Shrub Savanna.
3	<i>Q. arizonica</i> - <i>Q. emoryi</i> / Mixed Perennial Grass Woodland Association AND <i>Q. arizonica</i> / <i>Bouteloua curtipendula</i> Scrub Woodland Association	Due to the mixing of these two associations during AA, we decided to merge them into a new map class : <i>Q. arizonica</i> (<i>Q. emoryi</i>) / Mixed Perennial Grass Woodland Association.
4	<i>Fouquieria splendens</i> / [<i>Aloysia wrightii</i> - <i>Eysenhardtia orthocarpa</i>] / Mixed Perennial Grass Shrub Savanna AND <i>Fouquieria splendens</i> / <i>Cercocarpus montanus</i> Shrubland	Due to the very small area covered by these associations, their low accuracy (not identified in the field), and noteworthy overlap with [<i>Aloysia wrightii</i> - <i>Eysenhardtia orthocarpa</i>] / Mixed Perennial Grass Shrub Savanna, we dissolved them into that association.

Table 3-3. Accuracy assessment contingency table (error matrix) showing the number of plots placed within each map class by the producers (rows) and assessors (columns).

Map classes	1	2	3/4	5/6	7	8	9	10	11	12	13	14	15	16	17/ 18	19	20	21	22	23	24	25	Producers' total
1 PIN(DIS-CEM) / QUEARI / MUHEME W	11 (A)	-	-	4 (D)	-	-	-	-	2 (D)	2 (D)	-	-	-	-	1 (D)	-	-	-	-	-	-	-	20
2 PINDIS (QUEEMO) / (QUETOU) / MPG W&WS	-	19 (A)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1 (D)	-	-	-	-	-	20
3/4 [QUEARI - QUEEMO] / MPG TS**	-	-	31 (A)	4 (D)	-	-	-	3 (D)	-	-	-	-	-	-	2 (D)	-	-	-	-	-	-	-	40
5/6 QUEARI (QUEEMO) / MPG W**	3 (D)	-	4 (D)	29 (A)	-	-	-	-	-	4 (D)	-	-	-	-	-	-	-	-	-	-	-	-	40
7 QUEEMO / BOUCUR SW	-	1 (D)	6 (D)	-	14 (A)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	21
8 QUEEMO / ARCPUN / MPG WS	-	-	-	-	-	20 (A)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20
9 QUEEMO / MS IFTS	-	-	-	-	1 (D)	3 (D)	14 (A)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	18
10 QUEOBL / MPG TS	-	-	-	-	-	1 (D)	-	16 (A)	-	-	-	-	-	-	3 (D)	-	-	-	-	-	-	-	20
11 QUEARI - QUEEMO IFW	-	-	-	1 (D)	3 (D)	-	-	-	14 (A)	-	-	-	-	-	-	-	-	-	-	-	-	-	18
12 QUEARI - QUEHYP S	-	-	-	-	-	-	-	-	-	9 (A)	-	-	-	-	-	-	-	-	-	-	-	-	9
13 QUERUG (QUEHYP) S	-	-	-	-	-	-	-	-	-	1 (D)	4 (A)	-	-	-	-	-	-	-	-	-	-	-	5
14 [QUETUR - QUERUG - QUEHYP] S	-	-	-	-	-	-	-	-	-	-	-	5 (A)	-	-	-	-	-	-	-	-	-	-	5
16 DASWHE / BOUCUR - HETCON S	-	-	-	-	-	-	-	-	-	-	-	-	-	6 (A)	1 (D)	-	-	-	-	-	-	-	7
17/18 [CERMON - GARWRI - DASWHE - NOLMIC] WSS**	-	-	2 (D)	-	-	-	-	-	-	-	-	-	-	-	33 (A)	1 (D)	1 (D)	-	-	-	-	-	37
19 [CERMON - RHUVIR] SHRO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0 (A)	-	-	-	-	-	-	0
20 [ALOWRI - EYSORT] / MPG SS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4 (D)	-	26 (A)	-	-	-	-	-	30
21 [ALOWRI - PARINC] S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5 (A)	-	-	-	-	5
22 (QUERC) / [RHUVIR - GARWRI - EYSORT - ALOWRI] IFS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1 (D)	4 (A)	-	-	-	-	5
23 (PROVEL - BACSAR) / ERALEH H	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20 (A)	-	-	20
24 (AGAPAL - MIMACU) / MPG (CALERI) H	-	-	-	-	-	-	-	-	-	-	-	-	-	1 (D)	-	-	2 (D)	-	-	-	17 (A)	-	20
25 BACSAR / BOTBAR (ERALEH) SS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1 (D)	-	4 (A)	5
Assessors' total	14	20	43	38	18	24	14	19	16	16	4	5	0	7	44	1	30	6	4	21	17	4	365

A=agreement, D=disagreement. Cells showing agreement are also shaded ochre. Map classes that include more than one association are indicated with a "**". See Table 3-1 for abbreviations.

Table 3-4. Calculated population contingency table showing percentages of producer's (columns) and user's (rows) accuracy.

		Associations																									User's accuracy	Lower confidence interval (90%)	Upper confidence interval (90%)	Percent of total inference area
		1	2	3 QUEMO / MPG TS 4 QUEARI / MS / MPG TS	5 QUEARI - QUEEMO / MPG W 6 QUEARI / BOUCUR SW	7	8	9	10	11	12	13	14	16	17 DASWHE / BOUCUR SG 18 [CERMON - GARWRI] / MPG WSS	19	20	21	22	23	24	25								
Map classes		1	2	3 QUEMO / MPG TS 4 QUEARI / MS / MPG TS	5 QUEARI - QUEEMO / MPG W 6 QUEARI / BOUCUR SW	7	8	9	10	11	12	13	14	16	17 DASWHE / BOUCUR SG 18 [CERMON - GARWRI] / MPG WSS	19	20	21	22	23	24	25	User's accuracy	Lower confidence interval (90%)	Upper confidence interval (90%)	Percent of total inference area				
1	PIN(DIS-CEM) / QUEARI / MUHEME W	0.0217 (A)	–	–	0.0079 (D)	–	–	–	–	0.0040 (D)	0.0040 (D)	–	–	–	–	–	–	–	–	–	–	–	55.0%	34.2%	75.8%	3.95%				
2	PINDIS (QUEEMO) / (QUETOU) / MPG W&WS	–	0.0351 (A)	–	–	–	–	–	–	–	–	–	–	–	–	–	0.0018 (D)	–	–	–	–	–	95.0%	84.5%	100.0%	3.69%				
3/4	[QUEARI - QUEEMO] / MPG TS**	–	–	0.1095 (A)	0.0131 (D)	–	–	–	0.0120 (D)	–	–	–	–	–	–	–	–	–	–	–	–	–	77.5%	65.4%	89.6%	14.06%				
5/6	QUEARI (QUEEMO) / MPG W**	0.0066 (D)	–	0.0061 (D)	0.0537 (A)	–	–	–	–	–	0.0081 (D)	–	–	–	–	–	–	–	–	–	–	–	72.5%	59.6%	85.4%	7.45%				
7	QUEEMO / BOUCUR SW	–	0.0055 (D)	0.0328 (D)	–	0.0764 (A)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	66.7%	47.4%	86.0%	11.46%				
8	QUEEMO / ARCPUN / MPG WS	–	–	–	–	–	0.0820 (A)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100.0%	97.5%	100.0%	8.20%				
9	QUEEMO / MS IFTS	–	–	–	–	0.0013 (D)	0.0040 (D)	0.0186 (A)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	77.8%	58.9%	96.7%	2.39%				
10	QUEOBL / MPG TS	–	–	–	–	–	0.0024 (D)	–	0.0391 (A)	–	–	–	–	–	0.0073 (D)	–	–	–	–	–	–	–	80.0%	62.8%	97.2%	4.89%				
11	QUEARI - QUEEMO IFW	–	–	–	0.0018 (D)	0.0053 (D)	–	–	–	0.0248 (A)	–	–	–	–	–	–	–	–	–	–	–	–	77.8%	58.9%	96.7%	3.19%				
12	QUEARI - QUEHYP S	–	–	–	–	–	–	–	–	–	0.0158 (A)	–	–	–	–	–	–	–	–	–	–	–	100.0%	94.4%	100.0%	1.58%				
13	QUERUG (QUEHYP) S	–	–	–	–	–	–	–	–	–	0.0024 (D)	0.0097 (A)	–	–	–	–	–	–	–	–	–	–	80.0%	40.6%	100.0%	1.22%				
14	[QUETUR - QUERUG - QUEHYP] S	–	–	–	–	–	–	–	–	–	–	–	0.0034 (A)	–	–	–	–	–	–	–	–	–	100.0%	90.0%	100.0%	0.34%				
16	DASWHE / BOUCUR - HETCON S	–	–	–	–	–	–	–	–	–	–	–	–	0.0083 (A)	0.0014 (D)	–	–	–	–	–	–	–	85.7%	56.8%	100.0%	0.97%				
17/18	[CERMON - GARWRI - DASWHE - NOLMIC] WSS**	–	–	0.0061 (D)	–	–	–	–	–	–	–	–	–	–	0.0778 (A)	0.0031 (D)	0.0031 (D)	–	–	–	–	–	89.2%	79.4%	98.9%	9.00%				
19	[CERMON - RHUVIR] SHRO	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.0000 (A)	–	–	–	–	–	–	N/A	N/A	N/A	N/A				
20	[ALOWRI - EYSORT] / MPG SS	–	–	–	–	–	–	–	–	–	–	–	–	–	0.0077 (D)	–	0.0501 (A)	–	–	–	–	–	86.7%	74.8%	98.5%	5.78%				
21	[ALOWRI - PARINC] S	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.0087 (A)	–	–	–	–	100.0%	90.0%	100.0%	0.87%				
22	(QUERC) / [RHUVIR - GARWRI - EYSORT - ALOWRI] IFS	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.0017 (D)	0.0067 (A)	–	–	–	80.0%	40.6%	100.0%	0.84%				
23	(PROVEL - BACSAR) / ERALEH H	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.0935 (A)	–	–	100.0%	97.5%	100.0%	9.35%				
24	(AGAPAL - MIMACU) / MPG (CALERI) H	–	–	–	–	–	–	–	–	–	–	–	–	0.0044 (D)	–	–	0.0089 (D)	–	–	–	0.0755 (A)	–	85.0%	69.4%	100.0%	8.88%				
25	BACSAR / BOTBAR (ERALEH) SS	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.0004 (D)	–	0.0016 (A)	80.0%	40.6%	100.0%	0.20%				
Producer's accuracy		79.5%	86.5%	71%	69%	92.0%	92.7%	100.0%	78.8%	86.3%	53.3%	100.0%	100.0%	65.1%	75.9%	N/A	79.2%	83.7%	100.0%	99.6%	100.0%	100.0%	–	–	–	–				
Lower confidence interval (90%)		78.7%	86.2%	69%	68%	90.1%	92.7%	99.6%	77.9%	85.7%	53.3%	99.6%	100.0%	64.8%	75.0%	N/A	78.5%	83.7%	99.8%	99.6%	98.9%	99.9%	–	–	–	–				
Upper confidence interval (90%)		80.4%	86.9%	73%	71%	93.9%	92.8%	100.0%	79.6%	86.9%	53.4%	100.0%	100.0%	65.4%	76.9%	N/A	79.9%	83.7%	100.0%	99.6%	100.0%	100.0%	–	–	–	–				
Estimated true area (ha)		52.33	77.60	294.92	149%	159.03	169.27	35.56	95.02	55.13	56.78	18.65	6.58	24.35	202.28	N/A	121.02	19.80	12.88	179.76	144.52	2.99	–	–	–	–				

A=agreement, D=disagreement. Cells showing agreement are also shaded ochre. Values in each cell of the map were transformed to show the "proportion of the [inference] area in the corresponding true and mapped vegetation classes" (Lea and Curtis 2010). The estimated true area values indicate the estimated total area occupied by each map class within the inference area. These values are adjusted from the mapped area based on the results of the accuracy assessment and are not necessarily equivalent to the total area of digitized map classes. Map classes that include more than one association are indicated with a "****".

dicating the estimated total area occupied by each map class within the inference area. These values were adjusted from the mapped area based on the results of the accuracy assessment and are not necessarily equivalent to the total area of digitized map classes. For example, a class that was selected more often by the assessor than the producer will have a greater total area post-AA.

3.3.1 User's accuracy

Of the 21 map classes included in the AA, three had a user's accuracy of less than 75%. The *Pinus (discolor - cembroides) / Quercus arizonica / Muhlenbergia emersleyi* Woodland map class (row A) only achieved 55.0% (90% CI of 34.2%, 75.8%) because the assessors assigned half the plots to associations dominated by Arizona oak (*Quercus arizonica*). Many discrepancies may have occurred because this project spanned a major fire event that drastically altered vegetation composition in some places. This is especially pronounced for pine (*Pinus* sp.)-dominated communities, due to the high mortality and slow post-fire response of border pinyon (*P. discolor*).

The *Q. arizonica (Quercus emoryi) / Mixed Perennial Grass Woodland* map class (row D) only achieved a user's accuracy of 72.5% (90% CI of 59.6%, 85.4%), mainly due to occasional inclusions dominated by border pinyon (*P. discolor*) and local variation in canopy density causing the formation to present as a tree savanna. The *Q. emoryi / Bouteloua curtipendula* Scrub Woodland map class (row E) only achieved 66.7% (90% CI of 47.4%, 86.0%) user's accuracy, mainly due to local variation in canopy density, which caused the formation to present as a tree savanna. For woodland versus tree-savanna discrepancies, accuracy may have improved with larger associated AA plots.

3.3.2 Producer's accuracy

Of the 21 map classes in Table 3-4, four had a producer's accuracy less than 75%. The [*Q. arizonica - Quercus emoryi*] / Mixed Perennial Grass Tree Savanna map class (columns 3 and 4) achieved 70.7% producer's accuracy (90% CI of 68.9%, 72.6%) and the *Q. arizonica (Q. emoryi) / Mixed Peren-*

nial Grass Woodland map class (columns 5 and 6) achieved 69.5% producer's accuracy (90% CI of 68.3%, 70.6%), mainly due to woodland versus tree-savanna formation discrepancies. The *Q. arizonica - Quercus hypoleucoides* Shrubland Association (column 12) achieved 53.3% (90% CI of 53.3, 53.4), mainly due to the rapid post-fire response of silverleaf oak (*Q. hypoleucoides*). This created a number of small inclusions throughout adjacent, typically burned communities that were attributed to this type. Due to this association's 100% user accuracy, it can be affirmatively stated that it is a largely under-mapped community, with the estimated true map class area nearly double what is delineated in the final map.

The *Dasyllirion wheeleri / Bouteloua curtipendula - Heteropogon contortus* Shrubland Association (column 16) achieved a 65.1% (90% CI of 64.8, 65.4) producer's accuracy, solely because this restricted (18.8-ha) community was documented once within the widespread (172.9-ha) (*Agave palmeri - Mimosa aculeaticarpa*) / Mixed Perennial Grass (*Calliandra eriophylla*) Herbaceous Association (column 24). Due to how values are calculated for the population contingency table, discrepancies between associations of vastly different areas can have drastic effects on the accuracy of smaller types.

The [*Quercus turbinella - Quercus rugosa - Quercus hypoleucoides*] Shrubland (row and column 14) was the only association with both 100% user and producer accuracy.

3.3.3 Level of fit

Of the 263 plots assigned a matching association to their final map designation, an excellent fit was selected for 211 plots (80%), a good fit for 46 plots (18%), and a fair fit for 6 plots (2%). Assessors did not consider any of these plots a poor fit. For all fair fits, data-sheets were reviewed to determine which characteristics caused the lack of fit. The majority resulted from the variable composition and cover of associate species, rather than dominant species. Many map classes were defined by a couple of dominant species and a diverse and variable mix of associated species. Most of the fit issues captured this inherent variation across the mapped classes.

4 Final Map Product

4.1 Final associations and map graphic

The final 25 associations were matched to the most similar and suitable associations as described by and available through NatureServe Explorer and the USNVC site (<http://www.natureserve.org/>; usnvc.org) at the time of reporting. We matched only four associations to existing USNVC associations. Where no corollary was found to a mapped type within the NatureServe database, descriptions were limited to the study area. In these instances, SODN-specific codes were assigned to distinguish these from accepted types. The remaining 21 provisional types were drafted solely using our field data (Table 4-1).

Associations without NVC codes were assigned a SODN-specific code and are followed by a “P” for provisional, indicating they have not yet been incorporated into the NVC. One-page text and spatial summaries of each of the final 25 vegetation associations are presented at the end of this section; full descriptions of all associations can be found in Appendix D. Readers may refer to the digital maps and databases accompanying this report for more detail.

4.2 Vegetation inventory map

As described in Section 2.1.4, the map (Figure 4-1) was created with on-the-ground observations across three distinct field efforts from 2010 to 2015. The map was further refined as a result of accuracy assessment (see Section 3.3), with the creation of map classes. As Coronado NMEM sits within the transitional zone between numerous floristic provinces (Chihuahuan Desert, Sonoran Desert, and Madrean), it is by nature ecotonal, with diverse species and complex community interactions. The extreme topography, stark aspect shifts, complex geologic history, and recent fire events also lend numerous layers to the complicated and changing vegetation communities at the park.

The final map contained 192 polygons, not including those attributed as developed or

spanning vast expanses of exposed bedrock. Of these, the *Quercus emoryi* / *Bouteloua curtipendula* Scrub Woodland Association covered the most area, with over 223 hectares (551 acres) (Table 4-1). The *Quercus gambelii* (*Quercus rugosa*) Shrubland covered the least, at under a quarter of a hectare (0.58 acres). The herbaceous-dominated areas occurring in the lower-elevation, southeast corner of the park were mapped predominantly as two communities, the (*Agave palmeri* - *Mimosa aculeaticarpa*) / Mixed Perennial Grass (*Calliandra eriophylla*) Herbaceous Association and the (*Prosopis velutina* - *Baccharis sarothroides*) / *Eragrostis lehmanniana* Herbaceous Association. These two adjacent communities covered 173 hectares (427 acres) and 182 hectares (449 acres), respectively. Taken together, these two communities represent ~18% of the total park landscape. These communities are of specific concern to park staff due to the agave’s importance as a food source for the endangered lesser long-nosed bat (*Leptonycteris curasoae yerbabuenae*).

Woodland communities containing pinyon pine (*Pinus discolor*) covered approximately 149 hectares (368 acres; 8% of the total park landscape) and were restricted to the upper backslopes and ridgetops abutting Joe’s Canyon trail and below the Montezuma ridge. Other woodlands, with either white oak or emory oak (*Quercus arizonica*, *Quercus emoryi*) species as the primary dominant, were much more extensive, together covering 19% of the park.

Following the map are one-page summaries of the 25 associations identified and mapped at Coronado National Memorial during this project. These summaries are abridged versions of the full association descriptions provided in Appendix D. Each summary briefly describes the floristic and structural characteristics of the vegetation and shows (clockwise from left) (1) a representative photo of the association, (2) its distribution across the park, and (3) an example of the satellite imagery for one polygon (area shown is indicated by the red box).

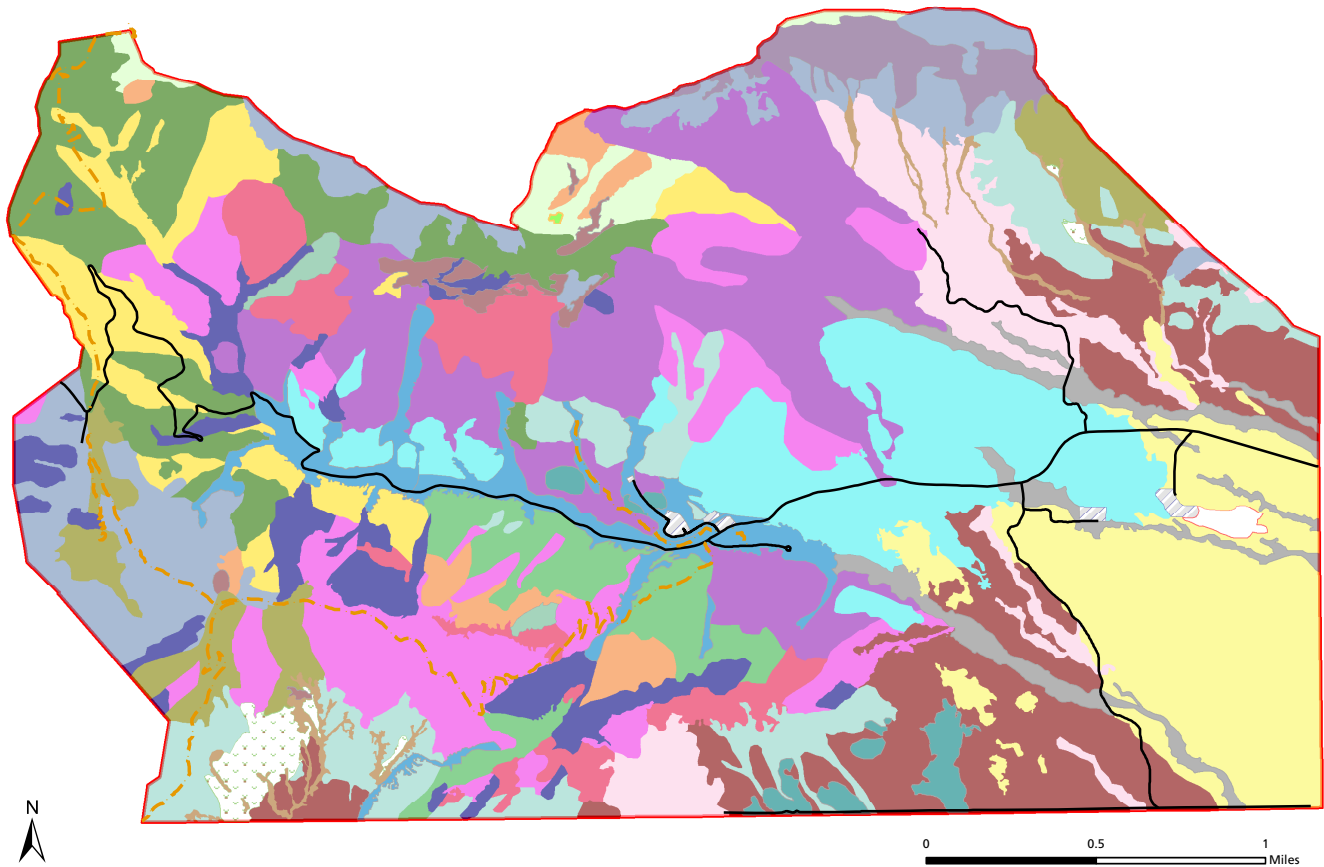
Table 4-1. Final list of classified vegetation associations for Coronado National Memorial, and their NVC codes (where available).

	Classified association name	NVC code	SODN code	Hectares occupied	Acres occupied
1	<i>Pinus (discolor - cembroides) / Quercus arizonica / Muhlenbergia emersleyi</i> Woodland Association	CEGL000769	–	76.98	190.21
2	<i>Pinus discolor (Quercus emoryi) / (Quercus toumeyi) / Mixed Perennial Grass Woodland and Wooded Shrubland Association (P)</i>	–	NPSSODN056	71.88	177.63
3	<i>Quercus emoryi / Mixed Perennial Grass Tree Savanna Association (P)</i>	–	NPSSODN061	155.74	384.86
4	<i>Quercus arizonica / Mixed Shrub / Mixed Perennial Grass Tree Savanna Association (P)</i>	–	NPSSODN057	118.06	291.74
5	<i>Quercus arizonica - Quercus emoryi / Mixed Perennial Grass Woodland Association (P)</i>	–	NPSSODN053	59.54	147.13
6	<i>Quercus arizonica / Bouteloua curtipendula</i> Scrub Woodland Association	CEGL000680	–	85.59	211.49
7	<i>Quercus emoryi / Bouteloua curtipendula</i> Scrub Woodland Association	CEGL000683	–	223.20	551.53
8	<i>Quercus emoryi / Arctostaphylos pungens / Mixed Perennial Grass Wooded Shrubland Association (P)</i>	–	NPSSODN059	159.65	394.51
9	<i>Quercus emoryi / Mixed Shrub Intermittently Flooded Tree Savanna Association (P)</i>	–	NPSSODN060	46.50	114.90
10	<i>Quercus oblongifolia / Mixed Perennial Grass Tree Savanna Association (P)</i>	–	NPSSODN063	95.13	235.07
11	<i>Quercus arizonica - Quercus emoryi</i> Intermittently Flooded Woodland Association (P)	–	NPSSODN052	62.20	153.70
12	<i>Quercus arizonica - Quercus hypoleucoides</i> Shrubland Association (P)	–	NPSSODN058	30.80	76.09
13	<i>Quercus rugosa (Quercus hypoleucoides)</i> Shrubland Association (P)	–	NPSSODN064	23.70	58.57
14	[<i>Quercus turbinella - Quercus rugosa - Quercus hypoleucoides</i>] Shrubland Association (P)	–	NPSSODN065	6.69	16.53
15	<i>Quercus gambelii (Quercus rugosa)</i> Shrubland Association (P)	–	NPSSODN062	0.23	0.58
16	<i>Dasyliion wheeleri / Bouteloua curtipendula - Heteropogon contortus</i> Shrubland Association (P)	–	NPSSODN055	18.81	46.47
17	<i>Dasyliion wheeleri / Bouteloua curtipendula</i> Shrub Grassland Association	CEGL001593	–	56.21	138.89
18	[<i>Cercocarpus montanus - Garrya wrightii</i>] / Mixed Perennial Grass Wooded Shrub Savanna Association (P)	–	NPSSODN050	118.97	293.99
19	[<i>Cercocarpus montanus - Rhus virens</i>] Shrubby Rock Outcrop Association (P)	–	NPSSODN051	32.43	80.13
20	[<i>Aloysia wrightii - Eysenhardtia orthocarpa</i>] / Mixed Perennial Grass Shrub Savanna and Shrubland Association (P)	–	NPSSODN048	112.46	277.90
21	[<i>Aloysia wrightii - Parthenium incanum</i>] Shrubland Association (P)	–	NPSSODN049	16.86	41.66
22	(<i>Quercus</i> sp.) / [<i>Rhus virens - Garrya wrightii - Eysenhardtia orthocarpa - Aloysia wrightii</i>] Intermittently Flooded Shrubland Association (P)	–	NPSSODN047	16.37	40.45
23	(<i>Prosopis velutina - Baccharis sarothroides</i>) / <i>Eragrostis lehmanniana</i> Herbaceous Association (P)	–	NPSSODN046	182.07	449.91
24	(<i>Agave palmeri - Mimosa aculeaticarpa</i>) / Mixed Perennial Grass (<i>Calliandra eriophylla</i>) Herbaceous Association (P)	–	NPSSODN045	172.93	427.32
25	<i>Baccharis sarothroides / Bothriochloa barbinodis (Eragrostis lehmanniana)</i> Shrub Savanna Association (PS)	–	NPSSODN054	3.80	9.39

P=proposed; PS=park special



Vegetation Inventory Map



Legend

- Park boundary
- Developed
- Roads
- Trails
- Sparse rock outcrop
- 1 *Pinus (discolor - cembroides) / Quercus arizonica / Muhlenbergia emersleyi* Woodland Association
- 2 *Pinus discolor (Quercus emoryi) / (Quercus toumeyii) / Perennial Grass Woodland and Wooded Shrubland Association (P)*
- 3 *Quercus emoryi / Mixed Perennial Grass Tree Savanna Association (P)*
- 4 *Quercus arizonica / Mixed Shrub / Mixed Perennial Grass Tree Savanna Association (P)*
- 5 *Quercus arizonica - Quercus emoryi / Mixed Perennial Grass Woodland Association (P)*
- 6 *Quercus arizonica / Bouteloua curtipendula* Scrub Woodland Association
- 7 *Quercus emoryi / Bouteloua curtipendula* Scrub Woodland Association
- 8 *Quercus emoryi / Arctostaphylos pungens / Mixed Perennial Grass Wooded Shrubland Association (P)*
- 9 *Quercus emoryi / Mixed Shrub Intermittently Flooded Tree Savanna Association (P)*
- 10 *Quercus oblongifolia / Mixed Perennial Grass Tree Savanna Association (P)*
- 11 *Quercus arizonica - Quercus emoryi* Intermittently Flooded Woodland Association (P)
- 12 *Quercus arizonica - Quercus hypoleucoides* Shrubland Association (P)
- 13 *Quercus rugosa (Quercus hypoleucoides)* Shrubland Association (P)
- 14 [*Quercus turbinella - Quercus rugosa - Quercus hypoleucoides*] Shrubland Association (P)
- 15 *Quercus gambelii (Quercus rugosa)* Shrubland Association (P)
- 16 *Dasylirion wheeleri / Bouteloua curtipendula - Heteropogon contortus* Shrubland Association (P)
- 17 *Dasylirion wheeleri / Bouteloua curtipendula* Shrub Grassland Association
- 18 [*Cercocarpus montanus - Garrya wrightii*] / Mixed Perennial Grass Wooded Shrub Savanna Association (P)
- 19 [*Cercocarpus montanus - Rhus virens*] Shrubby Rock Outcrop Association (P)
- 20 [*Aloysia wrightii - Eysenhardtia orthocarpa*] / Mixed Perennial Grass Shrub Savanna and Shrubland Association (P)
- 21 [*Aloysia wrightii - Parthenium incanum*] Shrubland Association (P)
- 22 (*Quercus sp.*) / [*Rhus virens - Garrya wrightii - Eysenhardtia orthocarpa - Aloysia wrightii*] Intermittently Flooded Shrubland Association (P)
- 23 (*Prosopis velutina - Baccharis sarothroides*) / *Eragrostis lehmanniana* Herbaceous Association (P)
- 24 (*Agave palmeri - Mimosa aculeaticarpa*) / Mixed Perennial Grass (*Calliandra eriophylla*) Herbaceous Association (P)
- 25 *Baccharis sarothroides / Bothriochloa barbinodis (Eragrostis lehmanniana)* Shrub Savanna Association (PS)

Figure 4-1. Final map graphic depicting classification at the map-class level (n=20).

#1 *Pinus (discolor - cembroides)* / *Quercus arizonica* / *Muhlenbergia emersleyi* Woodland Association (P)

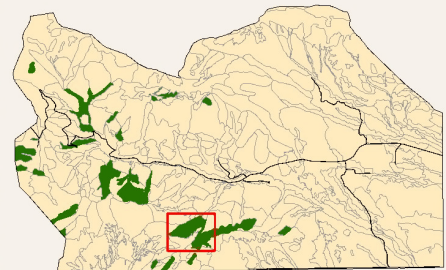
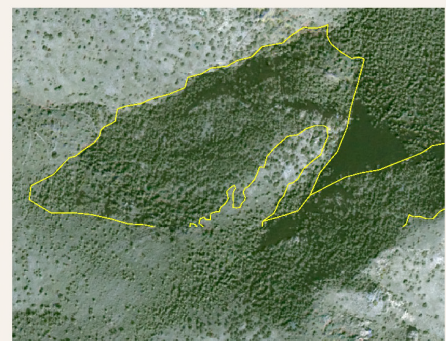
Border pinyon / Arizona white oak / Bullgrass Woodland and Forest Association

This woodland community is characterized by a variably dense tree canopy (25–70%) dominated by border pinyon (*Pinus discolor*) and Arizona white oak (*Quercus arizonica*) with one common associate, alligator juniper (*Juniperus deppeana*). Border pinyon (*P. discolor*) provides variable cover ranging from 9% in the woodland variation to 62% in the forest, with an average of 22% across the community. Arizona white oak (*Q. arizonica*) ranges in cover from 3%, typically in the forest variation, to 23% in the woodland. Alligator juniper (*J. deppeana*) is a variable, and usually sparse, associate that provides an average of 4% cover throughout. Other noteworthy canopy associates include silverleaf oak (*Quercus hypoleucoides*), Emory oak (*Quercus emoryi*), and Arizona madrone (*Arbutus arizonica*). Wright's silktassel (*Garrya wrightii*) is the most consistent and abundant subcanopy (0.5–2 m) associate, providing an average of 3% cover across the community. The field (<0.5 m) stratum is characterized by a low-cover mix of native perennial grass, providing an average of 9% cover across the community.

Common species

Pinus discolor
Quercus arizonica
Juniperus deppeana
Quercus hypoleucoides
Garrya wrightii

Overall, this community covers 4% (77 ha, 190 ac) of the park, predominantly on steep (35–50%), north-facing backslopes or within deep, narrow drainages at 1,710–2,010 meters (5,610–6,594 ft). The primary examples of this community occur in sheltered areas within the western half of the park.



#2 *Pinus discolor* (*Quercus emoryi*) / (*Quercus toumeyi*) / Mixed Perennial Grass Woodland and Wooded Shrubland Association (P)

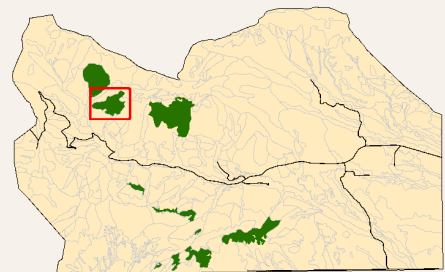
Border pinyon (Emory oak) / (Toumey oak) / Mixed Perennial Grass Woodland and Wooded Shrubland Association

This short-statured woodland community is characterized by a canopy (>2 m) dominated by border pinyon (*Pinus discolor*) with two common associates, Toumey oak (*Quercus toumeyi*) and Emory oak (*Quercus emoryi*). Border pinyon (*P. discolor*) is typically present as a short, stunted tree with heights ranging from 3 to 4 meters, but potentially under two meters where surface-rock cover is high. Overall, this species provides the majority of tree cover, contributing an average of 15% cover across the community, ranging from a low of 8% up to 21%. The two common associates vary greatly across the landscape, with areas where one might be absent or potentially co-dominant with border pinyon (*Pinus discolor*). Overall, Toumey oak (*Q. toumeyi*) provides a little more cover than Emory oak (*Q. emoryi*), with averages of 8% and 7%, respectively. In general, Toumey oak (*Q. toumeyi*) is most prevalent where the surface cover is dominated by rock, rarely providing more cover than border pinyon (*P. discolor*). The sparse field stratum is characterized by a low-cover (<10%) but diverse mix of perennial bunchgrasses. Bullgrass (*Muhlenbergia emersleyi*) and sideoats grama (*Bouteloua curtipendula*) are the most consistent species, followed by the more occasional Texas bluestem (*Schizachyrium cirratum*) and rare woolyspike balsam scale (*Elionurus barbiculmis*).

Common species

Pinus discolor
Quercus toumeyi
Quercus emoryi
Muhlenbergia emersleyi
Bouteloua curtipendula

Overall, this community covers 3.7% (72 ha, 172 ac) of the park, predominately on steep (30–50+%), generally south to east-facing mountain backslopes of 1,750–2,150 meters (5,741–7,053 ft). The surface cover is typically dominated by loose rock, gravel, and large outcrops of exposed bedrock. The primary examples of this community are on the large bedrock expanses that dot the slopes around Montezuma Peak and along Smugglers Ridge.



#3 *Quercus emoryi* / Mixed Perennial Grass Tree Savanna Association (P)

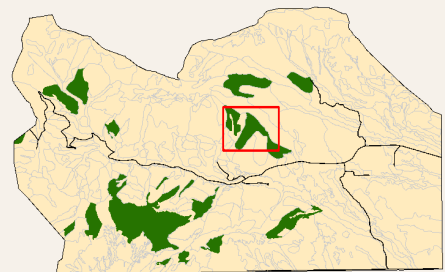
Emory oak / Mixed Perennial Grass Tree Savanna Association

This savanna community is characterized by a sparse (<15%) canopy dominated by Emory oak (*Quercus emoryi*) with a diverse matrix of perennial grasses (43%) in the field stratum (<0.5 m). Emory oak (*Q. emoryi*) is typically present as a small tree or a large tree-like shrub with heights of 3–4 meters [to 5 m], often increasing when growing in small drainages or on more sheltered, northerly aspects. This species provides an average of 9% cover across the community, with values ranging up to 20% in some locations. Mexican blue oak (*Quercus oblongifolia*) and Arizona white oak (*Quercus arizonica*) are occasional components of this community, with average cover around 1% and rarely up to 3%. Common sotol (*Dasyllirion wheeleri*), beargrass (*Nolina microcarpa*), and California brickellbush (*Brickellia californica*) are the most consistent and widespread subcanopy components, providing cover of 1–3% throughout. The field stratum (<0.5 m) is characterized by a dense (45%), diverse matrix of native and non-native perennial grasses dominated by single threeawn (*Aristida schiedeana*), sideoats grama (*Bouteloua curtipendula*), bullgrass (*Muhlenbergia emersleyi*), Lehmann lovegrass (*Eragrostis lehmanniana*), Texas bluestem (*Schizachyrium cirratum*), and tanglehead (*Heteropogon contortus*). Local dominance is highly variable, with areas solely dominated by one species or evenly split across many.

Common species

Quercus emoryi
Quercus oblongifolia
Dasyllirion wheeleri
Eragrostis lehmanniana
Aristida schiedeana

Overall, this community covers 8.0% (156 ha, 385 ac) of the park, mainly on south- to-southeast facing back-slopes of varying grades at 1,540–2,050 meters (5,025–6,725 ft). The primary examples of this community are on south-facing slopes east of Yaqui Ridge and on the exposed slopes of Montezuma Peak.



#4 *Quercus arizonica* / Mixed Shrub / Mixed Perennial Grass Tree Savanna Association (P)

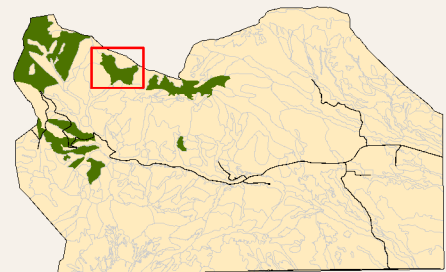
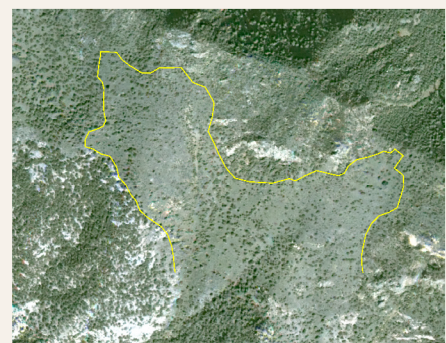
Arizona white oak / Mixed Perennial Grass Tree Savanna Association

This tree-savanna community is characterized by a sparse (10%) tree canopy (>2 m) dominated by Arizona white oak (*Quercus arizonica*), a variable mix of subcanopy (0.5–2 m) shrubs, and a moderately dense (35%) matrix of perennial grasses in the field stratum (<0.5 m). Arizona white oak (*Q. arizonica*) provides consistent cover around 10%, but may be lower in areas subjected to recent fire disturbance or on exposed, rocky slopes. Emory oak (*Quercus emoryi*) is an inconsistent and low-cover (3%) associate whose distribution follows a distinct and transitional pattern. The subcanopy stratum (0.5–2 m) is characterized by a low-cover (<10%) mix of shrubs and succulents most commonly dominated by mountain mahogany (*Cercocarpus montanus*), common sotol (*Dasyllirion wheeleri*), and/or beargrass (*Nolina microcarpa*). The field stratum (<0.5 m) is characterized by a moderately dense (35%) and diverse matrix of native perennial grasses dominated by sideoats grama (*Bouteloua curtipendula*), tanglehead (*Heteropogon contortus*), single threeawn (*Aristida schiedeana*), cane bluestem (*Bothriochloa barbinodis*) and bullgrass (*Muhlenbergia emersleyi*).

Common species

Quercus arizonica
Cercocarpus montanus
Dasyllirion wheeleri
Nolina microcarpa
Bouteloua curtipendula

Overall, this community covers 6.1% (118 ha, 292 ac) of the park, mainly on moderately steep (35–50%) south-to southeast-facing mountain backslopes at 1,750–2,230 meters (5,741–7,644 ft). The primary examples of this community are along the ridgeline near Montezuma Peak, in the northwest corner of the park, and around the Montezuma Canyon Road switchbacks.



#5 *Quercus arizonica* - *Quercus emoryi* / Mixed Perennial Grass Woodland Association (P)

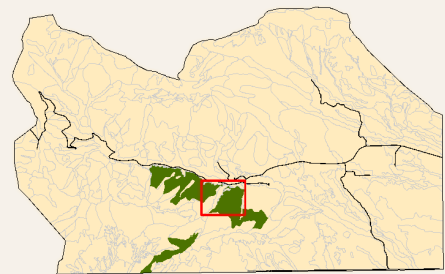
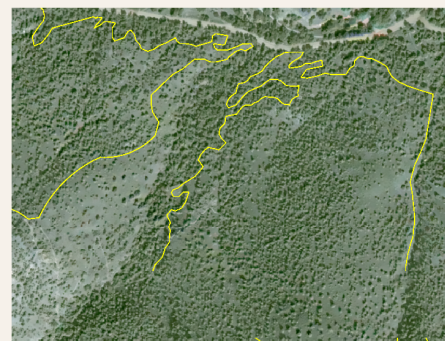
Arizona white oak - Emory oak / Mixed Perennial Grass Woodland Association

This woodland community is characterized by a moderately dense (25%) tree canopy co-dominated by Arizona white oak (*Quercus arizonica*) and Emory oak (*Quercus emoryi*), with a diverse matrix (35%) of perennial grasses in the field stratum (<0.5 m). Arizona white oak (*Q. arizonica*) is typically present as a small tree with heights ranging from 3 to 5 meters, often increasing when growing in small drainages (up to 6 m) or on more sheltered, northern aspects. Overall, this species provides consistent cover around 14%, but may reach 21% within some examples. The second dominant, Emory oak (*Quercus emoryi*), is typically present as a large shrub to small tree with an inconsistent cover of 10% across the community. The subcanopy stratum (0.5–2 m) is characterized by an inconsistent, low-cover (5%) mix of shrubs and succulents with no clear dominant species or common associates, including common sotol (*Dasyllirion wheeleri*), California brickellbush (*Brickellia californica*), beargrass (*Nolina microcarpa*), yucca (*Yucca madrensis*), and pointleaf manzanita (*Arctostaphylos pungens*). The field stratum (<0.5 m) is characterized by a moderately dense (35%) and diverse matrix of native perennial grasses dominated by single threeawn (*Aristida schiedeana*), sideoats grama (*Bouteloua curtipendula*), and Texas bluestem (*Schizachyrium cirratum*).

Common species

Quercus arizonica
Quercus emoryi
Dasyllirion wheeleri
Nolina microcarpa
Arctostaphylos pungens

Overall, this community covers 3.1% (60 ha, 148 ac) of the park, predominately on low-angle (<15%) toeslopes to steep (>50%) backslopes with a generally north-facing aspect at 1,610–1,810 meters (5,282–5,938 ft). The primary example of this community spans the north-facing slopes of Montezuma Canyon toward the eastern end of Joe's Canyon Trail.



#6 *Quercus arizonica* / *Bouteloua curtipendula* Scrub Woodland Association

Arizona white oak / Sideoats grama Scrub Woodland Association

This woodland community is characterized by a moderately dense (28%) tree canopy (>2 m) dominated by Arizona white oak (*Quercus arizonica*) with a diverse matrix of perennial grasses in the field stratum (<0.5 m). Arizona white oak (*Q. arizonica*) is typically present as a small tree with heights ranging from 3 to 5 meters. Overall, this species provides consistent cover around 20%, but may reach 45% within some examples. Numerous additional canopy tree species are scattered throughout this type, including Emory oak (*Quercus emoryi*), silverleaf oak (*Quercus hypoleucoides*), border pinyon (*Pinus discolor*), and alligator juniper (*Juniperus deppeana*).

The subcanopy stratum (0.5–2 m) is characterized by an inconsistent, low-cover (<10%) mix of shrubs and succulents with no species clearly dominant, or common associates. The field stratum (<0.5 m) is characterized by a sparse (13%) but diverse mix of native perennial grasses dominated by single threeawn (*Aristida schiedeana*), sideoats grama (*Bouteloua curtipendula*), and bullgrass (*Muhlenbergia emersleyi*).

Common species

Quercus arizonica

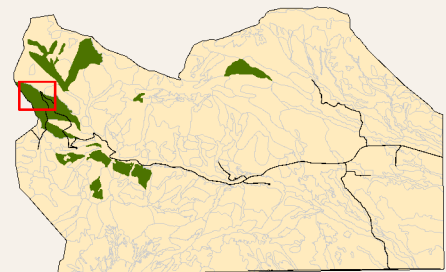
Quercus emoryi

Quercus hypoleucoides

Pinus discolor

Juniperus deppeana

Overall, this community covers 4.4% (86 ha, 213 ac) of the park, mainly on steep (>50%) south- and north- facing mountain backslopes at 1,730–2,380 meters (5,675–7,808 ft). The primary examples of this community are at the western end of Montezuma Canyon and in the northwest corner of the park.



#7 *Quercus emoryi* / *Bouteloua curtipendula* Scrub Woodland Association

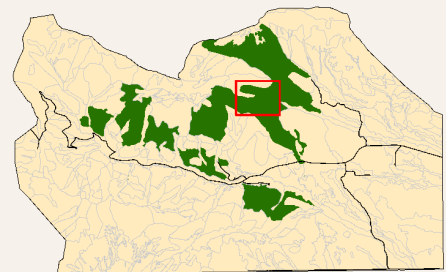
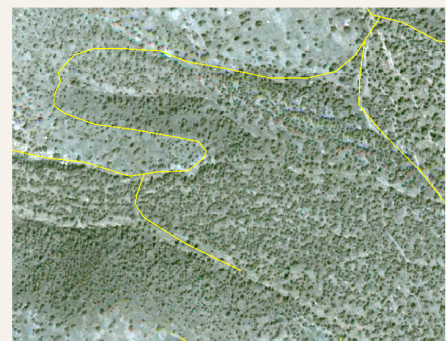
Emory oak / Sideoats grama Scrub Woodland Association

This woodland community is characterized by a moderately dense (30%) tree canopy (>2 m) dominated by Emory oak (*Quercus emoryi*) with a diverse matrix of perennial grasses (35%) in the field stratum (<0.5 m). Emory oak (*Q. emoryi*) is typically present as a small tree or large, tree-like shrub with heights ranging from 3 to 4 meters. Emory oak provides an average of 22% cover across the community, with values ranging up to 42% in some locations. Mexican blue oak (*Quercus oblongifolia*) is an occasional component of this community, with average cover around 2.5% and rarely up to 8%. The subcanopy stratum (0.5–2 m) is characterized by an inconsistent, low-cover (<10%) mix of shrubs and succulents with no species clearly dominant, nor common associates. Pointleaf manzanita (*Arctostaphylos pungens*) and common sotol (*Dasylirion wheeleri*) are widespread but sparse components that provide 0.5–3% cover throughout. The field stratum (<0.5 m) is characterized by a moderately dense (35%) and diverse matrix of native and non-native perennial grasses dominated by single threeawn (*Aristida schiedeana*), Texas bluestem (*Schizachyrium cirratum*), Lehmann lovegrass (*Eragrostis lehmanniana*), and tanglehead (*Heteropogon contortus*).

Common species

Quercus emoryi
Quercus oblongifolia
Arctostaphylos pungens
Dasylirion wheeleri
Mimosa aculeaticarpa

This woodland community spans predominately south- to southeast-facing backslopes of varying gradient, from near flat to more than 50%. At times, examples of this community may occupy a more northeastern aspect and reach down to the toe and footslopes as they transition into an alluvial fan. Within the park, this community is present across an elevational range of 1,540–2,050 meters (5,025–6,725 ft) and occupies 223 hectares (551 ac).



#8 *Quercus emoryi* / *Arctostaphylos pungens* / Mixed Perennial Grass Wooded Shrubland Association (P)

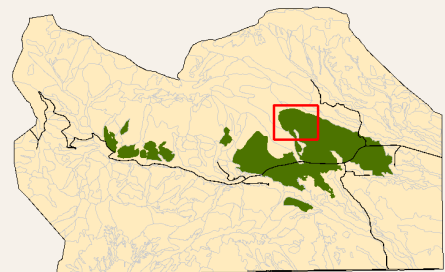
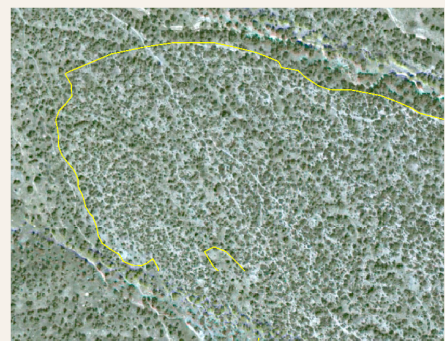
Emory oak / Pointleaf manzanita / Mixed Perennial Grass Wooded Shrubland Association

This wooded shrubland community is characterized by a sparse (10%) tree canopy (>2 m) dominated by Emory oak (*Quercus emoryi*), a moderately dense (20%) subcanopy (0.5–2 m) shrub layer dominated by pointleaf manzanita (*Arctostaphylos pungens*), and a field stratum (<0.5 m) dominated by a variable mix of perennial grasses. In general, Emory oak (*Q. emoryi*) is present as a short-statured (3–4 m) tree providing variable cover averaging to 9%, but ranging from 3 to 20%. Mexican blue oak (*Quercus oblongifolia*) is an occasional common associate, with local dominance rarely approaching 8%. The majority of cover within the subcanopy stratum is provided by pointleaf manzanita (*A. pungens*), with an average of 20% across the community, including areas reaching up to 40%. Other noteworthy shrubs and succulents include common sotol (*Dasyllirion wheeleri*), California brickellbush (*Brickellia californica*), Palmer's century plant (*Agave palm-eri*), evergreen sumac (*Rhus virens*), and catclaw mimosa (*Mimosa aculeaticarpa*). Overall, Lehmann lovegrass (*Eragrostis lehmanniana*) is the most dominant grass component, with variable cover ranging from absent up to 40%. Noteworthy native grass species include bullgrass (*Muhlenbergia emersleyi*), single threeawn (*Aristida schiedeana*), Texas bluestem (*Schizachyrium cirratum*), Plains lovegrass (*Eragrostis intermedia*), and sideoats grama (*Bouteloua curtipendula*).

Common species

Quercus emoryi
Quercus oblongifolia
Arctostaphylos pungens
Muhlenbergia emersleyi
Aristida schiedeana

Overall, this community covers 8.2% (160 ha, 395 ac) of the park, mainly on low-angle (<15%), south-facing footslopes at 1,550–1,850 meters (5,085–6,070 ft). The primary examples of this community are low toeslopes/alluvial fan along the eastern portion of Montezuma Canyon Road.



#9 *Quercus emoryi* / Mixed Shrub Intermittently Flooded Tree Savanna Association (P)

Emory oak / Mixed Shrub Intermittently Flooded Tree Savanna Association

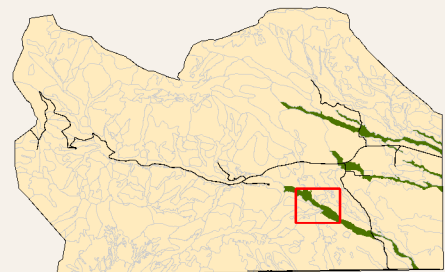
This intermittently flooded tree savanna community is characterized by a moderately sparse canopy (<20%) dominated by Emory oak (*Quercus emoryi*) with a diverse mix of shrubs and grasses in the understory. Emory oak (*Q. emoryi*) is typically present as a large tree with heights ranging from 6 to 10 meters [to 12 m], but is occasionally present as a small (2 m), shrub-like tree. This species provides an average of 13% cover across the community, with values ranging from a scant 3% up to 20% in some locations. The subcanopy stratum (0.5–2 m) is characterized by an inconsistent, low-cover (<10%) mix of shrubs and succulents with no consistently dominant species or common associates across the community. Local dominance is

Common species

Quercus emoryi
Chilopsis linearis
Mimosa aculeaticarpa
Prosopis velutina
Baccharis sarothroides

most commonly provided by desert willow (*Chilopsis linearis*), catclaw mimosa (*Mimosa aculeaticarpa*), velvet mesquite (*Prosopis velutina*), desertbroom (*Baccharis sarothroides*), and mulefat (*Baccharis salicifolia*). The field stratum (<0.5 m) is characterized by a dense (40%), diverse matrix of perennial grasses with scattered subshrubs and forbs. Overall, dominance is solely associated with Lehmann lovegrass (*Eragrostis lehmanniana*), with average cover around 12% with areas ranging up to 20%. This species is associated with the adjacent non-native grassland.

Overall, this community covers 2.4% (46 ha, 114 ac) of the park, mainly on low-angle (<15%), south- to south-east-flowing drainages and steeper, adjacent slopes at 1,500 meters (4,921 ft). The primary example of this community is the eastern portion of Montezuma Canyon Wash, where it cuts through the alluvial fan in the south-eastern portion of the park.



#10 *Quercus oblongifolia* / Mixed Perennial Grass Tree Savanna Association (P)

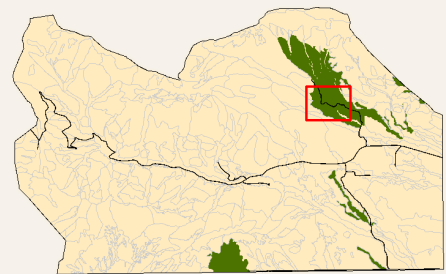
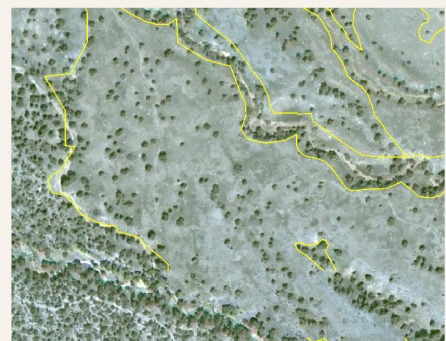
Mexican blue oak / Mixed Perennial Grass Tree Savanna Association

This tree savanna community is characterized by a sparse (10%) tree canopy (>2 m) dominated by Mexican blue oak (*Quercus oblongifolia*) with a dense (35%) matrix of perennial grasses. Mexican blue oak (*Q. oblongifolia*) is present as either a large tree with heights up to 8 meters, usually along drainages and low-angle slopes, or a small, shrubby tree less than 3 meters tall. This species provides an average of 10% cover across the community, with values ranging up to 18%, usually when spanning small drainages. Emory oak (*Quercus emoryi*) is a consistent but low-cover (1–3%) associate throughout. The subcanopy stratum (0.5–2 m) is characterized by a sparse (6%) mix of shrubs and succulents dominated by common sotol (*Dasyllirion wheeleri*), Tahitian kidneywood (*Eysenhardtia orthocarpa*), Evergreen sumac (*Rhus virens*), catclaw acacia (*Mimosa aculeaticarpa*), pointleaf manzanita (*Arctostaphylos pungens*), and Palmer's century plant (*Agave palmeri*). The field stratum (<0.5 m) is characterized by a dense (35%), diverse matrix of native and non-native perennial grasses dominated by tanglehead (*Heteropogon contortus*), Lehmann lovegrass (*Eragrostis lehmanniana*), Texas bluestem (*Schizachyrium cirratum*), and cane bluestem (*Bothriochloa barbinodis*).

Common species

Quercus oblongifolia
Quercus emoryi
Dasyllirion wheeleri
Eragrostis lehmanniana

Overall, this community covers 4.9% (95 ha, 235 ac) of the park, exclusively on low-angle (<15%), southeast-facing foot and toeslopes from 150 to 1,990 meters (5,000–6,500 ft). The primary example of this community is on the low slopes of Bob Thompson Peak.



#11 *Quercus arizonica* - *Quercus emoryi* Intermittently Flooded Woodland Association (P)

Arizona white oak - Emory oak Intermittently Flooded Woodland Association

This intermittently flooded woodland community is characterized by a variably dense (27–50%) upper canopy (>5 m) co-dominated by Arizona white oak (*Quercus arizonica*) and Emory oak (*Quercus emoryi*), with a sparse understory of mixed shrubs and perennial grasses. Arizona white oak (*Q. arizonica*) is present as a large tree (7 m) with a total average cover of 19%. Emory oak (*Q. emoryi*) is also present as a large tree (7 m) with slightly lower total cover, averaging to 16%. Arizona sycamore (*Platanus wrightii*) is occasional (1–2%) throughout the main drainage of the canyon, usually as large individuals with heights exceeding that of the oaks. Alligator juniper (*Juniperus deppeana*) and border pinyon (*Pinus discolor*) are low-cover associates that become more common in the upper reaches of the drainages and on steep, north-facing slopes. The most common associate shrubs include evergreen sumac (*Rhus virens*), pointleaf manzanita (*Arctostaphylos pungens*), betonyleaf brickellbush (*Brickellia betonicifolia*), and catclaw mimosa (*Mimosa aculeaticarpa*). The field stratum (<0.5 m) is characterized by a sparse (4–7%) mix of perennial grasses and forbs.

Common species

Quercus arizonica

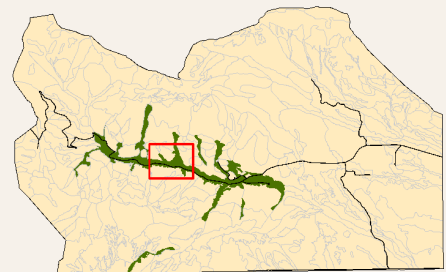
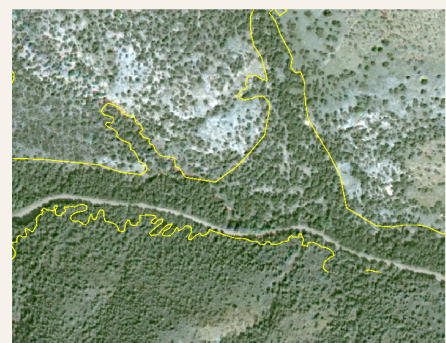
Quercus emoryi

Juniperus deppeana

Pinus discolor

Rhus virens

Overall, this community covers 3.2% (62 ha, 153 ac) of the park, exclusively in low-angle drainages and adjacent slopes of variable aspects at 1,560–1,920 meters (5,118–6,299 ft). The primary example of this community spans Montezuma Wash from the visitor center west to the beginning of the Montezuma Canyon Road switchbacks.



#12 *Quercus arizonica* - *Quercus hypoleuroides* Shrubland Association (P)

Arizona white oak - Silverleaf oak Shrubland Association

This shrubland community is characterized by a dense (40%) subcanopy stratum (0.5–2 m) co-dominated by Arizona white oak (*Quercus arizonica*) and silverleaf oak (*Quercus hypoleuroides*). These species are present as large shrubs (2 m) to small, shrubby trees (3 m) providing a variable 20% and 17% cover, respectively. Local dominance is often shared by both species, but there are numerous inclusions where either one can be the sole dominant with cover approaching 40%. Wright's silktassel (*Garrya wrightii*) is the next most-common associate shrub, providing around 2% cover. Fragrant sumac (*Rhus aromatica*), common sotol (*Dasylirion wheeleri*), yucca (*Yucca madrensis*), California brickellbush (*Brickellia californica*), Sonoran scrub oak (*Quercus tubinella*), and beargrass (*Nolina microcarpa*) are sparse associates, with cover less than 1%. The field stratum (<0.5 m) is generally sparse (<10%), with only bullgrass (*Muhlenbergia emersleyi*) providing noteworthy cover.

Common species

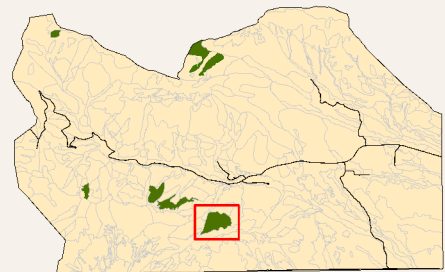
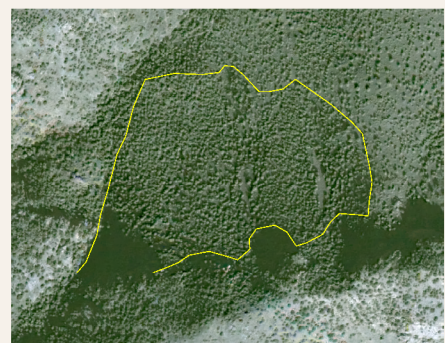
Quercus arizonica

Quercus hypoleuroides

Garrya wrightii

Muhlenbergia emersleyi

Overall, this community covers 1.6% (31 ha, 77 ac) of the park, mainly on steep (40–75%) mountain backslopes of varying aspects at 1,900–2,330 meters (6,233–7,644 ft). The primary examples of this community are on the north slopes of Montezuma Peak and the high, north-facing backslopes of Montezuma Canyon.



#13 *Quercus rugosa* (*Quercus hypoleucoides*) Shrubland Association (P)

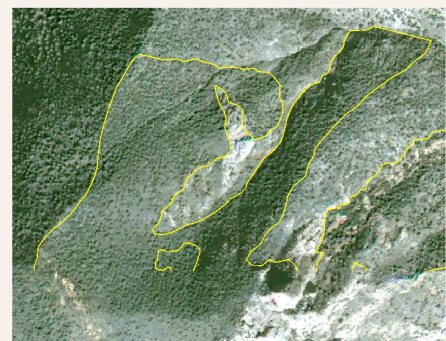
Netleaf oak (Silverleaf oak) Shrubland Association

This shrubland community is characterized by a dense (30–40%) subcanopy stratum (0.5–2 m) dominated by netleaf oak (*Quercus rugosa*) with one common associate, silverleaf oak (*Quercus hypoleucoides*). Netleaf oak (*Q. rugosa*) and silverleaf oak (*Q. hypoleucoides*) are present as large shrubs (2 m) to small, shrubby trees (3 m) providing an average of 30% and 5% cover, respectively. At times, silverleaf oak (*Q. hypoleucoides*) can provide inclusions where it becomes co-dominant with or more dominant than netleaf oak (*Q. rugosa*). Wright's silktassel (*Garrya wrightii*) and beargrass (*Nolina microcarpa*) are the next most-common shrubs, with each providing around 2% cover throughout. The field stratum (<0.5 m) is generally sparse (<5%), with only bullgrass (*Muhlenbergia emersleyi*) and longtongue muhly (*Muhlenbergia longiligula*) providing noteworthy cover.

Common species

Quercus rugosa
Quercus hypoleucoides
Garrya wrightii
Muhlenbergia emersleyi
Muhlenbergia longiligula

Overall, this community covers 1.2% (22 ha, 54 ac) of the park, primarily on steep (40–75%) mountain back-slopes of variable aspects at 1,840–2,330 meters (6,000–7,644 ft). The primary examples of this community are on the northeast slopes of Montezuma Peak and in the northwest corner of the park.



#14 [*Quercus turbinella* - *Quercus rugosa* - *Quercus hypoleucoides*] Shrubland Association (P)

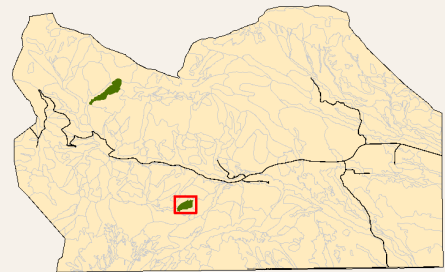
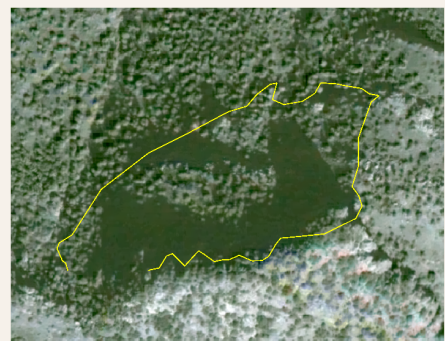
[Sonoran scrub oak - Netleaf oak - Silverleaf oak] Shrubland Association

This shrubland community is characterized by moderately dense (30%) subcanopy stratum (0.5–2 m) co-dominated by Sonoran scrub oak (*Quercus turbinella*), netleaf oak (*Quercus rugosa*), and silverleaf oak (*Quercus hypoleucoides*). These species are present as large shrubs (2 m) to small, shrubby trees (3 m) providing cover ranging from 5 to 12% each. In general, Sonoran scrub oak (*Q. turbinella*) tends to occupy the more exposed portions of this community, while the other two tend to occupy more sheltered portions often adjacent to cliff bands. Arizona white oak (*Quercus arizonica*) is a transitional associate most common on the lower slopes, where it begins to replace netleaf oak (*Q. rugosa*). Wright's silktassel (*Garrya wrightii*) is the most common associate throughout this community. The field stratum (<0.5 m) is generally sparse (<10%), with low-cover provided by bullgrass (*Muhlenbergia emersleyi*), white sagebrush (*Artemisia ludoviciana*), New Mexico fleabane (*Erigeron neomexicanus*), single threeawn (*Aristida schiedeana*), and oakwoods prairie clover (*Dalea versicolor*).

Common species

Quercus turbinella
Quercus rugosa
Quercus hypoleucoides
Garrya wrightii
Muhlenbergia emersleyi

Overall, this community covers 0.3% (7 ha, 17 ac) of the park, primarily on steep (50+%) mountain backslopes of varying aspects at 1,860–2,120 meters (6,102–7,000 ft). Often, this community abuts large, typically north-facing bedrock cliff bands. The primary examples of this community are restricted to two slopes in the upper reaches of Montezuma Canyon, one on north side and one on the south.



#15 *Quercus gambelii* (*Quercus rugosa*) Shrubland Association (P)

Gambel oak (Netleaf oak) Shrubland Association

This shrubland community is characterized by a dense (40%) subcanopy stratum (0.5–2 m) dominated by Gambel oak (*Quercus gambelii*) and netleaf oak (*Quercus rugosa*). These species are present as large, regenerating shrubs (2 m) providing a consistent 30% and patchy 7% cover, respectively. Common hoptree (*Ptelea trifoliata*) is the next most-common shrub, providing around 2% cover. The field stratum (<0.5 m) is generally sparse (<5%), with no clear dominant species or common associates. Documented components of this stratum include white sagebrush (*Artemisia ludoviciana*), muttongrass (*Poa fendleriana*), longtongue muhly (*Muhlenbergia longiligula*), Fendler's meadow rue (*Thalictrum fendleri*), and fragrant snake-root (*Ageratina herbacea*).

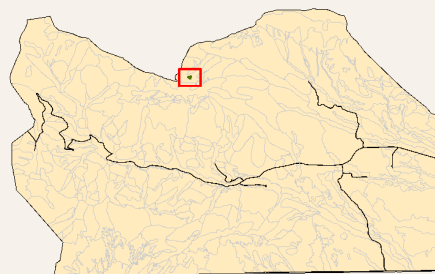
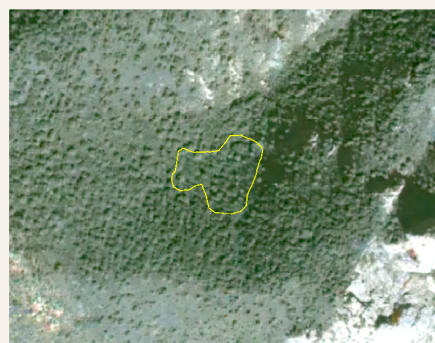
Common species

Quercus gambelii

Quercus rugosa

Ptelea trifoliata

Overall, this community covers 0.01% (0.2 ha, 0.6 ac) of the park, exclusively on steep (50+%), north-facing mountain backslopes at 2,210 meters (7,250 ft). The only example of this community is on upper slopes on the northeast side of Montezuma Peak.



#16 *Dasyilirion wheeleri* / *Bouteloua curtipendula* - *Heteropogon contortus* Shrubland Association (P)

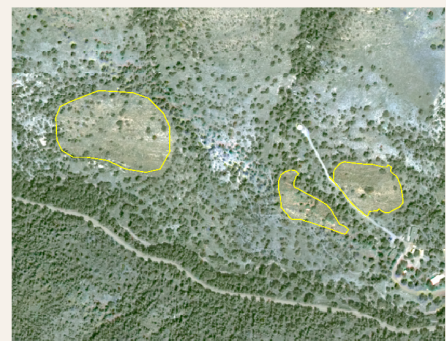
Common sotol / Sideoats grama - Tanglehead Shrubland Association

This shrubland community is characterized by a moderately sparse (15%) subcanopy stratum (0.5–2 m) dominated by common sotol (*Dasyilirion wheeleri*) and a moderately dense (20–40%) field stratum (<0.5 m) co-dominated by sideoats grama (*Bouteloua curtipendula*) and tanglehead (*Heteropogon contortus*). Common sotol (*D. wheeleri*) provides a consistent 10–20% cover across the community. Palmer's agave (*Agave palmeri*) is a consistent associate that can become a second dominant, but should never become more dominant than common sotol (*D. wheeleri*). Other noteworthy, but sparse, shrubs include Wright's beebush (*Aloysia wrightii*), evergreen sumac (*Rhus virens*), and Wright's silktassel (*Garrya wrightii*). Sideoats grama (*B. curtipendula*) and tanglehead (*H. contortus*) provide around 14% cover each, with varying cover based on bedrock dominance. At times, especially when in close proximity to non-native grasslands, Lehmann lovegrass (*Eragrostis lehmanniana*) may become a co-dominant. Other noteworthy species include cane bluestem (*Bothriochloa barbinodis*), bullgrass (*Muhlenbergia emersleyi*), and fairyduster (*Calliandra eriophyllum*).

Common species

Dasyilirion wheeleri
Bouteloua curtipendula
Heteropogon contortus
Agave palmeri
Eragrostis lehmanniana

Overall, this community covers 1.0% (19 ha, 47 ac) of the park, predominately on moderately steep (15–35%), south-facing slopes at 1,760–2,080 meters (5,774–6,824 ft). The surface is characterized by an even mix of loose rock and gravel, with conspicuous exposed limestone bedrock throughout. The primary examples of this community are on the low slopes on the south side of Smugglers Ridge and near the Cave Trail.



#17 *Dasyilirion wheeleri* / *Bouteloua curtipendula* Shrub Savanna Association

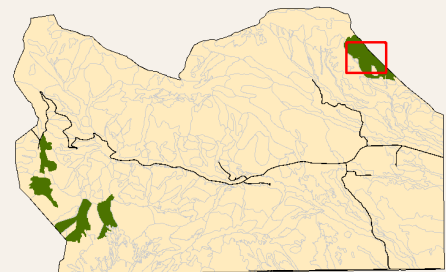
Common sotol / Sideoats grama Shrub Savanna Association

This shrub savanna community is characterized by a sparse (<10%) subcanopy stratum (0.5–2 m) dominated by common sotol (*Dasyilirion wheeleri*) and a field stratum (<0.5 m) dominated by sideoats grama (*Bouteloua curtipendula*). Common sotol (*D. wheeleri*) provides a consistent 5% cover across the community, with some areas up to 8%. Beargrass (*Nolina microcarpa*) is generally quite sparse (2%) but can occasionally become co-dominant with or more dominant than common sotol (*D. wheeleri*). Other noteworthy shrubs include evergreen sumac (*Rhus virens*), mountain mahogany (*Cercocarpus montanus*), and Wright's silktassel (*Garrya wrightii*). Sideoats grama (*B. curtipendula*) provides around 14% cover, ranging from 8 up to a high of 30%. While typically the dominant perennial grass, this species may occasionally be co-dominant with or second dominant to cane blue-stem (*Bothriochloa barbinodis*), bullgrass (*Muhlenbergia emersleyi*), and/or tanglehead (*Heteropogon contortus*).

Common species

Dasyilirion wheeleri
Nolina microcarpa
Cercocarpus montanus
Bouteloua curtipendula
Heteropogon contortus

Overall, this community covers 2.9% (56 ha, 138 ac) of the park, predominately on moderately steep (15–50%), south- to southeast-facing mountain backslopes and summits at 1,760–2,080 meters (5,774–6,824 ft). The primary examples of this community are on the slopes of Bob Thompson Peak and in the area of Coronado Peak.



#18 [*Cercocarpus montanus* - *Garrya wrightii*] / Mixed Perennial Grass Wooded Shrub Savanna Association (P)

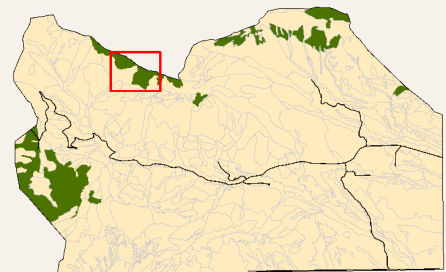
[Mountain mahogany - Wright's silktassel] / Mixed Perennial Grass Wooded Shrub Savanna Association

This community is characterized by a moderately dense (20%) subcanopy stratum (0.5–2 m) co-dominated by mountain mahogany (*Cercocarpus montanus*) and Wright's silktassel (*Garrya wrightii*), with a variable (20–40%) field stratum (<0.5 m) dominated by a diverse and variable mix of perennial bunch grasses. Both subcanopy dominants provide an average of 10% cover across the community, with the highest cover (up to 25%) occurring in close proximity to bedrock outcrops and/or where surface rock cover is high. These species may present as co-dominants, but often one or the other is the sole dominant. Common sotol (*D. wheeleri*) and beargrass (*Nolina microcarpa*) are sparse but consistent species that each provide around 2% cover. The dominant perennial grass typically consists of four species: sideoats grama (*B. curtipendula*), cane bluestem (*Bothriochloa barbinodis*), bullgrass (*Muhlenbergia emersleyi*), and single threeawn (*Aristida schiedeana*). On average, these species provide around 4–6% cover each, but can range up to 25% in some locations. Local dominance can be quite variable, with one species or a mix of many defining the grass component.

Common species

Cercocarpus montanus
Garrya wrightii
Bothriochloa barbinodis
Muhlenbergia emersleyi
Aristida schiedeana

Overall, this community covers 9.0% (175 ha, 432 ac) of the park, predominately on moderately steep (15–50%), south-facing mountain backslopes and summits at 1,760–2,080 meters (5,774 to 6,824 ft). The main occurrences of this community are along the ridgeline west of Montezuma Peak and on the slopes surrounding Coronado Peak.



#19 [*Cercocarpus montanus* - *Rhus virens*] Shrubby Rock Outcrop (P)

[Mountain mahogany - Evergreen sumac] Shrubby Rock Outcrop

This shrubby rock outcrop community is characterized by a moderately dense (30%) subcanopy stratum (0.5–2 m) co-dominated by mountain mahogany (*Cercocarpus montanus*) and evergreen sumac (*Rhus virens*), with a field stratum (<0.5 m) dominated by a mix of perennial grasses. The sub-dominants can range from small (1 m), shrubby individuals to large (3 m), tree-like individuals, with each providing around 10–12% throughout. Wright's beebush (*Aloysia wrightii*), common sotol (*Dasylirion wheeleri*), gumhead (*Gymnosperma glutinosum*) and Palmer's agave (*Agave palmeri*) are the most consistent associates. The perennial grass component is dominated by the invasive, Lehmann lovegrass (*Eragrostis lehmanniana*), with a mix of natives, including bullgrass (*Muhlenbergia emersleyi*), Plains lovegrass (*Eragrostis intermedia*), green sprangletop (*Leptochloa dubia*), sideoats grama (*Bouteloua curtipendula*), and cliff muhly (*Muhlenbergia polycaulis*).

Common species

Cercocarpus montanus

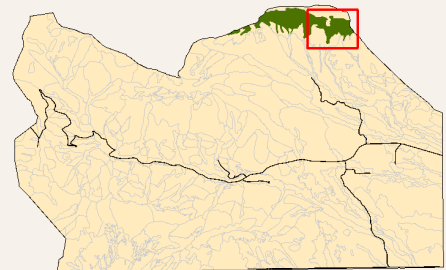
Rhus virens

Eragrostis lehmanniana

Muhlenbergia emersleyi

Eragrostis intermedia

Overall, this community covers 1.7% (32 ha, 79 ac) of the park, exclusively on steep (50+%), south- to southeast-facing mountain backslopes and summits at 1,800–2,190 meters (5,900–7,185 ft). The surface cover is characterized by a mix of loose rock and gravel with conspicuous and widespread exposed bedrock. The main occurrence of this community within the park is on upper backslopes on the southern aspect of Bob Thompson Peak.



#20 [*Aloysia wrightii* - *Eysenhardtia orthocarpa*] / Mixed Perennial Grass Shrub Savanna and Shrubland Association (P)

[Wright's beebrush - Tahitian kidneywood] / Mixed Perennial Grass Shrub Savanna and Shrubland Association

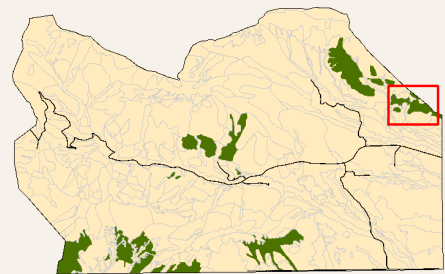
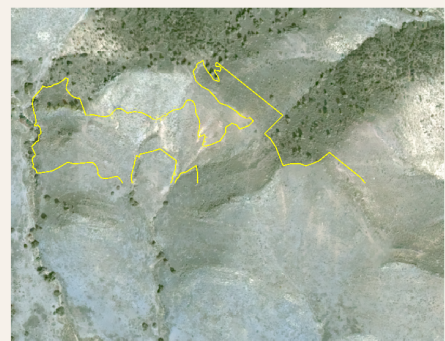
This shrub savanna community is characterized by a moderately dense (<20%) subcanopy stratum (0.5–2 m) co-dominated by Wright's beebrush (*Aloysia wrightii*) and Tahitian kidneywood (*Eysenhardtia orthocarpa*), with a field stratum (<0.5) dominated by a variable mix of perennial grasses. Overall, Wright's beebrush (*A. wrightii*) is the most dominant, with an average cover of 7% that typically presents as scattered patches, with the densest areas often associated with minor drainages. Tahitian kidneywood (*E. orthocarpa*) ranges from scattered small individuals contributing a few percent cover to shrubland variations with 10–20%. Common sotol (*D. wheeleri*) and Palmer's agave (*Agave palmeri*) are the most consistent associate succulents, with low cover (2–3%) throughout. In areas with significant bedrock outcrops, evergreen sumac (*Rhus virens*) can become a subdominant shrub. The field stratum is characterized by a moderately dense (35%) mix of native and non-native perennial grasses. The non-native grasses are solely composed of Lehmann lovegrass (*Eragrostis lehmanniana*), with the greatest cover (up to 30%) occurring near the highly disturbed alluvial fan in the park's southeast corner. Sideoats grama (*Bouteloua curtipendula*) and cane bluestem (*Bothriochloa barbino-*

dis) provide the highest and most consistent cover of native grasses, with an average of 6 and 4%, respectively.

Overall, this community covers 5.8% (112 ha, 277 ac) of the park, predominately on low- (<6%) to medium- (<50%) gradient, south-facing foot and toeslopes at 1,490–1,800 meters (4,888–5,905 ft). The largest occurrences of this community are located along the southern boundary and in the low hills just north of the park's eastern entrance.

Common species

Aloysia wrightii
Eysenhardtia orthocarpa
Rhus virens
Eragrostis lehmanniana
Bouteloua curtipendula



#21 [*Aloysia wrightii* - *Parthenium incanum*] Shrubland Association (P)

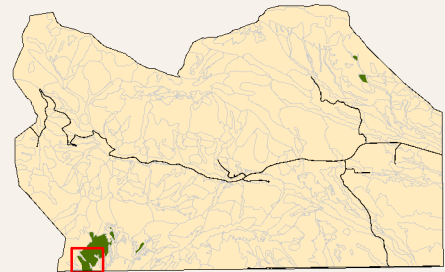
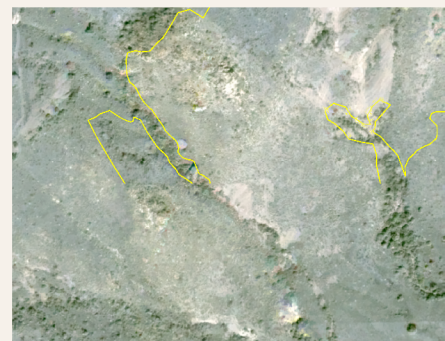
[Wright's beebrush - Mariola] Shrubland Association

This shrubland community is characterized by a dense (40%) subcanopy stratum (0.5–2 m) co-dominated by Wright's beebrush (*Aloysia wrightii*) and mariola (*Parthenium incanum*), with a field stratum (<0.5) composed of a variable mix of perennial grasses and low shrubs. The subcanopy dominants provide an average of 15% cover across the community and can present as co-dominants with each species providing similar cover, or with one species as the sole dominant while the other becomes a common associate. Evergreen sumac (*Rhus virens*) is the most consistent associate shrub, with variable cover across the community, including areas where it can become a co-dominant shrub. Common sotol (*Dasyllirion wheeleri*), gumhead (*Gymnosperma glutinosum*), and Tahitian kidneywood (*Eysenhardtia orthocarpa*) are noteworthy associates, with consistent, but low, cover throughout. The field stratum is characterized by a low-cover (<15%) mix of native perennial grasses and the low shrub, fairyduster (*Calliandra eriophylla*). Sideoats grama (*Bouteloua curtipendula*) is the most common grass, but tanglehead (*Heteropogon contortus*) and slim tridens (*Tridens muticus*) may be present.

Common species

Aloysia wrightii
Parthenium incanum
Rhus virens
Dasyllirion wheeleri
Gymnosperma glutinosum

Overall, this community covers 0.9% (17 ha, 42 ac) of the park, predominately on east- to southeast-facing back-slopes of variable gradient at 1,660–1,850 meters (5,446–6,070 ft). The primary occurrence of the type is located on the eastern slopes of Yaqui Ridge.



#22 (*Quercus*) / [*Rhus virens* - *Garrya wrightii* - *Eysenhardtia orthocarpa* - *Aloysia wrightii*] Intermittently Flooded Shrubland Association (P)

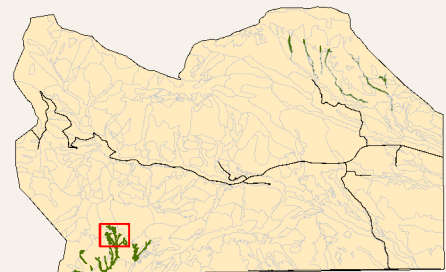
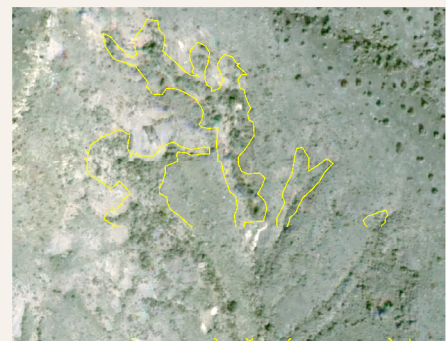
(Oak) / [Evergreen sumac - Wright's silktassel - Tahitian kidneywood - Wright's beebush]
Intermittently Flooded Shrubland Association

This intermittently flooded shrubland community is characterized by a sparse (<10%) canopy (>2 m) of mixed oak (*Quercus* sp.) species and a moderately dense (30%) subcanopy stratum (0.5–2 m) co-dominated by a variable mix of shrubs. The canopy is primarily composed of scattered Arizona white oak (*Quercus arizonica*) and Emory oak (*Quercus emoryi*), with occasional border pinyon (*Pinus discolor*) and Mexican blue oak (*Quercus oblongifolia*). The subcanopy stratum is characterized by the variable dominance of evergreen sumac (*Rhus virens*), Wright's silktassel (*Garrya wrightii*), Tahitian kidneywood (*Eysenhardtia orthocarpa*), and Wright's beebush (*Aloysia wrightii*). Local species composition is highly variable, with one species or a variable mix providing dominance. The field stratum (<0.5 m) is very sparse, with forbs and grasses distributed in patches on gravel bars and wash edges that are usually composed of the perennial grasses associated with adjacent herbaceous communities.

Common species

Quercus sp.
Rhus virens
Garrya wrightii
Eysenhardtia orthocarpa
Aloysia wrightii

Overall, this community covers 0.8% (16 ha, 40 ac) of the park, exclusively in moderately steep (15–50%), south-to southeast-flowing drainages at 1,630–2,500 meters (5,347–8,202 ft). The largest examples of this community occur along the networks of small drainages that flow off Bob Thompson Peak and in the bowl east of Yaqui Spring trail.



#23 (*Prosopis velutina* - *Baccharis sarothroides*) / *Eragrostis lehmanniana* Herbaceous Association (P)

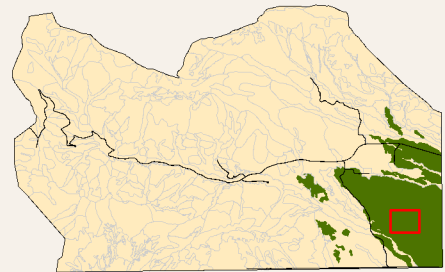
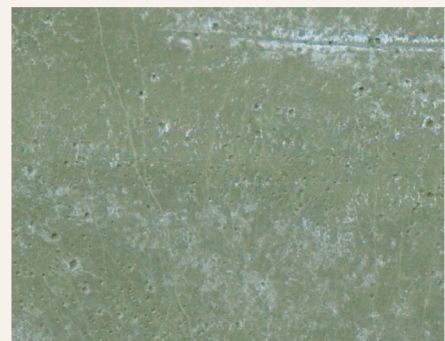
(Velvet mesquite - Desertbroom) / Lehmann lovegrass Herbaceous Association

This herbaceous community is characterized by an extremely dense (80%) matrix of perennial grass, solely dominated by Lehmann lovegrass (*Eragrostis lehmanniana*), with sparse (3%) shrub cover in the subcanopy stratum (>0.5–2 m) consisting of two common associates, velvet mesquite (*Prosopis velutina*) and desertbroom (*Baccharis sarothroides*). Velvet mesquite (*P. velutina*), while providing little cover (1%) throughout, is the most consistent and dominant species besides Lehmann lovegrass (*E. lehmanniana*), occasionally providing cover near 9%. Desertbroom (*Baccharis sarothroides*) and fairyduster (*Calliandra eriophylla*) are sparse but common associates, usually providing cover around 1% each. Lehmann lovegrass (*E. lehmanniana*), an introduced, perennial bunchgrass, has consistent, 75% cover across the whole community. Spidergrass (*Aristida ternipes*), cane bluestem (*Bothriochloa barbinodis*), and sideoats grama (*Bouteloua curtipendula*) are variable and extremely low-cover associate, perennial grasses.

Common species

Prosopis velutina
Baccharis sarothroides
Eragrostis lehmanniana
Calliandra eriophylla
Aristida ternipes

Overall, this community covers 9.4% (182 ha, 450 ac) of the park, exclusively on the low-angle, southeast-facing alluvial fan in the southeast corner of the project area.



#24 (*Agave palmeri* - *Mimosa aculeaticarpa*) / Mixed Perennial Grass (*Calliandra eriophylla*) Herbaceous Association (P)

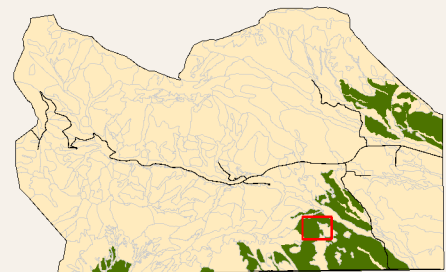
(Palmer's century plant - Catclaw mimosa) / Mixed Perennial Grass (Fairyduster) Herbaceous Association

This herbaceous community is characterized by a sparse (<5%) subcanopy stratum (0.5–2 m) defined by the common associates, Palmer's century plant (*Agave palmeri*) and catclaw mimosa (*Mimosa aculeaticarpa*), with a dense (66%) field stratum (<0.5%) dominated by a mix of perennial grasses and the low shrub, fairyduster (*Calliandra eriophylla*). Palmer's century plant (*A. palmeri*) provides consistent 3% cover throughout, while catclaw mimosa (*M. aculeaticarpa*) contributes similar, but patchy, cover. Other noteworthy shrubs include common sotol (*Dasylirion wheeleri*), Wright's beebrush (*Aloysia wrightii*), Tahitian kidneywood (*Eysenhardtia orthocarpa*), and beargrass (*Nolina microcarpa*). The field stratum is dominated by a dense (~50%) mix of native and non-native perennial grasses, as well as the low shrub, fairyduster (*Calliandra eriophylla*). The non-native grasses are predominately composed of Lehmann lovegrass (*Eragrostis lehmanniana*), with average cover of around 40%. Spidergrass (*Aristida ternipes*), sideoats grama (*Bouteloua curtipendula*), and tanglehead (*Heteropogon contortus*) provide the highest and most consistent cover of the native grasses, with cover for each around 5%. The other major field component, fairyduster (*C. eriophylla*), provides a consistent 5% low-growing cover throughout, with rare inclusions of dominance where cover approaches 18%.

Common species

Agave palmeri
Mimosa aculeaticarpa
Eragrostis lehmanniana
Calliandra eriophylla
Bouteloua curtipendula

Overall, this community covers 9% (172 ha, 425 ac) of the park, primarily on the south-facing foot- and toeslopes along the eastern end of Smugglers Ridge, on the low hills south of Bob Thompson Peak, and occasionally intermixed with the non-native grassland in the park's southeast corner.



#25 *Baccharis sarothroides* / *Bothriochloa barbinodis* (*Eragrostis lehmanniana*) Shrub Savanna Association (PS)

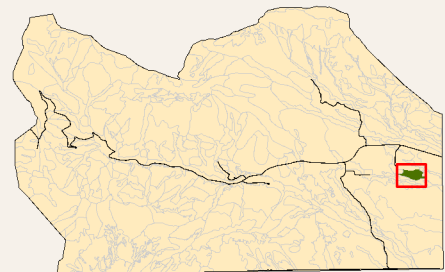
Desertbroom / Cane bluestem (Lehmann lovegrass) Shrub Savanna Association

This community is described as a “park special,” meaning it is recognized as a unique suite of plants directly due to the recent history of anthropogenic disturbance. This shrub savanna community is characterized by a moderately sparse (<15%) subcanopy stratum (0.5–2 m) dominated by desertbroom (*Baccharis sarothroides*) and a dense (36%) field stratum (<0.5) dominated by cane bluestem (*Bothriochloa barbinodis*) with one common associate, Lehmann lovegrass (*Eragrostis lehmanniana*). Desertbroom (*B. sarothroides*) provides a consistent 13% cover throughout. Velvet mesquite (*Prosopis velutina*) provides less than 1% cover and is the only other species recorded within this stratum. The grasses are dominated by a consistent 17% cover of cane bluestem (*B. barbinodis*) and a patchy 8% cover of Lehmann lovegrass (*E. lehmanniana*), mainly along a dirt road and in the ecotone with the adjacent non-native grasslands.

Common species

Baccharis sarothroides
Bothriochloa barbinodis
Eragrostis lehmanniana
Prosopis velutina

Overall, this community covers 0.2% (4 ha, 10 ac) of the park, exclusively on a low-angle (<6%), southeast-facing, lower alluvial fan at 1,510 meters (4,954 ft). The only example of this community spans a heavily disturbed site used as a staging area for the building of the border fence.



5 Discussion

5.1 Vegetation characterization: Importance of the Monument Fire

The drastic vegetation changes brought on by the Monument Fire, in June 2011, were the most significant difficulty encountered during the project. According to the Burned Area Reflectance Classification map (MTBS 2016) (a satellite-derived data layer of post-fire vegetation condition), around 1,809 hectares (92% of the park) were affected by the fire. Low-severity fire affected 52% of the park (1,024 ha). Moderate-severity fire affected 39% of the park (776 ha). Only 158 hectares (8% of the park) were unaffected; these areas were primarily along road corridors, around facilities, and in areas of high exposed bedrock cover. All 25 final associations were in some way altered by the fire, but the degree to which pre- and post-fire associations differed varied greatly, depending on species composition and/or growth form.

The largest and longest-lasting changes occurred in communities defined by the dominance of species with low resistance and/or low resilience to fire. These species included pointleaf manzanita (*Arctostaphylos pungens*) and border pinyon (*Pinus discolor*). In many post-fire stands, living individuals of these species were sparse to completely absent within map polygons. Unlike some species of manzanita, pointleaf manzanita does not produce a basal burl from which it re-sprouts after a fire event. Instead, this species must recolonize through the germination of seeds released from a dormant state by fire. Typically, recruitment occurs 1–5 years of the fire event. However, as of the AA sampling (five years post-fire), no seedlings had been observed during any post-fire vegetation mapping field work. It is possible that only a small seed bank of *A. pungens* was able to accumulate between the 1988 fire and the Monument Fire. Obligate seeding shrubs, including manzanitas, are very sensitive to relatively short fire intervals (Odion and Tyler 2002). A vegetation “type conversion” to non-native annual grass can happen as a result of this “immaturity risk” (Zedler et al. 1983).

It is also possible that the fire did not cause enough soil heating to rouse the seeds from dormancy. Poor shrub regeneration following previous fires may have caused the Monument Fire to burn too light and short for the seeds to emerge. Unlike many other species, some manzanitas can regenerate well following fires with a high degree of soil heating (Odion and Davis 2001). Their seeds can survive because they have excellent heat tolerance and can reside below the soil surface, where they are insulated. This provides the shrubs an advantage, but grasses dispersing from adjacent areas can outcompete the slow-growing manzanita seedlings, leading to type conversion.

Pointleaf manzanita was primarily associated with the *Quercus emoryi* / *Arctostaphylos pungens* / Mixed Perennial Grass Wooded Shrubland Association. While mortality was high within this association, pockets of living pointleaf manzanita were documented throughout its mapped extent. Due to this, we maintained the pre-fire polygon boundaries and described a post-fire variation within the local vegetation description. Depending on future *A. pungens* recruitment, areas mapped as this association may return to their assigned association or potentially merge into the similar and often adjacent *Quercus emoryi* / Mixed Perennial Grass Tree Savanna Association (#3).

As for border pinyon, mature individuals are suited to withstand fires of low to moderate severity, but mortality is generally high when subjected to more intense events. Unlike the dominant oaks throughout the park, this species is not known to re-sprout from its root crown and must regenerate from seeds. Following a mortality-level event, this species can be very slow to recolonize due to a variety of factors. First, trees can take up to 35 years to reach maturity, with cones taking an additional three years to mature. Once produced, the viability of seeds decreases quickly after the first year. Because Coronado NMEM experienced severe-to-extreme drought before and after the Monument Fire (USDM 2016), conditions for seed production and

germination were less than ideal. As with pointleaf manzanita, SODN crews have not documented any evidence of border-pinyon recruitment in the five years since the fire.

Across the park, only two associations were documented with border pinyon as a diagnostic species, each with differing fire effects. The *Pinus discolor* (*Quercus emoryi*) / (*Quercus toumeyii*) / Mixed Perennial Grass Woodland Association (#2) was largely unaffected by the fire due to the high cover of exposed bedrock typically associated with this community. In general, fire damage was evident only on the margins of this association. The other association, *Pinus (discolor - cembroides)* / *Quercus arizonica* / *Muhlenbergia emersleyi* Woodland (#1), was far more prone to fire effects. This was possibly because the considerably lower surface rock cover and higher accumulated litter allowed the fire to spread throughout the area assigned to this type. All examples of this type remained in one association that included a detailed narrative describing fire severity and post-fire recovery. As recolonization by border pinyon will require a significant amount of time, areas of this association subjected to high-severity fire are currently more accurately described as regenerating *Quercus arizonica* shrublands.

5.2 National Vegetation Classification placement

Placing the documented vegetation communities at Coronado NMEM into accepted USNVC associations proved difficult, mostly due to the limited vegetation-mapping work previously done in the borderlands of south-east Arizona—or at least the limited number of relevant types added to the USNVC database (usnvc.org). Of the 25 associations we identified, only four had accepted corollaries within the NVC at the time of report preparation. All four are current, accepted associations that fall under the Madrean encinal woodland group, G201, in the revised hierarchy. That number is expected to increase in future years as the NVC is refined and more data lead to new type descriptions.

5.3 Park flora

5.3.1 Park species list

The flora of Coronado NMEM is quite diverse for a park of its size. The current list of vascular plant species includes 87 families and 781 species (including 87 subspecies and varieties) (SODN unpublished data). During this effort, a total of 226 species were observed on plots, and an additional 30 were observed during polygon-scale data collection. A full list of species recorded during this project is provided in Appendix E.

A park plant species list is maintained and updated by SODN and available for public viewing on the Southwest Environmental Information Network (SEINet) data portal under the Agency Floras tab (<http://swbiodiversity.org/seinet/checklists/checklist.php?cl=2541&pid=5>). The SEINet list also provides links to herbarium specimens collected in the monument and that have been accessioned into any of the herbaria that participate in the SEINet.

5.3.2 Global rarity

Based on the rarity ranking system developed by The Nature Conservancy (now managed by NatureServe), we evaluated all plants observed during this effort to see if any were considered rare or imperiled. The “global rank” describes each species’s status globally and describes the risk of extinction, with rank G1 being critically imperiled and G5 being secure. State rank is also measured on a scale of 1–5, relative to distributions and abundances within state boundaries. Ten species had a rank of G3 (Table 4-1), defined as “Vulnerable - At moderate risk of extinction due to a restricted range, relatively few populations, recent or widespread declines, or other factors” (natureserve.org). Of these, two species also had state rankings: one comparable ranking of S3 and one S1 (“very rare”) ranking for for Arizona yellowhood (*Nissolia wislizeni*). This species was observed in one plot. More details on these ranking systems are available from the NatureServe website, <http://www.natureserve.org/biodiversity-science/publications/natureserve-conservation-status-assessments-methodology-assigning>.

Table 5-1. Species observed during project field work with either global or Arizona state rarity rankings.

Scientific name	Common name	Family	Global rank/ State rank
<i>Aralia humilis</i>	Arizona spikenard	Araliaceae	G3/SNR
<i>Brickellia floribunda</i>	Chihuahuan brickellbush	Asteraceae	G3/SNR
<i>Brickellia simplex</i>	Sonoran brickellbush	Asteraceae	G3/SNR
<i>Galium wrightii</i>	Wright's bedstraw	Rubiaceae	G3/SNR
<i>Garrya flavescens</i>	ashy siltassel	Garryaceae	G3/SNR
<i>Hedeoma dentata</i>	dentate falsepennyroyal	Lamiaceae	G3/S3
<i>Ipomoea longifolia</i>	pinkthroat morning-glory	Convolvulaceae	G3/SNR
<i>Macrosiphonia brachysiphon</i>	Huachuca Mountain rocktrumpet	Apocynaceae	G3/SNR
<i>Nissolia wislizeni</i>	Arizona yellowhood	Fabaceae	G3/S1
<i>Phaseolus ritensis</i>	Santa Rita Mountain bean	Fabaceae	G3/SNR

G3 = Vulnerable - At moderate risk of extinction due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors; SNR = Conservation status not yet assessed; S1 = very rare: 1–5 occurrences in the state or very few individuals or acres within the state; S3 = Uncommon or restricted: 21–50 occurrences in the state, either rather rare throughout a fairly wide range, or fairly common in a rather restricted range within the state.

5.4 Final products and geodatabase delivery

Both spatial and tabular data collected during this project were input into a file geodatabase designed to support relationships between the different data sources. This geodatabase contains all final map data, including photographs from plots and polygon locations and pdf versions of the type descriptions. Each spatial feature in the database (points and polygons) can be selected such that data listing species and their associated cover classes is displayed. Searches can be performed both forward and backward in this format, so the user can browse data by species and see all the locations, or by location and see all the species. A description of the geodatabase structure and attachment formats is provided in Appendix F.

All final products, including this report and the geodatabase, are available for download and viewing from the NPS data store at <https://irma.nps.gov/DataStore/Search/Quick>, and also by linking from the NPS Vegetation Mapping Inventory website, <http://science.nature.nps.gov/im/inventory/veg/products.cfm>. Spatial map data products can also be viewed without downloading by searching by park or geographic area using the NPS Vegetation Mapping Inventory map viewer <http://science.nature.nps.gov/im/inventory/veg/mapviewer/mapviewer.html>. Data can also be requested direct from SODN offices or accessed via the SODN website at <https://www.nps.gov/im/sodn/inventories-assessments.htm>.

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Appendix A: Lehmann Lovegrass Observations

During the accuracy assessment phase of the vegetation inventory in 2016, we decided to take advantage of the numerous and thoroughly distributed assessment locations (see Section 3.1) and had the field crew collect presence and cover data for Lehmann lovegrass (*E. lehmanniana*) at each of the 366 plots sampled (Figure A-1). Cover was estimated using Daubenmire cover classes. The cover data were given to the park staff as an additional separate data product for use in park exotic plant management and restoration activities. The map below represents the percent cover of Lehmann lovegrass at each sampled site.

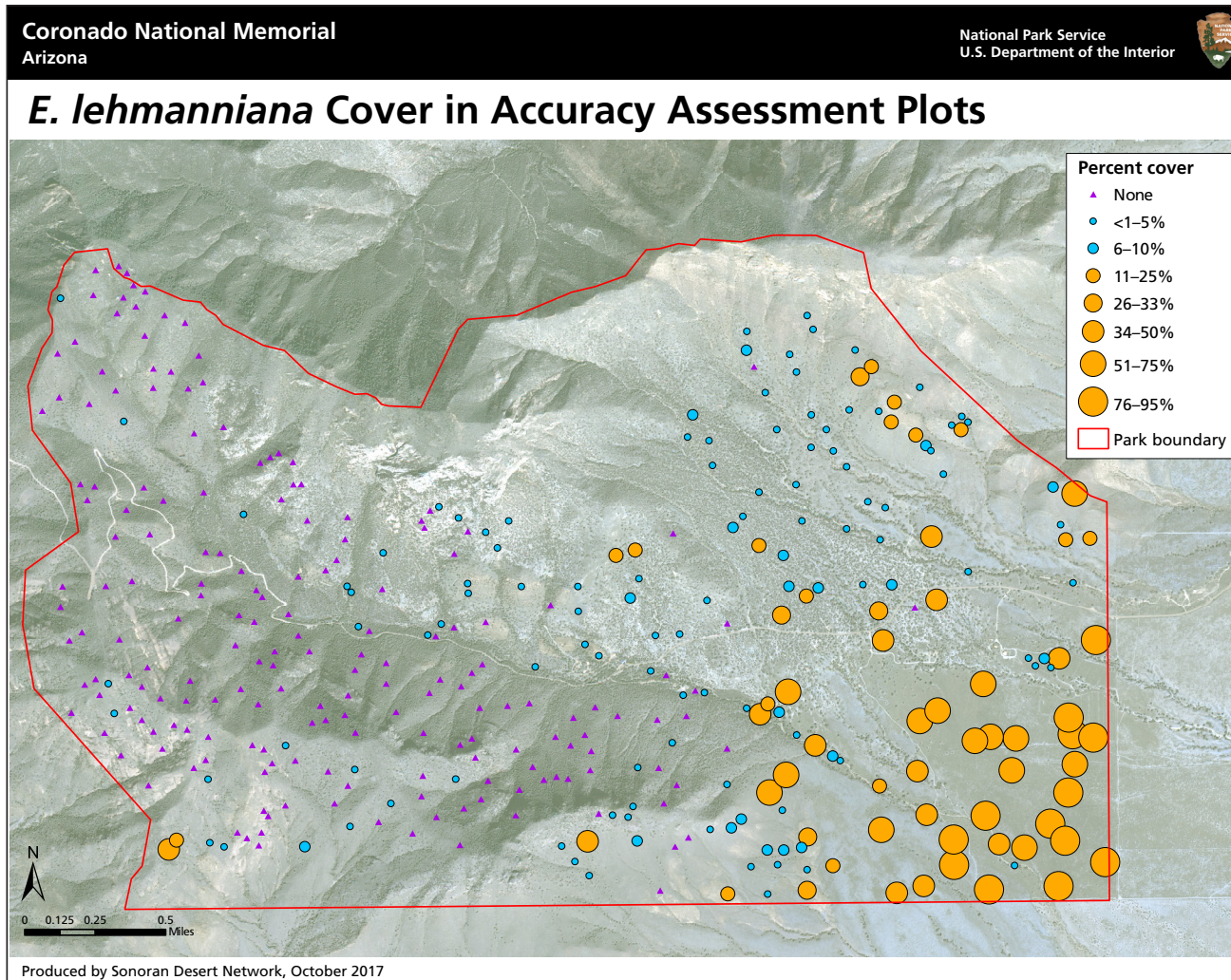


Figure A-1. This map shows the results from the 2016 accuracy assessment plot surveys, where presence of *E. lehmanniana* was recorded in all 366 plots, with recorded cover classes ranging from none to 76-95%.

Appendix B: Example Data Sheets



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USGS-NPS Vegetation Mapping Program Field Data Sheet: **Intermediate Plot Vegetation** Version: 0.054

Location and Event Information Proofread by: ____ Copied by: ____ Entered by: ____ Verified by: ____ Plot ID: ____

Park:	Sub-Map #:	Date (mm/dd/yyyy):	Plot ID:
Poly ID(s):		Field Poly ID:	Keyed Formation:
Observer(s):	Recorder:	Tentative Formation:	Protocol Name: VegMap
UTM NAD83: E 0 ____ N ____		m Bearing: ____	m Bearing: ____
			Protocol Version: 0.05.3

List top three dominant species by stratum. Rank (R) 1=dominant or co-dominant, 2=second dominant, 3=least dominant.

Record species cover class (C) and average height (H, in meters to nearest tenth) by stratum. Record LF, lifeform (T or S).

1 = < 1% 2 = 1-5% 3 = 6-10% 4 = 11-25% 5 = 26-33% 6 = 34-50% 7 = 51-75% 8 = 76-95% 9 = 96-100%

Canopy >5m	L	R	C	H	Canopy 2 – 5m	L	R	C	H	Sub-canopy 0.5 – 2m	L	R	C	Field 0 – 0.5m	R	C	
Total Cover All Species					Total Cover All Spp					Total Cover All Spp					Total Cover All Spp		

List other common associates

	L	C	H		L	C	Canopy 2 – 5m	L	C	H	Sub-canopy 0.5 – 2m	L	C	Field 0 – 0.5m	C	Field 0 – 0.5m	C

Association name: Use “—” within strata, “/” between strata and “()” to denote minor species

Disturbance Types

Camera Name	IP Photo and Bearing	4 photos (N, E, S, W)
-------------	----------------------	-----------------------

GPS Unit Name & HDOP

(X)	Plot Homogeneity
	Homogeneous
	Compositional trend
	Conspicuous inclusions
	Irregular
	Pattern mosaic

(X)	Stand Maturity
	Young/ regenerating
	Even age/ aggrading
	Mature/ even-age
	Transition/ break up
	Old growth/ senescent
	Uneven age
	Other:
	NA

<p>NOTES: Describe the overall vegetative community, especially noting differences from other similar communities.</p>
--


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 USGS-NPS Vegetation Mapping Program Field Data Sheet: **Intermediate Plot Soil/Landscape** Version: 0.05.4

Location and Event Information Proofread by: _____ Copied by: _____ Entered by: _____ Verified by: _____ Plot ID: _____

Park:	Sub-Map #:	Date (mm/dd/yyyy):	Plot ID:
Poly ID(s):		Field Poly ID:	Keyed Formation:
Observer(s):	Recorder:	Tentative Formation:	Protocol Name: VegMap
UTM NAD83: E 0 _____ N _____			Protocol Version: 0.05.3

Soil/Landscape Parameters

#	Topographic Position (Rank all that apply)	#	Landform (Rank all that apply)
	Crest/summit		Upper Alluvial Fan
	Shoulder		Lower Alluvial Fan
	Backslope		Floodplain
	Footslope		Alluvial Terrace
	Toeslope		Wash
	N/A		Arroyo
	Other:		Mountain
			Hill
			Colluvial Talus
			Outcrop
			Drainage (IFW/IFF)

X	Parent Material (Select One)
	Intrusive Igneous Bedrock
	Extrusive Igneous Bedrock
	Volcanic Ash Bedrock
	Metamorphic Bedrock
	Non-calcareous sedimentary rock
	Calcareous sedimentary rock
	Colluvium
	Old Alluvium
	New Alluvium
	Aeolian - Windblown

Slope Class (Rank all that apply #)	
0-1%	15 - 35%
1-6%	35 - 50%
6-15%	50+ %

Aspect (circle dominant aspect)			
N	NE	E	SE
S	SW	W	NW

Area Surface Cover (circle one class per feature)					
Feature	Class				
Bare Soil	None	Sparse (<1-15%)	Medium (16-35%)	Common (36-60%)	Dominant (>60%)
Gravel: 2-75 mm	None	Sparse (<1-15%)	Medium (16-35%)	Common (36-60%)	Dominant (>60%)
Rock: 75 + mm	None	Sparse (<1-15%)	Medium (16-35%)	Common (36-60%)	Dominant (>60%)
Bedrock Outcrops	None	Sparse (<1-15%)	Medium (16-35%)	Common (36-60%)	Dominant (>60%)
Physical Crust	None	Sparse (<1-15%)	Medium (16-35%)	Common (36-60%)	Dominant (>60%)
Biological Crust	None	Sparse (<1-15%)	Medium (16-35%)	Common (36-60%)	Dominant (>60%)
Down Wood	None	Sparse (<1-15%)	Medium (16-35%)	Common (36-60%)	Dominant (>60%)
Litter	None	Sparse (<1-15%)	Medium (16-35%)	Common (36-60%)	Dominant (>60%)

Erosion Features (circle one class per feature)			
Tunneling	None	Rare (<1 - 15%)	Common (16 - 60%) Prolific (>60%)
Sheet	None	Rare (<1 - 15%)	Common (16 - 60%) Prolific (>60%)
Rill	None	Rare (<1 - 15%)	Common (16 - 60%) Prolific (>60%)
Gully	None	Rare (<1 - 15%)	Common (16 - 60%) Prolific (>60%)
Pedestals	None	Rare (<1 - 15%)	Common (16 - 60%) Prolific (>60%)
Terracettes	None	Rare (<1 - 15%)	Common (16 - 60%) Prolific (>60%)
Burrowing	None	Rare (<1 - 15%)	Common (16 - 60%) Prolific (>60%)
Wash	None	Rare (<1 - 15%)	Common (16 - 60%) Prolific (>60%)

Intermediate_Plot_Soil_Landscape_Datasheet_v005_3_20130319.ppt

If you find this datasheet completed, please call (520) 343-8845



NOTES: 1) Write a short descriptive paragraph on the major soil type, slope position, and geomorphic features.
2) Sketch any soil or geologic features within the plot; *e.g.*, arroyos, changes in soils, rock outcrops.

Nail Location:

Appendix C: Dichotomous Key to Associations

Key to Vegetation Associations of Coronado National Memorial

1' - Community influenced by recent wildfire event.....2

1'' - Community not influenced by recent wildfire event3

2' - Pre-fire community contained a dominant tree canopy (> 10% cover) as evidenced by snags and/or considerable downed woodGroup A

2'' - Pre-fire community not as above..... Group C

3' - Community with a dominant (>10%) tree canopyGroup B

3'' - Community dominated by shrubs and/or grasses with a sparse (<<10%) to nonexistent tree canopy..... Group C

Group A: Tree dominant community with moderate to high burn severity

1' - Pre-fire canopy was dominated by small (3 - 4m) to large (> 4m) trees with a variable understory2

1'' - Pre-fire canopy and/or sub-canopy was dominated by shrubby oak species.....5

2' - Regenerating woodland or tree savanna dominated by Arizona white oak (*Quercus arizonica*). Emory oak (*Quercus emoryi*) and Mexican blue oak (*Quercus oblongifolia*) may be present, but should not be dominant3

2'' - Regenerating woodland or tree savanna community dominated by Emory oak (*Quercus emoryi*). Arizona white oak (*Quercus arizonica*) and Mexican blue oak (*Quercus oblongifolia*) may be present, but should not be dominant4

2''' - Community not as above Group B

3' - Community with consistent evidence (snags and/or downed wood) of pre-fire border pinyon (*Pinus discolor*) sole or co-dominance*Pinus (discolor - cembroides) / Quercus arizonica / Muhlenbergia emersleyi* Woodland

3'' - Regenerating Arizona white oak (*Quercus arizonica*) with sparse (< 20%) perennial grass*Quercus arizonica / Bouteloua curtipendula* Scrub Woodland

3''' - Sparse (<<10%) regenerating Arizona white oak (*Quercus arizonica*) with dense (>30%) perennial grasses. Emory oak (*Quercus emoryi*) may be a common associate, but should not be a dominant. Border pinyon (*Pinus discolor*) may be a sparse associate as either a living tree or snag.....*Quercus arizonica / Mixed Shrub/ Mixed Perennial Grass Tree Savanna*

4' - Community with consistent evidence (snags and/or downed wood) of pre-fire border pinyon (*Pinus discolor*) sole or co-dominance*Pinus discolor (Quercus emoryi) / (Quercus toumeyii)* Woodland

4'' - Sparse (<<10%) regenerating Emory oak (*Quercus emoryi*) with a dense (>30%) layer of perennial grasses. Lehmann's lovegrass (*Eragrostis lehmanniana*) may be the sole dominant grass. May contain Arizona white oak (*Quercus arizonica*) and evidence of alligator juniper (*Juniperus deppeana*) and/or border pinyon (*Pinus discolor*)

presence. Common sotol (*Dasyllirion wheeleri*) is a common sub-canopy component..... *Quercus emoryi* / Mixed Perennial Grass Tree Savanna

4''' - Community with consistent evidence (snags and/or downed wood) of pre-fire pointleaf manzanita (*Arctostaphylos pungens*) co- or sub-dominance *Quercus emoryi* / *Arctostaphylos pungens* / Mixed Perennial Grass Wooded Shrubland

4'''' - Dense (> 10%) regenerating Emory oak (*Quercus emoryi*) with moderately dense (< 35%) layer of perennial grasses *Quercus emoryi* / *Bouteloua curtipendula* Scrub Woodland

4'''' - Sparse (<< 10%) tree canopy associated with low-angle drainages, often with a patchy understory of cat-claw mimosa (*Mimosa aculeaticarpa*), desert willow (*Chilopsis linearis*), and velvet mesquite (*Prosopis velutina*). Mexican blue oak (*Quercus oblongifolia*) may be a common associate *Quercus emoryi* / Mixed Shrub Intermittently Flooded Tree Savanna

5' - Oaks species solely dominated by Arizona white oak (*Quercus arizonica*) 3

5'' - Oaks not solely dominated by Arizona white oak (*Quercus arizonica*) Group B

Group B: Tree dominant community with low burn severity or not influenced by a recent fire event

1' - Canopy dominated by small (3 - 4m) to large (> 4m) trees with a variable understory 2

1'' - Canopy and/or sub-canopy dominated by shrubby oak species 8

2' - Sparse to dense woodland community dominated by Border Pinyon (*Pinus discolor*) 3

2'' - Woodland or tree savanna community dominated by oaks (*Quercus* sp.) 4

3' - Co-dominants/sub-dominants include Emory oak (*Quercus emoryi*) and/or Toumey oak (*Quercus toumeyii*) with inclusions of pointleaf manzanita (*Arctostaphylos pungens*) *Pinus discolor* (*Quercus emoryi*) / (*Quercus toumeyii*) Woodland

3'' - Co-dominants/sub-dominants include Arizona white oak (*Quercus arizonica*) and/or alligator juniper (*Juniperus deppeana*) *Pinus (discolor - cembroides)* / *Quercus arizonica* / *Muhlenbergia emersleyi* Woodland

4' - Tree canopy dominated by Arizona white oak (*Quercus arizonica*). Emory oak (*Quercus emoryi*) and Mexican blue oak (*Quercus oblongifolia*) may be present, but should not be dominant 5

4'' - Tree canopy dominated by Emory oak (*Quercus emoryi*). Arizona white oak (*Quercus arizonica*) and Mexican blue oak (*Quercus oblongifolia*) may be present, but should not be dominant 6

4''' - Tree canopy co-dominated by Arizona white oak (*Quercus arizonica*) and Emory oak (*Quercus emoryi*) 7

4'''' - Sparse tree canopy (~ 11%) solely dominated by Mexican blue oak (*Quercus oblongifolia*) *Quercus oblongifolia* / Mixed Perennial Grass Tree Savanna

5' - Dense tree canopy (> 20%) dominated by Arizona white oak (*Quercus arizonica*) with sparse perennial grasses (< 20%) *Quercus arizonica* / *Bouteloua curtipendula* Scrub Woodland

5'' - Sparse tree canopy (< 15%) dominated by Arizona white oak (*Quercus arizonica*) with dense (>30%) perennial grasses. Emory oak (*Quercus emoryi*) may be a common associate, but should not be a dominant *Quercus arizonica* / Mixed Shrub / Mixed Perennial Grass Tree Savanna

6' - Sparse (<15%) tree canopy with a dense (>35%) layer of perennial grasses. May contain numerous associated trees including Arizona white oak (*Quercus arizonica*), alligator juniper (*Juniperus deppeana*), and border pinyon (*Pinus discolor*). Common sotol (*Dasyllirion wheeleri*) is a common sub-canopy component..... *Quercus emoryi* / Mixed Perennial Grass Tree Savanna

6'' - Sparse (<20%) tree canopy with a sub-canopy dominated by pointleaf manzanita (*Arctostaphylos pungens*) *Quercus emoryi* / *Arctostaphylos pungens* / Mixed Perennial Grass Wooded Shrubland

6''' - Dense (>20%) tree canopy with a moderately dense (< 35%) layer of perennial grasses..... *Quercus emoryi* / *Bouteloua curtipendula* Scrub Woodland

6'''' - Sparse (< 10%) tree canopy associated with low-angle drainages. Often with a patchy understory of cat-claw mimosa (*Mimosa aculeaticarpa*), desert willow (*Chilopsis linearis*), and velvet mesquite (*Prosopis velutina*). Mexican blue oak (*Quercus oblongifolia*) may be a common associate *Quercus emoryi* / Mixed Shrub Intermittently Flooded Tree Savanna

7' - Community associated with drainages and washes *Quercus arizonica* - *Quercus emoryi* Intermittently Flooded Woodland

7'' - Community not associated with drainages and washes *Quercus arizonica* - *Quercus emoryi* / Mixed Perennial Grass Woodland

8' - Oaks species solely dominated by Arizona white oak (*Quercus arizonica*) 5

8'' - Oaks co-dominated by Arizona white oak (*Quercus arizonica*) and silverleaf oak (*Quercus hypoleucoides*) *Quercus arizonica* - *Quercus hypoleucoides* Shrubland

8''' - Oaks dominated by netleaf oak (*Quercus rugosa*) with noteworthy silverleaf oak (*Quercus hypoleucoides*) *Quercus rugosa* (*Quercus hypoleucoides*) Shrubland

8'''' - Oaks co-dominated by Sonoran scrub oak (*Quercus turbinella*), netleaf oak (*Quercus rugosa*), and silverleaf oak (*Quercus hypoleucoides*) [*Quercus turbinella* - *Quercus rugosa* - *Quercus hypoleucoides*] Shrubland

8''''' - Oaks dominated by Gambel oak (*Quercus gambelii*) *Quercus gambelii* (*Quercus rugosa*) Shrubland

Group C: Shrub and/or grass dominated community with variable burn severity.

- 1' - Community predominately grass dominated with only sparse (< 5% [10]) shrub cover2
- 1'' - Community shrub dominated, or, if grass dominated, with considerable shrub (>10%) cover.....4
- 1''' - Community associated with narrow drainages dominated by a mix of shrubs, including: evergreen sumac (*Rhus virens*), Wright's silktassel (*Garrya wrightii*), Tahitian kidneywood (*Eysenhardtia orthocarpa*), and/or Wright's beebush (*Aloysia wrightii*). The canopy contains sparse oak (*Quercus* sp.) cover
(*Quercus*) / [*Rhus virens* - *Garrya wrightii* - *Eysenhardtia orthocarpa* - *Aloysia wrightii*] Intermittently
Flooded Shrubland
- 2' - Lehmann's lovegrass (*Eragrostis lehmanniana*) is the sole grass dominant. Velvet mesquite (*Prosopis velutina*) and desertbroom (*Baccharis sarothroides*) are sparse associates(*Prosopis velutina* - *Baccharis sarothroides*) / *Eragrostis lehmanniana* Herbaceous
- 2'' - Grass cover is a mix of natives and lehmann's lovegrass (*Eragrostis lehmanniana*). Palmer's agave (*Agave pamlerei*) and fairyduster (*Calliandra eriophylla*) are sparse associates (*Agave palmeri*- *Mimosa aculeaticarpa*) / Mixed Perennial Grass (*Calliandra eriophylla*) Herbaceous
- 2''' - Community predominately composed of sideoats grama (*Bouteloua curtipendula*) with a sparse (<5%), but consistent, cover of common sotol (*Dasyllirion wheeleri*). If present, Tahitian kidneywood (*Eysenhardtia orthocarpa*), Wright's beebush (*Aloysia wrightii*), and Palmer's agave (*Agave palmeri*) should be very sparse and/or only associated with minor drainages *Dasyllirion wheeleri* / *Bouteloua curtipendula* Shrub Savanna
- 2'''' - Not as above3
- 3' - Shrub layer dominated by mountain mahogany (*Cercocarpus montanus*) and/or Wright's silktassel (*Garrya wrightii*)4
- 3'' - Shrub layer not as above5
- 4' - Community associated with bedrock outcrops and co-dominated by mountain mahogany (*Cercocarpus montanus*) and evergreen sumac (*Rhus virens*)..... [*Cercocarpus montanus* - *Rhus virens*] Shrubby Rock Outcrop
- 4'' - Community dominated by mountain mahogany (*Cercocarpus montanus*) and/or Wright's silktassel (*Garrya wrightii*). Evergreen sumac (*Rhus virens*) is incidental, but should never be dominant. New Mexico locust (*Robinia neomexicana*) may provide reare inclusions of co-dominance. Often with a sparse (<<10% [20]) and variable tree canopy..... [*Cercocarpus montanus* - *Garrya wrightii*] / Mixed Perennial Grass Wooded Shrub Savanna
- 4''' - Community co-dominated by mountain mahogany (*Cercocarpus montanus*) and ocotillo (*Fouquieria splendens*) *Fouquieria splendens* / *Cercocarpus montanus* / Mixed Perennial Grass Shrub Savanna**

5' - Dominant shrubs include Tahitian kidneywood (*Eysenhardtia orthocarpa*), Wright's beebush (*Aloysia wrightii*), and/or mariola (*Parthenium incanum*)6

5'' - Dominant shrubs not as above7

6' - Community dominated by mariola (*Parthenium incanum*) with co-dominant/sub-dominant Wright's beebush (*Aloysia wrightii*). Tahitian kidneywood (*Eysenhardtia orthocarpa*) and gumhead (*Gymnosperma glutinosum*) may be sub-dominants.....[*Aloysia wrightii* - *Parthenium incanum*] Shrubland

6'' - Community dominated by Wright's beebush (*Aloysia wrightii*) and/or Tahitian kidneywood (*Eysenhardtia orthocarpa*) with common sotol (*Dasyllirion wheeleri*). If present, mariola (*Parthenium incanum*) and ocotillo (*Fouquieria splendens*) should be very sparse [*Aloysia wrightii* - *Eysenhardtia orthocarpa*] / Mixed Perennial Grass Shrub Savanna

6''' - Community dominated by ocotillo (*Fouquieria splendens*) with co-dominants Wright's beebush (*Aloysia wrightii*) and/or Tahitian kidneywood (*Eysenhardtia orthocarpa*). If present, mariola (*Parthenium incanum*) should be very sparse.....*Fouquieria splendens* / [*Aloysia wrightii* - *Eysenhardtia orthocarpa*] / Mixed Perennial Grass Shrub Savanna **

7' - Community dominated by > 10% [20] common sotol (*Dasyllirion wheeleri*) cover with a grass layer consisting of sideoats grama (*Bouteloua curtipendula*) and tanglehead (*Heteropogon contortus*)*Dasyllirion wheeleri* / *Bouteloua curtipendula* - *Heteropogon contortus* Shrubland

7'' - Community dominated by > 10% [15] desertbroom (*Baccharis sarothroides*) with a grass layer composed of cane bluestem (*Bothriochloa barbinodis*) and Lehman lovegrass (*Eragrostis lehmanniana*)*Baccharis sarothroides* / *Bothriochloa barbinodis* (*Eragrostis lehmanniana*) Shrub Savanna

7''' - Community dominated by > 10% velvet mesquite (*Prosopis velutina*) with a dense matrix of Lehmann lovegrass (*Eragrostis lehmanniana*)*Prosopis velutina* - *Baccharis sarothroides* / *Eragrostis lehmanniana* Herbaceous

Types marked with a ** were dissolved into the [*Aloysia wrightii* - *Eysenhardtia orthocarpa*] / Mixed Perennial Grass Shrub Savanna

Appendix D: Vegetation Type Descriptions

This appendix includes information on the 25 vegetation types that were identified and mapped at Coronado National Memorial between the years of 2010 and 2016. All information not identified as specific to Coronado National Memorial was collected from NatureServe Explorer (<http://www.natureserve.org/explorer/>) or from the United States National Vegetation Classification website at <http://usnvc.org/>. This includes the NatureServe or USNVC codes, global descriptions, vegetation hierarchy, ecological systems placement (if applicable) and references. Distinctions between floristically similar types are made based on physiognomic differences identified through use of the key given in Appendix G.

Woodland

- *Quercus arizonica* - *Quercus emoryi* Intermittently Flooded Woodland Association (P)
- *Quercus arizonica* - *Quercus emoryi* / Mixed Perennial Grass Woodland Association (P)
- *Pinus discolor* (*Quercus emoryi*) / (*Quercus toumeyii*) / Mixed Perennial Grass Woodland and Wooded Shrubland Association (P)
- *Pinus* (*discolor* - *cembroides*) / *Quercus arizonica* / *Muhlenbergia emersleyi* Woodland Association
- *Quercus arizonica* / *Bouteloua curtipendula* Scrub Woodland Association (P)
- *Quercus emoryi* / *Bouteloua curtipendula* Scrub Woodland Association

Shrubland

- (*Quercus* sp.) / [*Rhus virens* - *Garrya wrightii* - *Eysenhardtia orthocarpa* - *Aloysia wrightii*] Intermittently Flooded Shrubland Association (P)
- [*Aloysia wrightii* - *Eysenhardtia orthocarpa*] / Mixed Perennial Grass Shrub Savanna and Shrubland Association (P)
- [*Aloysia wrightii* - *Parthenium incanum*] Shrubland Association (P)
- [*Cercocarpus montanus* - *Rhus virens*] Shrubby Rock Outcrop Association (P)
- *Dasyllirion wheeleri* / *Bouteloua curtipendula* - *Heteropogon contortus* Shrubland Association (P)
- *Quercus arizonica* - *Quercus hypoleucoides* Shrubland Association (P)
- *Quercus emoryi* / *Arctostaphylos pungens* / Mixed Perennial Grass Wooded Shrubland Association (P)
- *Quercus gambelii* (*Quercus rugosa*) Shrubland Association (P)
- *Quercus rugosa* (*Quercus hypoleucoides*) Shrubland Association (P)
- [*Quercus turbinella* - *Quercus rugosa* - *Quercus hypoleucoides*] Shrubland Association (P)

Savanna

- *Baccharis sarothroides* / *Bothriochloa barbinodis* (*Eragrostis lehmanniana*) Shrub Savanna Association (PS)
- *Quercus emoryi* / Mixed Shrub Intermittently Flooded Tree Savanna Association (P)
- *Quercus arizonica* / Mixed Shrub / Mixed Perennial Grass Tree Savanna Association (P)
- *Quercus emoryi* / Mixed Perennial Grass Tree Savanna Association (P)
- *Quercus oblongifolia* / Mixed Perennial Grass Tree Savanna Association (P)

Wooded Shrub Savanna

- [*Cercocarpus montanus* - *Garrya wrightii*] / Mixed Perennial Grass Wooded Shrub Savanna Association (P)

Herbaceous

- (*Agave palmeri* - *Mimosa aculeaticarpa*) / Mixed Perennial Grass (*Calliandra eriophylla*) Herbaceous Association (P)
- (*Prosopis velutina* - *Baccharis sarothroides*) / *Eragrostis lehmanniana* Herbaceous Association (P)
- *Dasyllirion wheeleri* / *Bouteloua curtipendula* Shrub Grassland Association

1. *Pinus (discolor - cembroides)* / *Quercus arizonica* / *Muhlenbergia emersleyi* Woodland Association

Translated name: (Border pinyon, Mexican pinyon) / Arizona white oak / Bullgrass Woodland Association

NVC name: CEG000769

Identifier: N/A

NVC CLASSIFICATION

Division: *Juniperus deppeana* - *Quercus buckleyi* / *Rhus virens* Madrean - Balconian Forest & Woodland Division

Macrogroup: *Juniperus deppeana* - *Pinus cembroides* - *Quercus arizonica* Madrean Lowland Evergreen Woodland
Macrogroup

Group: *Pinus cembroides* - *Pinus discolor* - *Juniperus coahuilensis* Woodland Group

Association: *Pinus (discolor, cembroides)* / *Quercus arizonica* / *Muhlenbergia emersleyi* Woodland Association

DISTRIBUTION

Coronado National Memorial

This woodland community is present within the western half of the memorial, typically on northern aspects and in narrow, sheltered drainages.

ENVIRONMENTAL DESCRIPTION

Coronado National Memorial

This woodland predominantly occurs on steep (35–50%), north-facing backslopes or within deep, narrow drainages from 1,710–2,010 m (5,610–6,594 ft). When present on backslopes, the surface cover is dominated by an even mix of gravel and rock with scattered boulders and occasional bedrock outcrops. Areas not affected by recent fire activity will also have a noticeable litter component. When present in drainages, the surface cover is dominated by large boulders along with a channel of fine gravel.

VEGETATION DESCRIPTION

Coronado National Memorial

This woodland community is characterized by a moderate to dense tree canopy (25–70%) dominated by border pinyon (*Pinus discolor*) and Arizona white oak (*Quercus arizonica*) with one common associate, alligator juniper (*Juniperus deppeana*). Border pinyon (*P. discolor*) provides variable cover ranging from 9% in the woodland variation to 62% in the forest, with an average of 22% across the community. Arizona white oak (*Q. arizonica*) ranges in cover from 3%, typically in the forest variation, to 23% in the woodland. Alligator juniper (*J. deppeana*) is a variable, and usually sparse, associate that provides an average of 4% cover throughout; however, in one instance this species provided 12% cover and served as a co-dominant. Silverleaf oak (*Quercus hypoleucoides*) is a consistent, but sparse, associate, providing only 2% cover across the community, with rare inclusions of cover reaching up to 10%. Emory oak (*Quercus emoryi*) and Arizona madrone (*Arbutus arizonica*) are incidental.

The subcanopy (0.5–2 m) stratum is characterized by a low-cover mix of shrubs, providing an average of 7% across the community. Wright's silktassel (*Garrya wrightii*) is the most consistent and abundant, providing an average of 3% cover across the community, including a small inclusion with cover near 18%. Toumey oak (*Quercus toumeyii*) is a patchy associate that occasionally provides inclusions of subcanopy dominance. Mountain mahogany (*Cercocarpus montanus*) is occasional, usually providing the most cover where bedrock is more prevalent. Sonoran scruboak (*Quercus turbinella*) is an uncommon associate that is most common within the more exposed margins of this community.

The field (<0.5 m) stratum is characterized by a low-cover mix of native perennial grass, providing an average of 9% cover across the community. These cover values range from a low of 2% up to 20%, depending upon canopy density. In order from most to least abundant, the grass layer is composed of single threeawn (*Aristida schiedeana*), sideoats grama (*Bouteloua curtipendula*), longtongue muhly (*Muhlenbergia longiligula*), bullgrass (*Muhlen-*

bergia emersleyi), pinyon ricegrass (*Piptochaetium fimbriatum*), Texas bluestem (*Schizachyrium cirratum*), weeping lovegrass (*Eragrostis curvula*), and plains lovegrass (*Eragrostis intermedia*).

This community was variably affected by the Monument Fire in 2011. The portions of this community occurring within drainages remain largely unchanged; however, where it occupies backslopes, especially those with low bed-rock cover, overall vegetation cover and composition may be noticeably altered. Due to the slower fire response of border pinyon (*P. discolor*), its cover is typically reduced or potentially absent where severity was high. While its stature may be noticeably altered post-fire, the quickly regenerating Arizona white oak (*Q. arizonica*) likely provides similar abundance, but lower overall cover due to the temporary decrease in canopy size. Post-fire, the field stratum contributes more cover due to the quick recovery of the grasses, as well as, the decreased overstory cover.

GLOBAL TYPE CONCEPT DESCRIPTION

This diverse Madrean woodland savanna association is known from the Borderlands area of southeastern Arizona and southwestern New Mexico, and in the Sierra Del Carmen of northeastern Coahuila, Mexico (and potentially in Big Bend National Park in Texas). It occurs from about 1,650–2,060 m (5,400–6,750 ft) in elevation on gentle to steep hillslopes of northerly aspects. Stands are characterized by moderately open canopies (30–60% cover) of *Pinus cembroides* or *Pinus discolor* in association with the evergreen oaks *Quercus arizonica* or *Quercus grisea*. *Juniperus deppeana* is usually present but not dominant. The understory is diverse (96 species have been recorded for the association), grassy, and dominated by *Muhlenbergia emersleyi*. Other common grasses include *Piptochaetium fimbriatum*, *Schizachyrium cirratum*, and *Bouteloua curtipendula*.

MOST ABUNDANT SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	<i>Pinus discolor</i> , <i>Quercus arizonica</i> , <i>Juniperus deppeana</i>
Canopy (2–5 m)	<i>Pinus discolor</i> , <i>Quercus arizonica</i> , <i>Juniperus deppeana</i>
Subcanopy (0.5–2 m)	<i>Garrya wrightii</i> , <i>Cercocarpus montanus</i> , <i>Quercus toumeyii</i>
Field (0–0.5 m)	<i>Aristida schiedeana</i> , <i>Bouteloua curtipendula</i>

OTHER NOTEWORTHY ASSOCIATE SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	<i>Quercus hypoleucoides</i>
Canopy (2–5 m)	<i>Quercus hypoleucoides</i>
Subcanopy (0.5–2 m)	<i>Quercus turbinella</i>
Field (0–0.5 m)	<i>Muhlenbergia longiligula</i> , <i>Muhlenbergia emersleyi</i> , <i>Piptochaetium fimbriatum</i> , <i>Schizachyrium cirratum</i> , <i>Eragrostis intermedia</i>

CLASSIFICATION COMMENTS

Coronado National Memorial

This association was described from 3 classification plots and 15 classification polygons. While similar to the USNVC accepted association Cegl0001164, the local variation at Coronado NMem includes some notable differences. Originally, this community was named *Pinus discolor* - *Quercus arizonica* (*Juniperus deppeana*) woodland and forest association, but it was determined similar enough to Cegl0001164 to list it as that association. In general, the Coronado NMem variation includes more dominant alligator juniper (*Juniperus deppeana*), silverleaf oak (*Quercus hypoleucoides*), and Toumey oak (*Quercus toumeyii*), as well as a less dominant grass layer that was not included in the association name. It is anticipated that future revisions of this association in the NVC will encompass the variants from this park unit.

Global

Data not available.

Classification confidence: Low

NatureServe conservation status: Data not available

Global status: Data not available

Rounded global status: Data not available

Global range: This woodland savanna association is known from the Borderlands area of southeastern Arizona and southwestern New Mexico, and in the Sierra Del Carmen of northeastern Coahuila, Mexico (and potentially in Big Bend National Park). It may occur elsewhere in southwestern New Mexico, southeastern Arizona, and northern Mexico.

Reasons:

ELEMENT SOURCES

Plots: IP051, IP054, IP119

Polygons: F101, TS105, W002_D, W007_D, W018_NV, W030_D, W032_D, W300, W303, W306, W307, W308, W309, W311, W400

Local description authors: J. Galvin

2. *Pinus discolor* (*Quercus emoryi*) / (*Quercus toumeyi*) / Mixed Perennial Grass Woodland and Wooded Shrubland Association (P)

Translated name: Border pinyon (Emory oak) / (Toumey oak) / Mixed Perennial Grass Woodland and Wooded Shrubland Association

NVC name: Not available

Identifier: NPSSODN0056

NVC CLASSIFICATION

Division: --

Macrogroup: --

Group: --

Association: *Pinus discolor* (*Quercus emoryi*) / (*Quercus toumeyi*) / Mixed Perennial Grass Woodland and Wooded Shrubland Association

DISTRIBUTION

Coronado National Memorial

This woodland is distributed across the mid to upper elevation reaches of the memorial.

ENVIRONMENTAL DESCRIPTION

Coronado National Memorial

This woodland community is present on steep (30–50+%), generally south to east-facing mountain backslopes from 1,750 to 2,150 m (5,741–7,053 ft). The surface cover is typically dominated by loose rock, gravel, and large outcrops of exposed bedrock.

VEGETATION DESCRIPTION

Coronado National Memorial

This short-statured woodland community is characterized by a canopy (>2 m) dominated by border pinyon (*Pinus discolor*) with two common associates, Toumey oak (*Quercus toumeyi*) and Emory oak (*Quercus emoryi*). Border pinyon (*P. discolor*) is typically present as a short, stunted tree with heights ranging from 3 to 4 meters, but potentially under two meters where surface rock cover is high. Overall, this species provides the majority of the tree cover, contributing an average of 15% cover across the community, ranging from a low of 8% up to 21%. The two common associates vary greatly across the landscape, with areas where one might be absent or potentially co-dominant with border pinyon (*P. discolor*). Overall, Toumey oak (*Q. toumeyi*) provides a little more cover than Emory oak (*Q. emoryi*) with an average of 8% and 7%, respectively. In general, Toumey oak (*Q. toumeyi*) is most prevalent where the surface cover is dominated by rock, rarely providing more cover than border pinyon (*P. discolor*). Arizona white oak (*Quercus arizonica*) is a transitional component of the community that is more commonly present in more sheltered locations and at the upper elevational limit of this community. Sonoran shrub oak (*Quercus turbinella*), silverleaf oak (*Quercus hypoleucoides*), evergreen sumac (*Rhus virens*), alligator juniper (*Juniperus deppeana*), common sotol (*Dasyllirion wheeleri*), ocotillo (*Fouquieria splendens*), Wright's silktassel (*Garrya wrightii*), and mountain yucca (*Yucca madrensis*) are occasional components of this community. At times, especially where surface rock is conspicuous and/or on exposed ridgelines, mountain mahogany (*Cercocarpus montanus*) may become a common associate or a co-dominant.

The sparse field stratum is characterized by a low-cover (<10%) but diverse mix of perennial bunch grasses. Bullgrass (*Muhlenbergia emersleyi*) and sideoats grama (*Bouteloua curtipendula*) are the most consistent species, followed by the more occasional Texas bluestem (*Schizachyrium cirratum*) and rare woolyspike balsamscale (*Elionurus barbiculmis*). Locally, these species never provide more than a few percent cover, with averages closer to 1–2%. Other rare associate species include firecrackerbush (*Bouvardia ternifolia*), Palmer's century plant (*Agave palmeri*), plains lovegrass (*Eragrostis intermedia*), and single threeawn (*Aristida schiedeana*).

A wooded shrubland variation of this community is occasionally present within the memorial. This variation is characterized by an overstory of border pinyon (*P. discolor*), similar to the woodland variation, with a dense shrub layer co-dominated by pointleaf manzanita (*Arctostaphylos pungens*) and Toumey oak (*Q. toumeyii*). Each of these species provides about 15% cover, causing the shrub species to outcompete the trees.

This community was variably affected by the Monument Fire in 2011. The portions of this community occurring in areas with high bedrock cover remain largely unchanged; however, in less rocky locations, overall vegetation cover and composition may be noticeably altered. Due to the slower fire response of border pinyon (*P. discolor*), its cover is typically reduced or potentially absent in extreme cases. While their stature may be noticeably altered, the quickly regenerating Emory oak (*Q. emoryi*) and Toumey oak (*Q. toumeyii*) likely provide similar abundance, but lower overall cover due to the temporary decrease in canopy size.

GLOBAL TYPE CONCEPT DESCRIPTION

Data not available.

MOST ABUNDANT SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	None
Canopy (2–5 m)	<i>Pinus discolor</i> , <i>Quercus emoryi</i>
Subcanopy (0.5–2 m)	<i>Quercus toumeyii</i> , <i>Cercocarpus montanus</i> , <i>Arctostaphylos pungens</i>
Field (0–0.5 m)	<i>Muhlenbergia emersleyi</i> , <i>Schizachyrium cirratum</i> , <i>Bouteloua curtipendula</i>

OTHER NOTEWORTHY ASSOCIATE SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	None
Canopy (2–5 m)	<i>Fouquieria splendens</i> , <i>Quercus arizonica</i>
Subcanopy (0.5–2 m)	<i>Quercus turbinella</i> , <i>Dasyllirion wheeleri</i> , <i>Yucca madrensis</i> , <i>Rhus virens</i> , <i>Garrya wrightii</i> , <i>Quercus hypoleucoides</i>
Field (0–0.5 m)	<i>Elionurus barbiculmis</i> , <i>Bouvardia ternifolia</i> , <i>Eragrostis intermedia</i> , <i>Aristida schiedeana</i>

CLASSIFICATION COMMENTS

Coronado National Memorial

This association was described from 4 classification plots and 7 classification polygons. This association is very similar to the USNVC association *Pinus discolor* / *Quercus toumeyii* (CEGL000773). The major differences between CEGL000773 the Coronado NMem version are that, in this type, Emory oak (*Q. emoryi*) is a consistent common associate or sub-dominant and Toumey oak (*Q. toumeyii*) is not a consistent dominant.

Global

Data not available.

Classification confidence: Low

NatureServe conservation status: Data not available

Global status: Data not available

Rounded global status: Data not available

Global range: Data not available

Reasons:

ELEMENT SOURCES

Plots: IP011, IP029, IP049, IP057

Polygons: S103, W004_D, W005A_D, W006_D, W033_NV, W101, WS005_D

Local description authors: J. Galvin

3. *Quercus emoryi* / Mixed Perennial Grass Tree Savanna Association (P)

Translated name: Emory oak / Mixed Perennial Grass Tree Savanna Association

NVC name: Not available

Identifier: NPSSODN0061

NVC CLASSIFICATION

Division: --

Macrogroup: --

Group: --

Association: *Quercus emoryi* / Mixed Perennial Grass Tree Savanna Association

DISTRIBUTION

Coronado National Memorial

This community is distributed across the mid-elevation slopes throughout the memorial, from Bob Thompson Peak west to Yaqui Ridge.

ENVIRONMENTAL DESCRIPTION

Coronado National Memorial

This tree savanna community spans predominately south to southeast-facing backslopes of varying grades. At times, examples of this community may occupy a more northeastern aspect and reach down to the toe and footslopes. Within the memorial, this community is present across an elevational range from 1,540 to 2,050 m (5,025–6,725 ft).

VEGETATION DESCRIPTION

Coronado National Memorial

This tree savanna community is characterized by a sparse canopy (<15%) dominated by Emory oak (*Quercus emoryi*) with a diverse matrix of perennial grasses (43%) in the field stratum (<0.5 m). Emory oak (*Q. emoryi*) is typically present as a small tree or a large tree-like shrub with heights ranging from 3 to 4 m [5 m], often increasing when growing in small drainages or on more sheltered, northern aspects. This species provides an average of 9% cover across the community with values ranging up to 20% in some locations. Mexican blue oak (*Quercus oblongifolia*) and Arizona white oak (*Quercus arizonica*) are occasional components of this community, with average cover around 1% and rarely up to 3%. Arizona white oak (*Q. arizonica*) is most common on northern aspects, along small drainage inclusions, and/or at the upper elevational range of this community, while Mexican blue oak (*Q. oblongifolia*) tends to increase on the low-angle, southern aspects. Due the transitional nature of this community, there are areas where either oak species may become subdominant to or co-dominant with Emory oak (*Q. emoryi*). Border pinyon (*Pinus discolor*) is a patchy associate with sparse (1%) cover, usually at higher elevations and/or on more sheltered slopes. Alligator juniper (*Juniperus deppeana*) is an inconsistent associate that is typically present as large, scattered individuals, but can provide rare pockets of co-dominance with Emory oak (*Q. emoryi*). Silverleaf oak (*Quercus hypoleucoides*) is a rare associate that is most prevalent on north-facing, upper-backslopes that are in close proximity to the Arizona white oak (*Q. arizonica*)–silverleaf oak (*Q. hypoleucoides*) shrubland association. Sonoran scrub oak (*Quercus turbinella*) is a rare associate, mostly commonly present in exposed areas dominated by bedrock.

The subcanopy stratum (0.5–2 m) is characterized by an inconsistent, low-cover (<10%) mix of shrubs and succulents with no clear dominants or common associates across the whole community. Common sotol (*Dasylirion wheeleri*), beargrass (*Nolina microcarpa*), and California brickellbush (*Brickellia californica*) are the most consistent and widespread subcanopy components, providing cover of 1–3% throughout. Turpentine bush (*Ericameria laricifolia*) is present in only a few examples of this community, but, when present, provides significant cover (8–18%), typically on the high backslopes. Mountain mahogany (*Cercocarpus montanus*) is uncommon, but can

become noteworthy on the higher slopes and/or where surface rock dominates. Often, areas of increased Mountain mahogany (*C. montanus*) coincide with a drop in canopy cover. Pointleaf manzanita (*Arctostaphylos pungens*) provides variable cover (<5%) throughout, with the densest areas present on the lower slopes and within the transition zone to the similar Emory oak (*Q. emoryi*) / pointleaf manzanita (*A. pungens*) wooded shrubland community. Other associate shrubs and succulents include Tahitian kidneywood (*Eysenhardtia orthocarpa*), mountain yucca (*Yucca madrensis*), Palmer's century plant (*Agave palmeri*), catclaw mimosa (*Mimosa aculeaticarpa*), gum-head (*Gymnosperma glutinosum*), and evergreen sumac (*Rhus virens*).

The field stratum (<0.5 m) is characterized by a dense (45%) and diverse matrix of native and non-native perennial grasses with scattered subshrubs and forbs. Overall, dominance is split across eight species with each providing an average of 4–6% across the community. In order of most dominant to least, these species include single threawn (*Aristida schiedeana*), sideoats grama (*Bouteloua curtipendula*), bullgrass (*Muhlenbergia emersleyi*), Texas bluestem (*Schizachyrium cirratum*), tanglehead (*Heteropogon contortus*), woolyspike balsamscale (*Elionurus barbiculmis*), spiked crinkleawn (*Trachypogon spicatus*), and cane bluestem (*Bothriochloa barbinodis*). Local dominance is highly variable, with areas solely dominated by one species or evenly split across many. Plains lovegrass (*Eragrostis intermedia*) and green sprangletop (*Leptochloa dubia*) are sparse associates. Lehmann lovegrass (*Eragrostis lehmanniana*), an associate species, is most prevalent in disturbed areas and when adjacent to the widespread grasslands in the southeast corner of the memorial. Noteworthy subshrubs and forbs include Arizona bluecurls (*Trichostema arizonicum*), Apache plant (*Guardiola platyphylla*), prairie acacia (*Acaciella angustissima*), and oakwoods prairie clover (*Dalea versicolor*).

This community was variably affected by the 2011 Monument Fire. Currently, areas that experienced high fire severity are more accurately characterized as regenerating shrub savannas. In general, oak composition and abundance are similar to the pre-fire conditions; however, the growth form and overall cover is greatly reduced due to canopy loss. It also appears that Lehmann lovegrass (*E. lehmanniana*) is a more widespread component of this community following the fire.

GLOBAL TYPE CONCEPT DESCRIPTION

Data not available.

MOST ABUNDANT SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	None
Canopy (2–5 m)	<i>Quercus emoryi</i>
Subcanopy (0.5–2 m)	None
Field (0–0.5 m)	<i>Aristida schiedeana</i> , <i>Bouteloua curtipendula</i> , <i>Muhlenbergia emersleyi</i> , <i>Bothriochloa barbinodis</i> , <i>Schizachyrium cirratum</i> , <i>Heteropogon contortus</i> , <i>Elionurus barbiculmis</i> , <i>Trachypogon spicatus</i> , <i>Eragrostis lehmanniana</i>

OTHER NOTEWORTHY ASSOCIATE SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	None
Canopy (2–5 m)	<i>Quercus arizonica</i> , <i>Pinus discolor</i> , <i>Quercus oblongifolia</i> , <i>Juniperus deppeana</i>
Subcanopy (0.5–2 m)	<i>Dasyllirion wheeleri</i> , <i>Yucca madrensis</i> , <i>Agave palmeri</i> , <i>Nolina microcarpa</i> , <i>Ericameria laricifolia</i> , <i>Cercocarpus montanus</i> , <i>Arctostaphylos pungens</i> , <i>Eysenhardtia orthocarpa</i> , <i>Brickellia californica</i> , <i>Quercus turbinella</i> , <i>Gymnosperma glutinosum</i> , <i>Mimosa aculeaticarpa</i>
Field (0–0.5 m)	<i>Eragrostis intermedia</i> , <i>Leptochloa dubia</i> , <i>Trichostema arizonicum</i> , <i>Acaciella angustissima</i> , <i>Guardiola platyphylla</i> , <i>Dalea versicolor</i>

CLASSIFICATION COMMENTS

Coronado National Memorial

This association was described from 11 classification plots and 16 classification polygons.

Global

Data not available.

Classification confidence: Low

NatureServe conservation status: Data not available

Global status: Data not available

Rounded global status: Data not available

Global range: Data not available

Reasons:

ELEMENT SOURCES

Plots: IP012, IP017, IP019, IP023, IP030, IP036, IP045, IP079, IP093, IP112, IP115

Polygons: H309, SS103, SS105, SS301, TS001A_D, TS002, TS003_D, TS008_NV, TS010_D, TS012_D, TS014_D, TS015_D, TS022_D, TS023_D, TS107, W029_D

Local description authors: J. Galvin

4. *Quercus arizonica* / Mixed Shrub / Mixed Perennial Grass Tree Savanna Association (P)

Translated name: Arizona white oak / Mixed Shrub / Mixed Perennial Grass Tree Savanna Association

NVC name: Not available

Identifier: NPSSODN0057

NVC CLASSIFICATION

Division: --

Macrogroup: --

Group: --

Association: *Quercus arizonica* / Mixed Shrub / Mixed Perennial Grass Tree Savanna Association

DISTRIBUTION

Coronado National Memorial

This tree savanna community typically occurs on the slopes below Montezuma pass, along the Crest Trail, and across the ridgeline west of Montezuma Peak.

ENVIRONMENTAL DESCRIPTION

Coronado National Memorial

This tree savanna community spans a mix of moderately steep (35–50%) south to southeast-facing mountain backslopes from 1,750 to 2,230 m (5,741–7,644 ft). Surface cover is characterized by a variable mix of surface rock and gravel with scattered bare soil and litter. Bedrock outcrops are occasional throughout this community.

VEGETATION DESCRIPTION

Coronado National Memorial

This tree savanna community is characterized by a sparse (~ 10%) tree canopy (>2 m) dominated by Arizona white oak (*Quercus arizonica*), a variable mix of subcanopy (0.5–2 m) shrubs, and a moderately dense (35%) matrix of perennial grasses in the field stratum (<0.5 m). Arizona white oak (*Q. arizonica*) is typically present as a medium sized tree with heights ranging from 4 to 5 m, often increasing when growing in small drainages (up to 6 m) or on more sheltered, northern aspects. At times, this species may occur as a small (<2 m) shrub, typically when growing on steep and rocky slopes or in areas of historic fire disturbance. Overall, this species provides consistent cover around 10%, but may be lower in areas subjected to recent fire disturbance or on exposed, rocky slopes. Emory oak (*Quercus emoryi*) is an inconsistent and low-cover (3%) associate, whose distribution follows a distinct and transitional pattern. In general, this species is most prevalent in the lower elevational reaches of this community and on the more south to southeast-facing slopes where cover can rarely reach up to 6%. On the higher slopes and more sheltered aspects, this species is extremely rare and often absent. Two other tree species, border pinyon (*Pinus discolor*) and alligator juniper (*Juniperus deppeana*), are low-cover associates that are most prevalent in proximity to drainages and/or when sheltered by steep, north-facing slopes. At the upper elevational range of this community, shrubby netleaf oak (*Quercus rugosa*) and/or silverleaf oak (*Quercus hypoleucoides*) may be present.

The subcanopy stratum (0.5–2 m) is characterized by a low-cover (<10%) mix of shrubs and succulents most commonly dominated by mountain mahogany (*Cercocarpus montanus*), common sotol (*Dasyllirion wheeleri*), and/or beargrass (*Nolina microcarpa*). Across the whole community, each species provides a scant 2–3%, but can provide inclusions of higher cover where one, or a mix of the three, can dominate. Common sotol (*D. wheeleri*) is evenly distributed throughout the lower elevational range of this community, while beargrass (*N. microcarpa*) tends to occur on the higher slopes. At lower elevations mountain mahogany (*C. montanus*) is often limited to bedrock outcrops, but at higher elevation may be distributed throughout the tree savanna. At times, catclaw

mimosa (*Mimosa aculeaticarpa*) can provide dense inclusions of sole dominance. Other, low-cover associates include California brickellbush (*Brickellia californica*), mountain yucca (*Yucca madrensis*), Wright’s silktassel (*Garrya wrightii*), Tahitian kidneywood (*Eysenhardtia orthocarpa*), Wright’s beebrush (*Alyoysia wrightii*), Palmer’s century plant (*Agave palmeri*), Parry’s agave (*Agave parryi*), walkingstick cactus (*Cylindropuntia spinosior*), evergreen sumac (*Rhus virens*), and fragrant sumac (*Rhus aromatica*).

The field stratum (<0.5 m) is characterized by a moderately dense (35%) and diverse matrix of native perennial grasses with scattered subshrubs and forbs. Total perennial grass cover is quite consistent, generally falling in the 25–45% range. Overall, dominance is split across five species with each providing an average of 3–9% across the community. These species include sideoats grama (*Bouteloua curtipendula*), tanglehead (*Heteropogon contortus*), single threeawn (*Aristida schiedeana*), cane bluestem (*Bothriochloa barbinodis*) and bullgrass (*Muhlenbergia emersleyi*). Local dominance is highly variable, with areas solely dominated by one species or evenly split across many. Tanglehead (*H. contortus*) can be quite patchy, providing clear dominance with cover around 18% in some areas while being completely absent from others. Bullgrass (*M. emersleyi*) is most prevalent toward the upper elevational range of this community and/or on more northern aspects, while single threeawn (*A. schiedeana*) is most common at lower elevational range. Sideoats grama (*B. curtipendula*) and cane bluestem (*B. barbinodis*) are common throughout. Other noteworthy grasses in order of dominance include spidergrass (*Aristida ternipes*), green sprangletop (*Leptochloa dubia*), plains lovegrass (*Eragrostis intermedia*), Texas bluestem (*Schizachyrium cirratum*), woolyspike balsamscale (*Elionurus barbiculmis*), and spiked crinkleawn (*Trachypogon spicatus*). The invasive grass, Lehmann lovegrass (*Eragrostis lehmanniana*), is beginning to spread up the slopes into this predominately native grass dominated community. Noteworthy subshrubs and forbs include prairie acacia (*Acaciella angustissima*), white sage (*Artemisia ludoviciana*), fragrant snakeroot (*Ageratina herbacea*), and heartleaf goldeneye (*Viguiera cordifolia*).

This community was variably affected by the 2011 Monument Fire, ranging from low to moderate severity. Currently, areas that experienced moderate fire severity in 2011 are more accurately characterized as regenerating shrublands or, in extreme cases, as an herbaceous community. These areas often exhibit increased herbaceous species cover, specifically from heartleaf goldeneye (*V. cordifolia*). In general, oak composition and abundance is similar to the pre-fire conditions; however, the growth form and overall cover is greatly reduced due to the loss of canopy cover. Some areas, specifically the northwest corner of the monument, were also affected by the 1999 Peak Fire and appear to have stabilized as a shrub savanna.

GLOBAL TYPE CONCEPT DESCRIPTION

Data not available.

MOST ABUNDANT SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	None
Canopy (2–5 m)	<i>Quercus arizonica</i>
Subcanopy (0.5–2 m)	<i>Cercocarpus montanus</i> , <i>Dasyilirion wheeleri</i> , <i>Nolina microcarpa</i>
Field (0–0.5 m)	<i>Heteropogon contortus</i> , <i>Aristida schiedeana</i> , <i>Bouteloua curtipendula</i> , <i>Muhlenbergia emersleyi</i> , <i>Bothriochloa barbinodis</i>

OTHER NOTEWORTHY ASSOCIATE SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	None
Canopy (2–5 m)	<i>Quercus emoryi</i> , <i>Pinus discolor</i> , <i>Juniperus deppeana</i>
Subcanopy (0.5–2 m)	<i>Mimosa aculeaticarpa</i> , <i>Garrya wrightii</i> , <i>Aloysia wrightii</i> , <i>Agave palmeri</i> , <i>Eysenhardtia orthocarpa</i> , <i>Yucca madrensis</i> , <i>Cylindropuntia spinosior</i> , <i>Agave parryi</i> , <i>Rhus virens</i> , <i>Rhus aromatica</i>
Field (0–0.5 m)	<i>Leptochloa dubia</i> , <i>Schizachyrium cirratum</i> , <i>Elionurus barbiculmis</i> , <i>Eragrostis intermedia</i> , <i>Trachypogon spicatus</i> , <i>Acaciella angustissima</i> , <i>Artemisia ludoviciana</i> , <i>Ageratina herbacea</i> , <i>Viguiera cordifolia</i> , <i>Aristida ternipes</i> , <i>Eragrostis lehmanniana</i>

CLASSIFICATION COMMENTS

Coronado National Memorial

This association was described from 6 classification plots and 9 classification polygons.

Global

Data not available.

Classification confidence: Low

NatureServe conservation status: Data not available

Global status: Data not available

Rounded global status: Data not available

Global range: Data not available

Reasons:

ELEMENT SOURCES

Plots: IP003, IPS004, IPS005, IP127, IPS004, IPS005

Polygons: H306, SHRO101, SS101, TS020_NV, TS104, TS305, W027_D, WS015_D, W017_NV

Local description authors: J. Galvin

5. *Quercus arizonica* - *Quercus emoryi* / Mixed Perennial Grass Woodland Association (P)

Translated name: Arizona white oak - Emory oak / Mixed Perennial Grass Woodland Association

NVC name: Not available

Identifier: NPSSODN053

NVC CLASSIFICATION

Division: --

Macrogroup: --

Group: --

Association: *Quercus arizonica* - *Quercus emoryi* / Mixed Perennial Grass Woodland Association

DISTRIBUTION

Coronado National Memorial

This community occurs on the slopes of Montezuma Canyon, typically spanning the north-facing, eastern portion.

ENVIRONMENTAL DESCRIPTION

Coronado National Memorial

This community spans low-angle (<15%) toeslopes to steep (>50%) backslopes from 1,610 to 1,810 m (5,282–5,938 ft), with a predominately north-facing aspect. Surface cover is characterized by a variable mix of surface rock and gravel with sparse litter and bare soil.

VEGETATION DESCRIPTION

Coronado National Memorial

This woodland community is characterized by a moderately dense (25%) tree canopy co-dominated by Arizona white oak (*Quercus arizonica*) and Emory oak (*Quercus emoryi*), with a diverse matrix (35%) of perennial grasses in the field stratum (<0.5 m). Arizona white oak (*Q. arizonica*) is typically present as a small tree with heights ranging from 3 to 5 m, often increasing when growing in small drainages (up to 6 m) or on more sheltered, northern aspects. Overall, this species provides consistent cover around 14%, but may reach 21% within some examples. The second dominant, Emory oak (*Q. emoryi*), is typically present as a large shrub to small tree with an inconsistent cover of 10% across the community. There are occasional inclusions where cover of this species is dramatically higher, up to 30%, causing it to be co-dominant with, or more dominant than, Arizona white oak (*Q. arizonica*). This is a transitional community where there is a distinct gradient associated with the distribution of these tree species across the community. In general, Emory oak (*Q. emoryi*) is most common on the lower, east to northeast-facing slopes, while Arizona white oak (*Q. arizonica*) is most common on the higher, more north to northwest-facing slopes, as well as, along numerous minor drainages that cross the landscape. Additional canopy tree species are incidental throughout this type, including silverleaf oak (*Quercus hypoleucoides*), border pinyon (*Pinus discolor*), and alligator juniper (*Juniperus deppeana*). In a few examples, typically on north-facing slopes sheltered by large cliff bands, silverleaf oak (*Q. hypoleucoides*) can form dense, but small, stands where it is the sole dominant. This variation is treated as a conspicuous inclusion within this association. The other two tree species, border pinyon (*P. discolor*) and alligator juniper (*J. deppeana*), are often more prevalent in proximity to drainages and/or when sheltered by steep, north-facing slopes.

The subcanopy stratum (0.5–2 m) is characterized by an inconsistent, low-cover (5%) mix of shrubs and succulents with no clear dominants or common associates. Areas of high oak (*Quercus* sp.) subcanopy cover generally coincide with a post-fire regenerating variation of this community, where shrubby, short-statured Arizona white oak (*Q. arizonica*) and Emory oak (*Q. emoryi*) account for most of the cover. Other low-cover, but consistent, associates include common sotol (*Dasyllirion wheeleri*), California brickellbush (*Brickellia californica*), beargrass

(*Nolina microcarpa*), mountain yucca (*Yucca madrensis*), and pointleaf manzanita (*Arctostaphylos pungens*). Evergreen sumac (*Rhus virens*), fragrant sumac (*Rhus aromatica*), Wright’s silktassel (*Garrya wrightii*), Bigelow’s false willow (*Baccharis bigelovii*), Arizona baccharis (*Baccharis thesioides*), and walkingstick cactus (*Cylindropuntia spinosior*) are all uncommon associates.

The field stratum (<0.5 m) is characterized by a moderately dense (35%) and diverse matrix of native perennial grasses with scattered subshrubs and forbs. Total perennial grass cover is quite variable, ranging from a low of 17% up to 50%. Overall, dominance is split across three species, with each providing an average of 6–10% cover across the community. In order from most to least dominant, these species include single threeawn (*Aristida schiedeana*), sideoats grama (*Bouteloua curtipendula*), and Texas bluestem (*Schizachyrium cirratum*). Local dominance is highly variable, with areas solely dominated by one species or evenly split across many. Other noteworthy grasses, in order of dominance, include plains lovegrass (*Eragrostis intermedia*), bullgrass (*Muhlenbergia emersleyi*), cane bluestem (*Bothriochloa barbinodis*), and bulb panicgrass (*Zuloagaea bulbosa*). Noteworthy subshrubs and forbs include prairie acacia (*Acaciella angustissima*), white sage (*Artemisia ludoviciana*), and oakwoods prairie clover (*Dalea versicolor*).

MONUMENT FIRE

This community was variably affected by the 2011 Monument Fire. Currently, areas that experienced high fire severity in 2011 are more accurately characterized as regenerating shrublands, and likely exhibit increased herbaceous species cover, specifically, goldeneye (*Viguiera* sp.). Where severity was more moderate, this community may appear as a wooded shrubland, with a canopy strata of larger oaks that survived the fire and a subcanopy of shrubby, regenerating ones. In general, oak composition and abundance is similar to the pre-fire conditions; however, the growth form and overall cover is greatly reduced due to the loss of canopy cover.

GLOBAL TYPE CONCEPT DESCRIPTION

Data not available.

MOST ABUNDANT SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	None
Canopy (2–5 m)	<i>Quercus arizonica</i> , <i>Quercus emoryi</i>
Subcanopy (0.5–2 m)	<i>Quercus arizonica</i> , <i>Quercus emoryi</i>
Field (0–0.5 m)	<i>Aristida schiedeana</i> , <i>Bouteloua curtipendula</i> , <i>Schizachyrium cirratum</i>

OTHER NOTEWORTHY ASSOCIATE SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	None
Canopy (2–5 m)	<i>Pinus discolor</i> , <i>Juniperus deppeana</i>
Subcanopy (0.5–2 m)	<i>Quercus hypoleucoides</i> , <i>Arctostaphylos pungens</i> , <i>Dasyllirion wheeleri</i> , <i>Brickellia californica</i> , <i>Nolina microcarpa</i> , <i>Yucca madrensis</i> , <i>Rhus aromatica</i> , <i>Garrya wrightii</i> , <i>Baccharis bigelovii</i> , <i>Rhus virens</i> , <i>Cylindropuntia spinosior</i> , <i>Baccharis thesioides</i>
Field (0–0.5 m)	<i>Eragrostis intermedia</i> , <i>Muhlenbergia emersleyi</i> , <i>Bothriochloa barbinodis</i> , <i>Artemisia ludoviciana</i> , <i>Zuloagaea bulbosa</i> , <i>Acaciella angustissima</i> , <i>Dalea versicolor</i> , <i>Viguiera</i> sp.

CLASSIFICATION COMMENTS

Coronado National Memorial

This association was described from 6 classification plots and 6 classification polygons.

Global

Data not available.

Classification confidence: Low

NatureServe conservation status: Data not available

Global status: Data not available

Rounded global status: Data not available

Global range: Data not available

Reasons:

ELEMENT SOURCES

Plots: IP010, IP022, IP040, IP043, IP069, IP073

Polygons: SS107, SS302, TS001B_D, W021_D, W022_D, W036_D

Local description authors: J. Galvin

6. *Quercus arizonica* / *Bouteloua curtipendula* Scrub Woodland Association (P)

Translated name: Arizona white oak / Sideoats grama Scrub Woodland Association

NVC name: CEGJ000680

Identifier: N/A

NVC CLASSIFICATION

Division: *Juniperus deppeana* - *Quercus buckleyi* / *Rhus virens* Madrean - Balconian Forest & Woodland Division

Macrogroup: *Juniperus deppeana* - *Pinus cembroides* - *Quercus arizonica* Madrean Lowland Evergreen Woodland Macrogroup

Group: *Quercus arizonica* - *Quercus emoryi* - *Quercus oblongifolia* Woodland Group

Association: *Quercus arizonica* / *Bouteloua curtipendula* Scrub Woodland Association

DISTRIBUTION

Coronado National Memorial

This woodland community is predominantly on the slopes of Montezuma Canyon, most often toward the western end.

ENVIRONMENTAL DESCRIPTION

Coronado National Memorial

This woodland community spans a mix of steep (>50%) south and north-facing mountain backslopes from 1,730 to 2,380 m (5,675–7,808 ft). In general, examples on south-facing slopes are at the higher end of the elevational range, while the north-facing ones are at the lower end. Surface cover is characterized by a variable mix of surface rock and gravel, including occasional talus slopes.

VEGETATION DESCRIPTION

Coronado National Memorial

This woodland community is characterized by a moderately dense (28%) tree canopy (>2 m) dominated by Arizona white oak (*Quercus arizonica*), with a diverse matrix of perennial grasses in the field stratum (<0.5 m). Arizona white oak (*Q. arizonica*) is typically present as a small tree with heights ranging from 3–5 m, often increasing when growing in small drainages (up to 6 m) or on more sheltered, northern aspects. At times, this species may occur as a small (<2 m) shrub, typically when growing on steep and rocky slopes or in areas of historic fire disturbance. Overall, this species provides consistent cover around 20%, but may reach 45% within some examples. Emory oak (*Quercus emoryi*) is an inconsistent and low-cover (1%) associate, whose distribution follows a distinct and transitional pattern. In general, this species is most prevalent in the lower elevational reaches of this community and on the more south to southeast-facing slopes. On the higher slopes and more sheltered aspects, this species is extremely rare. Numerous other canopy tree species are incidental throughout this type, including silverleaf oak (*Quercus hypoleucoides*), border pinyon (*Pinus discolor*), and alligator juniper (*Juniperus deppeana*). In a few examples, typically on north-facing slopes sheltered by large cliff bands, silverleaf oak (*Q. hypoleucoides*) can form dense, but small, stands where it is the sole dominant. This variation is treated as a conspicuous inclusion within this association. The other two tree species, border pinyon (*P. discolor*) and alligator juniper (*J. deppeana*), are more prevalent in proximity to drainages and/or when sheltered by steep, north-facing slopes, but will not have consistent distribution across the slopes or have more than a few scattered individuals.

The subcanopy stratum (0.5–2 m) is characterized by an inconsistent, low-cover (<10%) mix of shrubs and succulents with no clear dominants or common associates. Areas of high subcanopy cover generally coincide with a shrubland variation of this community, where short-statured Arizona white oak (*Q. arizonica*) accounts for most of the cover. This variation may be due to fire history or the extreme exposure of the habitat. Other, low-cover associates include evergreen sumac (*Rhus virens*), Wright's beebrush (*Aloysia wrightii*), common sotol (*Dasylirion wheeleri*), California brickellbush (*Brickellia californica*), mountain mahogany (*Cercocarpus montanus*), mountain

yucca (*Yucca madrensis*), Wright's silktassel (*Garrya wrightii*), catclaw mimosa (*Mimosa aculeaticarpa*), and bear-grass (*Nolina microcarpa*). Often, increased shrub diversity and cover coincides with the presence of high surface rock cover and/or proximity to drainages.

The field stratum (<0.5 m) is characterized by a sparse (13%) but diverse mix of native perennial grasses with scattered subshrubs and forbs. Total perennial grass cover is relatively consistent, typically ranging from a low of 10% up to 25%. Overall, dominance is split across three species with each providing an average of 3–4% across the community. In order of most dominant to least, these species include single threeawn (*Aristida schiedeana*), sideoats grama (*Bouteloua curtipendula*), and bullgrass (*Muhlenbergia emersleyi*). Local dominance is highly variable, with areas solely dominated by one species or evenly split across many. Other noteworthy grasses, in order of dominance, include Texas bluestem (*Schizachyrium cirratum*), bulb panicgrass (*Zuloagaea bulbosa*), plains lovegrass (*Eragrostis intermedia*), and cane bluestem (*Bothriochloa barbinodis*). Tanglehead (*Heteropogon contortus*) is a rare associate; however, when present, it is often the sole dominant with cover around 18%. Noteworthy subshrubs and forbs include prairie acacia (*Acaciella angustissima*), white sage (*Artemisia ludoviciana*), fragrant snakeroot (*Ageratina herbacea*), heartleaf goldeneye (*Viguiera cordifolia*), chaparral fleabane (*Erigeron oreophilus*), and dentate false pennyroyal (*Hedeoma dentata*).

This community was variably affected by the 2011 Monument Fire and the 1988 Peak Fire. Currently, areas that experienced high fire severity in 2011 are more accurately characterized as regenerating shrublands and likely exhibit increased herbaceous species cover, specifically, heartleaf goldeneye (*V. cordifolia*). In general, oak composition and abundance are similar to the pre-fire conditions; however, the growth form and overall cover is greatly reduced due to the loss of canopy cover. Examples of this community subjected to high severity during the Peak Fire, mainly in the northwest corner of the memorial, have regenerated and seemingly stabilized as shrublands.

GLOBAL TYPE CONCEPT DESCRIPTION

Data not available.

MOST ABUNDANT SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	None
Canopy (2–5 m)	<i>Quercus arizonica</i>
Subcanopy (0.5–2 m)	<i>Quercus arizonica</i>
Field (0–0.5 m)	<i>Aristida schiedeana</i> , <i>Bouteloua curtipendula</i> , <i>Muhlenbergia emersleyi</i>

OTHER NOTEWORTHY ASSOCIATE SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	None
Canopy (2–5 m)	<i>Quercus emoryi</i> , <i>Pinus discolor</i> , <i>Juniperus deppeana</i> , <i>Quercus hypoleucoides</i>
Subcanopy (0.5–2 m)	<i>Brickellia californica</i> , <i>Rhus virens</i> , <i>Mimosa aculeaticarpa</i> , <i>Garrya wrightii</i> , <i>Yucca madrensis</i> , <i>Cercocarpus montanus</i> , <i>Aloysia wrightii</i> , <i>Dasyllirion wheeleri</i> , <i>Nolina microcarpa</i>
Field (0–0.5 m)	<i>Schizachyrium cirratum</i> , <i>Zuloagaea bulbosa</i> , <i>Eragrostis intermedia</i> , <i>Bothriochloa barbinodis</i> , <i>Heteropogon contortus</i> , <i>Acaciella angustissima</i> , <i>Artemisia ludoviciana</i> , <i>Ageratina herbacea</i> , <i>Viguiera cordifolia</i> , <i>Erigeron oreophilus</i> , <i>Hedeoma dentata</i>

CLASSIFICATION COMMENTS

Coronado National Memorial

The local variation of this association was described from 6 classification plots and 14 classification polygons. Overall, the accepted USNVC type (CEGL000680) is a good fit with the local Coronado NMem variation with one exception. At Coronado NMem, perennial grass dominance is split across several species (*A. schiedeana* and *M. emersleyi*), not just sideoats grama (*B. curtipendula*).

Global

Data not available.

Classification confidence: Low

NatureServe conservation status: Data not available

Global status: Data not available

Rounded global status: Data not available

Global range: Data not available

Reasons:

ELEMENT SOURCES

Plots: IPS006, IP028, IP088, IP095, IP103, IP117

Polygons: S301, S305, TS103, W008_D, W010_D, W011_D, W012_D, W025_D, W031_D, W100, W102, W305, W401, W500

Local description authors: J. Galvin

7. *Quercus emoryi* / *Bouteloua curtipendula* Scrub Woodland Association

Translated name: Emory oak / Sideoats grama Scrub Woodland Association

NVC name: CEG000683

Identifier: N/A

NVC CLASSIFICATION

Division: *Juniperus deppeana* - *Quercus buckleyi* / *Rhus virens* Madrean - Balconian Forest & Woodland Division

Macrogroup: *Juniperus deppeana* - *Pinus cembroides* - *Quercus arizonica* Madrean Lowland Evergreen Woodland Macrogroup

Group: *Quercus arizonica* - *Quercus emoryi* - *Quercus oblongifolia* Woodland Group

Association: *Quercus emoryi* / *Bouteloua curtipendula* Scrub Woodland Association

DISTRIBUTION

Coronado National Memorial

This community is widespread throughout the lower elevation reaches of the memorial, usually on the mid to low slopes of Montezuma Peak.

ENVIRONMENTAL DESCRIPTION

Coronado National Memorial

This woodland community spans predominately south to southeast-facing backslopes of varying slopes, from near flat to more than 50%. At times, examples of this community may occupy a more northeastern aspect and reach down to the toe and footslopes as they transition into an alluvial fan. Within the memorial, this community is present across an elevational range from 1,540 to 2,050 m (5,025–6,725 ft).

VEGETATION DESCRIPTION

Coronado National Memorial

This woodland community is characterized by a moderately dense (30%) tree canopy (>2 m) dominated by Emory oak (*Quercus emoryi*) with a diverse matrix of perennial grasses (35%) in the field stratum (<0.5 m). Emory oak (*Q. emoryi*) is typically present as a small tree or large, tree-like shrub with heights ranging from 3–4 m, often increasing when growing in small drainages (up to 8 m) or on more sheltered, northern aspects and decreasing on the steeper and more exposed upper backslopes (<2 m). Emory oak provides an average of 22% cover across the community with values ranging up to 42% in some locations. Mexican blue oak (*Quercus oblongifolia*) is an occasional component of this community with average cover around 2.5% and rarely up to 8%. Typically, this species is most common on low angled slopes, usually along small, shallow drainages. Arizona white oak (*Q. arizonica*) provides little cover overall with an average of only 1%; however, as the community moves up Montezuma Canyon, cover increases enough to become a common associate. Alligator juniper (*Juniperus deppeana*) and border pinyon (*Pinus discolor*) are uncommon canopy associates.

The subcanopy stratum (0.5–2 m) is characterized by an inconsistent, low-cover (<10%) mix of shrubs and succulents with no clear dominants or common associates. Pointleaf manzanita (*Arctostaphylos pungens*) provides variable cover throughout, with the densest areas present on the lower slopes and within the transition zone to the similar Emory oak (*Q. emoryi*) / pointleaf manzanita (*A. pungens*) wooded shrubland community. Common sotol (*Dasylirion wheeleri*) is a widespread, but sparse, component that provides between 0.5 and 3% cover throughout. Catclaw mimosa (*Mimosa aculeaticarpa*) is a patchy associate that can provide dense inclusions of local dominance. Other associate shrubs and succulents include mountain yucca (*Yucca madrensis*), California brickellbush (*Brickellia californica*), Palmer's century plant (*Agave palmeri*), beargrass (*Nolina microcarpa*), walkingstick cactus (*Cylindropuntia spinosior*), and evergreen sumac (*Rhus virens*).

The field stratum (<0.5 m) is characterized by a moderately dense (~35%) and diverse matrix of native and non-native perennial grasses with scattered subshrubs and forbs. Overall, dominance is split across three species with each providing an average of 4–6% across the community. In order of most dominant to least, these species include single threeawn (*Aristida schiedeana*), Texas bluestem (*Schizachyrium cirratum*), and tanglehead (*Heteropogon contortus*). Local dominance is highly variable, with areas solely dominated by one species or evenly split across many. Other noteworthy grasses, include sideoats grama (*Bouteloua curtipendula*), cane bluestem (*Bothriochloa barbinodis*), plains lovegrass (*Eragrostis intermedia*), woolyspike balsamscale (*Elionurus barbiculmis*), spiked crinkleawn (*Trachypogon spicatus*), and bullgrass (*Muhlenbergia emersleyi*). Lehmann lovegrass (*Eragrostis lehmanniana*) is associate species that is most prevalent in disturbed areas and when adjacent to the widespread grasslands in the southeast corner of the memorial. Noteworthy subshrubs and forbs include Arizona bluecurls (*Trichostema arizonicum*), Apache plant (*Guardiola platyphylla*), and prairie acacia (*Acaciella angustissima*).

This community was variably affected by the 2011 Monument Fire. Currently, areas that experienced high fire severity are more accurately characterized as regenerating shrub savannas. In general, oak composition and abundance is similar to the pre-fire conditions; however, the growth form and overall cover is greatly reduced due to the loss of canopy cover. It also appears that Lehmann lovegrass (*E. lehmanniana*) is a more widespread component of this community following the fire.

GLOBAL TYPE CONCEPT DESCRIPTION

This diverse Madrean woodland savanna association is known from the Borderlands area of southeastern Arizona and southwestern New Mexico, extending west to Buenos Aires National Wildlife Area and east into Trans-Pecos Texas, and in the Sierra Del Carmen of northeastern Coahuila, Mexico. Stands occur on gentle to moderate hillslopes of northerly aspects, and elevations range from 1,380 to 1,980 m (4,528–6,500 ft). Substrates are igneous volcanic rhyolites, andesites and tuffs. This association is characterized by moderately open canopies (30% cover) dominated by *Quercus emoryi*. *Quercus grisea* or *Quercus arizonica* along with *Juniperus deppeana*, *Pinus discolor*, or *Pinus cembroides* can be present, but they are not dominant or co-dominant. The understory is moderately diverse (55 species have been recorded for the association), characteristically grassy, and dominated by *Bouteloua curtipendula*. Other common grasses include *Bouteloua gracilis*, *Muhlenbergia emersleyi*, and *Eragrostis intermedia*.

MOST ABUNDANT SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	None
Canopy (2–5 m)	<i>Quercus emoryi</i> , <i>Quercus oblongifolia</i>
Subcanopy (0.5–2 m)	<i>Arctostaphylos pungens</i> , <i>Dasyllirion wheeleri</i> , <i>Mimosa aculeaticarpa</i>
Field (0–0.5 m)	<i>Aristida schiedeana</i> , <i>Schizachyrium cirratum</i> , <i>Heteropogon contortus</i> , <i>Eragrostis lehmanniana</i>

OTHER NOTEWORTHY ASSOCIATE SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	None
Canopy (2–5 m)	<i>Quercus arizonica</i> , <i>Juniperus deppeana</i> , <i>Pinus discolor</i>
Subcanopy (0.5–2 m)	<i>Brickellia californica</i> , <i>Yucca madrensis</i> , <i>Agave palmeri</i> , <i>Nolina microcarpa</i> , <i>Cylindropuntia spinosior</i> , <i>Rhus virens</i>
Field (0–0.5 m)	<i>Bouteloua curtipendula</i> , <i>Trachypogon spicatus</i> , <i>Bothriochloa barbinodis</i> , <i>Eragrostis intermedia</i> , <i>Elionurus barbiculmis</i> , <i>Muhlenbergia emersleyi</i> , <i>Acaciella angustissima</i> , <i>Guardiola platyphylla</i> , <i>Trichostema arizonicum</i>

CLASSIFICATION COMMENTS

Coronado National Memorial

The local variation of this association was described from 10 classification plots and 16 classification polygons. Overall, the accepted USNVC type (CEGL000683) is a good fit to the local Coronado NMem variation with one exception. At Coronado NM, perennial grass dominance is split across several species, including single threeawn (*Aristida schiedeana*), Texas bluestem (*Schizachyrium cirratum*), and tanglehead (*Heteropogon contortus*). While sideoats grama (*Bouteloua curtipendula*) is present, it is only a noteworthy associate and not the primary dominant. The grass layer was originally characterized as “mixed grass” in the association name and did not note any individual species.

Global

Data not available.

Classification confidence: Low

NatureServe conservation status: Data not available

Global status: Data not available

Rounded global status: Data not available

Global range: Data not available

Reasons:

ELEMENT SOURCES

Plots: IP014, IP015, IP033, IP035, IP042, IP094, IP102, IP122, IP126, IP143

Polygons: SS104, SS306, TS025_D, TS304, TS306, W005B_D, W009_D, W014_D, W016_D, W023_D, W034_D, W035_D, W039_D, W301, W402, WS010_NV

Local description authors: J. Galvin

8. *Quercus emoryi* / *Arctostaphylos pungens* / Mixed Perennial Grass Wooded Shrubland Association (P)

Translated name: Emory oak / Pointleaf manzanita / Mixed Perennial Grass Wooded Shrubland Association

NVC name: Not available

Identifier: NPSSODN0059

NVC CLASSIFICATION

Division: --

Macrogroup: --

Group: --

Association: *Quercus emoryi* / *Arctostaphylos pungens* / Mixed Perennial Grass Wooded Shrubland Association

DISTRIBUTION

Coronado National Memorial

Within the memorial, this community occupies the low slopes of Montezuma canyon, typically north of the park road.

ENVIRONMENTAL DESCRIPTION

Coronado National Memorial

This wooded shrubland community spans generally low-angle (<15%), south-facing footslopes from 1,550 to 1,850 m (5,085–6,070 ft). The surface cover is dominated by a mix of rock, gravel, and litter with sparse soil.

VEGETATION DESCRIPTION

Coronado National Memorial

This wooded shrubland community is characterized by a sparse (10%) tree canopy (>2 m) dominated by Emory oak (*Quercus emoryi*), a moderately dense (20%) subcanopy (0.5–2 m) shrub layer dominated by pointleaf manzanita (*Arctostaphylos pungens*), and a field stratum (<0.5 m) dominated by a variable mix of perennial grasses. In general, Emory oak (*Q. emoryi*) is present as a short-statured (3–4 m) tree providing variable cover averaging to 9%, but ranging from 3 to 20%. Mexican blue oak (*Quercus oblongifolia*) is an occasional common associate with local dominance rarely approaching 8%. A single occurrence of this community exists where Mexican blue oak (*Q. oblongifolia*) has greater cover than Emory oak (*Q. emoryi*). Arizona white oak (*Quercus arizonica*) is a sparse associate that is typically present within the small drainages that cross this community. Alligator juniper (*Juniperus deppeana*) is incidental.

The majority of cover within the subcanopy stratum is provided by pointleaf manzanita (*A. pungens*), with an average of 20% across the community, including areas reaching up to 40%. Most occurrences of this community are shrub dominated, but, in a few instances, Emory oak (*Q. emoryi*) has much greater abundance than the manzanita, and the community is more accurately described as a woodland. The reverse can also be true where pointleaf manzanita (*A. pungens*) is so dominant that the community presents as a shrubland. Other noteworthy shrubs and succulents include common sotol (*Dasylirion wheeleri*), California brickellbush (*Brickellia californica*), Toumey oak (*Quercus toumeyii*), Palmer's century plant (*Agave palmeri*), evergreen sumac (*Rhus virens*), walkingstick cactus (*Cylindropuntia spinosior*), and catclaw mimosa (*Mimosa aculeaticarpa*). Velvet mesquite (*Prosopis velutina*) is a rare associate in this community.

The field stratum (<0.5 m) is characterized by a moderately dense (25%) and diverse matrix of native and non-native perennial grasses, with scattered subshrubs and forbs. Overall, Lehmann lovegrass (*Eragrostis lehmanniana*) is the most dominant grass component with variable cover ranging from absent up to 40%. Typically, this species is most common within disturbed areas and when adjacent to the widespread grasslands in the southeast corner of the memorial. In order of most dominant to least, noteworthy native grass species include bullgrass (*Muhlen-*

bergia emersleyi), single threeawn (*Aristida schiedeana*), Texas bluestem (*Schizachyrium cirratum*), plains lovegrass (*Eragrostis intermedia*), sideoats grama (*Bouteloua curtipendula*), woolyspike balsamscale (*Elionurus barbiculmis*), cane bluestem (*Bothriochloa barbinodis*), spiked crinkleawn (*Trachypogon spicatus*), tanglehead (*Heteropogon contortus*), and hairy grama (*Bouteloua hirsuta*). Local dominance is highly variable, with areas solely dominated by one species or evenly split across many. Noteworthy subshrubs and forbs include fairyduster (*Calliandra eriophylla*), Arizona bluecurls (*Trichostema arizonicum*), flaxflowered ipomopsis (*Ipomopsis longiflora*), and prairie acacia (*Acaciella angustissima*).

This community was variably affected by the 2011 Monument Fire. Currently, areas that experienced high fire severity are more accurately characterized as regenerating shrub savannas. In general, oak composition and abundance is similar to the pre-fire conditions; however, the growth form and overall cover is greatly reduced due to the loss of canopy cover. The major difference relates to the cover of pointleaf manzanita (*A. pungens*). Unlike the oaks, this species is not fire adapted, and, as such, is slow to recolonize areas subjected to moderate to high fire severity. Areas with high pointleaf manzanita (*A. pungens*) mortality are more accurately described as regenerating Emory oak (*Q. emoryi*) / mixed perennial grass shrub savannas. As a result, the post-fire variation of this community is nearly identical to the post-fire variation of the Emory oak (*Q. emoryi*) / mixed perennial grass tree savanna association. Areas of high severity can still be distinguished by their occurrence on the low-angle foot/toeslopes and the presence of pointleaf manzanita (*A. pungens*) snags. It also appears that Lehmann lovegrass (*E. lehmanniana*) is a more widespread component of this community following the fire.

GLOBAL TYPE CONCEPT DESCRIPTION

Data not available.

MOST ABUNDANT SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	None
Canopy (2–5 m)	<i>Quercus emoryi</i>
Subcanopy (0.5–2 m)	<i>Arctostaphylos pungens</i>
Field (0–0.5 m)	<i>Eragrostis lehmanniana</i> , <i>Muhlenbergia emersleyi</i> , <i>Bouteloua curtipendula</i> , <i>Eragrostis intermedia</i> , <i>Schizachyrium cirratum</i>

OTHER NOTEWORTHY ASSOCIATE SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	None
Canopy (2–5 m)	<i>Quercus arizonica</i> , <i>Quercus oblongifolia</i> , <i>Juniperus deppeana</i>
Subcanopy (0.5–2 m)	<i>Dasyllirion wheeleri</i> , <i>Brickellia californica</i> , <i>Quercus toumeyi</i> , <i>Agave palmeri</i> , <i>Cylindropuntia spinosior</i> , <i>Mimosa aculeaticarpa</i> , <i>Rhus virens</i> , <i>Prosopis velutina</i>
Field (0–0.5 m)	<i>Trachypogon spicatus</i> , <i>Elionurus barbiculmis</i> , <i>Bothriochloa barbinodis</i> , <i>Calliandra eriophylla</i> , <i>Trichostema arizonicum</i> , <i>Ipomopsis longiflora</i> , <i>Acaciella angustissima</i>

CLASSIFICATION COMMENTS

Coronado National Memorial

This association was described from 11 classification plots and 12 classification polygons. An accepted USNVC association, CEGJ000682, has a very similar name to this association, but due to the lack of any description, it has been elected to keep this as a separate, provisional association.

Global

Data not available.

Classification confidence: Low

NatureServe conservation status: Data not available

Global status: Data not available

Rounded global status: Data not available

Global range: Data not available

Reasons:

ELEMENT SOURCES

Plots: IP005, IP006, IP018, IP041, IP055, IP066, IP071, IP076, IP084, IP133, IP139

Polygons: S005_D, SS305, TS301, W041_D, W043_D, WS001_D, WS009_D, WS012_D, WS014_D, WS018_D, WS300, WS400

Local description authors: J. Galvin

9. *Quercus emoryi* / Mixed Shrub Intermittently Flooded Tree Savanna Association (P)

Translated name: Emory oak / Mixed Shrub Intermittently Flooded Tree Savanna Association

NVC name: Not available

Identifier: NPSSODN0060

NVC CLASSIFICATION

Division: --

Macrogroup: --

Group: --

Association: *Quercus emoryi* / Mixed Shrub Intermittently Flooded Tree Savanna Association

DISTRIBUTION

Coronado National Memorial

This community is distributed along the drainages that flow through the grasslands and tree savannas in the southeast corner of the memorial.

ENVIRONMENTAL DESCRIPTION

Coronado National Memorial

This community spans low-angle (<15%), predominately south to southeast-flowing drainages and the steeper, adjacent slopes at 1,500 m (4,921 ft). Within the watercourse, the surface cover is dominated by fine gravel/sand with scattered rocks and boulders. The adjacent slopes are more heavily dominated by bare soil and litter.

VEGETATION DESCRIPTION

Coronado National Memorial

This intermittently flooded tree savanna community is characterized by a moderately sparse canopy (<20%) dominated by Emory oak (*Quercus emoryi*), with a diverse mix of shrubs and grasses in the understory. Emory oak (*Q. emoryi*) is typically present as a large tree with heights ranging from 6 to 10 m [12 m], but is occasionally present as a small (2 m), shrub-like tree. This species provides an average of 13% cover across the community, with values ranging from a scant 3% up to 20% in some locations. Mexican blue oak (*Quercus oblongifolia*) and Arizona white oak (*Quercus arizonica*) are occasional components of this community, with average cover around 1% and rarely up to 3%. Arizona white oak (*Q. arizonica*) is most common in the ecotone with the similar Arizona white oak (*Q. arizonica*) and Emory oak (*Q. emoryi*) intermittently flooded woodland, while Mexican blue oak (*Q. oblongifolia*) is distributed throughout. Velvet ash (*Fraxinus velutina*) is an uncommon canopy associate.

The subcanopy stratum (0.5–2 m) is characterized by an inconsistent, low-cover (<10%) mix of shrubs and succulents with no consistent dominants or common associates across the community. Local dominance is most commonly provided by desert willow (*Chilopsis linearis*), catclaw mimosa (*Mimosa aculeaticarpa*), velvet mesquite (*Prosopis velutina*), desertbroom (*Baccharis sarothroides*), and mule-fat (*Baccharis salicifolia*). These species generally provide scattered dense inclusions of dominance, often on the adjacent broad and low-angle slopes outside the watercourse and on vegetated islands within the watercourse. Western soapberry (*Sapindus drummondii*) provides rare inclusions of dominance. Other noteworthy species include Arizona grape (*Vitis arizonica*), Tahitian kidneywood (*Ehysenhardtia orthocarpa*), Chihuahuan brickellbush (*Brickellia floribunda*), rubber rabbitbush (*Ericameria nauseosa*), evergreen sumac (*Rhus virens*), and Apache plant (*Guardiola platyphylla*).

The field stratum (<0.5 m) is characterized by a dense (40%) and diverse matrix of perennial grasses with scattered subshrubs and forbs. Overall, dominance is solely associated with Lehmann lovegrass (*Eragrostis lehmanniana*) with average cover around 12%, with areas ranging up to 20%. This species is associated with the adjacent non-native grassland. Other noteworthy grass species include single threeawn (*Aristida schiedeana*), sideoats

grama (*Bouteloua curtipendula*), tanglehead (*Heteropogon contortus*), and spidergrass (*Aristida ternipes*).

This community was variably affected by the 2011 Monument Fire. Currently, areas that experienced high fire severity are more accurately characterized as regenerating intermittently flooded shrublands. In general, oak composition and abundance are similar to the pre-fire conditions; however, the growth form and overall cover is greatly reduced due to the loss of canopy. It also appears that Lehmann lovegrass (*E. lehmanniana*) is a more widespread component of this community following the fire.

GLOBAL TYPE CONCEPT DESCRIPTION

Data not available.

MOST ABUNDANT SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	None
Canopy (2–5 m)	<i>Quercus emoryi</i>
Subcanopy (0.5–2 m)	<i>Chilopsis linearis</i> , <i>Prosopis velutina</i> , <i>Mimosa aculeaticarpa</i> , <i>Baccharis sarothroides</i> , <i>Baccharis salicifolia</i>
Field (0–0.5 m)	<i>Eragrostis lehmanniana</i>

OTHER NOTEWORTHY ASSOCIATE SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	None
Canopy (2–5 m)	<i>Quercus oblongifolia</i> , <i>Quercus arizonica</i> , <i>Fraxinus velutina</i>
Subcanopy (0.5–2 m)	<i>Sapindus drummondii</i> , <i>Ehysenhardtia orthocarpa</i> , <i>Vitis arizonica</i> , <i>Guardiola platyphylla</i> , <i>Rhus virens</i> , <i>Ericameria nauseosa</i> , <i>Brickellia floribunda</i>
Field (0–0.5 m)	<i>Aristida schiedeana</i> , <i>Bouteloua curtipendula</i> , <i>Heteropogon contortus</i> , <i>Aristida ternipes</i>

CLASSIFICATION COMMENTS

Coronado National Memorial

This association was described from one classification plot and 6 classification polygons.

Global

Data not available.

Classification confidence: Low

NatureServe conservation status: Data not available

Global status: Data not available

Rounded global status: Data not available

Global range: Data not available

Reasons:

ELEMENT SOURCES

Plots: IP109

Polygons: IFW100, IFW102, SS300, TS303, W042_D, W310

Local description authors: J. Galvin

10. *Quercus oblongifolia* / Mixed Perennial Grass Tree Savanna Association (P)

Translated name: Mexican blue oak / Mixed Perennial Grass Tree Savanna Association

NVC name: Not available

Identifier: NPSSODN0063

NVC CLASSIFICATION

Division: --

Macrogroup: --

Group: --

Association: *Quercus oblongifolia* / Mixed Perennial Grass Tree Savanna Association

DISTRIBUTION

Coronado National Memorial

This tree savanna community is present on the slopes surrounding Joe's Spring Road and above the western end of the border road.

ENVIRONMENTAL DESCRIPTION

Coronado National Memorial

This tree savanna community spans generally low-angle (<15%), southeast-facing foot and toes slopes from 150 to 1,990 m (5,000–6,500 ft). At times, this community is present on higher backslopes with grades approaching 50% and along shallow drainages that reach down into the alluvial fan. Ground cover is dominated by a variable mix of gravel, rock, and bare soil with sporadic bedrock outcrops and patchy litter.

VEGETATION DESCRIPTION

Coronado National Memorial

This tree savanna community is characterized by a sparse (10%) tree canopy (>2 m) dominated by Mexican blue oak (*Quercus oblongifolia*) with a dense (35%) matrix of perennial grasses. Mexican blue oak (*Q. oblongifolia*) is present as either a large tree with heights up to 8 m—usually along drainages and low-angle slopes—or a small, shrubby tree less than 3 m tall. This species provides an average of 10% cover across the community with values ranging up to 18%, usually when spanning small drainages. Emory oak (*Quercus emoryi*) is a consistent, but low-cover (1–3%), associate throughout.

The subcanopy stratum (0.5–2 m) is characterized by a sparse (6%) mix of shrubs and succulents across the upland slopes; however, when spanning small drainages, cover is conspicuously higher (15%). Common sotol (*Dasylirion wheeleri*) is the most consistent and dominant (3%) species, appearing in all examples of this community. In order from most to least dominant, additional noteworthy shrubs and succulents include Tahitian kidney-wood (*Eysenhardtia orthocarpa*), Evergreen sumac (*Rhus virens*), catclaw acacia (*Mimosa aculeaticarpa*), pointleaf manzanita (*Arctostaphylos pungens*), Palmer's century plant (*Agave palmeri*), and Wright's beebrush (*Aloysia wrightii*). Associates are common along small drainages and nearby, adjacent slopes.

The field stratum (<0.5 m) is characterized by a dense (35%) and diverse matrix of native and non-native perennial grasses with scattered subshrubs and forbs. Overall, dominance is split across four species with each providing an average of 4–8% across the community. In order of most dominant to least, these species include tanglehead (*Heteropogon contortus*), Lehmann lovegrass (*Eragrostis lehmanniana*), Texas bluestem (*Schizachyrium cirratum*), and cane bluestem (*Bothriochloa barbinodis*). Local dominance is highly variable, with areas solely dominated by one species or evenly split across many. Green sprangletop (*Leptochloa dubia*), spidergrass (*Aristida ternipes*), single threeawn (*Aristida schiedeana*), sideoats grama (*Bouteloua curtipendula*), bullgrass (*Muhlenbergia emersleyi*), and plains lovegrass (*Eragrostis intermedia*) are sparse associates. Noteworthy subshrubs and forbs include fairyduster (*Calliandra eriophylla*), Arizona bluecurls (*Trichostema arizonicum*), Apache plant (*Guardiola platyphylla*), and prairie acacia (*Acaciella angustissima*)

While this community was affected by the Monument Fire in 2011, fire severity was low, leaving the structure and composition of the community largely unchanged.

GLOBAL TYPE CONCEPT DESCRIPTION

Data not available.

MOST ABUNDANT SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	<i>Quercus oblongifolia</i>
Canopy (2–5 m)	<i>Quercus oblongifolia</i>
Subcanopy (0.5–2 m)	<i>Dasyllirion wheeleri</i>
Field (0–0.5 m)	<i>Heteropogon contortus</i> , <i>Eragrostis lehmanniana</i> , <i>Schizachyrium cirratum</i> , <i>Bothriochloa barbinodis</i>

OTHER NOTEWORTHY ASSOCIATE SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	<i>Quercus emoryi</i>
Canopy (2–5 m)	<i>Quercus emoryi</i>
Subcanopy (0.5–2 m)	<i>Calliandra eriophylla</i> , <i>Eysenhardtia orthocarpa</i> , <i>Mimosa aculeaticarpa</i> , <i>Arctostaphylos pungens</i> , <i>Agave palmeri</i> , <i>Aloysia wrightii</i>
Field (0–0.5 m)	<i>Leptochloa dubia</i> , <i>Aristida ternipes</i> , <i>Aristida schiedeana</i> , <i>Bouteloua curtipendula</i> , <i>Muhlenbergia emersleyi</i> , <i>Eragrostis intermedia</i> , <i>Guardiola platyphylla</i> , <i>Trichostema arizonicum</i> , <i>Acaciella angustissima</i>

CLASSIFICATION COMMENTS

Coronado National Memorial

This association was described from 5 classification plots and 9 classification polygons. This association is similar to two accepted associations listed in the USNVC, CEG000974 (*Quercus oblongifolia* / *Dasyllirion wheeleri* Scrub) and CEG000973 (*Quercus oblongifolia* / *Bouteloua curtipendula* Scrub). Due to the lack of any vegetation description for CEG000974 and noteworthy difference in formation and cover for CEG000973, we decided to leave our association separate.

Global

Data not available.

Classification confidence: Low

NatureServe conservation status: Data not available

Global status: Data not available

Rounded global status: Data not available

Global range: Data not available

Reasons:

ELEMENT SOURCES

Plots: IP034, IP060, IP089, IP116, IP137

Polygons: TS004_D, TS005_D, TS007_D, TS024_D, TS101, TS307, W028_D, W040_D, WS020_D

Local description authors: J. Galvin

11. *Quercus arizonica* - *Quercus emoryi* Intermittently Flooded Woodland Association (P)

Translated name: Arizona white oak - Emory oak Intermittently Flooded Woodland Association

NVC name: Not available

Identifier: NPSSODN005

NVC CLASSIFICATION

Division: --

Macrogroup: --

Group: --

Association: *Quercus arizonica* - *Quercus emoryi* Intermittently Flooded Woodland Association

DISTRIBUTION

Coronado National Memorial

This community spans the middle stretch of Montezuma Canyon wash, from the picnic area up-canyon to the first switchback, as well as numerous minor side drainages.

ENVIRONMENTAL DESCRIPTION

Coronado National Memorial

This community spans low-angle drainages and the adjacent slopes of variable aspects from 1,560 to 1,920 m (5,118–6,299 ft). Within the watercourse, the surface cover is dominated by fine gravel with scattered boulders and occasional expanses of exposed bedrock. The adjacent slopes are typically dominated by bare soil with a considerable layer of oak leaf litter and duff.

VEGETATION DESCRIPTION

Coronado National Memorial

This intermittently flooded woodland community is characterized by a moderate to dense (27–50%) upper canopy (>5 m) co-dominated by Arizona white oak (*Quercus arizonica*) and Emory oak (*Quercus emoryi*), with a sparse understory of mixed shrubs and perennial grasses. Arizona white oak (*Q. arizonica*) is present as a large tree (7 m) with a total average cover of 19%. In general, this species is most dominant in the narrow, upper reaches of the drainages and gradually becomes less and less common in the lower stretches, where the canyon begins to widen and become more exposed. Emory oak (*Q. emoryi*) is also present as a large tree (7 m) with slightly lower total cover averaging to 16%. This species is most dominant in the wider, lower reaches and gradually becomes less common in the upper reaches of the drainage. Arizona sycamore (*Platanus wrightii*) is occasional (1–2%) throughout the main drainage of the canyon, usually as large individuals with heights exceeding that of the oaks. Alligator juniper (*Juniperus deppeana*) and border pinyon (*Pinus discolor*) are low-cover associates that become more common in the upper reaches of the drainages and on steep, north-facing slopes. Arizona madrone (*Arbutus arizonica*), silverleaf oak (*Quercus hypoleucoides*), black cherry (*Prunus serotina*), and Arizona walnut (*Juglans major*) are occasional throughout. Mexican blue oak (*Quercus oblongifolia*) is rare in the lower reaches. One large and conspicuous Gooding's willow (*Salix gooddingii*) is present in the main drainage.

The subcanopy stratum (0.5–2 m) is characterized by a diverse, but low-cover (3–10%), mix of shrubs and sub-shrubs. The most common of these are evergreen sumac (*Rhus virens*), pointleaf manzanita (*Arctostaphylos pungens*), betonyleaf brickellbush (*Brickellia betonicifolia*), catclaw mimosa (*Mimosa aculeaticarpa*), mountain yucca (*Yucca madrensis*), Wright's silktassel (*Garrya wrightii*), Fendler's ceanothus (*Ceanothus fendleri*), fragrant sumac (*Rhus aromatica*), and Chihuahuan brickellbush (*Brickellia floribunda*). Mule-fat (*Baccharis salicifolia*), a facultative wetland species, is a sparse but noteworthy component of the shrub layer.

The field stratum (<0.5 m) is characterized by a sparse (4–7%) mix of perennial grasses and forbs. Typically, the highest cover, especially for the grasses, is along the margins of the community in the ecotone with the adjacent

tree savannas. Perennial grass cover is divided amongst a diverse suite of natives and non-natives, including sideoats grama (*Bouteloua curtipendula*), green sprangletop (*Leptochloa dubia*), deergrass (*Muhlenbergia rigens*), cane bluestem (*Bothriochloa barbinodis*), spiked crinkleawn (*Trachypogon spicatus*), single threeawn (*Aristida schiedeana*), woolyspike balsamscale (*Elionurus barbiculmis*), weeping lovegrass (*Eragrostis curvula*), and Lehmann lovegrass (*Eragrostis lehmanniana*). In general, the non-native grasses are most common where the canyon starts to widen in the lower reaches.

GLOBAL TYPE CONCEPT DESCRIPTION

Data not available.

MOST ABUNDANT SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	<i>Quercus arizonica</i> , <i>Quercus emoryi</i>
Canopy (2–5 m)	<i>Quercus arizonica</i> , <i>Quercus emoryi</i>
Subcanopy (0.5–2 m)	<i>Rhus virens</i>
Field (0–0.5 m)	None

OTHER NOTEWORTHY ASSOCIATE SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	<i>Platanus wrightii</i> , <i>Juniperus deppeana</i> , <i>Pinus discolor</i> , <i>Quercus hypoleucoides</i>
Canopy (2–5 m)	<i>Arbutus arizonica</i> , <i>Juglans major</i> , <i>Prunus serotina</i>
Subcanopy (0.5–2 m)	<i>Rhus aromatica</i> , <i>Brickellia floribunda</i> , <i>Garrya wrightii</i> , <i>Arctostaphylos pungens</i> , <i>Ceanothus fendleri</i> , <i>Baccharis salicifolia</i>
Field (0–0.5 m)	<i>Eragrostis lehmanniana</i> , <i>Muhlenbergia emersleyi</i> , <i>Muhlenbergia rigens</i> , <i>Brickellia betonicifolia</i> , <i>Leptochloa dubia</i> , <i>Bouteloua curtipendula</i> , <i>Bothriochloa barbinodis</i> , <i>Trachypogon spicatus</i> , <i>Aristida schiedeana</i> , <i>Elionurus barbiculmis</i> , <i>Eragrostis curvula</i>

CLASSIFICATION COMMENTS

Coronado National Memorial

This association was described from 3 classification plots and 5 classification polygons.

Global

Data not available.

Classification confidence: Low

NatureServe conservation status: Data not available

Global status: Data not available

Rounded global status: Data not available

Global range: Data not available

Reasons:

ELEMENT SOURCES

Plots: IP104, IP118, IP125

Polygons: W001_D, W003_NV, W024_D, W302, W304

Local description authors: J. Galvin

12. *Quercus arizonica* - *Quercus hypoleucoides* Shrubland Association (P)

Translated name: Arizona white oak - Silverleaf oak Shrubland Association

NVC name: Not available

Identifier: NPSSODN0058

NVC CLASSIFICATION

Division: --

Macrogroup: --

Group: --

Association: *Quercus arizonica* - *Quercus hypoleucoides* Shrubland Association

DISTRIBUTION

Coronado National Memorial

Within the memorial, this community is restricted to three locations: the north slopes of Montezuma Peak, along the northwestern boundary, and on the north-facing slopes above Montezuma Canyon.

ENVIRONMENTAL DESCRIPTION

Coronado National Memorial

This shrubland community spans steep (40–75%), mountain backslopes of varying aspects from 1,900 to 2,330 m (6,233–7,644 ft). The surface cover is characterized by an even mix of loose rock and gravel with patchy litter and occasional exposed bedrock. At times, the surface cover can best be described as talus.

VEGETATION DESCRIPTION

Coronado National Memorial

This shrubland community is characterized by a dense (40%) subcanopy stratum (0.5–2 m) co-dominated by Arizona white oak (*Quercus arizonica*) and silverleaf oak (*Quercus hypoleucoides*). Arizona white oak (*Q. arizonica*) and silverleaf oak (*Q. hypoleucoides*) are present as large shrubs (2 m) to small, shrubby trees (3 m) providing a variable 20% and 17% cover, respectively. Local dominance is often shared by both species, but there are numerous inclusions where either one can be the sole dominant with cover approaching 40%. This most commonly occurs with silverleaf oak (*Q. hypoleucoides*) at the base of bedrock cliff bands. Wright's silktassel (*Garrya wrightii*) is the next most common associate shrub, providing around 2% cover. Netleaf oak (*Quercus rugosa*) is present as a transitional associate that is most common on higher and/or more sheltered slopes. Fragrant sumac (*Rhus aromatica*), common sotol (*Dasyllirion wheeleri*), mountain yucca (*Yucca madrensis*), California brickellbush (*Brickellia californica*), Sonoran scrub oak (*Quercus turbinella*), and beargrass (*Nolina microcarpa*) are sparse associates with covers at less than one percent.

The field stratum (<0.5 m) is generally sparse (<10%), with only bullgrass (*Muhlenbergia emersleyi*) providing noteworthy cover. Other documented components of this stratum include single threeawn (*Aristida schiedeana*), Bigelow's bristlehead (*Carphochaete bigelovii*), sideoats grama (*Bouteloua curtipendula*), Texas bluestem (*Schizachyrium cirratum*), white sagebrush (*Artemisia ludoviciana*), plains lovegrass (*Eragrostis intermedia*), oakwoods prairie clover (*Dalea versicolor*), and bastardsage (*Eriogonum wrightii*).

Areas covered by this association burned over during the Monument Fire of 2011, ranging from low to high severity. Due to the shrubby nature of this community and the rapid post-fire response of the dominant oaks, this community remains largely unchanged. Areas subjected to high fire severity that were previously characterized as pine and/or oak woodlands, may now belong to this shrubby community.

GLOBAL TYPE CONCEPT DESCRIPTION

Data not available.

MOST ABUNDANT SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	None
Canopy (2–5 m)	None
Subcanopy (0.5–2 m)	<i>Quercus arizonica</i> , <i>Quercus hypoleucoides</i>
Field (0–0.5 m)	None

OTHER NOTEWORTHY ASSOCIATE SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	None
Canopy (2–5 m)	None
Subcanopy (0.5–2 m)	<i>Garrya wrightii</i> , <i>Muhlenbergia emersleyi</i> , <i>Quercus rugosa</i> , <i>Dasyllirion wheeleri</i> , <i>Yucca madrensis</i> , <i>Nolina microcarpa</i> , <i>Quercus tubinella</i> , <i>Brickellia californica</i>
Field (0–0.5 m)	<i>Carphochaete bigelovii</i> , <i>Artemisia ludoviciana</i> , <i>Schizachyrium cirratum</i> , <i>Eriogonum wrightii</i> , <i>Aristida schiedeana</i> , <i>Dalea versicolor</i> , <i>Bouteloua curtipendula</i> , <i>Eragrostis intermedia</i>

CLASSIFICATION COMMENTS

Coronado National Memorial

This association was described from 2 classification plots and 5 classification polygons.

Global

Data not available.

Classification confidence: Low

NatureServe conservation status: Data not available

Global status: Data not available

Rounded global status: Data not available

Global range: Data not available

Reasons:

ELEMENT SOURCES

Plots: IP077, IP083

Polygons: S101, S102, S308, W020_D, W037_D

Local description authors: J. Galvin

13. *Quercus rugosa* (*Quercus hypoleucoides*) Shrubland Association (P)

Translated name: Netleaf oak (Silverleaf oak) Shrubland Association

NVC name: Not available

Identifier: NPSSODN0064

NVC CLASSIFICATION

Division: --

Macrogroup: --

Group: --

Association: *Quercus rugosa* (*Quercus hypoleucoides*) Shrubland Association

DISTRIBUTION

Coronado National Memorial

Within the memorial, this community is restricted to the northern slopes of Montezuma Peak and the exposed ridgelines along the northwestern boundary.

ENVIRONMENTAL DESCRIPTION

Coronado National Memorial

This shrubland community spans steep (40–75%) mountain backslopes of variable aspects from 1,840 to 2,330 m (6,000–7,644 ft). The surface is characterized by an even mix of loose rock and gravel with patchy litter and occasional exposed bedrock.

VEGETATION DESCRIPTION

Coronado National Memorial

This shrubland community is characterized by a dense (30–40%) subcanopy stratum (0.5–2 m) dominated by netleaf oak (*Quercus rugosa*) with one common associate, silverleaf oak (*Quercus hypoleucoides*). Netleaf oak (*Q. rugosa*) and silverleaf oak (*Q. hypoleucoides*) are present as large shrubs (2 m) to small, shrubby trees (3 m) providing an average of 30% and 5% cover, respectively. At times, silverleaf oak (*Q. hypoleucoides*) can provide inclusions where it becomes co-dominant with, or more dominant than, netleaf oak (*Q. rugosa*). Wright's silktassel (*Garrya wrightii*) and beargrass (*Nolina microcarpa*) are the next most common shrubs, with each providing around 2% cover throughout. Arizona white oak (*Quercus arizonica*) is a transitional component of this community that is most common on the lower, more exposed slopes and is all but absent from the upper backslopes. Common sotol (*Dasylirion wheeleri*), New Mexico locust (*Robinia neomexicana*), Sonoran scrub oak (*Quercus turbinella*), and mountain yucca (*Yucca madrensis*) are all sparse associates with cover less than one percent. Mountain mahogany (*Cercocarpus montanus*) is patchy and is typically associated with increased exposed bedrock and/or exposed ridgelines.

The field stratum (<0.5 m) is generally sparse (<5%) with only bullgrass (*Muhlenbergia emersleyi*) and longtongue muhly (*Muhlenbergia longiligula*) providing noteworthy cover. Other documented components of this stratum include mutton grass (*Poa fendleriana*), Arizona bluecurls (*Trichostema arizonicum*), Texas bluestem (*Schizachyrium cirratum*), white sagebrush (*Artemisia ludoviciana*), purple threeawn (*Aristida purpurea*), dentate false pennyroyal (*Hedeoma dentata*), and fragrant snakeroot (*Ageratina herbacea*).

Areas covered by this association burned over during the Monument Fire of 2011, ranging from a low to high severity burn. All examples of this type were mapped post-fire and exhibited rapid regeneration of the dominant oak species. Based on scattered snags present in the post-fire community, the pre-fire community exhibited a similar shrubby formation.

GLOBAL TYPE CONCEPT DESCRIPTION

Data not available.

MOST ABUNDANT SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	None
Canopy (2–5 m)	None
Subcanopy (0.5–2 m)	<i>Quercus rugosa</i> , <i>Quercus hypoleucoides</i> , <i>Garrya wrightii</i>
Field (0–0.5 m)	<i>Muhlenbergia emersleyi</i> , <i>Muhlenbergia longiligula</i>

OTHER NOTEWORTHY ASSOCIATE SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	None
Canopy (2–5 m)	None
Subcanopy (0.5–2 m)	<i>Quercus arizonica</i> , <i>Nolina microcarpa</i> , <i>Dasylirion wheeleri</i> , <i>Yucca madrensis</i> , <i>Robinia neomexicana</i> , <i>Quercus tubinella</i>
Field (0–0.5 m)	<i>Artemisia ludoviciana</i> , <i>Schizachyrium cirratum</i> , <i>Aristida purpurea</i> , <i>Poa fendleriana</i> , <i>Hedeoma dentata</i> , <i>Ageratina herbacea</i> , <i>Trichostema arizonicum</i>

CLASSIFICATION COMMENTS

Coronado National Memorial

This association was described from 3 classification polygons.

Global

Data not available.

Classification confidence: Low

NatureServe conservation status: Data not available

Global status: Data not available

Rounded global status: Data not available

Global range: Data not available

Reasons:

ELEMENT SOURCES

Plots: None

Polygons: S309, S401, S402

Local description authors: J. Galvin

14. [*Quercus turbinella* - *Quercus rugosa* - *Quercus hypoleucoides*] Shrubland Association (P)

Translated name: [Sonoran scrub oak - Netleaf oak - Silverleaf oak] Shrubland Association

NVC name: Not available

Identifier: NPSSODN0065

NVC CLASSIFICATION

Division: --

Macrogroup: --

Group: --

Association: [*Quercus turbinella* - *Quercus rugosa* - *Quercus hypoleucoides*] Shrubland Association

DISTRIBUTION

Coronado National Memorial

Within the memorial, this shrubland community is restricted to two slopes in the upper reaches of Montezuma Canyon, one on the north side and one on the south.

ENVIRONMENTAL DESCRIPTION

Coronado National Memorial

This shrubland community spans steep (50+%) mountain backslopes of varying aspects from 1,860 to 2,120 m (6,102–7,000 ft). The surface is characterized by an even mix of loose rock and gravel with patchy bare soil and occasional exposed bedrock. Often, this community abuts large, typically north-facing bedrock cliff bands.

VEGETATION DESCRIPTION

Coronado National Memorial

This shrubland community is characterized by a moderately dense (30%) subcanopy stratum (0.5–2 m) co-dominated by sonoran scrub oak (*Quercus turbinella*), netleaf oak (*Quercus rugosa*), and silverleaf oak (*Quercus hypoleucoides*). These species are present as large shrubs (2 m) to small, shrubby trees (3 m) providing cover ranging from 5–12% each. In general, Sonoran scrub oak (*Q. turbinella*) tends to occupy the more exposed portions of this community, while the other two tend to occupy more sheltered portions that are often adjacent to cliff bands. Arizona white oak (*Quercus arizonica*) is a transitional associate that is most common on the lower slopes where it begins to replace netleaf oak (*Q. rugosa*) as the community transitions to the similar Arizona whiteoak (*Q. arizonica*) and silverleaf oak (*Q. hypoleucoides*) shrubland. Wright's silktassel (*Garrya wrightii*) is the most common associate throughout this community. An assortment of additional shrubby trees provide sparse (<3%) cover, including Toumey oak (*Quercus toumeyii*), alligator juniper (*Juniperus deppeana*), Emory oak (*Quercus emoryi*), and border pinyon (*Pinus discolor*). Mountain yucca (*Yucca madrensis*), pointleaf manzanita (*Arctostaphylos pungens*), California brickellbush (*Brickellia californica*), Palmer's century plant (*Agave palmeri*), and common sotol (*Dasylirion wheeleri*) are all occasional associates in this stratum.

The field stratum (<0.5 m) is generally sparse (<10%), with low-cover provided by bullgrass (*Muhlenbergia emersleyi*), white sagebrush (*Artemisia ludoviciana*), New Mexico fleabane (*Erigeron neomexicanus*), single threeawn (*Aristida schiedeana*), oakwoods prairie clover (*Dalea versicolor*), Wright's bedstraw (*Galium wrightii*), shortleaf baccharis (*Baccharis brachyphylla*), and Wright's cudweed (*Pseudognaphalium canescens*).

Areas covered by this association burned over during the Monument Fire of 2011, with a mostly moderate severity. All examples of this type were mapped post-fire and exhibit rapid regeneration of the dominant oak species. Pre-fire, it is likely that border pinyon (*P. discolor*) and alligator juniper (*J. deppeana*) were more common. Scattered snags of these species are still present within examples of this type.

GLOBAL TYPE CONCEPT DESCRIPTION

Data not available.

MOST ABUNDANT SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	None
Canopy (2–5 m)	None
Subcanopy (0.5–2 m)	<i>Quercus turbinella</i> , <i>Quercus hypoleucoides</i> , <i>Quercus rugosa</i>
Field (0–0.5 m)	None

OTHER NOTEWORTHY ASSOCIATE SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	None
Canopy (2–5 m)	<i>Juniperus deppeana</i> , <i>Pinus discolor</i> , <i>Quercus emoryi</i>
Subcanopy (0.5–2 m)	<i>Quercus arizonica</i> , <i>Quercus toumeyi</i> , <i>Dasyllirion wheeleri</i> , <i>Yucca madrensis</i> , <i>Brickellia californica</i> , <i>Arctostaphylos pungens</i>
Field (0–0.5 m)	<i>Muhlenbergia emersleyi</i> , <i>Erigeron neomexicana</i> , <i>Artemisia ludoviciana</i> , <i>Galium wrightii</i> , <i>Aristida schiedeana</i> , <i>Pseudognaphalium canescens</i> , <i>Baccharis brachyphylla</i> , <i>Dalea versicolor</i>

CLASSIFICATION COMMENTS

Coronado National Memorial

This association was described from 2 classification polygons.

Global

Data not available.

Classification confidence: Low

NatureServe conservation status: Data not available

Global status: Data not available

Rounded global status: Data not available

Global range: Data not available

Reasons:

ELEMENT SOURCES

Plots: None

Polygons: S105, S303

Local description authors: J. Galvin

15. *Quercus gambelii* (*Quercus rugosa*) Shrubland Association (P)

Translated name: Gambel oak (Netleaf oak) Shrubland Association

NVC name: Not available

Identifier: NPSSODN0062

NVC CLASSIFICATION

Division: --

Macrogroup: --

Group: --

Association: *Quercus gambelii* (*Quercus rugosa*) Shrubland Association

DISTRIBUTION

Coronado National Memorial

Within the memorial, this shrubland community is restricted to one location on the north slope of Montezuma Peak.

ENVIRONMENTAL DESCRIPTION

Coronado National Memorial

This shrubland community spans steep (50+%), north-facing mountain backslopes at 2,210 m (7,250 ft). The surface is characterized by dense leaf litter with an even mix of loose rock, gravel, and bare soil filling in the rest.

VEGETATION DESCRIPTION

Coronado National Memorial

This shrubland community is characterized by a dense (40%) subcanopy stratum (0.5–2 m) dominated by Gambel oak (*Quercus gambelii*) and netleaf oak (*Quercus rugosa*). These species are present as large, regenerating shrubs (2 m) providing a consistent 30% and patchy 7% cover, respectively. Common hoptree (*Ptelea trifoliata*) is the next most common shrub, providing around 2% cover. Shrub diversity is quite low, with only three species providing noteworthy cover.

The field stratum (<0.5 m) is generally sparse (<5%) with no clear dominants or common associates. Documented components of this stratum include white sagebrush (*Artemisia ludoviciana*), muttongrass (*Poa fendleriana*), longtongue muhly (*Muhlenbergia longiligula*), Fendler's meadow rue (*Thalictrum fendleri*), and fragrant snakeroot (*Ageratina herbacea*).

The area covered by this association burned over during the Monument Fire of 2011, ranging from a low to high severity burn. The single example of this type was mapped post-fire and exhibited rapid regeneration of the dominant oak species. In time, this community will likely exhibit higher subcanopy cover.

GLOBAL TYPE CONCEPT DESCRIPTION

Data not available.

MOST ABUNDANT SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	None
Canopy (2–5 m)	None
Subcanopy (0.5–2 m)	<i>Quercus gambelii</i> , <i>Quercus rugosa</i>
Field (0–0.5 m)	None

OTHER NOTEWORTHY ASSOCIATE SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	None
Canopy (2–5 m)	None
Subcanopy (0.5–2 m)	<i>Ptelea trifoliata</i>
Field (0–0.5 m)	<i>Artemisia ludoviciana</i> , <i>Poa fendleriana</i> , <i>Muhlenbergia longiligula</i> , <i>Thalictrum fendleri</i> , <i>Ageratina herbacea</i>

CLASSIFICATION COMMENTS

Coronado National Memorial

This association was described from one classification polygon.

Global

Data not available.

Classification confidence: Low

NatureServe conservation status: Data not available

Global status: Data not available

Rounded global status: Data not available

Global range: Data not available

Reasons:

ELEMENT SOURCES

Plots: None

Polygons: S310

Local description authors: J. Galvin

16. *Dasyilirion wheeleri* / *Bouteloua curtipendula* - *Heteropogon contortus* Shrubland Association (P)

Translated name: Common sotol / Sideoats grama - Tanglehead Shrubland Association

NVC name: Not available

Identifier: NPSSODN0055

NVC CLASSIFICATION

Division: --

Macrogroup: --

Group: --

Association: *Dasyilirion wheeleri* / *Bouteloua curtipendula* - *Heteropogon contortus* Shrubland Association

DISTRIBUTION

Coronado National Memorial

Within the memorial, this community is restricted to the low slopes near the Coronado Cave and along the western half of the border road.

ENVIRONMENTAL DESCRIPTION

Coronado National Memorial

This shrubland community spans moderately steep (15–35%), south-facing slopes from 1,760 to 2,080 m (5,774–6,824 ft). The surface cover is characterized by an even mix of loose rock and gravel with conspicuous, exposed limestone bedrock throughout.

VEGETATION DESCRIPTION

Coronado National Memorial

This shrubland community is characterized by a moderately sparse (15%) subcanopy stratum (0.5–2 m) dominated by common sotol (*Dasyilirion wheeleri*) and a field stratum (<0.5 m) co-dominated by sideoats grama (*Bouteloua curtipendula*) and tanglehead (*Heteropogon contortus*). In general, there are no species in the canopy strata (>2 m).

The subcanopy stratum is characterized by a consistent 10–20% cover of common sotol (*D. wheeleri*) across the community. Palmer's agave (*Agave palmeri*) is a consistent associate that can become a second dominant, but should never become more dominant than common sotol (*D. wheeleri*). Wright's beebrush (*Aloysia wrightii*) is a sparse associate that can provide notable cover along minor washes that cross this community. Other noteworthy, but sparse, shrubs include evergreen sumac (*Rhus virens*), Wright's silktassel (*Garrya wrightii*), Tahitian kidneywood (*Eysenhardtia orthocarpa*), and California brickellbush (*Brickellia californica*).

The field stratum (<0.5 m) is characterized by a moderately dense (20–40%) matrix of native, perennial grasses co-dominated by sideoats grama (*B. curtipendula*) and tanglehead (*H. contortus*). On average, these species provide around 14% cover each, with cover varying based on bedrock dominance. At times, especially when in close proximity to non-native grasslands, Lehmann lovegrass (*Eragrostis lehmanniana*) may become a co-dominant. Other noteworthy species include cane bluestem (*Bothriochloa barbinodis*), bullgrass (*Muhlenbergia emersleyi*), woolyspike balsamscale (*Elionurus barbiculmis*), spiked crinkleawn (*Trachypogon spicatus*), and fairyduster (*Calianthemum eriophyllum*).

GLOBAL TYPE CONCEPT DESCRIPTION

Data not available.

MOST ABUNDANT SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	None
Canopy (2–5 m)	None
Subcanopy (0.5–2 m)	<i>Dasyllirion wheeleri</i>
Field (0–0.5 m)	<i>Bouteloua curtipendula</i> , <i>Heteropogon contortus</i>

OTHER NOTEWORTHY ASSOCIATE SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	None
Canopy (2–5 m)	None
Subcanopy (0.5–2 m)	<i>Aloysia wrightii</i> , <i>Brickellia californica</i> , <i>Agave palmeri</i> , <i>Eysenhardtia orthocarpa</i> , <i>Garrya wrightii</i> , <i>Rhus virens</i>
Field (0–0.5 m)	<i>Eragrostis lehmanniana</i> , <i>Bothriochloa barbinodis</i> , <i>Muhlenbergia emersleyi</i> , <i>Elionurus barbiculmis</i> , <i>Trachypogon spicatus</i> , <i>Calliandra eriophyllum</i>

CLASSIFICATION COMMENTS

Coronado National Memorial

This association was described from 1 classification plot and 2 classification polygons.

Global

Data not available.

Classification confidence: Low

NatureServe conservation status: Data not available

Global status: Data not available

Rounded global status: Data not available

Global range: Data not available

Reasons:

ELEMENT SOURCES

Plots: IPS001

Polygons: SS009B_D, SS106

Local description authors: J. Galvin

17. *Dasyllirion wheeleri* / *Bouteloua curtipendula* Shrub Grassland Association

Translated name: Common sotol / Sideoats grama Shrub Grassland Association

NVC name: CEG001593

Identifier: N/A

NVC CLASSIFICATION

Division: *Acacia greggii* - *Opuntia leptocaulis* - *Muhlenbergia porteri* North American Warm Desert Scrub & Grassland Division

Macrogroup: *Bouteloua eriopoda* - *Muhlenbergia emersleyi* - *Pleuraphis mutica* Chihuahuan Semi-Desert Grassland Macrogroup

Group: *Bouteloua eriopoda* - *Bouteloua ramosa* - *Muhlenbergia porteri* Semi-Desert Grassland Group

Association: *Dasyllirion wheeleri* / *Bouteloua curtipendula* Shrub Grassland Association

DISTRIBUTION

Coronado National Memorial

Within the memorial this association is found along Yaqui Ridge, on the slopes of Bob Thompson Peak, and on Coronado Peak.

ENVIRONMENTAL DESCRIPTION

Coronado National Memorial

This community spans moderately steep (15–50%), south to southeast-facing mountain backslopes and summits from 1,760 to 2,080 m (5,774–6,824 ft). The surface is characterized by an even mix of loose rock and gravel with conspicuous exposed bedrock throughout.

VEGETATION DESCRIPTION

Coronado National Memorial

This shrub grassland community is characterized by a sparse (<10%) subcanopy stratum (0.5–2 m) dominated by common sotol (*Dasyllirion wheeleri*) and a field stratum (<0.5 m) dominated by sideoats grama (*Bouteloua curtipendula*). In general, the canopy strata (>2 m) are extremely sparse (<5%), consisting mainly of Emory oak (*Quercus emoryi*) with rare occurrences of Arizona white oak (*Quercus arizonica*), Mexican blue oak (*Quercus oblongifolia*), and alligator juniper (*Juniperus deppeana*). When present along drainages, on sheltered slopes, and/or adjacent to bedrock outcrops, these species can become more common, occasionally creating small, wooded inclusions. These areas of increased tree cover become more consistent as slopes trend more west to northwest-facing.

The subcanopy stratum is characterized by the dominance (albeit with variable cover) of common sotol (*D. wheeleri*), providing an average of 5% cover across the whole community, but with areas up to 8%. Beargrass (*Nolina microcarpa*) is generally quite sparse (2%), but can occasionally become co-dominant with or more dominant than common sotol (*D. wheeleri*). Mountain mahogany (*Cercocarpus montanus*) is a sparse associate that is most common where surface bedrock is high and/or within the ecotone with the similar [*Cercocarpus montanus* - *Garrya wrightii*] shrubland community. Other noteworthy shrubs include evergreen sumac (*Rhus virens*), and Wright's silktassel (*Garrya wrightii*), mountain yucca (*Yucca madrensis*), gumhead (*Gymnosperma glutinosum*), Tahitian kidneywood (*Eysenhardtia orthocarpa*), Palmer's century plant (*Agave palmeri*), and California brickellbush (*Brickellia californica*).

The field stratum (<0.5 m) is characterized by a moderately dense (30%) matrix of native, perennial grasses dominated by sideoats grama (*B. curtipendula*). On average, this species provides around 14% cover, ranging from 8 up to a high of 30%. While typically the dominant perennial grass, this species may occasionally be co-dominant

with, or second dominant to, cane bluestem (*Bothriochloa barbinodis*), bullgrass (*Muhlenbergia emersleyi*), and/or tanglehead (*Heteropogon contortus*). Other noteworthy grasses, from most to least dominant include single three-awn (*Aristida schiedeana*), plains lovegrass (*Eragrostis intermedia*), Texas bluestem (*Schizachyrium cirratum*), and green sprangletop (*Leptochloa dubia*). Prairie acacia (*Acaciella angustissima*), bastard sage (*Eriogonum wrightii*), and showy goldeneye (*Heliomeris multiflora*) are sparse, but noteworthy, associates.

Areas covered by this association were affected by the Monument Fire in 2011, with severities in the low to moderate range. While charring of trees and shrub was noted during the post-fire field effort, mortality was low to nonexistent throughout the community. Fire effects were mainly limited to the grass dominated field stratum, which quickly regenerated.

GLOBAL TYPE CONCEPT DESCRIPTION

This type occurs on steep rocky scarps and dip slopes at various aspects, but is more frequently found on warmer exposures. Elevations range from 1,550 to 1,980 m (5,100–6,500 ft). Substrates are derived from limestone, sandstone, granite and rhyolite. Soils are shallow and rocky, but surface soil characteristics vary with parent material. On limestone, soils tend to be finer textured, thus potentially hindering infiltration. Granitic soils, by contrast, are usually coarse and well-drained, which creates a relatively more mesic environment. This Chihuahuan Desert grassland is characterized by a diverse mix of bunchgrasses. *Bouteloua curtipendula* is well-represented and dominant, while *Bouteloua eriopoda*, *Aristida purpurea*, *Bouteloua hirsuta*, and *Eragrostis intermedia* are common to well-represented and may co-dominate. In the shrub layer, *Dasyllirion wheeleri* is well-represented and a conspicuous indicator. Other desert indicators include *Parthenium incanum*, *Fouquieria splendens*, *Aloysia wrightii*, *Mimosa aculeaticarpa* var. *biuncifera*, and *Viguiera stenoloba*. Of the 75 forbs known from this association, *Artemisia ludoviciana*, *Eriogonum wrightii*, *Melampodium leucanthum*, *Machaeranthera pinnatifida* var. *pinnatifida*, *Notholaena standleyi*, *Trixis californica*, and *Bahia absinthifolia* are the most constant.

MOST ABUNDANT SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	None
Canopy (2–5 m)	None
Subcanopy (0.5–2 m)	<i>Dasyllirion wheeleri</i> , <i>Nolina microcarpa</i>
Field (0–0.5 m)	<i>Bouteloua curtipendula</i> , <i>Bothriochloa barbinodis</i> , <i>Muhlenbergia emersleyi</i> , <i>Heteropogon contortus</i>

OTHER NOTEWORTHY ASSOCIATE SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	None
Canopy (2–5 m)	<i>Quercus emoryi</i> , <i>Quercus arizonica</i> , <i>Quercus oblongifolia</i> , <i>Juniperus deppeana</i>
Subcanopy (0.5–2 m)	<i>Cercocarpus montanus</i> , <i>Garrya wrightii</i> , <i>Yucca madrensis</i> , <i>Brickellia californica</i> , <i>Agave palmeri</i> , <i>Eysenhardtia orthocarpa</i> , <i>Yucca madrensis</i> , <i>Gymnosperma glutinosum</i>
Field (0–0.5 m)	<i>Aristida schiedeana</i> , <i>Eragrostis intermedia</i> , <i>Schizachyrium cirratum</i> , <i>Heliomeris multiflora</i> , <i>Leptochloa dubia</i> , <i>Acaciella angustissima</i> , <i>Eriogonum wrightii</i>

CLASSIFICATION COMMENTS

Coronado National Memorial

The local variation of this association was described from 1 classification plot and 5 classification polygons. The dominant shrubs are a great match and the grasses are a fair match to the USNVC accepted association (CEGL001593). Dominant grasses within the local variation are noticeably different with cane bluestem (*B. bar-*

binodis), bullgrass (*M. emersleyi*), and tanglehead (*H. contortus*) as the most common species outside of sideoats grama (*B. curtipendula*). All grass associates from the accepted association are present within the local variation, but are all extremely sparse. Beargrass (*N. microcarpa*) and mountain mahogany (*C. montanus*) are noteworthy components of the local variation that are absent from global description.

Global

Data not available.

Classification confidence: Low

NatureServe conservation status: Data not available

Global status: Data not available

Rounded global status: Data not available

Global range: Data not available

Reasons:

ELEMENT SOURCES

Plots: IP026

Polygons: H301A, H307, SS012_D, SS304, SS309

Local description authors: J. Galvin

18. [*Cercocarpus montanus* - *Garrya wrightii*] / Mixed Perennial Grass Wooded Shrub Savanna Association (P)

Translated name: [Mountain mahogany - Wright's silktassel] / Mixed Perennial Grass Wooded Shrub Savanna Association

NVC name: Not available

Identifier: NPSSODN0050

NVC CLASSIFICATION

Division: --

Macrogroup: --

Group: --

Association: [*Cercocarpus montanus* - *Garrya wrightii*] / Mixed Perennial Grass Wooded Shrub Savanna Association

DISTRIBUTION

Coronado National Memorial

Within the memorial this wooded shrub savanna association is widespread across the higher elevation slopes, specifically: Montezuma Peak, Bob Thompson Peak, and Coronado Peak.

ENVIRONMENTAL DESCRIPTION

Coronado National Memorial

This shrub savanna community spans moderately steep (15–50%), generally south-facing mountain backslopes and summits from 1,760 to 2,080 m (5,774–6,824 ft). At times, this community can occupy a more northern aspect. The surface is characterized by an even mix of loose rock and gravel with conspicuous exposed bedrock.

VEGETATION DESCRIPTION

Coronado National Memorial

This community is characterized by a moderately dense (20%) subcanopy stratum (0.5–2 m) co-dominated by mountain mahogany (*Cercocarpus montanus*) and Wright's silktassel (*Garrya wrightii*), with a variable (20–40%) field stratum (<0.5 m) dominated by a diverse and variable mix of perennial bunch grasses. In general, the canopy strata (>2 m) is sparse (<10%), typically consisting of a mix of Arizona white oak (*Quercus arizonica*), border pin-yon (*Pinus discolor*), and alligator juniper (*Juniperus deppeana*), with each proving a few percent cover across the community. Locally, each species may be the sole canopy dominant or co-dominant with the other two species. When present along drainages, on sheltered slopes, and/or adjacent to bedrock outcrops, these species can become more common, occasionally creating small, wooded inclusions. These areas of increased tree cover become more consistent as slopes trend more west to northwest-facing or when present on high mountain shoulders.

The subcanopy stratum is characterized by the co-dominance of mountain mahogany (*C. montanus*) and Wright's silktassel (*G. wrightii*) with a variable mix of associated shrubs and succulents. Both species provide an average of 10% cover across the community, with the highest cover (up to 25%) occurring in close proximity to bedrock outcrops and/or where surface rock cover is high. These species may present as co-dominant, but often one or the other is the sole dominant. Areas of co-dominance are most commonly on the high backslopes and/or exposed ridgelines. Common sotol (*Dasyllirion wheeleri*) and beargrass (*Nolina microcarpa*) are sparse, but very consistent species that each provides around 2% cover. Often, these two species co-occur with similar cover, but there are instances where one is clearly the dominant while the other is a sparse associate. Evergreen sumac (*Rhus virens*) is an associate that provides the most cover in areas of high surface rock, typically on exposed ridgelines and/or in the ecotone with the similar mountain mahogany (*C. montanus*) and evergreen sumac (*R. virens*) shrubby rock outcrop community. Walkingstick cactus (*Cylindropuntia spinosior*) provides conspicuous cover, typically in dense bands along exposed ridgelines. Other noteworthy shrubs include California brickellbush (*Brickellia californica*), mountain yucca (*Yucca madrensis*), yerba de pasmo (*Baccharis pteronioides*), Tahitian kidneywood

(*Eysenhardtia orthocarpa*), Palmer’s century plant (*Agave palmeri*), turpentine bush (*Ericameria laricifolia*), and gumhead (*Gymosperma glutinosum*). Along the high ridgelines, on talus slopes, and/or along drainages, New Mexico locust (*Robinia neomexicana*) may provide small inclusions of dominance.

The field stratum (<0.5 m) is characterized by a variable mix of native, perennial grasses, usually dominated by four species: sideoats grama (*Bouteloua curtipendula*), cane bluestem (*Bothriochloa barbinodis*), bullgrass (*Muhlenbergia emersleyi*), and single threeawn (*Aristida schiedeana*). On average, these species provide around 4–6% cover each, but can range up to 25% in some locations. Local dominance can be quite variable, with one species or a mix of many defining the grass component. In general, sideoats grama (*B. curtipendula*) and single threeawn (*A. schiedeana*) are most common at the lower elevational range of this community, while bullgrass (*M. emersleyi*) tends to occur at the higher end. Other noteworthy grasses include plains lovegrass (*Eragrostis intermedia*), Texas bluestem (*Schizachyrium cirratum*), and tanglehead (*Heteropogon contortus*). Prairie acacia (*Acaciella angustissima*), Arizona bluecurls (*Trichostema arizonicum*), white sagebrush (*Artemisia ludoviciana*), and bastard sage (*Eriogonum wrightii*) are sparse, but noteworthy, associates.

Areas covered by this association were affected by the Monument Fire in 2011, with severities in the low to moderate range. During the post-fire field effort, some areas showed minor charring on the trees and shrubs, but mortality was low to nonexistent in these areas. Fire effects were mainly limited the grass dominated field stratum, which quickly regenerated. Other areas, specifically the northeastern slopes of Coronado Peak, were subjected to both the Monument Fire, as well as, the 1999 Peak Fire. Canopy cover in these areas is low to nonexistent and Wright’s silktassel (*G. wrightii*) is often the only dominant shrub. Where fire severity was high and perennial grass mortality noteworthy, heartleaf goldeneye (*Viguiera cordifolia*) and toothleaf goldeye (*Viguiera dentata*) may be field stratum dominants.

GLOBAL TYPE CONCEPT DESCRIPTION

Data not available.

MOST ABUNDANT SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	None
Canopy (2–5 m)	None
Subcanopy (0.5–2 m)	<i>Cercocarpus montanus</i> , <i>Garry wrightii</i>
Field (0–0.5 m)	<i>Bouteloua curtipendula</i> , <i>Bothriochloa barbinodis</i> , <i>Muhlenbergia emersleyi</i>

OTHER NOTEWORTHY ASSOCIATE SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	None
Canopy (2–5 m)	<i>Quercus arizonica</i> , <i>Quercus emoryi</i> , <i>Pinus discolor</i> , <i>Juniperus deppeana</i>
Subcanopy (0.5–2 m)	<i>Dasyllirion wheeleri</i> , <i>Nolina microcarpa</i> , <i>Yucca madrensis</i> , <i>Brickellia californica</i> , <i>Baccharis pteronioides</i> , <i>Agave palmeri</i> , <i>Cylindropuntia spinosior</i>
Field (0–0.5 m)	<i>Aristida schiedeana</i> , <i>Eragrostis intermedia</i> , <i>Schizachyrium cirratum</i> , <i>Trichostema arizonicum</i> , <i>Leptochloa dubia</i> , <i>Heteropogon contortus</i> , <i>Acaciella angustissima</i> , <i>Eriogonum wrightii</i>

CLASSIFICATION COMMENTS

Coronado National Memorial

This association was described from 11 classification plots and 13 classification polygons.

Global

Data not available.

Classification confidence: Low

NatureServe conservation status: Data not available

Global status: Data not available

Rounded global status: Data not available

Global range: Data not available

Reasons:

ELEMENT SOURCES

Plots: IP002, IPS002, IPS003, IP004, IP009, IP026, IP038, IP048, IP062, IP070, IP081

Polygons: H308, S006_D, S007_D, S100, S300, S302, S306, SS001_D, SS303, SS308, SS310, W026_D, WS016_D

Local description authors: J. Galvin

19. [*Cercocarpus montanus* - *Rhus virens*] Shrubby Rock Outcrop Association (P)

Translated name: [Mountain mahogany - Evergreen sumac] Shrubby Rock Outcrop Association

NVC name: Not available

Identifier: NPSSODN0051

NVC CLASSIFICATION

Division: --

Macrogroup: --

Group: --

Association: [*Cercocarpus montanus* - *Rhus virens*] Shrubby Rock Outcrop Association

DISTRIBUTION

Coronado National Memorial

Within the memorial, this shrubby rock outcrop association is restricted the high backslopes around Bob Thompson and Montezuma peak, as well as, the saddle that connects them.

ENVIRONMENTAL DESCRIPTION

Coronado National Memorial

This shrubby rock outcrop community spans steep (50+%), south to southeast-facing mountain backslopes and summits from 1,800 to 2,190 m (5,900–7,185 ft). The surface is characterized by a mix of loose rock and gravel with conspicuous and widespread exposed bedrock. The parent material is predominately sedimentary rock, usually limestone.

VEGETATION DESCRIPTION

Coronado National Memorial

This shrubby rock outcrop community is characterized by a moderately dense (30%) subcanopy stratum (0.5–2 m) co-dominated by mountain mahogany (*Cercocarpus montanus*) and evergreen sumac (*Rhus virens*), with a field stratum (<0.5 m) dominated by a mix of perennial grasses. In general, the canopy strata (>2 m) are extremely sparse, consisting mainly of scattered Arizona white oak (*Quercus arizonica*) and border pinyon (*Pinus discolor*), usually along drainage inclusions or in the ecotone with adjacent wooded communities.

The subcanopy is defined by the co-dominance of mountain mahogany (*C. montanus*) and evergreen sumac (*R. virens*), with each providing 10–12% cover throughout. Both species range from small (1 m), shrubby individuals to large (3 m), tree-like individuals. Wright's beebrush (*Aloysia wrightii*), common sotol (*Dasylirion wheeleri*), gumhead (*Gymnosperma glutinosum*) and Palmer's agave (*Agave palmeri*) are the most consistent associates. Catclaw mimosa (*Mimosa aculeaticarpa*) is a sparse associate that occasionally provides small inclusions of dominance.

The field stratum (<0.5 m) is characterized by a moderately dense (<25%) matrix of perennial grasses, dominated by the invasive Lehmann lovegrass (*Eragrostis lehmanniana*) with a mix of natives, including bullgrass (*Muhlenbergia emersleyi*), plains lovegrass (*Eragrostis intermedia*), green sprangletop (*Leptochloa dubia*), sideoats grama (*Bouteloua curtipendula*), and cliff muhly (*Muhlenbergia polycaulis*). Cochise scaly cloakfern (*Astrolepis cochisensis*), bastardsage (*Eriogonum wrightii*), white sagebrush (*Artemisia ludoviciana*), and copper fern (*Bommeria hispida*) are sparse associates.

Due to the high cover of surface rock, areas covered by this community were minimally affected by the 2011 Monument Fire.

GLOBAL TYPE CONCEPT DESCRIPTION

Data not available.

MOST ABUNDANT SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	None
Canopy (2–5 m)	None
Subcanopy (0.5–2 m)	<i>Cercocarpus montanus</i> , <i>Rhus virens</i>
Field (0–0.5 m)	<i>Eragrostis lehmaniana</i>

OTHER NOTEWORTHY ASSOCIATE SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	None
Canopy (2–5 m)	<i>Quercus arizonica</i> , <i>Pinus discolor</i>
Subcanopy (0.5–2 m)	<i>Aloysia wrightii</i> , <i>Brickellia californica</i> , <i>Dasyllirion wheeleri</i> , <i>Agave palmeri</i> , <i>Gymnosperma glutinosum</i>
Field (0–0.5 m)	<i>Bouteloua curtipendula</i> , <i>Muhlenbergia emersleyi</i> , <i>Eragrostis intermedia</i> , <i>Leptochloa dubia</i> , <i>Muhlenbergia polycaulis</i> , <i>Astrolepis cochisensis</i> , <i>Eriogonum wrightii</i> , <i>Artemisia ludoviciana</i> , <i>Bommeria hispida</i>

CLASSIFICATION COMMENTS

Coronado National Memorial

This association was described from 1 classification polygon.

Global

Data not available.

Classification confidence: Low

NatureServe conservation status: Data not available

Global status: Data not available

Rounded global status: Data not available

Global range: Data not available

Reasons:

ELEMENT SOURCES

Plots: N/A

Polygons: S400

Local description authors: J. Galvin

20. [*Aloysia wrightii* - *Eysenhardtia orthocarpa*] / Mixed Perennial Grass Shrub Savanna and Shrubland Association (P)

Translated name: [Wright's beebrush - Tahitian kidneywood] / Mixed Perennial Grass Shrub Savanna and Shrubland Association

NVC name: Not available

Identifier: NPSSODN0048

NVC CLASSIFICATION

Division: --

Macrogroup: --

Group: --

Association: [*Aloysia wrightii* - *Eysenhardtia orthocarpa*] / Mixed Perennial Grass Shrub Savanna and Shrubland Association

DISTRIBUTION

Coronado National Memorial

Within the memorial, this community spans low slopes along the southwestern boundary and on a series of low hills near the eastern boundary.

ENVIRONMENTAL DESCRIPTION

Coronado National Memorial

This shrubland community spans low-angle (<6%) to medium- (<50%) gradient, south-facing foot and toeslopes with some occurrences spanning backslopes and exposed ridgelines, from 1,490 to 1,800 m (4,888–5,905 ft). The surface is characterized by an even mix of small rocks and gravel with occasional outcrops of exposed bedrock, typically composed of limestone.

VEGETATION DESCRIPTION

Coronado National Memorial

This shrub savanna community is characterized by a moderately dense (<20%) subcanopy stratum (0.5–2 m) co-dominated by Wright's beebrush (*Aloysia wrightii*) and Tahitian kidneywood (*Eysenhardtia orthocarpa*), with a field stratum (<0.5 m) dominated by a variable mix of perennial grasses. Cover in the canopy stratum (>2 m) is rare and typically associated with minor drainages. When present, cover in these strata is usually composed of mixed oaks, including, Mexican blue oak (*Quercus oblongifolia*), Emory oak (*Quercus emoryi*), and Arizona white oak (*Quercus arizonica*), with occasional inclusions of velvet mesquite (*Prosopis velutina*). In areas with rock outcrops, ocotillo (*Fouquieria splendens*) may become a conspicuous, but low-cover, component of this community.

The subcanopy stratum is defined by a variable mix of shrubs co-dominated by Wright's beebrush (*A. wrightii*) and Tahitian kidneywood (*E. orthocarpa*). Overall, Wright's beebrush (*A. wrightii*) is the most dominant, with an average cover of 7% that typically presents as scattered dense patches, with the densest areas often associated with minor drainages. Tahitian kidneywood (*E. orthocarpa*) ranges from scattered small individuals contributing a few percent cover to shrubland variations with 10–20%. Common sotol (*Dasyllirion wheeleri*) and Palmer's agave (*Agave palmeri*) are the most consistent associate succulents, with low cover (2–3%) throughout. In areas with significant bedrock outcrops, evergreen sumac (*Rhus virens*) can become a sub-dominant shrub. Other noteworthy subcanopy components include mountain mahogany (*Cercocarpus montanus*), California brickellbush (*Brickellia californica*), fragrant snakeroot (*Ageratina herbacea*), gumhead (*Gymnosperma glutinosum*), and desertbroom (*Baccharis sarothroides*). Rarely, catclaw mimosa (*Mimosa aculeaticarpa*) provides small inclusions of dominance within this shrub savanna.

The field stratum is characterized by a moderately dense (35%) mix of native and non-native perennial grasses. The non-native grasses are solely composed of Lehmann lovegrass (*Eragrostis lehmanniana*), with the great-

est cover (up to 30%) occurring near the highly disturbed alluvial fan in the southeast corner of the memorial. Sideoats grama (*Bouteloua curtipendula*) and cane bluestem (*Bothriochloa barbinodis*) provide the highest and most consistent cover of the native grasses with an average of 6% and 4%, respectively. In order from most to least dominant, other noteworthy native grasses include tanglehead (*Heteropogon contortus*), spidergrass (*Aristida ternipes*), green sprangletop (*Leptochloa dubia*), plains lovegrass (*Eragrostis intermedia*), single threeawn (*Aristida schiedeana*), bullgrass (*Muhlenbergia emersleyi*), and streambed bristlegrass (*Setaria leucopila*). Other noteworthy field components include fairyduster (*Calliandra eriophylla*), prairie acacia (*Acaciella angustissima*), yerba de pascmo (*Baccharis pteronioides*), and Wright’s cudweed (*Pseudognaphalium canescens*).

On exposed ridgelines and/or where limestone outcrops are common, ocotillo (*F. splendens*) can become a canopy dominant, with cover approaching 10%. In these areas, numerous associates not typical of the broader community may be present, including Cochise scaly cloakfern (*Astrolepis cochisensis*), Wright’s cudweed (*Pseudognaphalium canescens*), coralbean (*Erythrina flabelliformis*), walkingstick cactus (*Cylindropuntia spinosior*), and cactus apple (*Opuntia engelmannii*). At times, mountain mahogany (*C. montanus*) may provide noteworthy cover and present as a subcanopy co-dominant.

Areas covered by this association were variably affected by the Monument Fire of 2011, ranging from low to high severity. Post-fire, examples of this type may exhibit lower cover of succulents and shrubs within the subcanopy and field strata. All examples of this community mapped post-fire contain noticeably lower cover of all woody species. In addition, the distribution of Lehmann lovegrass (*E. lehmanniana*) likely increased and is more common on the higher slopes previously dominated by natives; it may be the sole grass component in some examples.

GLOBAL TYPE CONCEPT DESCRIPTION

Data not available.

MOST ABUNDANT SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	None
Canopy (2–5 m)	None
Subcanopy (0.5–2 m)	<i>Aloysia wrightii</i> , <i>Dasyllirion wheeleri</i> , <i>Eysenhardtia orthocarpa</i>
Field (0–0.5 m)	<i>Eragrostis lehmanniana</i> , <i>Bouteloua curtipendula</i> , <i>Bothriochloa barbinodis</i>

OTHER NOTEWORTHY ASSOCIATE SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	None
Canopy (2–5 m)	<i>Quercus emoryi</i> , <i>Quercus arizonica</i> , <i>Quercus oblongifolia</i> , <i>Fouquieria splendens</i> , <i>Pinus discolor</i>
Subcanopy (0.5–2 m)	<i>Brickellia californica</i> , <i>Cercocarpus montanus</i> , <i>Baccharis sarothroides</i> , <i>Rhus virens</i> , <i>Cylindropuntia spinosior</i> , <i>Erythrina flabelliformis</i> , <i>Opuntia engelmannii</i>
Field (0–0.5 m)	<i>Heteropogon contortus</i> , <i>Leptochloa dubia</i> , <i>Aristida ternipes</i> , <i>Eragrostis intermedia</i> , <i>Muhlenbergia emersleyi</i> , <i>Astrolepis cochisensis</i> , <i>Pseudognaphalium canescens</i> , <i>Aristida schiedeana</i> , <i>Baccharis pteronioides</i>

CLASSIFICATION COMMENTS

Coronado National Memorial

This association was described from 5 classification plots and 18 classification polygons.

Global

Data not available.

Classification confidence: Low

NatureServe conservation status: Data not available

Global status: Data not available

Rounded global status: Data not available

Global range: Data not available

Reasons:

ELEMENT SOURCES

Plots: IP024, IP037, IP052, IP090

Polygons: H101, H103, H305, S001_D, S008_D, S009_D, S010_D, S012_NV, SS002_D, SS003_D, SS004_D, SS006_D, SS008_D, SS009_D, SS10_D, SS013_D, SS102, SS400

Local description authors: J. Galvin

21. [*Aloysia wrightii* - *Parthenium incanum*] Shrubland Association (P)

Translated name: [Wright's beebrush - Mariola] Shrubland Association

NVC name: Not available

Identifier: NPSSODN0049

NVC CLASSIFICATION

Division: --

Macrogroup: --

Group: --

Association: [*Aloysia wrightii* - *Parthenium incanum*] Shrubland Association

DISTRIBUTION

Coronado National Memorial

Within the memorial, this shrubland association is primarily restricted to the low slope on the east side of Yaqui Ridge, but may occur as small inclusions within other shrubland communities.

ENVIRONMENTAL DESCRIPTION

Coronado National Memorial

This shrubland community spans east to southeast-facing backslopes of variable gradients from 1,660 to 1,850 m (5,446–6,070 ft). The surface is characterized by dominant gravel and small rocks with conspicuous bedrock outcrops throughout.

VEGETATION DESCRIPTION

Coronado National Memorial

This shrubland community is characterized by a dense (40%) subcanopy stratum (0.5–2 m) co-dominated by Wright's beebrush (*Aloysia wrightii*) and mariola (*Parthenium incanum*), with a field stratum (<0.5 m) composed of a variable mix of perennial grasses and low shrubs. Cover in the canopy stratum (>2 m) is rare and typically associated with minor drainages or bedrock outcrops. Ocotillo (*Fouquieria splendens*) provides the most conspicuous cover, often occurring where exposed bedrock is prevalent. Mexican blue oak (*Quercus oblongifolia*) is an uncommon canopy associate.

The subcanopy stratum is defined by a variable mix of shrubs consistently dominated by Wright's beebrush (*A. wrightii*) and/or mariola (*P. incanum*), with each providing an average 15% cover throughout. In some examples of this community, these species may present as co-dominants, while in others, one species may become the sole dominant with the other becoming a common associate. Evergreen sumac (*Rhus virens*) is the most consistent associate shrub with variable cover across the community, including areas where it can become a co-dominant shrub. Common sotol (*Dasyllirion wheeleri*), gumhead (*Gymnosperma glutinosum*), and Tahitian kidneywood (*Eysenhardtia orthocarpa*) are noteworthy associates with consistent, but low, cover throughout.

The field stratum is characterized by a low-cover (<15%) mix of native perennial grasses and the low shrub fairy-duster (*Calliandra eriophylla*). Sideoats grama (*Bouteloua curtipendula*) is the most common grass, but tanglehead (*Heteropogon contortus*) and slim tridens (*Tridens muticus*) may be notably present. Other sparse associates include purple threeawn (*Aristida purpurea*), ratany (*Krameria erecta*), Cochise scaly cloakfern (*Astroblepis cochisensis*), black grama (*Bouteloua eriopoda*), cane bluestem (*Bothriochloa barbinodis*), bullgrass (*Muhlenbergia emersleyi*), and Arizona bluecurls (*Trichostema arizonicum*).

GLOBAL TYPE CONCEPT DESCRIPTION

Data not available.

MOST ABUNDANT SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	None
Canopy (2–5 m)	None
Subcanopy (0.5–2 m)	<i>Aloysia wrightii</i> , <i>Parthenium incanum</i> , <i>Rhus virens</i>
Field (0–0.5 m)	<i>Bouteloua curtipendula</i> , <i>Heteropogon contortus</i> , <i>Tridens muticus</i>

OTHER NOTEWORTHY ASSOCIATE SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	None
Canopy (2–5 m)	<i>Fouquieria splendens</i> , <i>Quercus oblongifolia</i>
Subcanopy (0.5–2 m)	<i>Dasyllirion wheeleri</i> , <i>Eysenhardtia orthocarpa</i> , <i>Gymnosperma glutinosum</i>
Field (0–0.5 m)	<i>Leptochloa dubia</i> , <i>Aristida purpurea</i> , <i>Trichostema arizonicum</i> , <i>Bothriochloa barbinodis</i> , <i>Krameria erecta</i> , <i>Astrolepis cochisensis</i> , <i>Bouteloua eriopoda</i> , <i>Muhlenbergia emersleyi</i>

CLASSIFICATION COMMENTS

Coronado National Memorial

This association was described from 1 classification plot and 2 classification polygons.

Global

Data not available.

Classification confidence: Low

NatureServe conservation status: Data not available

Global status: Data not available

Rounded global status: Data not available

Global range: Data not available

Reasons:

ELEMENT SOURCES

Plots: IP087

Polygons: S002_D, S010_D

Local description authors: J. Galvin

22. (*Quercus* sp.) / [*Rhus virens* - *Garrya wrightii* - *Eysenhardtia orthocarpa* - *Aloysia wrightii*] Intermittently Flooded Shrubland Association (P)

Translated name: (Oak) / [Evergreen sumac - Wright's silktassel - Tahitian kidneywood - Wright's beebrush]
Intermittently Flooded Shrubland Association
NVC name: Not available
Identifier: NPSSODN0047

NVC CLASSIFICATION

Division: --
Macrogroup: --
Group: --
Association: (*Quercus*) / [*Rhus virens* - *Garrya wrightii* - *Eysenhardtia orthocarpa* - *Aloysia wrightii*] Intermittently Flooded Shrubland Association

DISTRIBUTION

Coronado National Memorial

Within the memorial, this community is restricted to narrow, south-flowing drainages on the slopes of Coronado and Bob Thompson peaks.

ENVIRONMENTAL DESCRIPTION

Coronado National Memorial

This intermittently flooded shrubland community spans moderately steep (15–50%), south to southeast-flowing drainages from 1,630 to 2,500 m (5,347–8,202 ft). The surface cover is characterized by a mix of loose rock and gravel with scattered bedrock outcrops.

VEGETATION DESCRIPTION

Coronado National Memorial

This intermittently flooded shrubland community is characterized by a sparse (<10%) oak (*Quercus* sp.) canopy (>2 m) and a moderately dense (30%) subcanopy stratum (0.5–2 m) co-dominated by a variable mix of shrubs. The canopy is primarily composed of scattered Arizona white oak (*Quercus arizonica*), Emory oak (*Quercus emoryi*), border pinyon (*Pinus discolor*), and Mexican blue oak (*Quercus oblongifolia*) with rare occurrences of Arizona walnut (*Juglans major*).

The subcanopy stratum is characterized by the variable dominance of evergreen sumac (*Rhus virens*), Wright's silktassel (*Garrya wrightii*), Tahitian kidneywood (*Eysenhardtia orthocarpa*), and Wright's beebrush (*Aloysia wrightii*). Local species composition is highly variable with one species or a variable mix providing dominance. Catclaw mimosa (*Mimosa aculeaticarpa*) is an associate that can provide rare inclusions of dominance. Where exposed bedrock dominates, mountain mahogany (*Cercocarpus montanus*) can become a dominant shrub species. Thurber's cotton (*Gossypium thurberi*) and Canyon grape (*Vitis arizonica*) are conspicuous, low-cover associates.

The field stratum (<0.5 m) is very sparse, with forbs and grasses distributed in patches on gravel bars and wash edges that are usually composed of perennial grasses associated with the adjacent herbaceous-dominated communities. These associates include sideoats grama (*Bouteloua curtipendula*), bullgrass (*Muhlenbergia emersleyi*), cane bluestem (*Bothriochloa barbinodis*), green sprangletop (*Leptochloa dubia*), and tanglehead (*Heteropogon contortus*). Deergrass (*Muhlenbergia rigens*), a facultative wetland species, can become a dominant near springs or other perennial sources of water.

GLOBAL TYPE CONCEPT DESCRIPTION

Data not available.

MOST ABUNDANT SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	None
Canopy (2–5 m)	<i>Quercus emoryi</i> , <i>Quercus oblongifolia</i> , <i>Quercus arizonica</i>
Subcanopy (0.5–2 m)	<i>Rhus virens</i> , <i>Ehysenhardtia orthocarpa</i> , <i>Garrya wrightii</i> , <i>Aloysia wrightii</i>
Field (0–0.5 m)	None

OTHER NOTEWORTHY ASSOCIATE SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	None
Canopy (2–5 m)	<i>Juglans major</i> , <i>Pinus discolor</i>
Subcanopy (0.5–2 m)	<i>Mimosa aculeaticarpa</i> , <i>Gossypium thurberi</i> , <i>Vitis arizonica</i> , <i>Cercocarpus montanus</i>
Field (0–0.5 m)	<i>Bouteloua curtipendula</i> , <i>Muhlenbergia emersleyi</i> , <i>Bothriochloa barbinodis</i> , <i>Leptochloa dubia</i> , <i>Heteropogon contortus</i> , <i>Muhlenbergia rigens</i>

CLASSIFICATION COMMENTS

Coronado National Memorial

This association was described from 3 classification plots and 3 classification polygons.

Global

Data not available.

Classification confidence: Low

NatureServe conservation status: Data not available

Global status: Data not available

Rounded global status: Data not available

Global range: Data not available

Reasons:

ELEMENT SOURCES

Plots: IP020, IP098, IP120

Polygons: WS002_D, WS003_D, WS007_D

Local description authors: J. Galvin

23. (*Prosopis velutina* - *Baccharis sarothroides*) / *Eragrostis lehmanniana* Herbaceous Association (P)

Translated name: (Velvet mesquite - Desertbroom) / Lehmann lovegrass Herbaceous Association

NVC name: Not available

Identifier: NPSSODN0046

NVC CLASSIFICATION

Division: --

Macrogroup: --

Group: --

Association: (*Prosopis velutina* - *Baccharis sarothroides*) / *Eragrostis lehmanniana* Herbaceous Association

DISTRIBUTION

Coronado National Memorial

This herbaceous association occupies the southeastern corner of the memorial.

ENVIRONMENTAL DESCRIPTION

Coronado National Memorial

This shrubland community spans a low-angle (<6%), southeast-facing upper alluvial fan from 1,480 to 1,560 m (4,855–5,118 ft). The surface cover is characterized by dominant bare soil with common gravel and rock throughout.

VEGETATION DESCRIPTION

Coronado National Memorial

This herbaceous community is characterized by an extremely dense (80%) matrix of perennial grass, solely dominated by Lehmann lovegrass (*Eragrostis lehmanniana*), with sparse (3%) shrub cover in the subcanopy stratum (>0.5–2 m), which consists of two common associates, velvet mesquite (*Prosopis velutina*) and desertbroom (*Baccharis sarothroides*). Canopy cover (>2 m) is extremely sparse (<1%), and, if present, is typically composed of a few scattered Emory oak (*Quercus emoryi*) or Mexican blue oak (*Quercus oblongifolia*). In general, areas with greater canopy cover are toward the higher elevation, northern boundary of the community or associated with minor drainages.

The subcanopy stratum (0.5–2 m) is characterized by sparse (3[10]%) cover of shrubs and small, shrubby trees. Velvet mesquite (*P. velutina*), while providing little cover (1%) throughout, is the most consistent and dominant species besides Lehmann lovegrass (*E. lehmanniana*), occasionally providing cover near 8%. This species is most commonly present as a shrub, but can sporadically occur as a small tree that reaches into the canopy strata. Desertbroom (*B. sarothroides*) is another sparse, but common, associate, usually providing cover around 1%. In order from most to least dominant, other noteworthy shrubs include yerba de pasmo (*Baccharis pteronioides*), Palmer's century plant (*Agave palmeri*), catclaw mimosa (*Mimosa aculeaticarpa*), Chihuahuan brickellbush (*Brickellia floribunda*), and cactus apple (*Opuntia engelmannii*).

The field stratum (<0.5 m) is solely dominated by a matrix of Lehmann lovegrass (*E. lehmanniana*), an introduced, perennial bunchgrass. This species provides a consistent 75% cover across the whole community. Spidergrass (*Aristida ternipes*), cane bluestem (*Bothriochloa barbinodis*), and sideoats grama (*Bouteloua curtipendula*) are variable and extremely low-cover (<1%) associated perennial grasses. Other noteworthy species in this stratum include camphorweed (*Heterotheca subaxillaris*), bastard sage (*Eriogonum wrightii*), fairyduster (*Calliandra eriophylla*), Wright's cudweed (*Pseudognaphalium canescens*), and blue grama (*Bouteloua gracilis*).

This community experienced a predominately moderate burn severity during the Monument Fire of 2011. Pre-fire, this community was defined by the sole dominance of Lehmann lovegrass (*E. lehmanniana*) and that has

not changed. The largest change is a decrease in shrub cover, most noticeably of velvet mesquite (*P. velutina*) and desertbroom (*B. sarothroides*).

At times, usually where the upper alluvial fan and toeslopes meet, this community can present as a tree savanna with increased cover in the canopy strata. This cover is typically split between tree-like velvet mesquite (*P. velutina*), large (up to 7 m) Emory oak (*Q. emoryi*), and Mexican blue oak (*Quercus oblongifolia*), with total cover less than 10%. This variation is essentially a gradient between the Emory oak (*Q. emoryi*) / mixed perennial grass woodland on the toeslopes and this community across the alluvial fan. The Lehmann lovegrass (*E. lehmanniana*) dominant field stratum is identical to the herbaceous variation.

GLOBAL TYPE CONCEPT DESCRIPTION

Data not available.

MOST ABUNDANT SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	None
Canopy (2–5 m)	None
Subcanopy (0.5–2 m)	<i>Prosopis velutina</i> , <i>Baccharis sarothroides</i>
Field (0–0.5 m)	<i>Eragrostis lehmanniana</i>

OTHER NOTEWORTHY ASSOCIATE SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	<i>Quercus emoryi</i> , <i>Quercus oblongifolia</i>
Canopy (2–5 m)	<i>Quercus emoryi</i> , <i>Quercus oblongifolia</i>
Subcanopy (0.5–2 m)	<i>Mimosa aculeaticarpa</i> , <i>Brickellia floribunda</i> , <i>Baccharis pteronioides</i> , <i>Opuntia engelmannii</i>
Field (0–0.5 m)	<i>Heterotheca subaxillaris</i> , <i>Calliandra eriophylla</i> , <i>Pseudognaphalium canescens</i> , <i>Baccharis pteronioides</i> , <i>Aristida ternipes</i> , <i>Eriogonum wrightii</i> , <i>Agave palmeri</i> , <i>Bothriochloa barbinodis</i>

CLASSIFICATION COMMENTS

Coronado National Memorial

This association was described from 4 classification plots and 10 classification polygons.

Global

Data not available.

Classification confidence: Low

NatureServe conservation status: Data not available

Global status: Data not available

Rounded global status: Data not available

Global range: Data not available

Reasons:

ELEMENT SOURCES

Plots: IP008, IP021, IP061, IP086

Polygons: H004_D, H102, H303, H304, SS014_D, SS018_D, TS026_D, TS100, TS300, TS302

Local description authors: J. Galvin

24. (*Agave palmeri* - *Mimosa aculeaticarpa*) / Mixed Perennial Grass (*Calliandra eriophylla*) Herbaceous Association (P)

Translated name: (Palmer's century plant - Catclaw mimosa) / Mixed Perennial Grass (Fairyduster) Herbaceous Association

NVC name: Not available

Identifier: NPSSODN0045

NVC CLASSIFICATION

Division: --

Macrogroup: --

Group: --

Association: (*Agave palmeri* - *Mimosa aculeaticarpa*) / Mixed Perennial Grass (*Calliandra eriophylla*) Herbaceous Association

DISTRIBUTION

Coronado National Memorial

Within the memorial, this herbaceous association spans low slopes along the eastern end of Smugglers Ridge, on the low hills south of Bob Thompson Peak, and occasionally intermixed with the non-native grassland in the southeast corner.

ENVIRONMENTAL DESCRIPTION

Coronado National Memorial

This herbaceous community spans low-angle (<6%) to medium (<50%), south-facing foot and toeslopes with some occurrences spanning backslopes from 1,490 to 1,620 m (4,888–5,315 ft). The surface is characterized by an even mix of small rock and gravel with patchy litter and bare soil.

VEGETATION DESCRIPTION

Coronado National Memorial

This herbaceous community is characterized by a sparse (<5%) subcanopy stratum (0.5–2 m) defined by the common associates, Palmer's century plant (*Agave palmeri*) and catclaw mimosa (*Mimosa aculeaticarpa*), with a dense (66%) field stratum (<0.5 m) dominated by a mix of perennial grasses and fairyduster (*Calliandra eriophylla*). The canopy strata (>2 m) are usually devoid of species, but ocotillo (*Fouquieria splendens*, usually where exposed bedrock is prevalent) and Mexican blue oak (*Quercus oblongifolia*, along small drainage inclusions) are rare associates.

The subcanopy stratum is defined by the sparse (3[7]%) but consistent presence of Palmer's century plant (*A. palmeri*) throughout. Catclaw mimosa (*M. aculeaticarpa*) provides patchy cover throughout, often with cover similar to that of Palmer's agave (*A. palmeri*). Common sotol (*Dasylirion wheeleri*) is an inconsistent associate with trivial cover across the whole community, but with occasional inclusions where it is co-dominant with, or, rarely, dominant over, Palmer's century plant (*A. palmeri*). This typically occurs in the ecotone with the similar common sotol (*D. wheeleri*) / mixed perennial grass community and/or on the higher footslopes and backslopes. Along the numerous minor drainages that traverse this community, Wright's beebrush (*Aloysia wrightii*) and Tahitian kidneywood (*Eysenhardtia orthocarpa*) can provide noteworthy cover. Other subcanopy species of note include walkingstick cactus (*Cylindropuntia spinosior*), cactus apple (*Opuntia engelmannii*), velvet mesquite (*Prosopis velutina*), and beargrass (*Nolina microcarpa*).

The field stratum is dominated by a dense (~50%) mix of native and non-native perennial grasses, as well as, the low shrub, fairyduster (*Calliandra eriophylla*). The non-native grasses are predominately composed of Lehmann lovegrass (*Eragrostis lehmanniana*), with an average cover around 40%, but weeping lovegrass (*Eragrostis curvula*) contributes rare inclusions of co-dominance. Spidergrass (*Aristida ternipes*), sideoats grama (*Bouteloua curtipendula*), and tanglehead (*Heteropogon contortus*) provide the highest and most consistent cover of the native grasses,

with cover for each around 5%. In order from most to least dominant, other noteworthy native grasses include green sprangletop (*Leptochloa dubia*), cane bluestem (*Bothriochloa barbinodis*), single threeawn (*Aristida schiedeana*), plains lovegrass (*Eragrostis intermedia*), Texas bluestem (*Schizachyrium cirratum*), and black grama (*Bouteloua eriopoda*). In general, the non-native grasses are most common on the lower slopes where the community transitions to the similar velvet mesquite (*P. velutina*) / Lehmann lovegrass (*E. lehmanniana*) herbaceous association. On the higher slopes, the native grasses tend to out-compete the non-natives. The other major field component, fairyduster (*C. eriophylla*), provides a consistent 5% low-growing cover throughout, with rare inclusions of dominance where cover approaches 18%. When conditions are appropriate, annual forbs—specifically, longleaf false goldeneye (*Heliomeris longifolia*)—may become a conspicuous component of this stratum. Other noteworthy field components include Arizona bluecurls (*Trichostema arizonicum*), Wright’s cudweed (*Pseudognaphalium canescens*), yerba de pascmo (*Baccharis pteronioides*), Huachuca Mountain rocktrumpet (*Macrosiphonia brachysiphon*), and tulip pricklypear (*Opuntia phaeacantha*).

Areas covered by this association were variably affected by the Monument Fire of 2011, ranging from low to moderate severity. Post-fire examples of this type may exhibit lower cover of succulents and shrubs within the subcanopy and field strata. All examples of this community mapped post-fire contain noticeably lower cover of Palmer’s century plant (*A. palmeri*). In addition, the distribution of Lehmann lovegrass (*E. lehmanniana*) likely increased and is more common on the higher slopes previously dominated by natives, and may be the sole grass component on the lower slopes.

GLOBAL TYPE CONCEPT DESCRIPTION

Data not available.

MOST ABUNDANT SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	None
Canopy (2–5 m)	None
Subcanopy (0.5–2 m)	<i>Agave palmeri</i> , <i>Mimosa aculeaticarpa</i> , <i>Dasyllirion wheeleri</i>
Field (0–0.5 m)	<i>Eragrostis lehmanniana</i> , <i>Aristida ternipes</i> , <i>Bouteloua curtipendula</i> , <i>Calliandra eriophylla</i> , <i>Heteropogon contortus</i>

OTHER NOTEWORTHY ASSOCIATE SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	None
Canopy (2–5 m)	<i>Quercus oblongifolia</i> , <i>Fouquieria splendens</i>
Subcanopy (0.5–2 m)	<i>Aloysia wrightii</i> , <i>Cylindropuntia spinosior</i> , <i>Opuntia engelmannii</i> , <i>Prosopis velutina</i> , <i>Eysenhardtia orthocarpa</i> , <i>Nolina microcarpa</i>
Field (0–0.5 m)	<i>Eragrostis intermedia</i> , <i>Eragrostis curvula</i> , <i>Leptochloa dubia</i> , <i>Bothriochloa barbinodis</i> , <i>Aristida schiedeana</i> , <i>Schizachyrium cirratum</i> , <i>Heliomeris longifolia</i> , <i>Trichostema arizonicum</i> , <i>Pseudognaphalium canescens</i> , <i>Baccharis pteronioides</i> , <i>Macrosiphonia brachysiphon</i> , <i>Opuntia phaeacantha</i> , <i>Bouteloua eriopoda</i>

CLASSIFICATION COMMENTS

Coronado National Memorial

This association was described from 11 classification plots and 11 classification polygons.

Global

Data not available.

Classification confidence: Low

NatureServe conservation status: Data not available

Global status: Data not available

Rounded global status: Data not available

Global range: Data not available

Reasons:

ELEMENT SOURCES

Plots: IP007, IP032, IP039, IP044, IP050, IP056, IP059, IP072, IP078, IP082, IP097, IP140

Polygons: H001_D, H002_D, H003_D, H100, H105, H107, H301B, H302, SS304_D, SS016_NV, SS020_D

Local description authors: J. Galvin

25. *Baccharis sarothroides* / *Bothriochloa barbinodis* (*Eragrostis lehmanniana*) Shrub Savanna Association (PS)

Translated name: Desertbroom / Cane bluestem (Lehmann lovegrass) Shrub Savanna Association

NVC name: Not available

Identifier: NPSSODN0054

NVC CLASSIFICATION

Division: --

Macrogroup: --

Group: --

Association: *Baccharis sarothroides* / *Bothriochloa barbinodis* (*Eragrostis lehmanniana*) Shrub Savanna

DISTRIBUTION

Coronado National Memorial

This association occupies a restoration area that spans a heavily disturbed site used as a staging area for the building of the border fence.

ENVIRONMENTAL DESCRIPTION

Coronado National Memorial

This shrub savanna community spans a low-angle (<6%), southeast-facing, lower alluvial fan at 1,510 m (4,954 ft). The surface cover is characterized by dominant bare soil and gravel.

VEGETATION DESCRIPTION

Coronado National Memorial

This community is described as a “park special,” meaning it is recognized as a unique suite of plants due directly to the recent history of anthropogenic disturbance. This shrub savanna community is characterized by a moderately sparse (<15%) subcanopy stratum (0.5–2 m) dominated by desertbroom (*Baccharis sarothroides*) and a dense (36%) field stratum (<0.5) dominated by cane bluestem (*Bothriochloa barbinodis*), with one common associate, Lehmann lovegrass (*Eragrostis lehmanniana*). Canopy species (>2 m) are extremely rare, with just a few scattered Emory oak (*Quercus emoryi*) along the margins of the community.

The subcanopy is solely dominated by desertbroom (*B. sarothroides*), which provides a consistent 13% cover throughout. Velvet mesquite (*Prosopis velutina*) provides less than one percent cover and is the only other species recorded within this stratum.

The field stratum is characterized by the dominance of the native, perennial bunch-grass cane bluestem (*B. barbinodis*) with a consistent 17% cover throughout. Lehmann lovegrass (*E. lehmanniana*) provides around 8% cover, mainly along a dirt road and in the ecotone with the adjacent non-native grasslands. Other noteworthy species of perennial grass include green sprangletop (*Leptochloa dubia*), streambed bristlegrass (*Setaria leucophila*), and Arizona cottontop (*Digitaria californica*). This area is included within the Palmer’s century plant (*Agave palmeri*) restoration site. Crewmembers documented the presence of this species, but it provided extremely low cover (<1%).

GLOBAL TYPE CONCEPT DESCRIPTION

Data not available.

MOST ABUNDANT SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	None
Canopy (2–5 m)	None
Subcanopy (0.5–2 m)	<i>Baccharis sarothroides</i>
Field (0–0.5 m)	<i>Bothriochloa barbinodis</i> , <i>Eragrostis lehmanniana</i>

OTHER NOTEWORTHY ASSOCIATE SPECIES

Coronado National Memorial

Stratum	Species
Canopy (>5 m)	<i>Quercus emoryi</i>
Canopy (2–5 m)	None
Subcanopy (0.5–2 m)	<i>Prosopis velutina</i>
Field (0–0.5 m)	<i>Leptochloa dubia</i> , <i>Digitaria californica</i> , <i>Setaria leucopila</i> , <i>Agave palmeri</i>

CLASSIFICATION COMMENTS

Coronado National Memorial

This park special association was described from one classification polygon.

Global

Data not available.

Classification confidence: Data not available

NatureServe conservation status: Data not available

Global status: Data not available

Rounded global status: Data not available

Global range: Data not available

Reasons:

ELEMENT SOURCES

Plots: None

Polygons: SS307

Local description authors: J. Galvin

Appendix E: Species List

Family	Scientific name	Common name	Nativity	Duration	Primary_Lifeform
Acanthaceae	<i>Anisacanthus thurberi</i>	Thurber's desert honeysuckle	Native	Perennial	Shrub
Amaranthaceae	<i>Froelichia arizonica</i>	Arizona snakecotton	Native	Perennial	Forb/Herb
Amaranthaceae	<i>Gomphrena sonora</i>	Sonoran globe amaranth	Native	Annual	Forb/Herb
Anacardiaceae	<i>Rhus aromatica</i>	fragrant sumac	Native	Perennial	Shrub
Anacardiaceae	<i>Rhus virens</i>	evergreen sumac	Native	Perennial	Shrub
Apocynaceae	<i>Mandevilla brachysiphon</i>	Huachuca Mountain rocktrumpet	Native	Perennial	Subshrub
Araliaceae	<i>Aralia humilis</i>	Arizona spikenard	Native	Perennial	Shrub
Asparagaceae	<i>Agave palmeri</i>	Palmer's century plant	Native	Perennial	Succulent
Asparagaceae	<i>Agave parryi</i>	Parry's agave	Native	Perennial	Succulent
Asparagaceae	<i>Agave schottii</i>	Schott's century plant	Native	Perennial	Succulent
Asparagaceae	<i>Dasylirion wheeleri</i>	common sotol	Native	Perennial	Subshrub
Asparagaceae	<i>Nolina microcarpa</i>	sacahuista	Native	Perennial	Subshrub
Asparagaceae	<i>Yucca madrensis</i>	yucca	Native	Perennial	Succulent
Asteraceae	<i>Acourtia wrightii</i>	brownfoot	Native	Perennial	Forb/Herb
Asteraceae	<i>Ageratina herbacea</i>	fragrant snakeroot	Native	Perennial	Subshrub
Asteraceae	<i>Ambrosia confertiflora</i>	weakleaf bur ragweed	Native	Perennial	Forb/Herb
Asteraceae	<i>Artemisia ludoviciana</i>	white sagebrush	Native	Perennial	Forb/Herb
Asteraceae	<i>Baccharis bigelovii</i>	Bigelow's false willow	Native	Perennial	Shrub
Asteraceae	<i>Baccharis brachyphylla</i>	shortleaf baccharis	Native	Perennial	Shrub
Asteraceae	<i>Baccharis pteronioides</i>	yerba de pasmo	Native	Perennial	Shrub
Asteraceae	<i>Baccharis salicifolia</i>	mule-fat	Native	Perennial	Shrub
Asteraceae	<i>Baccharis sarothroides</i>	desertbroom	Native	Perennial	Shrub
Asteraceae	<i>Baccharis thesioides</i>	Arizona baccharis	Native	Perennial	Subshrub
Asteraceae	<i>Bahia absinthifolia</i>	hairseed bahia	Native	Perennial	Forb/Herb
Asteraceae	<i>Bidens bigelovii</i>	Bigelow's beggarticks	Native	Annual	Forb/Herb
Asteraceae	<i>Brickellia betonicifolia</i>	betonyleaf brickellbush	Native	Perennial	Forb/Herb
Asteraceae	<i>Brickellia brachyphylla</i>	plumed brickellbush	Native	Perennial	Forb/Herb
Asteraceae	<i>Brickellia californica</i>	California brickellbush	Native	Perennial	Shrub
Asteraceae	<i>Brickellia eupatorioides</i>	false boneset	Native	Perennial	Subshrub
Asteraceae	<i>Brickellia floribunda</i>	Chihuahuan brickellbush	Native	Perennial	Subshrub
Asteraceae	<i>Brickellia simplex</i>	Sonoran brickellbush	Native	Perennial	Subshrub
Asteraceae	<i>Brickellia venosa</i>	veiny brickellbush	Native	Perennial	Subshrub
Asteraceae	<i>Carphochaete bigelovii</i>	Bigelow's bristlehead	Native	Perennial	Subshrub
Asteraceae	<i>Cirsium ochrocentrum</i>	yellowspine thistle	Native	Perennial	Forb/Herb
Asteraceae	<i>Conyza canadensis</i>	Canadian horseweed	Native	Annual	Forb/Herb
Asteraceae	<i>Ericameria laricifolia</i>	turpentine bush	Native	Perennial	Shrub
Asteraceae	<i>Ericameria nauseosa</i>	rubber rabbitbrush	Native	Perennial	Shrub
Asteraceae	<i>Erigeron concinnus</i>	Navajo fleabane	Native	Perennial	Forb/Herb
Asteraceae	<i>Erigeron divergens</i>	spreading fleabane	Native	Biennial	Forb/Herb
Asteraceae	<i>Erigeron flagellaris</i>	trailing fleabane	Native	Biennial	Forb/Herb
Asteraceae	<i>Erigeron neomexicanus</i>	New Mexico fleabane	Native	Perennial	Forb/Herb
Asteraceae	<i>Erigeron oreophilus</i>	chaparral fleabane	Native	Perennial	Forb/Herb
Asteraceae	<i>Fleischmannia pycnocephala</i>	lavender thoroughwort	Native	Perennial	Forb/Herb

Appendix E: Species List, cont.

Family	Scientific name	Common name	Nativity	Duration	Primary_Lifeform
Asteraceae	<i>Guardiola platyphylla</i>	Apache plant	Native	Perennial	Forb/Herb
Asteraceae	<i>Gymnosperma glutinosum</i>	gumhead	Native	Perennial	Subshrub
Asteraceae	<i>Heliomeris longifolia</i>	longleaf false goldeneye	Native	Annual	Forb/Herb
Asteraceae	<i>Heliomeris multiflora</i>	showy goldeneye	Native	Perennial	Forb/Herb
Asteraceae	<i>Heterotheca subaxillaris</i>	camphorweed	Native	Annual	Forb/Herb
Asteraceae	<i>Heterotheca villosa</i>	hairy false goldenaster	Native	Perennial	Forb/Herb
Asteraceae	<i>Hymenothrix wrightii</i>	Wright's thimblehead	Native	Perennial	Forb/Herb
Asteraceae	<i>Lasianthaea podocephala</i>	San Pedro daisy	Native	Perennial	Forb/Herb
Asteraceae	<i>Machaeranthera tagetina</i>	mesa tansyaster	Native	Annual	Forb/Herb
Asteraceae	<i>Parthenium incanum</i>	mariola	Native	Perennial	Shrub
Asteraceae	<i>Pseudognaphalium canescens</i>	Wright's cudweed	Native	Annual	Forb/Herb
Asteraceae	<i>Senecio flaccidus</i>	threadleaf ragwort	Native	Perennial	Subshrub
Asteraceae	<i>Solidago velutina</i>	threeneerve goldenrod	Native	Perennial	Forb/Herb
Asteraceae	<i>Solidago wrightii</i>	Wright's goldenrod	Native	Perennial	Forb/Herb
Asteraceae	<i>Stephanomeria pauciflora</i>	brownplume wirelettuce	Native	Perennial	Forb/Herb
Asteraceae	<i>Stevia serrata</i>	sawtooth candyleaf	Native	Perennial	Forb/Herb
Asteraceae	<i>Thymophylla pentachaeta</i>	fiveneedle pricklyleaf	Native	Perennial	Subshrub
Asteraceae	<i>Trixis californica</i>	American threefold	Native	Perennial	Shrub
Asteraceae	<i>Verbesina longifolia</i>	longleaf crownbeard	Native	Perennial	Forb/Herb
Asteraceae	<i>Verbesina rothrockii</i>	Rothrock's crownbeard	Native	Perennial	Forb/Herb
Asteraceae	<i>Viguiera cordifolia</i>	heartleaf goldeneye	Native	Perennial	Forb/Herb
Asteraceae	<i>Viguiera dentata</i>	toothleaf goldeneye	Native	Perennial	Forb/Herb
Asteraceae	<i>Xanthisma spinulosum</i>	lacy tansyaster	Native	Perennial	Forb/Herb
Asteraceae	<i>Zinnia grandiflora</i>	Rocky Mountain zinnia	Native	Perennial	Subshrub
Berberidaceae	<i>Berberis wilcoxii</i>	Wilcox's barberry	Native	Perennial	Shrub
Bignoniaceae	<i>Chilopsis linearis</i>	desert willow	Native	Perennial	Tree
Brassicaceae	<i>Hesperidanthus linearifolius</i>	slimleaf plainsmustard	Native	Perennial	Forb/Herb
Cactaceae	<i>Cylindropuntia spinosior</i>	walkingstick cactus	Native	Perennial	Succulent
Cactaceae	<i>Echinocereus coccineus</i>	scarlet hedgehog cactus	Native	Perennial	Succulent
Cactaceae	<i>Echinocereus engelmannii</i>	Engelmann's hedgehog cactus	Native	Perennial	Succulent
Cactaceae	<i>Echinocereus rigidissimus</i>	rainbow hedgehog cactus	Native	Perennial	Succulent
Cactaceae	<i>Escobaria vivipara</i>	spinystar	Native	Perennial	Succulent
Cactaceae	<i>Opuntia chlorotica</i>	dollarjoint pricklypear	Native	Perennial	Succulent
Cactaceae	<i>Opuntia engelmannii</i>	cactus apple	Native	Perennial	Succulent
Cactaceae	<i>Opuntia phaeacantha</i>	tulip pricklypear	Native	Perennial	Succulent
Caprifoliaceae	<i>Lonicera albiflora</i>	western white honeysuckle	Native	Perennial	Vine

Appendix E: Species List, cont.

Family	Scientific name	Common name	Nativity	Duration	Primary_Lifeform
Commelinaceae	<i>Tradescantia pinetorum</i>	pinewoods spiderwort	Native	Perennial	Forb/Herb
Convolvulaceae	<i>Evolvulus arizonicus</i>	wild dwarf morning-glory	Native	Perennial	Forb/Herb
Convolvulaceae	<i>Evolvulus nuttallianus</i>	shaggy dwarf morning-glory	Native	Perennial	Forb/Herb
Convolvulaceae	<i>Ipomoea capillacea</i>	purple morning-glory	Native	Perennial	Forb/Herb
Convolvulaceae	<i>Ipomoea coccinea</i>	redstar	Non-Native	Annual	Vine
Convolvulaceae	<i>Ipomoea hederifolia</i>	scarletcreeper	Native	Annual	Vine
Convolvulaceae	<i>Ipomoea longifolia</i>	pinkthroat morning-glory	Native	Perennial	Vine
Cucurbitaceae	<i>Cucurbita digitata</i>	fingerleaf gourd	Native	Perennial	Vine
Cupressaceae	<i>Juniperus deppeana</i>	alligator juniper	Native	Perennial	Tree
Cyperaceae	<i>Carex geophila</i>	White Mountain sedge	Native	Perennial	Graminoid
Cyperaceae	<i>Cyperus mutisii</i>	Mutis' flatsedge	Native	Perennial	Graminoid
Cyperaceae	<i>Cyperus retroflexus</i>	oneflower flatsedge	Native	Perennial	Graminoid
Ericaceae	<i>Arbutus arizonica</i>	Arizona madrone	Native	Perennial	Tree
Ericaceae	<i>Arctostaphylos pungens</i>	pointleaf manzanita	Native	Perennial	Shrub
Euphorbiaceae	<i>Croton pottsii</i>	leatherweed	Native	Perennial	Subshrub
Euphorbiaceae	<i>Tragia ramosa</i>	branched noseburn	Native	Perennial	Forb/Herb
Fabaceae	<i>Acacia angustissima</i>	prairie acacia	Native	Perennial	Subshrub
Fabaceae	<i>Acmispon greenei</i>	Greene's bird's-foot trefoil	Native	Perennial	Forb/Herb
Fabaceae	<i>Acmispon oroboides</i>	New Mexico bird's-foot trefoil	Native	Perennial	Forb/Herb
Fabaceae	<i>Acmispon wrightii</i>	Wright's deervetch	Native	Perennial	Forb/Herb
Fabaceae	<i>Amorpha fruticosa</i>	false indigo bush	Native	Perennial	Shrub
Fabaceae	<i>Astragalus nuttallianus</i>	smallflowered milkvetch	Native	Annual	Forb/Herb
Fabaceae	<i>Astragalus thurberi</i>	Thurber's milkvetch	Native	Perennial	Forb/Herb
Fabaceae	<i>Calliandra eriophylla</i>	fairyduster	Native	Perennial	Shrub
Fabaceae	<i>Calliandra humilis</i>	dwarf stickpea	Native	Perennial	Subshrub
Fabaceae	<i>Chamaecrista nictitans</i>	sensitive partridge pea	Native	Annual	Forb/Herb
Fabaceae	<i>Coursetia caribaea</i>	anil falso	Native	Perennial	Subshrub
Fabaceae	<i>Dalea albiflora</i>	whiteflower prairie clover	Native	Perennial	Forb/Herb
Fabaceae	<i>Dalea grayi</i>	Gray's prairie clover	Native	Perennial	Forb/Herb
Fabaceae	<i>Dalea versicolor</i>	oakwoods prairie clover	Native	Perennial	Subshrub
Fabaceae	<i>Desmodium batocaulon</i>	San Pedro ticktrefoil	Native	Perennial	Forb/Herb
Fabaceae	<i>Desmodium cinerascens</i>	spiked ticktrefoil	Native	Perennial	Subshrub
Fabaceae	<i>Erythrina flabelliformis</i>	coralbean	Native	Perennial	Shrub
Fabaceae	<i>Eysenhardtia orthocarpa</i>	Tahitian kidneywood	Native	Perennial	Shrub
Fabaceae	<i>Galactia wrightii</i>	Wright's milkpea	Native	Perennial	Vine
Fabaceae	<i>Indigofera sphaerocarpa</i>	Sonoran indigo	Native	Perennial	Shrub
Fabaceae	<i>Lathyrus graminifolius</i>	grassleaf pea	Native	Perennial	Vine
Fabaceae	<i>Mimosa aculeaticarpa</i>	catclaw mimosa	Native	Perennial	Shrub
Fabaceae	<i>Mimosa dysocarpa</i>	velvetpod mimosa	Native	Perennial	Shrub
Fabaceae	<i>Mimosa grahamii</i>	Graham's mimosa	Native	Perennial	Shrub
Fabaceae	<i>Nissolia wislizeni</i>	Arizona yellowhood	Native	Perennial	Vine
Fabaceae	<i>Phaseolus acutifolius</i>	tepary bean	Native	Annual	Vine
Fabaceae	<i>Phaseolus ritensis</i>	Santa Rita Mountain bean	Native	Perennial	Vine
Fabaceae	<i>Prosopis glandulosa</i>	honey mesquite	Native	Perennial	Tree

Appendix E: Species List, cont.

Family	Scientific name	Common name	Nativity	Duration	Primary_Lifeform
Fabaceae	<i>Prosopis velutina</i>	velvet mesquite	Native	Perennial	Tree
Fabaceae	<i>Robinia neomexicana</i>	New Mexico locust	Native	Perennial	Shrub
Fabaceae	<i>Senna bauhinoides</i>	twingleaf senna	Native	Perennial	Forb/Herb
Fabaceae	<i>Tephrosia vicioides</i>	red hoarypea	Native	Perennial	Forb/Herb
Fabaceae	<i>Vicia ludoviciana</i>	Louisiana vetch	Native	Annual	Vine
Fabaceae	<i>Zornia reticulata</i>	zarzabacoa de dos hojas	Native	Perennial	Forb/Herb
Fagaceae	<i>Quercus arizonica</i>	Arizona white oak	Native	Perennial	Tree
Fagaceae	<i>Quercus emoryi</i>	Emory oak	Native	Perennial	Tree
Fagaceae	<i>Quercus gambelii</i>	Gambel oak	Native	Perennial	Tree
Fagaceae	<i>Quercus hypoleucoides</i>	silverleaf oak	Native	Perennial	Tree
Fagaceae	<i>Quercus oblongifolia</i>	Mexican blue oak	Native	Perennial	Tree
Fagaceae	<i>Quercus rugosa</i>	netleaf oak	Native	Perennial	Shrub
Fagaceae	<i>Quercus toumeyi</i>	Toumey oak	Native	Perennial	Shrub
Fagaceae	<i>Quercus turbinella</i>	Sonoran scrub oak	Native	Perennial	Shrub
Fouquieriaceae	<i>Fouquieria splendens</i>	ocotillo	Native	Perennial	Shrub
Garryaceae	<i>Garrya flavescens</i>	ashy silktassel	Native	Perennial	Shrub
Garryaceae	<i>Garrya wrightii</i>	Wright's silktassel	Native	Perennial	Shrub
Geraniaceae	<i>Geranium caespitosum</i>	pineywoods geranium	Native	Perennial	Subshrub
Hydrangeaceae	<i>Philadelphus microphyllus</i>	littleleaf mock orange	Native	Perennial	Shrub
Juglandaceae	<i>Juglans major</i>	Arizona walnut	Native	Perennial	Tree
Krameriaceae	<i>Krameria erecta</i>	littleleaf ratany	Native	Perennial	Shrub
Krameriaceae	<i>Krameria lanceolata</i>	trailing krameria	Native	Perennial	Subshrub
Lamiaceae	<i>Hedeoma dentata</i>	dentate false pennyroyal	Native	Perennial	Forb/Herb
Lamiaceae	<i>Hedeoma nana</i>	dwarf false pennyroyal	Native	Perennial	Forb/Herb
Lamiaceae	<i>Monarda citriodora</i>	lemon beebalm	Native	Perennial	Forb/Herb
Lamiaceae	<i>Salvia lemmonii</i>	Lemmon's sage	Native	Perennial	Shrub
Lamiaceae	<i>Stachys coccinea</i>	scarlet hedgenettle	Native	Perennial	Forb/Herb
Lamiaceae	<i>Trichostema arizonicum</i>	Arizona bluecurls	Native	Perennial	Subshrub
Linaceae	<i>Linum puberulum</i>	plains flax	Native	Annual	Forb/Herb
Malpighiaceae	<i>Aspicarpa hirtella</i>	chaparral asthead	Native	Perennial	Subshrub
Malvaceae	<i>Ayenia filiformis</i>	Trans-Pecos ayenia	Native	Perennial	Subshrub
Malvaceae	<i>Gossypium thurberi</i>	Thurber's cotton	Native	Perennial	Shrub
Malvaceae	<i>Sida abutilifolia</i>	spreading fanpetals	Non-Native	Perennial	Forb/Herb
Malvaceae	<i>Sphaeralcea wrightii</i>	Wright's globemallow	Native	Perennial	Subshrub
Nyctaginaceae	<i>Mirabilis coccinea</i>	scarlet four o'clock	Native	Perennial	Forb/Herb
Nyctaginaceae	<i>Mirabilis linearis</i>	narrowleaf four o'clock	Native	Perennial	Forb/Herb
Nyctaginaceae	<i>Mirabilis longiflora</i>	sweet four o'clock	Native	Perennial	Forb/Herb
Oleaceae	<i>Fraxinus velutina</i>	velvet ash	Native	Perennial	Tree
Onagraceae	<i>Oenothera cespitosa</i>	tufted evening primrose	Native	Perennial	Forb/Herb
Onagraceae	<i>Oenothera primiveris</i>	desert evening primrose	Native	Annual	Forb/Herb
Orobanchaceae	<i>Brachystigma wrightii</i>	Arizona desert foxglove	Native	Perennial	Forb/Herb
Papaveraceae	<i>Argemone pleiacantha</i>	southwestern pricklypoppy	Native	Perennial	Forb/Herb
Pinaceae	<i>Pinus discolor</i>	border pinyon	Native	Perennial	Tree

Appendix E: Species List, cont.

Family	Scientific name	Common name	Nativity	Duration	Primary_Lifeform
Plantaginaceae	<i>Maurandella antirrhiniflora</i>	roving sailor	Native	Perennial	Vine
Plantaginaceae	<i>Penstemon barbatus</i>	beardlip penstemon	Native	Perennial	Forb/Herb
Platanaceae	<i>Platanus wrightii</i>	Arizona sycamore	Native	Perennial	Tree
Poaceae	<i>Aristida purpurea</i>	purple threeawn	Native	Perennial	Graminoid
Poaceae	<i>Aristida schiedeana</i>	single threeawn	Native	Perennial	Graminoid
Poaceae	<i>Aristida ternipes</i>	spidergrass	Native	Perennial	Graminoid
Poaceae	<i>Bothriochloa barbinodis</i>	cane bluestem	Native	Perennial	Graminoid
Poaceae	<i>Bouteloua curtipendula</i>	sideoats grama	Native	Perennial	Graminoid
Poaceae	<i>Bouteloua eriopoda</i>	black grama	Native	Perennial	Graminoid
Poaceae	<i>Bouteloua gracilis</i>	blue grama	Native	Perennial	Graminoid
Poaceae	<i>Bouteloua hirsuta</i>	hairy grama	Native	Perennial	Graminoid
Poaceae	<i>Bouteloua radicata</i>	purple grama	Native	Perennial	Graminoid
Poaceae	<i>Bouteloua repens</i>	slender grama	Native	Perennial	Graminoid
Poaceae	<i>Bromus anomalus</i>	nodding brome	Native	Perennial	Graminoid
Poaceae	<i>Bromus ciliatus</i>	fringed brome	Native	Perennial	Graminoid
Poaceae	<i>Cynodon dactylon</i>	Bermudagrass	Non-Native	Perennial	Graminoid
Poaceae	<i>Digitaria californica</i>	Arizona cottontop	Native	Perennial	Graminoid
Poaceae	<i>Elionurus barbiculmis</i>	woolyspike balsamscale	Native	Perennial	Graminoid
Poaceae	<i>Elymus elymoides</i>	squirreldail	Native	Perennial	Graminoid
Poaceae	<i>Eragrostis cilianensis</i>	stinkgrass	Non-Native	Annual	Graminoid
Poaceae	<i>Eragrostis curvula</i>	weeping lovegrass	Non-Native	Perennial	Graminoid
Poaceae	<i>Eragrostis intermedia</i>	plains lovegrass	Native	Perennial	Graminoid
Poaceae	<i>Eragrostis lehmanniana</i>	Lehmann lovegrass	Non-Native	Perennial	Graminoid
Poaceae	<i>Eragrostis superba</i>	Wilman lovegrass	Non-Native	Perennial	Graminoid
Poaceae	<i>Erioneuron avenaceum</i>	shortleaf woollygrass	Native	Perennial	Graminoid
Poaceae	<i>Heteropogon contortus</i>	tanglehead	Native	Perennial	Graminoid
Poaceae	<i>Hilaria belangeri</i>	curly-mesquite	Native	Perennial	Graminoid
Poaceae	<i>Leptochloa dubia</i>	green sprangletop	Native	Perennial	Graminoid
Poaceae	<i>Melinis repens</i>	rose Natal grass	Non-Native	Annual	Graminoid
Poaceae	<i>Muhlenbergia alopecuroides</i>	bristly wolfstail	Native	Perennial	Graminoid
Poaceae	<i>Muhlenbergia emersleyi</i>	bullgrass	Native	Perennial	Graminoid
Poaceae	<i>Muhlenbergia filiformis</i>	pullup muhly	Native	Annual	Graminoid
Poaceae	<i>Muhlenbergia longiligula</i>	longtongue muhly	Native	Perennial	Graminoid
Poaceae	<i>Muhlenbergia polycaulis</i>	cliff muhly	Native	Perennial	Graminoid
Poaceae	<i>Muhlenbergia rigens</i>	deergrass	Native	Perennial	Graminoid
Poaceae	<i>Muhlenbergia rigida</i>	purple muhly	Native	Perennial	Graminoid
Poaceae	<i>Muhlenbergia tenuifolia</i>	slender muhly	Native	Annual	Graminoid
Poaceae	<i>Piptochaetium fimbriatum</i>	pinyon ricegrass	Native	Perennial	Graminoid
Poaceae	<i>Poa fendleriana</i>	muttongrass	Native	Perennial	Graminoid
Poaceae	<i>Schizachyrium cirratum</i>	Texas bluestem	Native	Perennial	Graminoid

Appendix E: Species List, cont.

Family	Scientific name	Common name	Nativity	Duration	Primary_Lifeform
Poaceae	<i>Schizachyrium sanguineum</i>	crimson bluestem	Native	Perennial	Graminoid
Poaceae	<i>Setaria leucopila</i>	streambed bristlegrass	Native	Perennial	Graminoid
Poaceae	<i>Sorghum halepense</i>	Johnsongrass	Non-Native	Perennial	Graminoid
Poaceae	<i>Sporobolus wrightii</i>	big sacaton	Native	Perennial	Graminoid
Poaceae	<i>Trachypogon spicatus</i>	spiked crinkleawn	Native	Perennial	Graminoid
Poaceae	<i>Tridens muticus</i>	slim tridens	Native	Perennial	Graminoid
Poaceae	<i>Tripsacum lanceolatum</i>	Mexican gamagrass	Native	Perennial	Graminoid
Poaceae	<i>Zuloagaea bulbosa</i>	bulb panicgrass	Native	Perennial	Graminoid
Polemoniaceae	<i>Ipomopsis longiflora</i>	flaxflowered ipomopsis	Native	Annual	Forb/Herb
Polemoniaceae	<i>Ipomopsis thurberi</i>	El Paso skyrocket	Native	Perennial	Forb/Herb
Polygalaceae	<i>Polygala obscura</i>	velvetseed milkwort	Native	Perennial	Subshrub
Polygonaceae	<i>Eriogonum polycladon</i>	sorrel buckwheat	Native	Annual	Forb/Herb
Polygonaceae	<i>Eriogonum wrightii</i>	bastardsage	Native	Perennial	Shrub
Pteridaceae	<i>Argyrochosma limitanea</i>	southwestern false cloak fern	Native	Perennial	Fern
Pteridaceae	<i>Astrolepis cochisensis</i>	Cochise scaly cloakfern	Native	Perennial	Fern
Pteridaceae	<i>Astrolepis sinuata</i>	wavy scaly cloakfern	Native	Perennial	Fern
Pteridaceae	<i>Bommeria hispida</i>	copper fern	Native	Perennial	Fern
Pteridaceae	<i>Cheilanthes eatonii</i>	Eaton's lipfern	Native	Perennial	Fern
Pteridaceae	<i>Cheilanthes fendleri</i>	Fendler's lipfern	Native	Perennial	Fern
Pteridaceae	<i>Cheilanthes lindheimeri</i>	fairyswords	Native	Perennial	Fern
Pteridaceae	<i>Cheilanthes wootonii</i>	beaded lipfern	Native	Perennial	Fern
Pteridaceae	<i>Cheilanthes wrightii</i>	Wright's lipfern	Native	Perennial	Fern
Pteridaceae	<i>Notholaena grayi</i>	Gray's cloak fern	Native	Perennial	Fern
Pteridaceae	<i>Notholaena standleyi</i>	star cloak fern	Native	Perennial	Fern
Pteridaceae	<i>Pellaea atropurpurea</i>	purple cliffbrake	Native	Perennial	Fern
Pteridaceae	<i>Pellaea truncata</i>	spiny cliffbrake	Native	Perennial	Fern
Pteridaceae	<i>Pellaea wrightiana</i>	Wright's cliffbrake	Native	Perennial	Fern
Ranunculaceae	<i>Thalictrum fendleri</i>	Fendler's meadow-rue	Native	Perennial	Forb/Herb
Rhamnaceae	<i>Ceanothus fendleri</i>	Fendler's ceanothus	Native	Perennial	Shrub
Rosaceae	<i>Cercocarpus montanus</i>	alderleaf mountain mahogany	Native	Perennial	Shrub
Rosaceae	<i>Prunus serotina</i>	black cherry	Native	Perennial	Tree
Rosaceae	<i>Purshia mexicana</i>	Mexican cliffrose	Native	Perennial	Shrub
Rubiaceae	<i>Bouvardia ternifolia</i>	firecrackerbush	Native	Perennial	Shrub
Rubiaceae	<i>Galium microphyllum</i>	bracted bedstraw	Native	Perennial	Forb/Herb
Rubiaceae	<i>Galium wrightii</i>	Wright's bedstraw	Native	Perennial	Forb/Herb
Rutaceae	<i>Ptelea trifoliata</i>	common hoptree	Native	Perennial	Shrub
Salicaceae	<i>Populus fremontii</i>	Fremont cottonwood	Native	Perennial	Tree
Santalaceae	<i>Comandra umbellata</i>	bastard toadflax	Native	Perennial	Forb/Herb
Santalaceae	<i>Phoradendron villosum</i>	Pacific mistletoe	Native	Perennial	Shrub
Sapindaceae	<i>Sapindus saponaria</i>	wingleaf soapberry	Native	Perennial	Tree
Saxifragaceae	<i>Heuchera sanguinea</i>	coralbell	Native	Perennial	Forb/Herb
Solanaceae	<i>Datura wrightii</i>	sacred thorn-apple	Native	Perennial	Forb/Herb
Solanaceae	<i>Nicotiana obtusifolia</i>	desert tobacco	Native	Perennial	Forb/Herb

Appendix E: Species List, cont.

Family	Scientific name	Common name	Nativity	Duration	Primary_ Lifeform
Solanaceae	<i>Physalis crassifolia</i>	yellow nightshade groundcherry	Native	Perennial	Forb/Herb
Solanaceae	<i>Solanum elaeagnifolium</i>	silverleaf nightshade	Native	Perennial	Forb/Herb
Verbenaceae	<i>Aloysia wrightii</i>	Wright's beebrush	Native	Perennial	Shrub
Verbenaceae	<i>Glandularia bipinnatifida</i>	Dakota mock vervain	Native	Perennial	Forb/Herb
Verbenaceae	<i>Verbena neomexicana</i>	hillside vervain	Native	Perennial	Forb/Herb
Vitaceae	<i>Vitis arizonica</i>	canyon grape	Native	Perennial	Vine

Appendix F: Geodatabase Specifications, Description, and Schema

A file geodatabase was used to house the final map and related data products. It was populated with point and polygon feature classes, relationship classes and tables as shown in Figure G1. All data is NAD 83 zone 12N. The geodatabase also contains multiple look-up tables including cover classes, surficial geology and plant species names among others.

Feature class and related table descriptions:

- **Veg_Polys:** 27 multi-part polygon features each attributed with community type, type codes and map class codes.
- **tPolySpeciesCover:** this table was generated by building a query in the access database storing project data. Species records were exported as a list within each height class and their mid-point cover class values are given. This table is related to Veg_Polys feature class (mapping units) such that the user can select any polygon and see which species were observed there. Conversely the user can select species or even species with a certain cover value and use the relationship in the opposite direction - to view which polygonal areas have that particular species in that particular abundance. This related table to feature is alone a powerful exploratory tool within this GDB.
- **Plot Locations:** 102 point locations. This was data collected in the field. This table is related to tPlotEvents which lists basic information on plot location and shape, date sampled and soil cover characteristics and total cover by strata for vegetation.
- **tPlotEvents** is in turn linked to tPlotEventSpecies which details the stratum, species code and percent cover of each species recorded in that plot. TPlotevents also relates to tPlots which contains landscape, landform and geological attributes for each site. This table is derived from field collected data and is exported out of access.
- **VegPoly_Photopoints:** these are locations where photos were taken. These were recorded in the field on handheld Trimble GPS units and subsequently merged and imported into the GDB.

Feature class attachments:

File attachments were created for three feature classes in the GBD, the veg_polys, plot_locations and VegPoly_PhotoPoints. In ArcMap 10 this attachment function allows for photos or other files to be embedded into the GDB such that they are always accessible through the ArcMap environment. Photos were attached to each plot point (one photo) and each polygon photo point (four, one in each cardinal direction). PDF versions of the one page vegetation type descriptions are attached to each polygon. All attachments are viewed by using the HTML pop-up tool in the standard toolbar . Once this tool is activated the user just clicks on any polygon or any photo point and a window opens showing a small icon of the attachment as well as displaying the attributes of the feature.

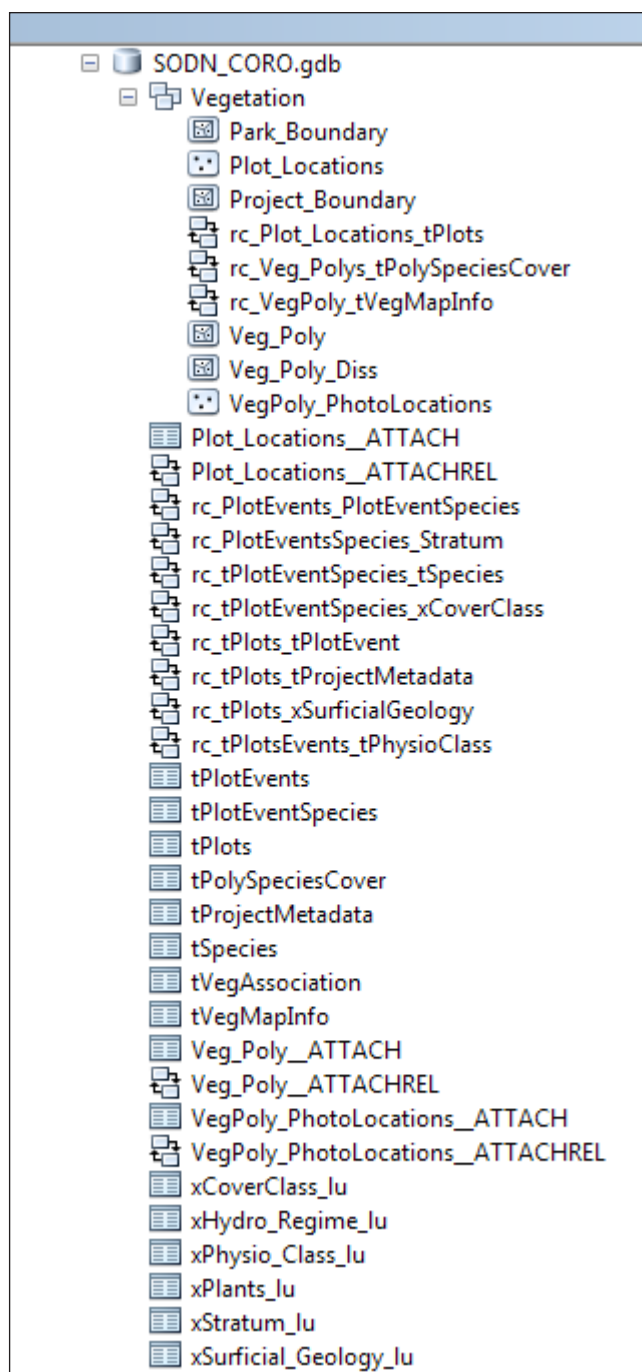


Figure F1. Geodatabase schema.

Geodatabase:

- SODN_CORO.gdb

Feature Dataset:

- Vegetation - UTM Zone 12N. Contains all feature classes and some relationship classes

Feature Classes:

- Park_Boundary - Unit boundary
- Plot_Locations - Plot corners (also used as plot photo points for feature attachments).
- Project_Boundary - extent of mapped area (park boundary with a buffer).
- Veg_Polys - Vegetation Polygons with a unique identifier (Poly_ID or Poly_Code).
- VegPoly_PhotoLocations - Four photos are taken at each point; one for each cardinal direction.

Tables:

- tPlotEvents - Plot metadata and veg info
- tPlotEventSpecies - Recorded species within plot
- tPlots - Landscape attribute data
- tPolySpeciesCover - Species list and their cover values for each polygon sampled
- tProjectMetadata - Metadata
- tSpecies - Species list
- tVegAssociation - Western veg associations list
- tVegMapInfo - Association data and codes
- xCoverClass_lu - lookup table for cover classes
- xHydroRegime_lu - lookup table for hydro regimes
- xPhysioClass_lu - lookup table for physio classes
- xPlants_lu - lookup table for plants with USDA symbol
- xStratum_lu - lookup table for strata
- xSurficial_Geology_lu - lookup table for surficial geology

Relationship Classes:

- Relates tables to other tables and feature class tables based on a keyed field

Appendix G: Key to Vegetation Formations

KEY TO VEGETATION FORMATIONS:

1. What is the dominant surface cover?

- Trees.....go to2
- Shrubsgo to3
- Herbaceousgo to4
- Sparse vegetation (1–10%) or Rock/Bare Soil.....go to5
- Agriculturego to6

2. Trees

1¹ Tree Cover > 60%?

2¹ Site is predominantly associated with an ephemeral watercourse. **Intermittently Flooded Forest (IFF)**

2² Site is predominantly associated with a perennial watercourse. **Riparian Forest (RF)**

2³ Site is in an upland zone. **Forest (F)**

1² Tree Cover < 60%?

3¹ Site is predominantly associated with an ephemeral watercourse. **Intermittently Flooded Woodland (IFW)**

3² Site is predominantly associated with a perennial watercourse. **Riparian Woodland (RW)**

3³ Site is in an upland zone. **Woodland (W)**

3. Shrubs

1¹ Tree Cover > 10%. **Wooded Shrubland (WS)**

1² Tree Cover < 10%. **Shrubland (S)**

4. Herbaceous

1¹ Tree cover < 10% AND Shrub cover < 10% **Herbaceous (H)**

1² Tree and/or Shrub cover >10%

2¹ Tree cover > Shrub cover **Tree Savanna (TS)**

2² Tree cover < Shrub cover **Shrub Savanna (SS)**

5. Sparse Vegetation/Rock/Bare Soil

1¹ Site is predominantly bedrock or surface rock with vegetative cover less than 10%.

2¹ Vegetation is primarily tree cover. **Wooded Rock Outcrop (WRO)**

2² Vegetation is primarily shrub cover. **Shrubby Rock Outcrop (SHRO)**

2³ Vegetation is primarily herbaceous cover. **Herbaceous Rock Outcrop (HRO)**

2⁴ There is no clear dominant. **Sparse Rock Outcrop (SRO)**

1² Site is predominantly covered with boulders, cobble, bare soil, or gravel with vegetative cover less than 10%.

3¹ There is no vegetation cover. **Barren (B)**

3² Vegetation is primarily tree cover. **Wooded Barren (WB)**

3³ Vegetation is primarily shrub cover. **Shrubby Barren (SHB)**

3⁴ Vegetation is primarily shrub cover. **Herbaceous Barren (HB)**

3⁵ There is no clear dominant. **Sparse Barren (SB)**

6. Agriculture

Site is predominantly agricultural land. **Agricultural (A)**

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