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# Vegetation Mapping Inventory Project

## *Mojave National Preserve and Castle Mountains National Monument*

Joshua trees with mixed desert understory shrubs near Castle Mountains National Monument.
NPS / CHRIS LEA

# Vegetation mapping inventory project: Mojave National Preserve and Castle Mountains National Monument

Science Report NPS/SR—2024/225

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# Abstract

This study presents a comprehensive vegetation mapping inventory project undertaken in Mojave National Preserve (MOJA) and Castle Mountains National Monument (CAMO), two areas within the National Park Service's Mojave Desert Network (MOJN). Covering a combined area of over 1.6 million acres along the California-Nevada border, these sites encompass diverse desert ecosystems, including valleys, washes, sand dunes, volcanic formations, and Joshua tree forests. The project, initiated in 2010 by the National Park Service's Vegetation Mapping Inventory (VMI), aimed to document and classify the plant communities in these areas.

The project unfolded over six phases between 2011 and 2021, starting with a review of existing vegetation data and the development of a comprehensive work plan. In collaboration with the California Native Plant Society (CNPS) and the University of Nevada, Las Vegas (UNLV), field data were collected from 630 plots and observation points, supplemented by 588 samples from previous studies. The data were used to classify 67 plant alliances and two landform types, ultimately identifying 136 plant associations within MOJA and CAMO.

The vegetation map for the project, covering the entire 1.6-million-acre area, was created using a hybrid mapping approach that combined manual and automated techniques. The map was based on 2018 National Agriculture Imagery Program (NAIP) basemap data and was validated through ground-based verification efforts. The accuracy of the final vegetation map was assessed at 91%, with a Kappa value of 92%, indicating a high level of reliability.

The final products of this project include a spatial geodatabase, digital field photos, metadata, a classification report, and a field key to the vegetation alliances. These resources provide a valuable tool for ongoing research and conservation efforts in these ecologically significant areas.

# Executive Summary

Mojave National Preserve (MOJA) is a large, 1.6-million-acre (650,00 ha) unit of the National Park Service (NPS) that is located on the eastern California–Nevada border. The preserve covers a vast expanse of the Mojave Desert ecosystem that includes a diverse mix of plant communities occurring on a very rugged and arid landscape. Contained within its borders are broad alluvial valleys, desert washes, playas, sand dunes, volcanic formations, domes, hills, and mountain ranges. Castle Mountains National Monument (CAMO) was recently added as a unit of the NPS in 2016 and is situated in the northeast corner of MOJA. CAMO encompasses about 21,000 acres (8,500 ha) along the Nevada border, supporting Joshua tree forests and unique mountain grasslands. To better understand and document the vegetation diversity occurring at both sites, the National Park Service's Vegetation Mapping Inventory (VMI)[1] and Mojave Desert Network (MOJN) initiated a vegetation inventory effort in 2010.

Actual work began in 2011 on a ten-year, six-phase project with a review of the existing vegetation data, a summary of the previous classifications, and a work plan for the network were created. In phase two, the NPS VMI and California Native Plant Society (CNPS), in conjunction with researchers from the University of Nevada, Las Vegas (UNLV), collected 630 classification plots and observation points across the landscape. Field data were then entered into the VMI-specific PLOTS database along with an additional 588 samples from a variety of past studies. In phase three, CNPS analyzed the PLOTS data to classify 67 plant alliances and two landform types using the revised US National Vegetation Classification (rUSNVC) standard. From this list, 136 plant associations were estimated to occur at MOJA and CAMO. During phase four, Cogan Technology, Inc. (CTI) created the digital vegetation map layer for the project, which covered over 1.6 million acres (640,000 ha). In the accuracy assessment (AA) phase, contracted field crews collected data at 720 AA point locations that were randomly placed by map class throughout the project area. In the final phase, CTI finalized the classification, reported the AA results, revised the final vegetation map, and delivered the final products to the NPS VMI.

The resulting spatial database and vegetation map layer were created using a combination of 2018 National Agriculture Imagery Program (NAIP) basemap data, ground-based verification efforts, and a two-step or hybrid mapping approach that used both manual and automated techniques. By comparing the vegetation signatures on the imagery to the field data, 87 map units (72 vegetated and 15 land-use/land-cover) were developed and used to delineate the plant communities. The interpreted vegetation polygons were then digitized into a Geographic Information System (GIS) layer that was field-tested, reviewed, and revised. The final MOJA and CAMO vegetation map layer was assessed for overall thematic accuracy at 91% with a Kappa value of 92%.

Products developed for MOJA and CAMO are described and presented in this report and stored in the accompanying project digital files. Project deliverables include the final report, the spatial

[1] NPS Vegetation Mapping Inventory (VMI) was formerly known as the USGS-NPS Vegetation Mapping Program but underwent a name change. The program is referred to as NPS VMI throughout this report.

geodatabase, digital field photos, metadata, a classification report, and a field key to the vegetation alliances. For a full list of the MOJA and CAMO products available for download, please visit the NPS Inventory & Monitoring Vegetation Inventory.

Hiking through a Mojave yucca shrub stand in the Mojave National Preserve with the New York Mountains in the background. NPS / CHRIS LEA

# Acknowledgments

The vegetation inventory, classification, and mapping products presented in this report represent the hard work of a very dedicated and inspired team. The author thanks all who participated over the last 10-plus years in this long but worthwhile endeavor. I am especially grateful to the staff at the NPS Inventory and Monitoring Mojave Desert Network (MOJN) in Boulder City, Nevada, who provided support throughout this effort. These include Allen Calvert (Program Manager), Jeanne Taylor and Mindy Trask (previous Vegetation Mapping Coordinators), Nicole Hupp (Ecologist), Nita Tallent (previous Program Manager), and Mark Lehman (Data Manager).

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Thanks to all who helped this project in so many ways.

# Introduction

## National Park Service Vegetation Mapping Inventory Program

The National Park Service (NPS) Vegetation Mapping Inventory (VMI)[2] program was started as a cooperative effort between the NPS and the United States Geological Survey (USGS) to classify, describe, and map existing vegetation communities in more than 270 national park units across the United States. The primary objective of the NPS VMI is to produce high-quality plant community classifications, standardized maps, and associated data for the current vegetation in each park unit with a natural resource component. This information fills data gaps and complements a wide variety of resource assessments, park management, and conservation needs. Among its many uses, the NPS VMI products have helped park managers better identify and conserve plant biodiversity, manage non-native and rare species, monitor insect and disease effects, and provide a baseline to examine wildlife habitat relationships and the effects of wildland fires.

In 1999, the NPS VMI was reaffirmed by the Director of the NPS by approving the Natural Resource Challenge to encourage national parks to focus on the preservation of the nation's natural heritage through science, natural resource inventories, and expanded resource monitoring. The Natural Resource Challenge provided funding for 12 baseline inventories to be completed in each of the 270 vegetated park units. The NPS VMI is among those 12 baseline inventories.

The NPS VMI follows well-established procedures that are compatible with other agencies and organizations. The inventory uses the revised National Vegetation Classification Standard Version 2 (rUSNVC; FGDC 2008), a system that is integrated with other major efforts in the taxonomic classification of vegetation and is a Federal Geographic Data Committee (FGDC) standard (FGDC 1997 and FGDC 2008). In addition, stringent quality control procedures ensure the reliability of the vegetation data and encourage the use of resulting maps, reports, and databases at multiple scales.

A complete vegetation inventory and mapping project for an NPS unit follows a standard 12-step procedure (NPS 2009) and includes the following standard products (Cook 2016):

- A Detailed Vegetation Report
- Digital Vegetation Map Layers
- Vegetation Plot and Plant Community Data
- Accuracy Assessment Data and Analysis
- A Dichotomous Vegetation Key to the Plant Communities
- A Key or Guide to the Vegetation Mapping Units

[2] NPS Vegetation Mapping Inventory (VMI) was formerly known as the USGS-NPS Vegetation Mapping Program but underwent a name change. The program is referred to as NPS VMI throughout this report.

Maps and other spatial data for the NPS units in the continental US are normally produced in the Universal Transverse Mercator (UTM) projection, the North America Datum of 1983 (NAD 83), which uses meters for map and distance units and has a nominal 1:24,000 mapping scale with a minimum mapping unit (MMU) of 1.2 acres (0.5 ha). All NPS VMI geospatial products must meet both the National Map Accuracy Standards for positional accuracy [The Nature Conservancy (TNC); ESRI 1994a; Lea and Curtis 2010] and the minimum map class accuracy goal of 60% percent (NPS 2009) for all vegetation classes.

### National Vegetation Classification Standard

In 1994, the USGS and NPS formed the Vegetation Mapping Program, which later became known as the NPS Vegetation Mapping Inventory (VMI), to catalog and map the vegetation within all NPS units with a natural resource component. In the same year, the Program also adopted the US National Vegetation Classification (USNVC; Grossman et al. 1998) as a basis for the *a priori* definition of vegetation units to be inventoried. NatureServe has since revised the USNVC (rUSNVC) and, in 2008, the FGDC formally endorsed it (FGDC 2008).

The use of a standardized vegetation classification system, such as the rUSNVC, helps ensure data compatibility throughout the NPS and other agencies (FGDC 2008). A standard system is critical for a systematic inventory and classification of the nation's biological resources, assists with efficient stewardship, and helps prioritize conservation efforts. The rUSNVC is being used for vegetation classification and mapping projects throughout the NPS Inventory and Monitoring Mojave Desert Network (MOJN) and all the other 32 NPS Inventory and Monitoring Networks in the United States. The USNVC has been in existence for over two decades and has evolved from the original classification systems first developed jointly by TNC, NatureServe, and various other state Natural Heritage Programs (TNC; ESRI 1994a; Grossman et al. 1998).

The rUSNVC is a hierarchical system that allows for vegetation classification at multiple scales (FGDC 2008). There are eight levels with specific criteria set for each level (Table 1). The upper three levels are based on climate and physiognomic characteristics that reflect geographically widespread (global) topographic and edaphic factors. The middle three levels focus largely on broad sets of diagnostic plant species and habitat factors along regional-to-continental topographic, edaphic, and disturbance gradients. The lower two levels (as in the original USNVC) are the plant alliance and association (i.e., plant communities) and are distinguished by differences in the local floristic composition (Grossman et al. 1998).

**Table 1.** Summary of rUSNVC revised hierarchy levels and criteria for natural vegetation.

| Levels | Hierarchy Level | Criteria |
|---|---|---|
| Upper: Physiognomy plays a predominant role | L1—Formation Class | Broad combinations of general dominant growth forms that are adapted to basic temperature (energy budget), moisture, and substrate/aquatic conditions. |
| Upper: Physiognomy plays a predominant role | 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/aquatic conditions. |
| Upper: Physiognomy plays a predominant role | 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. |
| Middle: Floristics and physiognomy play predominant roles | L4—Division | Combinations of dominant and diagnostic growth forms and a broad set of diagnostic plant species that reflect biogeographic differences in composition and continental differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes. |
| Middle: Floristics and physiognomy play predominant roles | L5—Macrogroup | Combinations of moderate sets of diagnostic plant species and diagnostic growth forms that reflect biogeographic differences in composition and sub-continental to regional differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes. |
| Middle: Floristics and physiognomy play predominant roles | 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 regional mesoclimate, geology, substrates, hydrology, and disturbance regimes. |
| Lower: Floristics plays a predominant role | 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. |
| Lower: Floristics plays a predominant role | 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. |

The broader alliances are physiognomically distinct groups (e.g., forests, woodlands, shrublands, herbaceous vegetation, etc.) of plant associations sharing one or more differential or diagnostic species (Mueller-Dombois and Ellenberg 1974). These are commonly the dominant plant(s) found in the uppermost strata of the community. The plant association is the base unit of the classification and, following Jennings et al. (2009), is "a vegetation classification unit defined on the basis of a characteristic range of species composition, diagnostic species occurrence, habitat conditions, and physiognomy". In the winter of 2016, the NVC for the conterminous United States was formally released. In the spring of 2017, the revised version 2.01 was made available through the USNVC Explorer.

Content for the rUSNVC is currently maintained by NatureServe and is being peer-reviewed through collaboration with federal agencies and the Ecological Society of America (Faber-Langendoen et al. 2009). Refer to USNVC and NatureServe Explorer for publicly available and regularly updated content.

All rUSNVC associations and alliances (or equivalents) are commonly used for map units or classes in the NPS VMI to ensure compatibility throughout the NPS as well as with other federal and state agencies. Vegetation maps and supporting ecological information based on the rUSNVC allow for efficient comparisons of similar types across large areas and through time. Referencing the rUSNVC assures that map units are not based on confusing local (common) plant names or site-specific habitats. Future researchers using the vegetation data can always reference the rUSNVC descriptions for timely and accurate information on the common species and habitat. Having the ability to cross-reference the vegetation map units with the rUSNVC types also allows for efficient comparison to other studies relating to a wide variety of resource assessment, park management, and planning needs.

### Mojave Desert Inventory and Monitoring Network

The Mojave Desert Network (MOJN) is the largest Inventory and Monitoring network in the continental United States. Encompassing NPS sites in California, Nevada, and Arizona, the MOJN works with eight national park units across the Mojave and Great Basin Deserts (Figure 1). MOJN park units include Mojave National Preserve (MOJA), Castle Mountains National Monument (CAMO), Death Valley National Park (DEVA), Great Basin National Park (GRBA), Joshua Tree National Park (JOTR), Lake Mead National Recreation Area (LAKE), Manzanar National Historic Site (MANZ), and Grand Canyon-Parashant National Monument (PARA). The MOJN focuses on collecting and analyzing data about various park natural resource conditions, providing inventories of park species and natural features, and monitoring changes over time. To accomplish this work, MOJN staff also partner with a variety of federal and state agencies, private organizations, and universities.

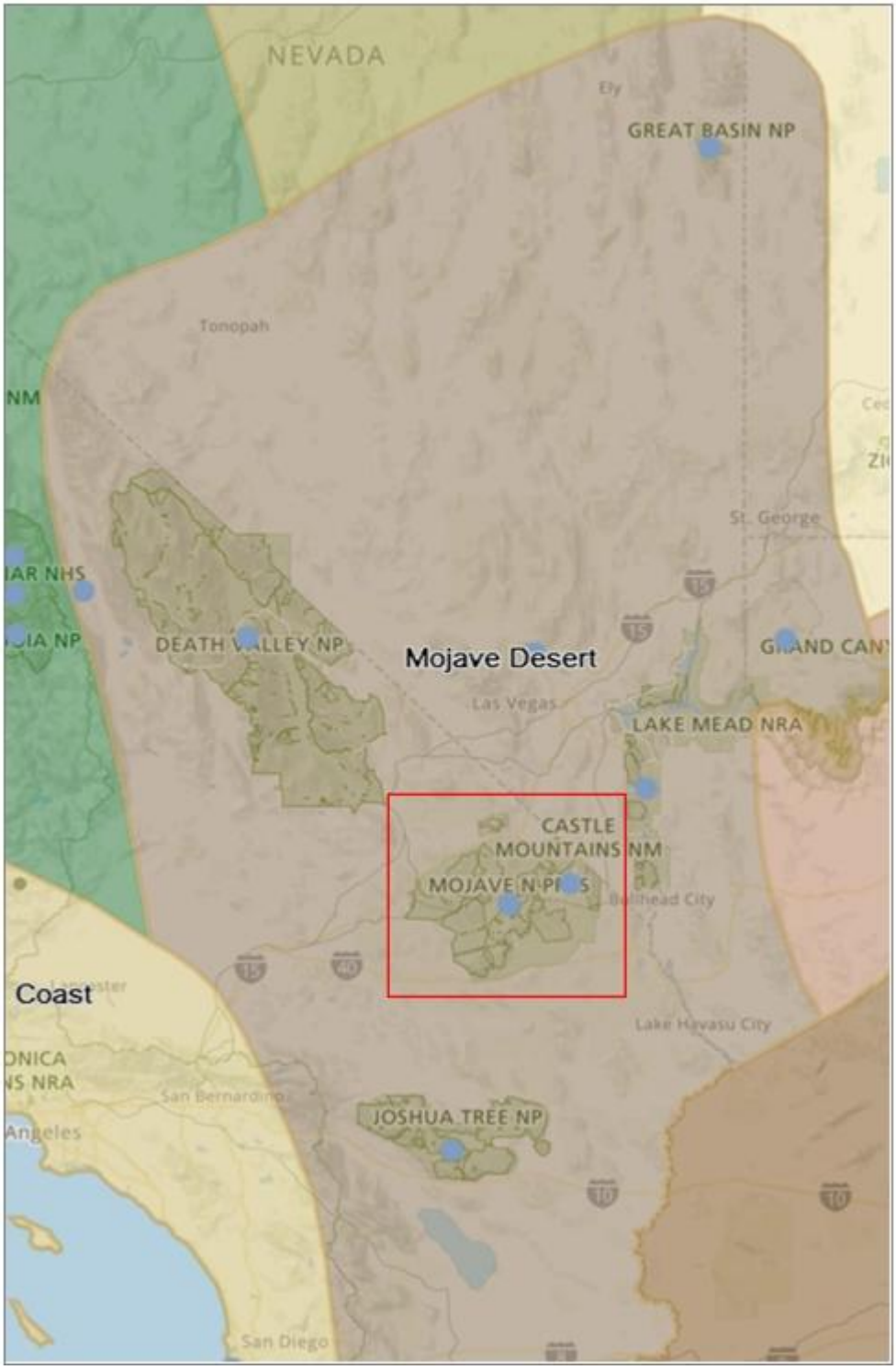


**Figure 1.** The Mojave Desert Inventory and Monitoring Network map. NPS / MOJN

## Mojave National Preserve

The Mojave National Preserve is a very large unit of the NPS that was established by Congress on October 31, 1994, through the California Desert Protection Act. The resulting national preserve covers a vast expanse of desert lands within the Great Basin, Sonoran, and Mojave Desert ecosystems (NPS 2002). MOJA is located in San Bernardino County in Southern California and is comprised of two separate but nearby units (Figure 2). The larger southern portion is located between Interstate I-15 to the north and Interstate I-40 to the south. The smaller northern unit lies just north of I-15. The larger section of MOJA shares a common border with the State of Nevada, and both units are located about 100 miles from Las Vegas, Nevada, and 200 miles from Los Angeles, California.

MOJA is an arid landscape with a wide variety of unique landforms, including low-elevation playas (dry lake beds), desert washes, bajadas (alluvial fans), low hills, sand dunes, volcanic formations, badlands, and various mountain ranges. Notable features include Soda Lake (dry), the Kelso Sand Dunes, the Devil's Playground (sand/playa), the Cima Dome, the Lanfair, Ivanpah, Clipper, and Shadow Valleys, numerous cinder cones and lava beds, Fenner, Colton, and the Mid Hills, and the Clark, Cowhole, Ivanpah, Old Dad, Granite, Providence, Castle, New York, Woods, Piute, and Hackberry Mountains. The Providence Mountain State Recreation Area (Mitchell Caverns), the University of California's Granite Mountains Natural Reserve, and the California State University's Soda Springs Desert Studies Center at Soda Springs are all within the preserve.

MOJA is a very large park unit with a variety of natural environments based in part on geology, soils, hydrology, elevation, and landform. About 695,200 acres of MOJA have been designated as protected wilderness (NPS 2002). Significant fires have occurred in MOJA and have impacted the natural settings by removing the vegetation. Human activity has also altered the landscape relating to private ranch and residential inholdings, abandoned and active mines, two-track roads/social trails, utility and railroad corridors, and cattle and burro grazing.

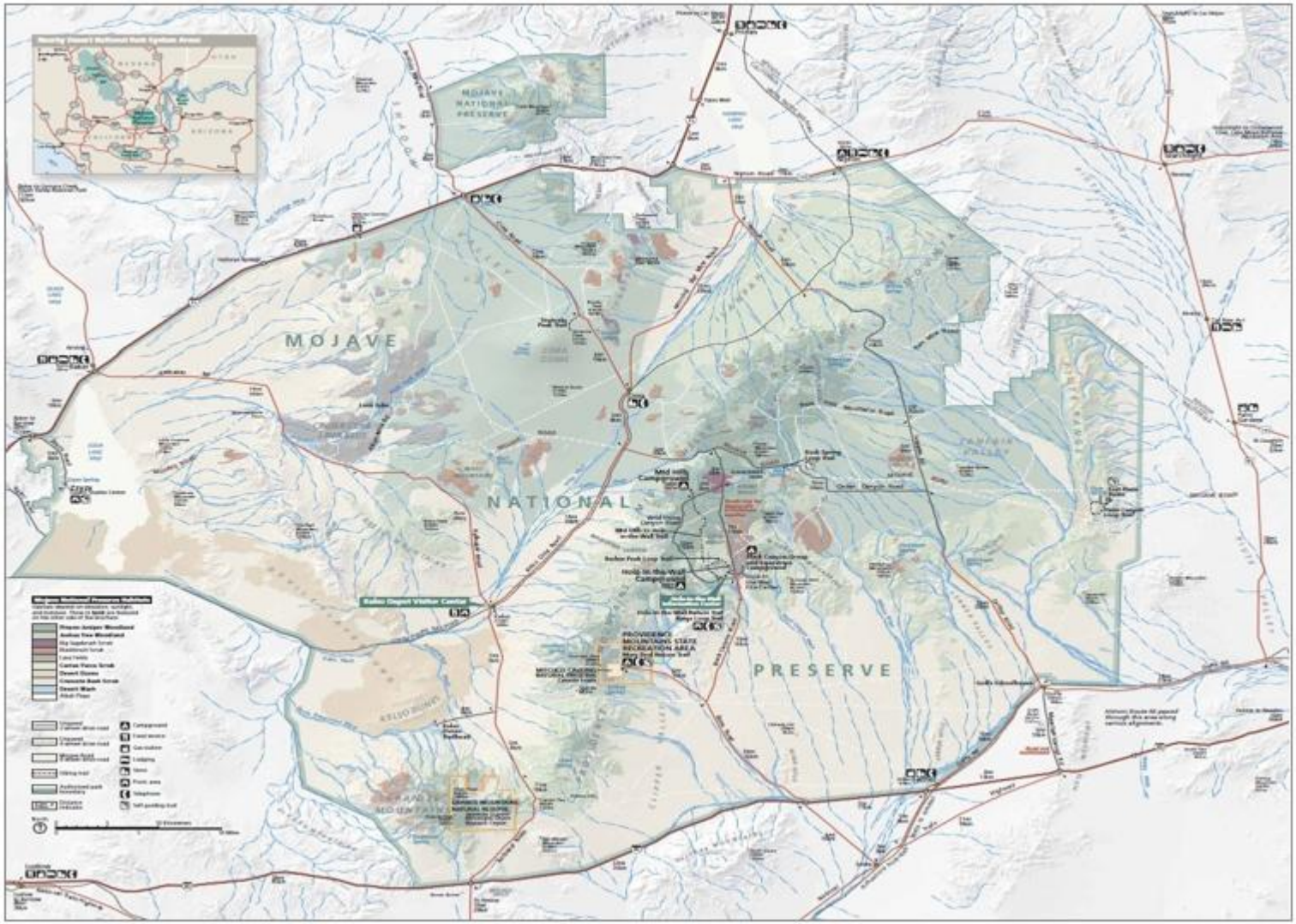


**Figure 2.** Mojave National Preserve map. NPS

### Castle Mountains National Monument

The Castle Mountains National Monument (CAMO) was recently added to the NPS by a presidential designation in 2016. The monument encompasses about 21,000 acres along the California border with Nevada and is bounded on three sides by MOJA (Figure 3). CAMO supports natural high and mid-elevation desert environments and has a long history of mining and ranching activities.

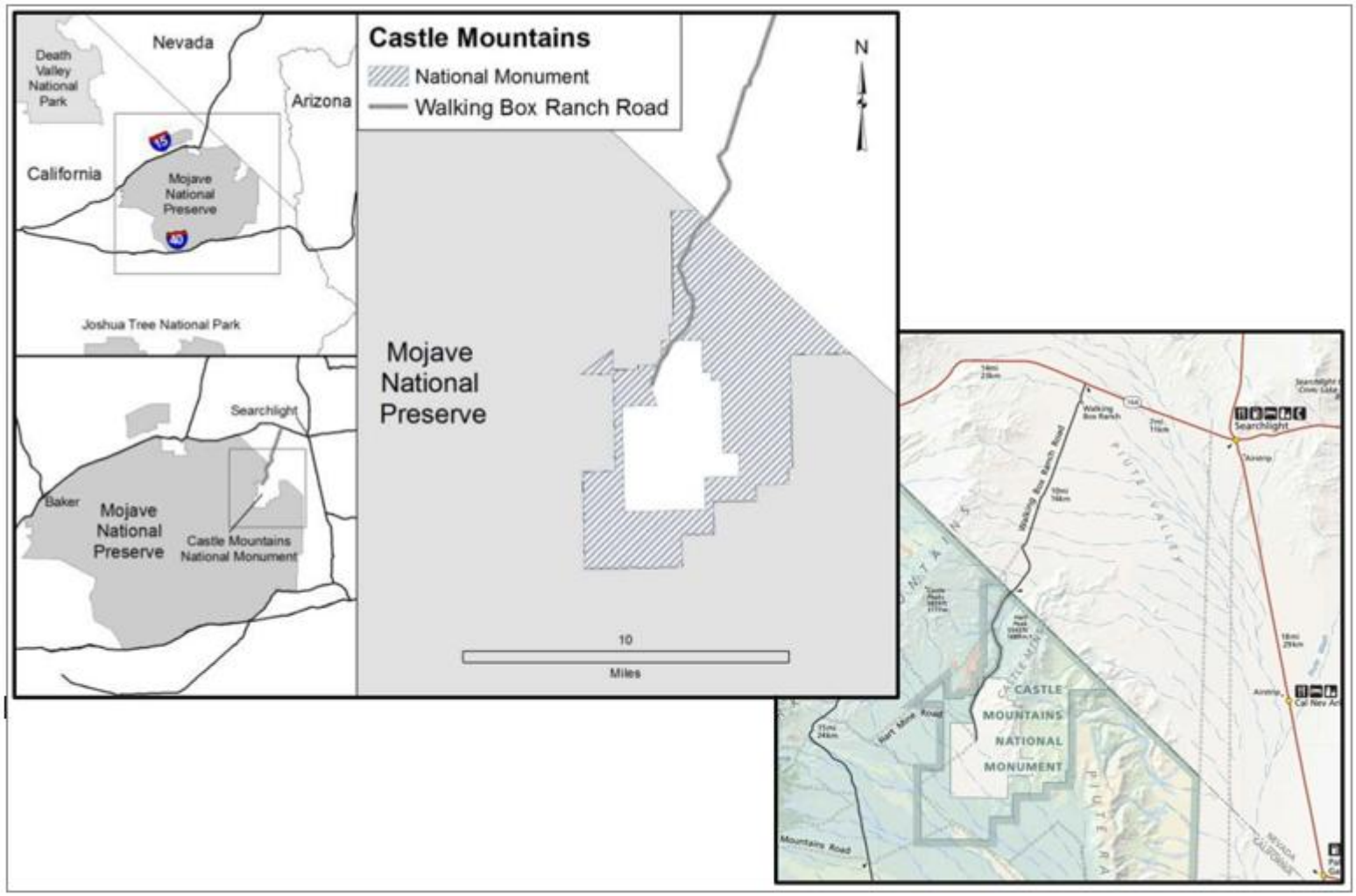


**Figure 3.** Castle Mountains National Monument maps. NPS

## Natural Setting and Vegetation

MOJA and CAMO are dry, weathered places with various prominent landforms occurring along a steep elevational gradient. In this unique setting, plants with unique adaptations and requirements tend to sort themselves out into natural plant communities. These include herbaceous and various scrub (sparse shrub) vegetation on low-elevation playas, sand dunes, desert washes, and alluvial basins and sparse to open creosotebush and saltbush shrublands on large desert plains/floors, valleys, bajadas, and desert pavement areas. Intricate networks of incised drainages and wash channels dissect these areas, providing important wildlife habitats. At mid-elevations, dry and rocky areas support large and expansive stands of Mojave yucca, cacti, and other mixed shrubs. Joshua tree (shrub) woodlands with various mixes of understory shrubs and grasses become pervasive throughout the higher of the mid-elevation uplands. Along a transition into the mountains and high hills, sparse juniper trees can be found on rocky slopes and in drainages. Blackbrush and joint-fir shrubs, along with the occasional big sagebrush stand, continue from the mid-elevations up into the mountains as both shrublands and understory elements. Higher up, chaparral shrubs are present on dry mountain slopes, and mesic areas here support tall deciduous shrubs and live oak trees in rock crevices and drainages. Pinyon pine and juniper trees cover large areas of the mountains at the highest elevations, and rare white fir trees can be found in the Clark Mountain Range. Other unique vegetation types can be found at almost all elevations and include pockets of riparian cottonwood and willow trees, wet drainages with willow and seep willow (*baccharis*) shrubs, and marsh-like wetlands around seeps, springs, and ponds.

The unique blending of landforms, geology, and plant communities, along with possible future threats posed by development, mining, climate change, fire, and other anthropogenic events, have led to similar past vegetation studies at MOJA. Recent and comparable efforts include a summary report on the plant assemblages by vegetation types based on a combination of life forms, dominant species, and habitat types (Gardner 2007). This report lists seven main plant types and five sub-types for the entire Mojave Desert region. From 1997 to 1999, the Central Mojave Desert Vegetation Mapping Project was conducted by the USGS (Thomas et al. 2004). The USGS described and mapped MOJA and CAMO as part of their ecosystem mapping effort using 22 dominant plant types within 11 vegetation systems and landforms.

Using the previous studies and work from this project, a predictive vegetative pattern can be created for MOJA and CAMO based on elevation and location. This outline, although not definitive, provides a general framework for sorting the vegetation into convenient categories. The following list and figures highlight these efforts. The 10 unique life forms are listed first, followed by Figure 4, which provides a broad aerial overview of their general locations on the ground. Figures 5 and 6 show generalized landform profiles, while Figure 7 presents representative ground photographs for each of the common types.

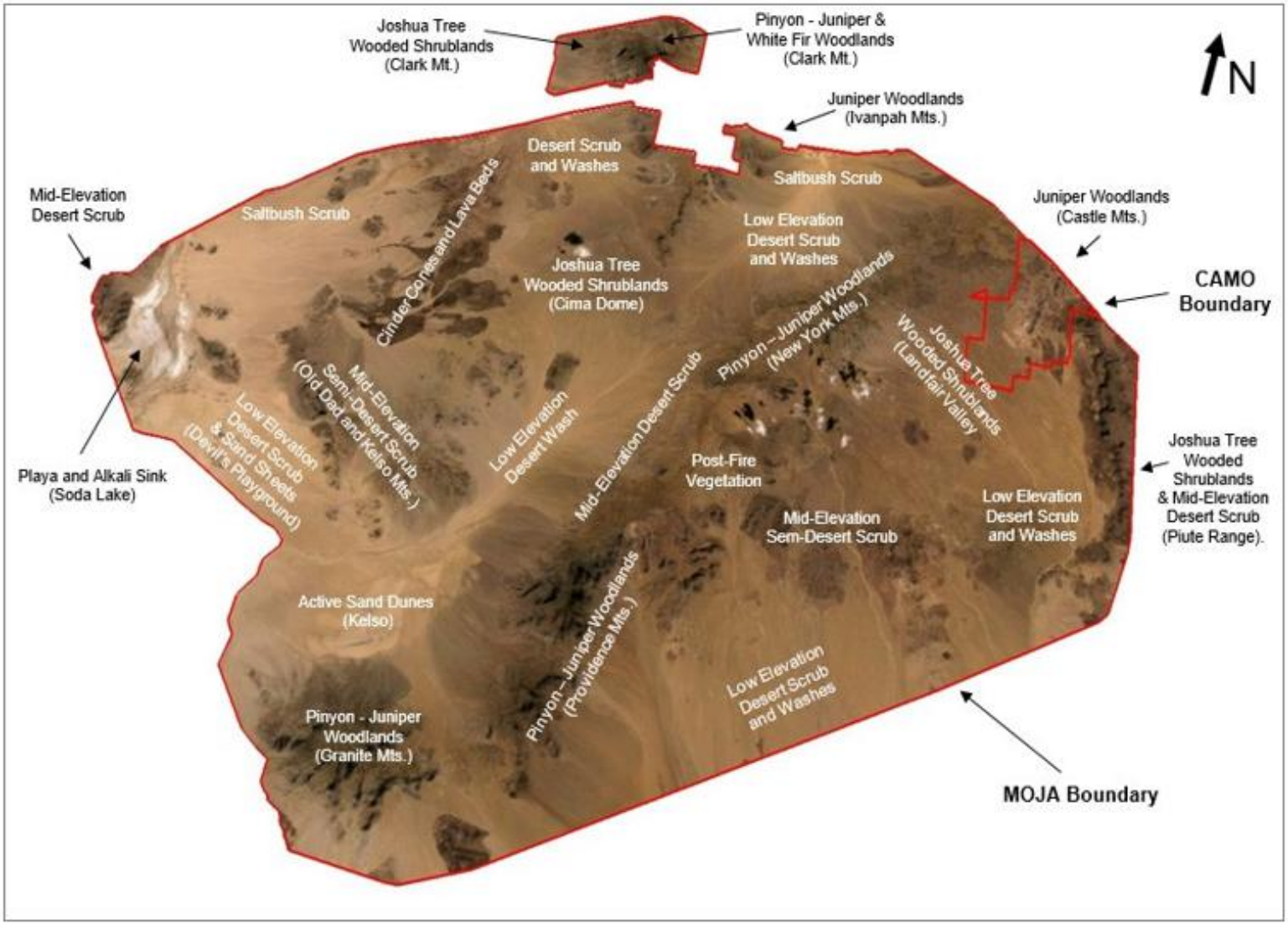


**Figure 4.** Overview of the vegetation patterns at MOJA and CAMO. NPS / CTI

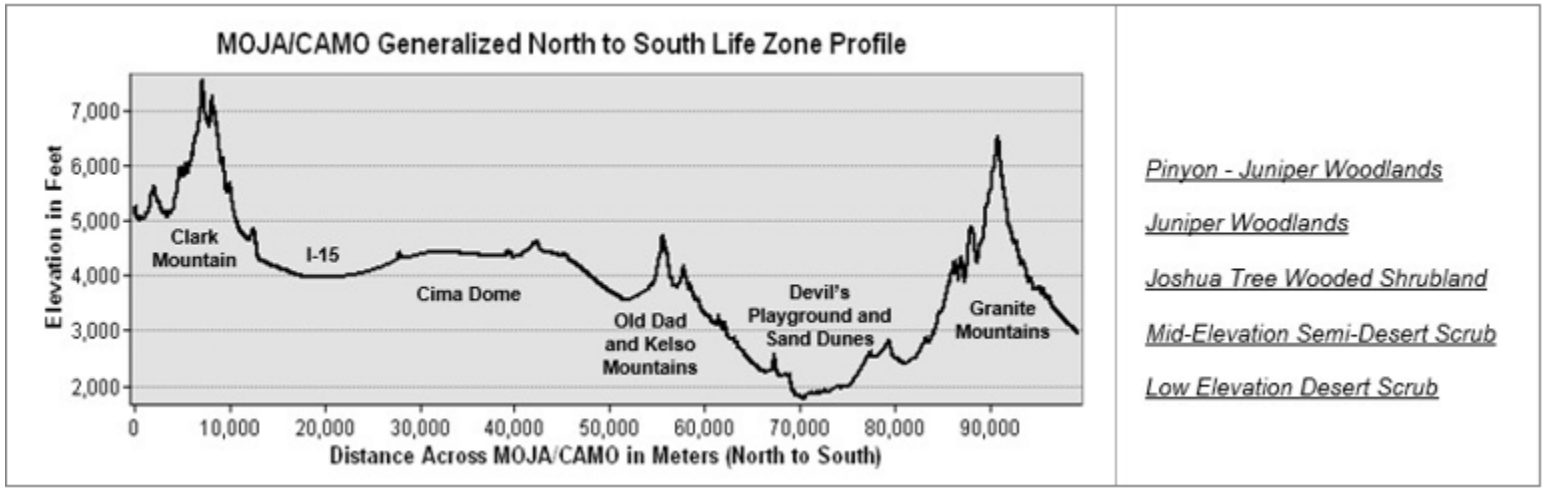


**Figure 5.** MOJA/CAMO generalized representative north-to-south life zone cross-section profile. NPS / CTI

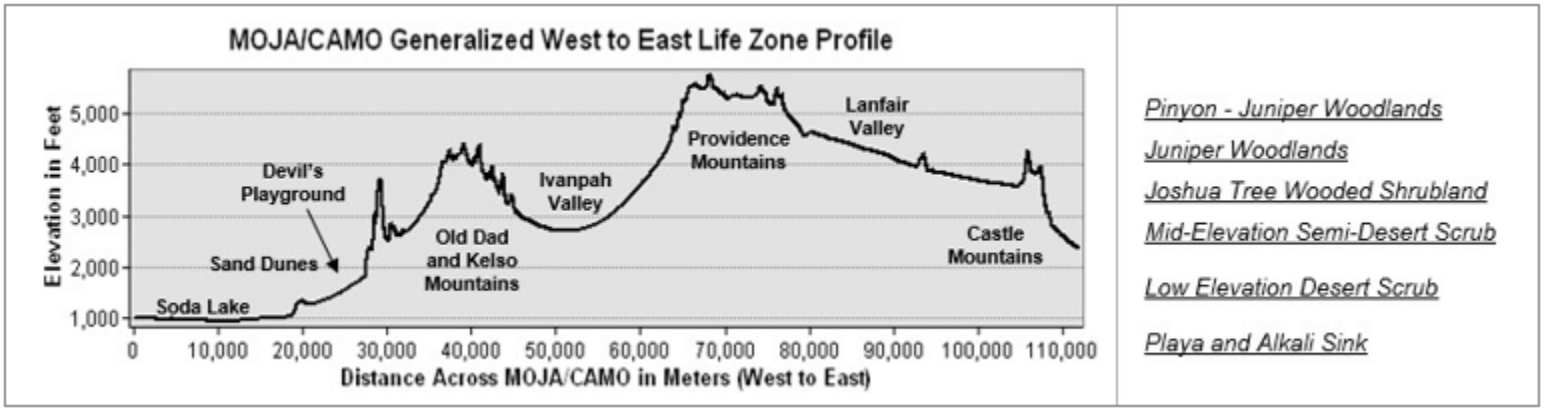


**Figure 6.** MOJA/CAMO generalized representative west-to-east life zone cross-section profile. NPS / CTI

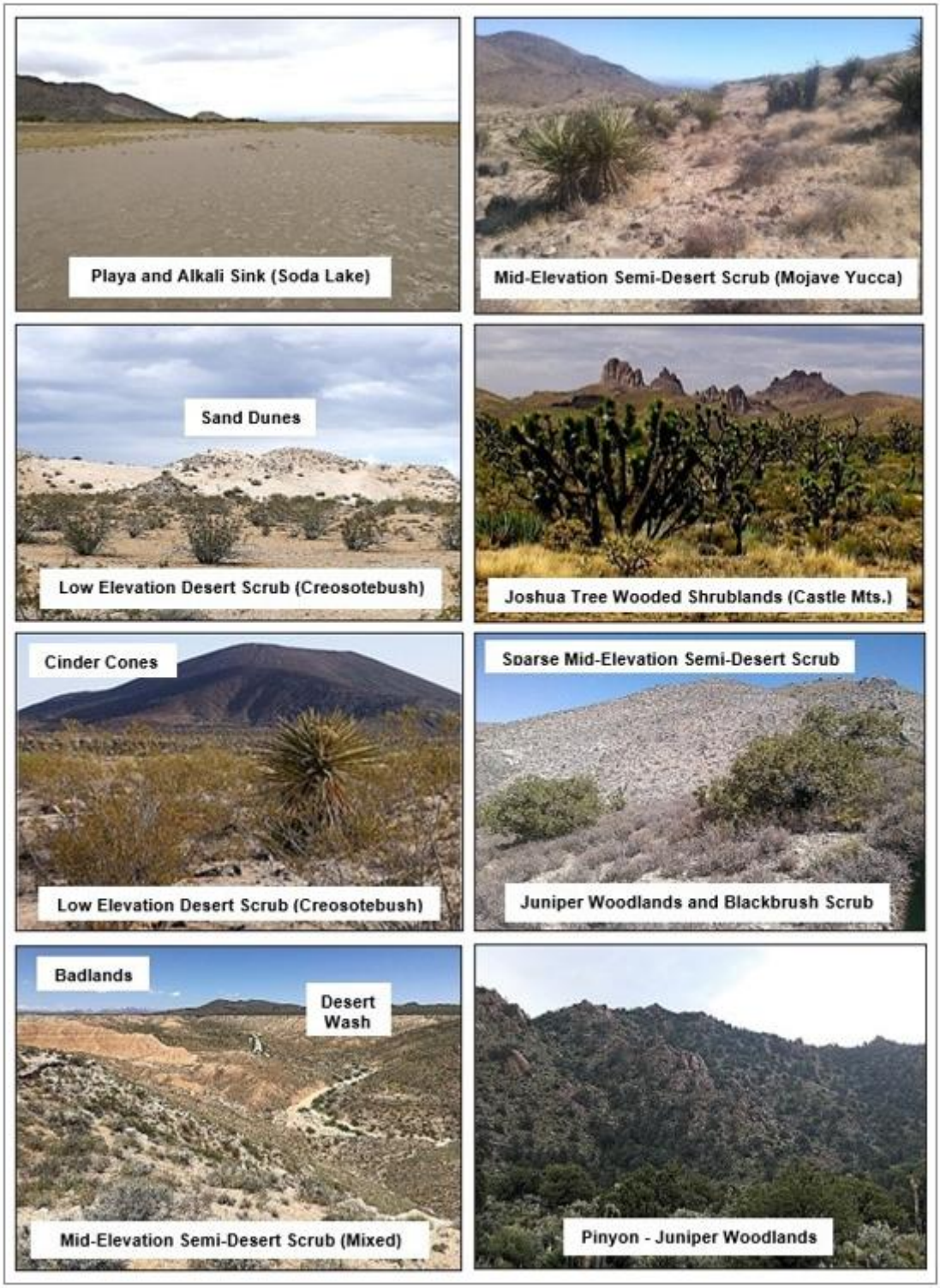


**Figure 7.** Representative photos of the MOJA and CAMO life zones and landforms. NPS / CTI

***General MOJA and CAMO Vegetated Life Zones (from high to low elevation).***
For each life zone (*with corresponding landform in parentheses*), we provide the estimated elevation range, which may vary by location, as well as past project equivalents and the dominant vegetation types for each topographic position.

1) Pinyon-Juniper Woodlands (High Mountains)
**Elevation Range:** 4,500–7,500 feet (1,370–2,290 m)

**Past Project Equivalents:** Pinyon-Juniper Woodland (Gardner 2007), Pinyon-Juniper Woodland, Sparsely Vegetated, and High Elevation Wash System (Thomas et al. 2004)

**Dominant Vegetation by Topographic Position:**

- Protected slopes: Mesic woodlands = pinyon pine - Juniper, white fir (rare), and Sonoran live oak shrubs. Understory = dense bitterbrush, big sagebrush, and blackbrush shrubs.
- Exposed slopes: Dry woodlands = pinyon pine and juniper trees. Understory = open blackbrush and upland shrubs.
- Canyons and high washes: Trees and tall shrubs = canyon live oak (rare), pinyon pine, and juniper trees. Understory = tall Sonoran live oak and mixed deciduous shrubs.
- Ridges, rock outcrops, and talus: Sparse vegetation = mixed dwarf shrubs and grasses.

2) Juniper Woodlands (Low Mountains and High Hills)
**Elevation Range:** 3,000–5,000 feet (915–1,680 m)

**Past Project Equivalents:** Pinyon-Juniper Woodland (Gardner 2007), Juniper Wooded Shrubland, High Elevation Wash System, and Big Sagebrush Shrubland (Thomas et al. 2004)

**Dominant Vegetation by Topographic Position:**

- Protected slopes: Open woodlands = Utah and California juniper trees. Understory = blackbrush, sagebrush, bitterbush, and other upland shrubs.
- Exposed slopes: Sparse woodlands and dense upland shrubs = short Utah and California juniper trees, mixed Joshua trees, dense blackbrush, and big sagebrush shrubs. Understory = mixed shrubs (woodlands), dwarf shrubs, and grasses (shrublands).
- Low canyons and washes: Sparse trees and medium-sized shrubs = short juniper trees and mixed upland shrubs.
- Rock outcrops and talus: Sparse vegetation = mixed dwarf shrubs and grasses.

3) Joshua Tree Wooded Shrublands (Low Hills, High Valleys, High Alluvial Fans)
**Elevation Range:** 2,500–4,500 feet (760–1,370 m)

**Past Project Equivalents:** Joshua Tree Woodland (Gardner 2007), Joshua Tree Wooded Shrubland and Mid-Elevation Wash System (Thomas et al. 2004)

**Dominant Vegetation by Topographic Position:**

- High valleys and low protected slopes: Open woodlands and open shrublands = Joshua trees and blackbrush. Understory = blackbrush and mixed mid-elevation desert shrubs (woodlands), desert shrubs, cacti, creosotebush, and grasses (shrublands).
- Dry exposed slopes: Sparse and tall shrublands = sparse Joshua trees and Mojave yucca. Understory = sparse blackbrush, cacti, joint-firs, and desert shrubs.
- Washes and drainages: Dense short to medium-sized shrubs = desert almond, Mexican bladdersage, burrobrush, purple sage, and other tall, mid-elevation shrubs.
- Rock outcrops and talus: Sparse vegetation = mixed sparse dwarf desert shrubs, cacti, and yuccas.

4) Mid-Elevation Semi-Desert Scrub (Low Hills and High Valleys)
**Elevation Range:** 2,000–4,000 feet (610–1,220 m)

**Past Project Equivalents:** Blackbrush Scrub (Gardner 2007), Mid-Elevation Mixed Desert Scrub, Blackbrush Shrubland, Mojave Yucca Shrubland, Galleta Grasslands, Nevada Joint-fir Shrubland and Mid-Elevation Wash System (Thomas et al. 2004)

**Dominant Vegetation by Topographic Position:**

- High alluvial fans and valleys: Open shrub woodlands = Joshua trees. Understory = blackbrush, creosotebush, and mixed mid-elevation desert shrubs.
- Dry alluvial plains: Mixed mid-elevation desert scrub = Mojave yucca, Nevada joint-fir, spiny hopsage, Utah mortonia, buckhorn cholla, desert almond, Mormon-tea, water jacket, and other mid-elevation desert shrubs. Understory = Dwarf shrubs, cacti, big galleta, and other grasses.
- Grasslands = Burrograss, James' Galleta, big galleta, and black grama grasses.
- Washes and Drainages: Medium-sized shrubs = desert almond, Mexican bladdersage, burrobush, and purple sage. Understory = big galleta and other grasses.
- Rock outcrops, rocky slopes, and desert pavement: Sparse vegetation = brittlebush, white burrobush, green rabbitbrush, cacti, creosotebush, and sparse grasses.

5) Lava Beds and Cinder Cones (Various Volcanic Formations)
**Elevation Range:** 1,000–5,000 feet (305–1,515 m)

**Past Project Equivalents:** Lava Beds and Cinder Cones (Thomas et al. 2004)

**Dominant Vegetation by Topographic Position:**

- High elevation: Open shrub woodlands = Joshua trees and Mojave yucca. Understory = creosotebush and mixed mid-elevation desert shrubs.

- Mid-elevation slopes: Mixed mid-elevation desert scrub = Nevada joint-fir, spiny hopsage, Utah buckhorn cholla, desert almond, Mormon-tea, and other mid-elevation shrubs. Understory = dwarf shrubs, cacti, big galleta, and other grasses.
- Low-elevation slopes: Low-elevation desert scrub = saltbush, white burrobush, and creosotebush. Understory = sparse grasses and cacti.
- Bare lava and cinders: Sparse vegetation = little (if any) vegetation.

6) Low-Elevation Desert Scrub (Low Valleys and Floors, and Alluvial Fans and Plains)
**Elevation Range:** 1,000–3,000 feet (305–915 m)

**Past Project Equivalents:** Desert Scrub, Cactus Scrub, Creosote Bush Scrub, Desert Wash Woodland (Gardner 2007), Creosote Bush Shrubland, White Burrobush Shrubland, Creosote Bush/Brittlebush Mosaic, and Low-Elevation Wash System (Thomas et al. 2004)

**Dominant Vegetation by Topographic Position:**

- Low valleys and alluvial fans: Desert shrublands and scrub = Creosotebush, Mojave yucca. Understory = white burrobush, broom snakeweed, brome grasses, and eastern Mojave buckwheat.
- Washes and drainage channels: Short shrubs and sparse trees = acacias, mesquite, smoketrees, desert-willow trees, rabbitbrush, creosotebush, and white burrobush shrubs. Understory = creosotebush and white burrobush (woodlands), dwarf shrubs, and sparse grasses (shrublands).
- Desert pavement, sparse drainages, and rock outcrops: Sparse vegetation = brittlebush, white burrobush, green rabbitbrush, cacti, creosotebush, and sparse grasses.

7) Sand Dunes (Active and Stabilized Sand Dunes, Sand Sheets and Sand Ramps)
**Elevation Range:** 900–3,000 feet (275–915 m)

**Past Project Equivalents:** Desert Dune (Gardner 2007), Interior Dunes (Thomas et al. 2004)

**Dominant Vegetation by Topographic Position:**

- Stable dunes: Herbaceous vegetation = big galleta grass, desert twinbugs, desert panicgrass, birdcage evening primrose, and Thurber's sandpaper plant. Understory = little (if any) vegetation.
- Active dunes: Sparse vegetation = little (if any) vegetation.
- Sand sheets and flats: Desert scrub = creosotebush and sparse saltbushes. Understory = big galleta grass.

8) Saltbush Scrub, Alkali Sinks, and Playas (Dry Lake Beds and Flats)
**Elevation Range:** 900–4,000 feet (275–1,220 m)

**Past Project Equivalents:** Saltbush Scrub, Shadscale Scrub, and Alkali Sink (Gardner 2007), Saltbush Complex, Playa, and Desert Sink (Thomas et al. 2004)

**Dominant Vegetation by Topographic Position:**

- Moderately alkaline flats: Low desert scrub = cattle saltbush, fourwing saltbush, shadscale, and winter fat. Understory = sparse inland saltgrass, iodine bush, and Mojave seablite.
- Playa margins: Halophytic shrubs = inland saltgrass, iodine bush, seepweed, and Mojave seablite. Understory = little (if any) vegetation.
- Playas, salt crusts, and alkali sinks: Sparse vegetation = little (if any) vegetation.

9) Marshes and Riparian Areas (Seeps, Springs, and Ponds)
**Elevation Range:** All elevations

**Past Project Equivalents:** Palm Oasis and Desert Riparian (Gardner 2007)

**Dominant Vegetation by Topographic Position:**

- Seeps, springs, and wet drainages (rare): Trees and shrubs = Fremont cottonwood, Goodding's willow, and honey mesquite trees and desert baccharis, arroyo willow, and narrowleaf willow shrubs. Understory = goldenrod, needlegrass, and mixed herbaceous vegetation.
- Ponds and standing water margins (rare): Mesic herbaceous vegetation = cattails, alkali sacaton, common reed, and bulrushes.

10) Post-fire and Disturbed Areas (All Landforms)
**Elevation Range:** All elevations

**Past Project Equivalents:** N/A

**Dominant Vegetation by Topographic Position:**

- Recent and severely burned areas: Dwarf shrubs and grasses = broom snakeweed, globemallows, and eastern Mojave buckwheat. Understory = brome and other grasses.
- Older burns: Recovering mid-elevation shrublands = desert bitterbrush, Nevada broomsage, catclaw acacia, Mexican bladdersage, and rabbitbrush. Understory = broom snakeweed, brome grasses, and recovering seedling shrubs and trees.
- Disturbed grasslands: Early successional vegetation = bristly fiddleneck, red brome, redstem stork's-bill, Arabian schismus, and common Mediterranean grass.
- Other disturbed areas: Shrubs and grasses = broom snakeweed, rubber rabbitbrush, salt cedar, Athel tamarisk. Understory = brome grasses, Russian thistle, schismus grass, and various other early successional plants.

## Vegetation Mapping Inventory Project

The decision to inventory, classify, and map the vegetation at MOJA was initially made in response to guidelines set forth by the NPS Inventory and Monitoring Program (NPS 2009). It was done in cooperation with MOJN and the local NPS staff. Work started at MOJA in 2011 when CTI was contracted to complete a work plan for vegetation inventories in all of the park units in the MOJN. Using the guidance outlined in the work plan, the NPS VMI[3] contracted with the California Native Plant Society (CNPS) and the University of Nevada, Las Vegas (UNLV) to sample plot and observation point (rapid assessment) data in the representative vegetation plant associations in MOJA and create a rUSNVC report for each park unit.

After the plot data were collected, CTI was also contracted to begin work on the vegetation map layer in 2013. A draft vegetation draft layer was completed in 2015 in anticipation of the accuracy assessment (AA) data collection. In 2016, after CAMO was designated as a National Monument, this area was added to the MOJA inventory project. As a consequence, an additional field survey session was conducted by CNPS to sample and classify the vegetation, and the new CAMO lands were incorporated into the MOJA draft map. Once completed, the combined vegetation maps were assessed for accuracy by CTI subcontracted ecologists in 2020. Data from the AA effort were then used to evaluate the draft products, and the results were sent to the NPS VMI for review and approval in 2020–2021.

## Project Scope

All vegetation inventory work for MOJA and CAMO occurred within the administrative boundary as provided in a digital GIS layer by the NPS VMI and the NPS Land Resource Division. The total acreage for MOJA was 1,586,563 acres (642,082 ha), and the CAMO addition was 29,360 acres (11,882 ha). Mapping was done within the combined MOJA and CAMO boundaries (including inholdings), and all fieldwork was conducted only on NPS-managed lands. The final MOJA/CAMO project boundary used for this project (Figure 8) covered 1,616,577 acres (654,206 ha).

Overall, the staff from NPS VMI, MOJN, CTI, CNPS, and various sub-contractors (with critical support from MOJA staff) worked together to meet all project objectives. The results presented in this report and accompanying digital files represent the final products outlined in the NPS VMI Guidance documents (NPS 2009) and the NPS VMI final product guidelines (Cook 2012). No future efforts relating to this project are planned at the time of this report.

[3] NPS Vegetation Mapping Inventory (VMI) was formerly known as the USGS-NPS Vegetation Mapping Program but underwent a name change. The program is referred to as NPS VMI throughout this report.

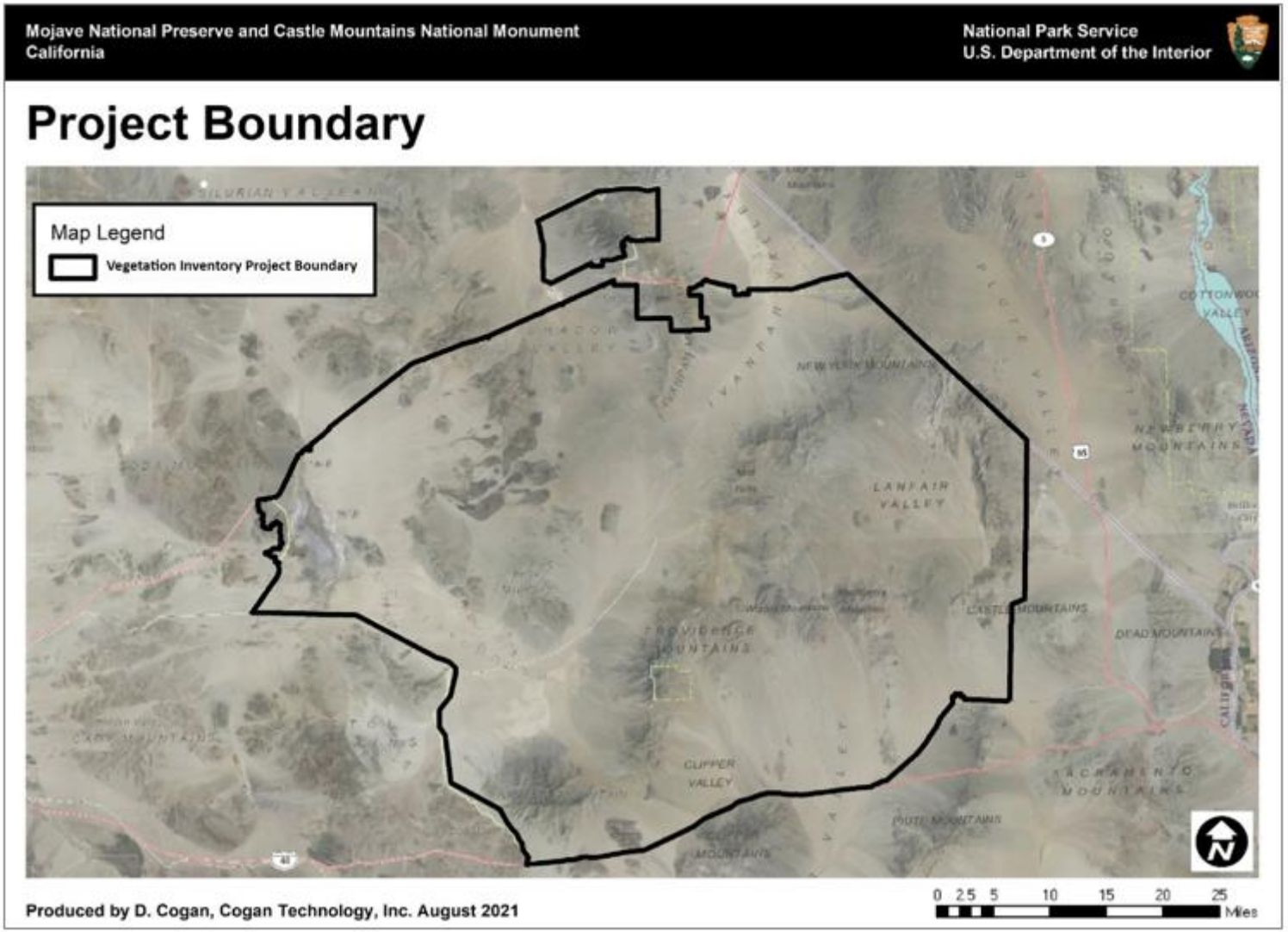


**Figure 8.** Map of the MOJA and CAMO Vegetation Inventory Project boundary. NPS / CTI

# Methods

All methods and protocols for this project, as outlined in the following sections of this report, can be found in the original program documents produced by TNC and Environmental Research Systems Institute (1994a; 1994b; 1994c) and in later revisions (Lea 2011; Lea and Curtis 2010). The standard vegetation inventory tasks were implemented for MOJA and CAMO as outlined in the 12-Step Guidance for NPS Vegetation Inventories (NPS 2009). The major project categories are summarized below, and the following report sections give detailed descriptions for each:

1. Plan, gather legacy and historical data, and coordinate tasks.
2. Survey MOJA and CAMO to inventory the vegetation using sample plots and observation points.
3. Classify the survey data to rUSNVC standard associations and alliances and crosswalk these to identifiable map units.
4. Acquire current digital imagery and map the vegetation using the rUSNVC list of types.
5. Assess the accuracy of the final map product.
6. Summarize the project findings in a final report, create the final vegetation spatial database, and produce all the other standard deliverables.

All protocols for this project can be found in the NPS Inventory & Monitoring Vegetation Mapping Inventory.

### Planning, Data Gathering, and Coordination

Planning for this project got underway in 2009, and numerous on-site meetings and conference calls were attended by representatives from CTI, NPS VMI, MOJA, and CNPS. The goals of these efforts were to

- Discuss the overall project and review the necessary requirements,
- Discuss the availability of existing data,
- Learn about the management issues and concerns,
- Discuss procedural issues and data management,
- Develop a project scope of work and project timeline,
- Discuss future project needs and funding.

After the initial meeting and calls, individual work responsibilities were assigned, tasked, or contracted with various entities, including CNPS for the vegetation fieldwork and CTI for the mapping and AA portions.


Plot Data Collection at MOJA and CAMO. NPS / UNLV

### Field Surveys

In 2009, CNPS started the fieldwork at MOJA by obtaining, reviewing, and compiling all legacy datasets. CNPS reviewed four recent studies that collected relevant and usable data. These were entered into the PLOTS database (NPS VMI standard) and formed the basis for the collection of new field samples. From 2010 to 2011, CNPS ecologists, along with staff and students from UNLV, collected new classification/mapping data specifically for MOJA. All new field data were collected following the standard NPS protocols for revised, second-phase field data forms (Evans et al. 2020, Lea 2011). The new data filled in gaps where there was no existing vegetation information, especially in recently burned and recovering areas. Additionally, CNPS conducted new surveys at CAMO in 2016 once this area was added to the scope of the project.

The legacy surveys for MOJA included a total of 588 samples from a variety of past studies in and around MOJA and CAMO (Thomas et al. 2004; Evans 2000; Figure 9). In 2011, an additional 600 new vegetation plots and observation (rapid assessment) surveys from NPS/UNLV were added, followed by 30 from NPS/CNPS for CAMO in 2016 (Figures 10 and 11). A detailed accounting of all the field survey methods can be found in the companion Vegetation Classification Report (Evans et al. 2020) (see the supplemental digital folder in DataStore).

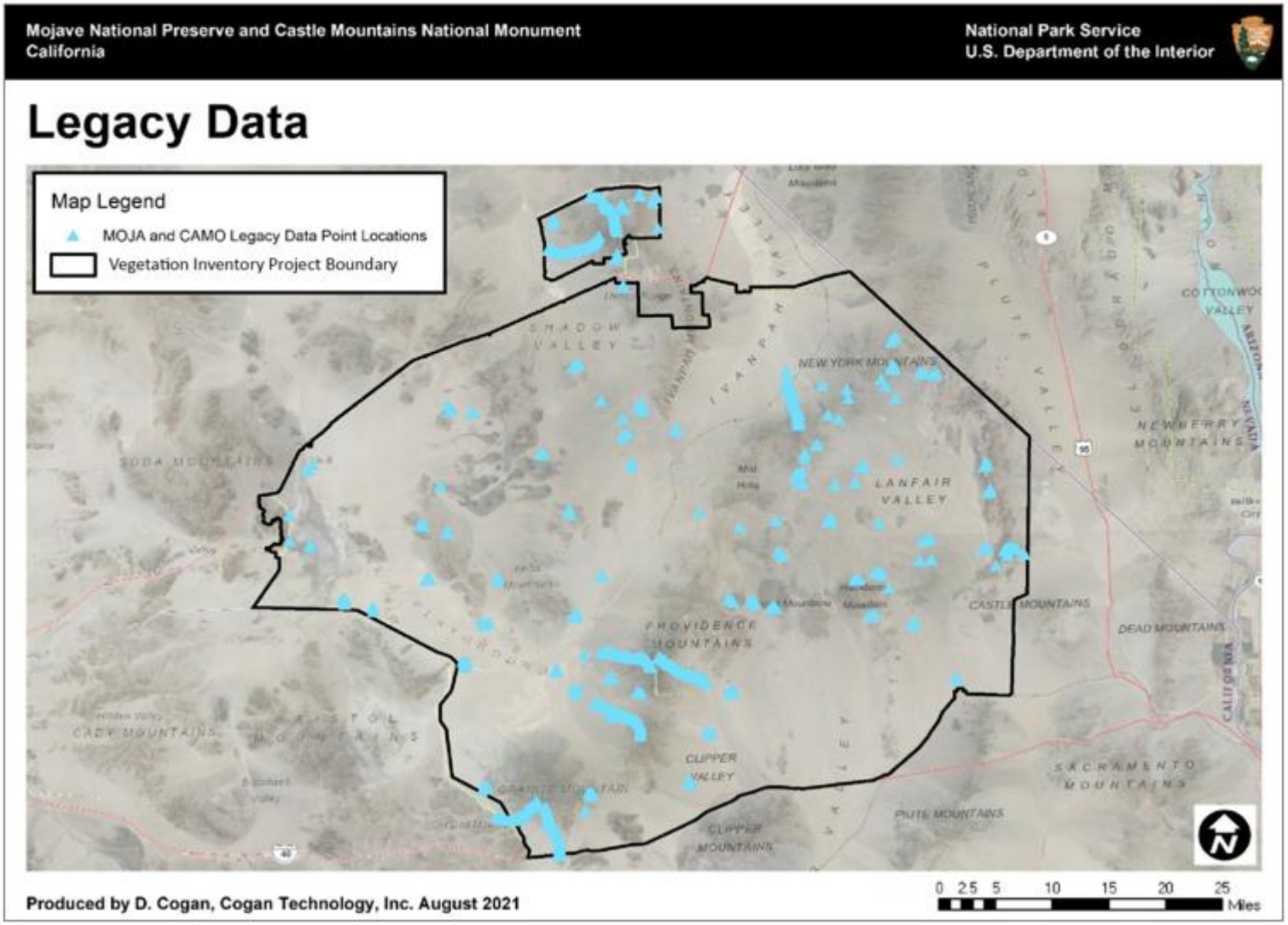


**Figure 9.** Map of the legacy data locations at MOJA and CAMO. NPS / CTI

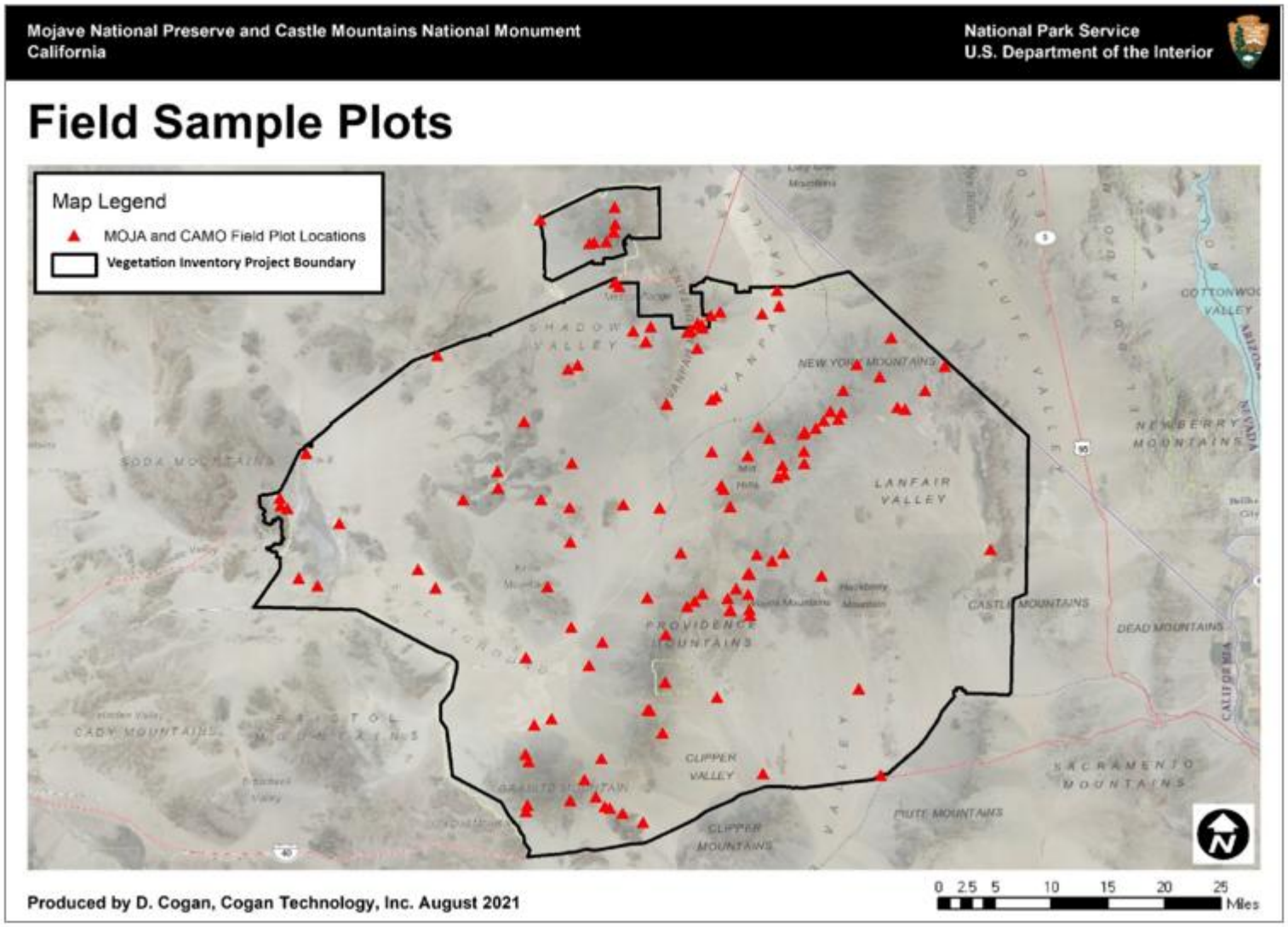


**Figure 10.** Map of the vegetation plot locations at MOJA and CAMO. NPS / CTI

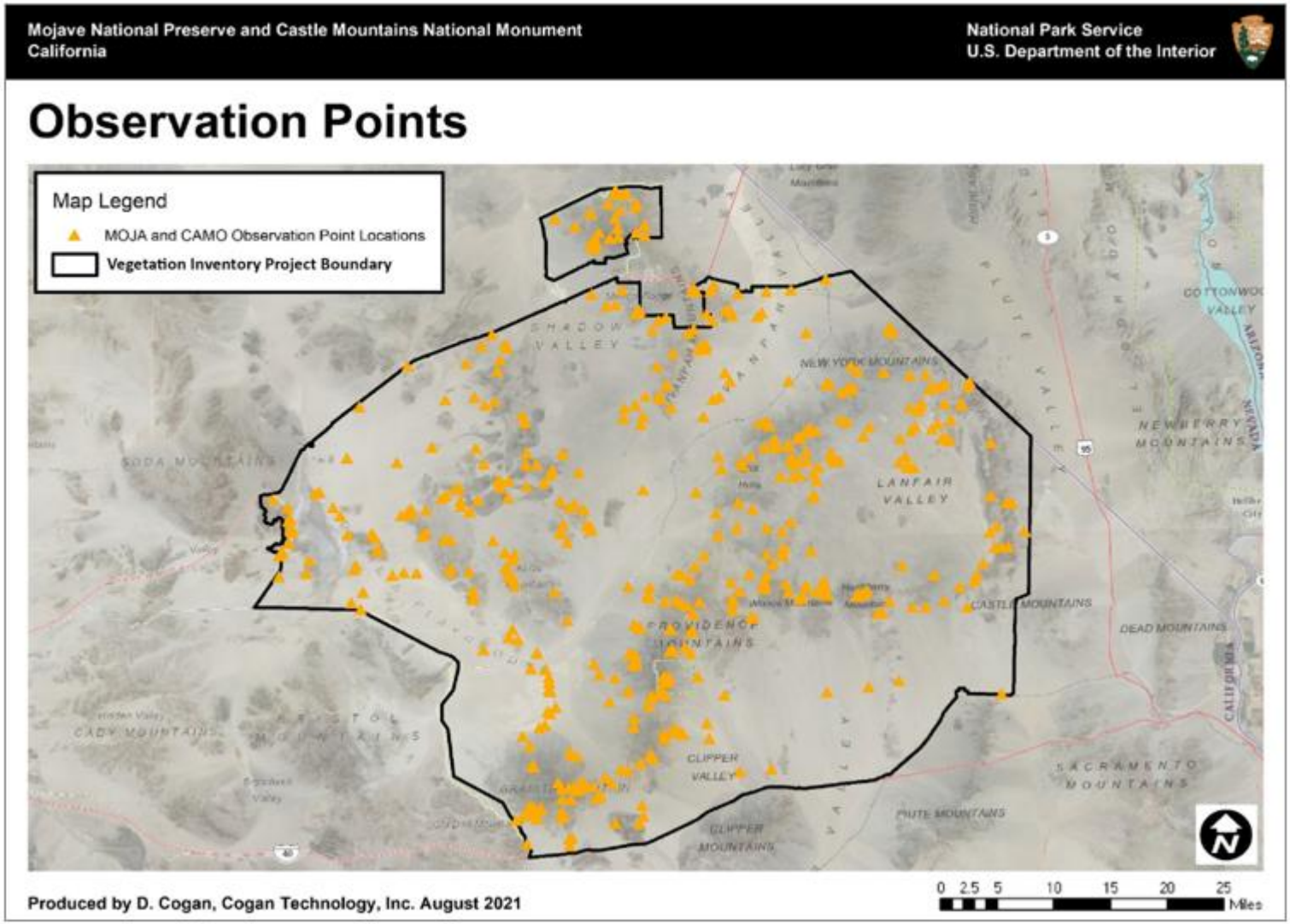


**Figure 11.** Map of the observation point locations at MOJA and CAMO. NPS / CTI

## Vegetation Classification

In 2013, CNPS staff combined and compiled the existing legacy and all new data from the MOJA and CAMO field surveys. The total data set was populated with approximately 4,000 data points that included similar vegetation communities found at LAKE and DEVA. Data were then matched to existing vegetation types known from existing desert vegetation classifications. Next, CNPS made corrections, simplifications, and used guidelines to resolve plant identification, taxonomic, and other date consistency issues (Evans et al. 2020). The results of this effort produced a draft list of rUSNVC alliances. Next, the CNPS performed cluster analysis routines and other classification analyses to interpret first the generic vegetation types (i.e., macrogroups and alliances) and then finer plant communities (i.e., associations/alliances) (Evans et al. 2020). The final list of rUSNVC types for MOJA and CAMO was provided to the NPS for approval. A full description of the classification process can be found in the companion Vegetation Classification Report (Evans et al. 2020).

During the classification process, CNPS staff also created detailed local and global descriptions for the following: 1) all of the alliances, 2) any new associations, and 3) any associations that had a sample size of at least three or more. The MOJA and CAMO plant types were then reviewed by NatureServe for incorporation into the rUSNVC. After review, NatureServe provided global descriptions for all associations that had a sample size of at least 10 and/or had at least one supporting literature citation. NatureServe also assigned associations with database codes as either CEGL (community element global) or CEPP (community element proposed or provisional associations) for all MOJA and CAMO associations. Once the association codes were assigned, CNPS provided CTI with the classification and accompanying descriptions for use in the mapping.

## Digital Imagery and Vegetation Mapping

The enormous size of the MOJA/CAMO project area warranted the use of a modified or hybrid mapping approach. Early discussions determined the need to have an approach that included a coarse-level (scale) automated or machine-logic image processing stage and a fine-scale stage that included photo interpretation and manual delineation. Based on similar work done by CTI in other desert environments, the automated stage would use multiresolution image segmentation routines to capture high-contrast landforms and drainage/wash features. The second phase would build off these segmented polygons to delineate the fine-level plant alliance/association-based map units.

### *Coarse-Scale Mapping*

To complete the automated phase, CTI subcontracted with Photo Science (based in Lexington, Kentucky) to create a MOJA landform layer and a drainage/wash layer. Photo Science reviewed and acquired all National Elevation Dataset (NED) 10-meter DEMs for the project area and mosaiced them into a seamless coverage. The DEM data were then manipulated to create the following derived spatial layers: aspect, slope, three hillshade datasets (different azimuth angles), a contour range layer, and a compound topographic index (or wetness index) that models water flow and accumulation.

Photo Science also acquired the 2012 National Agriculture Imagery Program (NAIP) imagery for the entire project area as high-resolution (1-meter pixels) digital ortho quarter quadrangles (DOQQs). The NAIP DOQQs were mosaiced and resampled from 1-meter to 10-meter pixels to match the DEM

resolution. ERDAS Imagine software was then used to derive a normalized difference vegetation index (NDVI) and a near-infrared (NIR) band texture layer from the imagery using a 9x9 moving window.

To create the landform spatial model, the NIR band, red band, NDVI, slope, contours, and hillshade layers were imported into Trimble eCognition software. eCognition was used to segment the derived layers in a stepwise fashion until obvious landform patterns were observed. For the purposes of this effort, a landform was defined as a repeatable landscape feature (i.e., mountain, hill, basin, etc.) that contained unique geographic and vegetation patterns. The completed segments were then exported as shapefiles into ArcGIS software. In ArcGIS, the segments were classified into preliminary landforms using a combination of modeling and manual labeling. For modeling, segments were classified using attribute thresholds such as elevation, slope, aspect, band values, or a combination of thresholds. All preliminary segments were manually reviewed, and attributes were changed if needed. Once all segments were correctly classified, common boundaries were dissolved, resulting in the final MOJA/CAMO landform polygons.

To delineate the intricate network of drainages and washes at MOJA/CAMO, the final landform shapefile was imported back into eCognition using a chessboard segmentation process that divided the landforms into individual or grouped features. Next, a Canny Brightness index using the NIR and red bands and a Zabud index (using image band ratios) were created for each landform. Through a series of multiresolution segmentation routines, preliminary drainage/wash segments were created and classified using thresholds obtained from the mean band values, NDVI, elevation, slope, the Canny Brightness, Zabud, and wetness indices, and general landscape position. All classified segments were then manually reviewed and edited to correct any commission and omission errors. Once completed, all riparian/wash polygons were combined into a single layer, and the polygon boundary lines were smoothed.

#### *Fine-Scale Mapping*

During the planning and coordination phase, CTI staff reviewed all available digital imagery for its potential use as the MOJA/CAMO basemap. The most favorable was the USDA NAIP imagery for California located on the USGS National Map Download Application website. The corresponding 2012, 2014, and 2016 NAIP 4-band (3 true color + 1 color infrared bands), 1-meter DOQQs for the MOJA/CAMO project area were downloaded (Figure 12), and these were used in combination during the early mapping stages. In 2019, the NAIP 2018 imagery was made available, and all fine-scale mapping was switched to this more recent basemap.

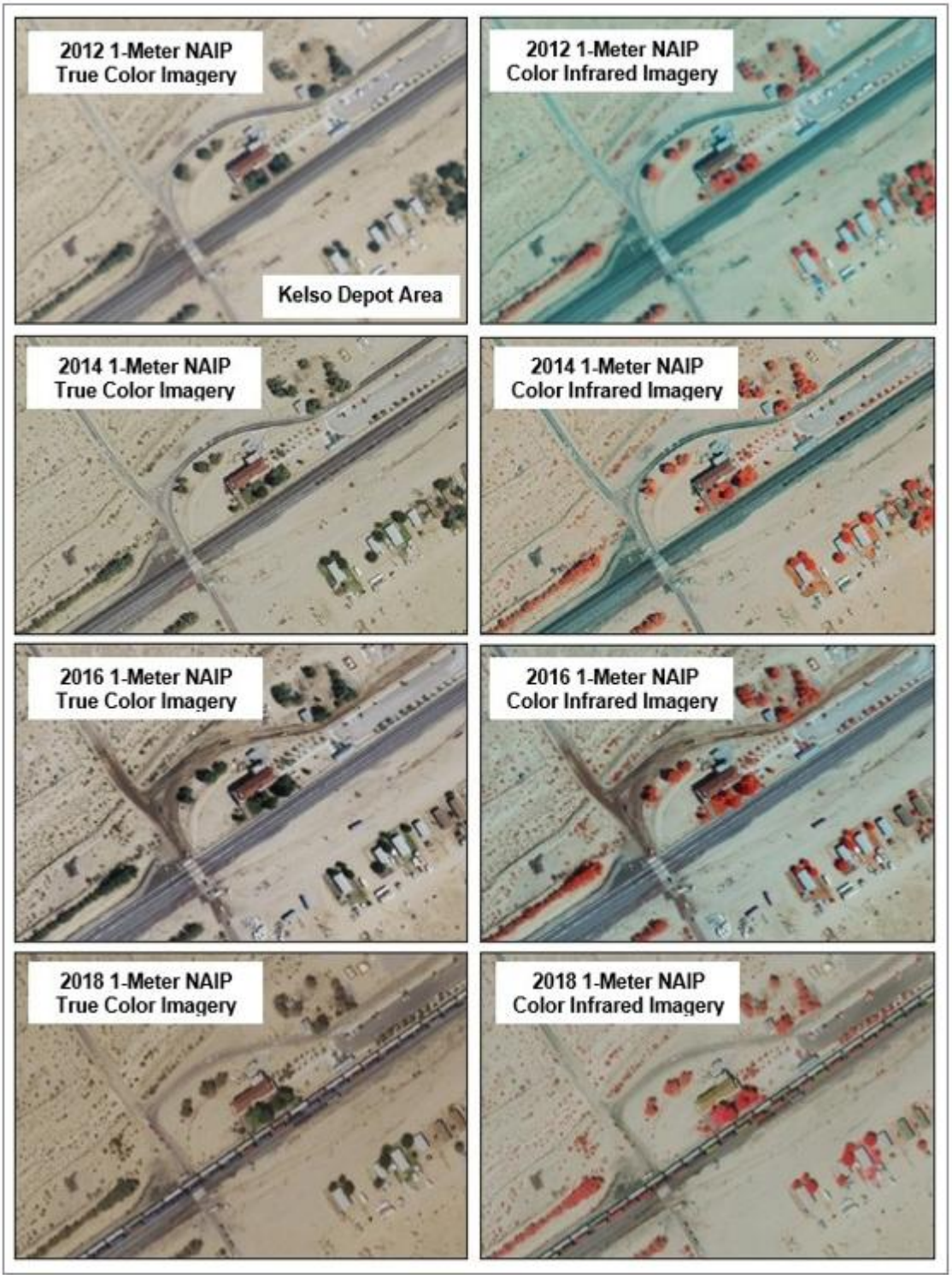


**Figure 12.** Examples of the NAIP imagery for MOJA and CAMO. NPS / CTI

Once digital copies of the imagery were acquired and compiled, interpretation and mapping of the vegetation began using a four-step process that included (1) importing and updating the coarse-level mapping, (2) photo interpretation and digitizing, (3) ground-truthing the mapped data, and (4) map refinement and finalization. Figure 13 shows a summary of the mapping stages and the spatial layers used or produced during the vegetation mapping process.

In the first step, all the final coarse-level landforms and drainage/wash polygons were combined and edited into one layer. Next, the existing MOJA/CAMO roads and trails layer was converted from lines to polygons using buffering routines and added to the polygon map. Once the preliminary polygon layer was cleaned and smoothed, manual editing was used to remove unnecessary and small polygons, updated polygon lines were compared to the 2016 NAIP imagery, and new polygons were added in areas that were not adequately delineated. Cleaning was considered complete when all resulting polygons matched homogenous stands of vegetation.

During the next stage of mapping, the coarse-level vegetation map was exported as shapefiles and converted to ArcGIS coverages. At this stage, the mapping shifted to photo interpretation, on-screen digitizing, and other manual mapping techniques using the most recent 2018 NAIP imagery. All vegetation delineations were visually inspected and manually moved, edited, and updated as needed. Any obvious problems in the mapping (such as shifting and sliver polygons) were edited and resolved. Once the preliminary lines were completed, temporary map unit names and placeholder codes were used to attribute each vegetation polygon. The resulting draft vegetation layer was then verified on the ground.

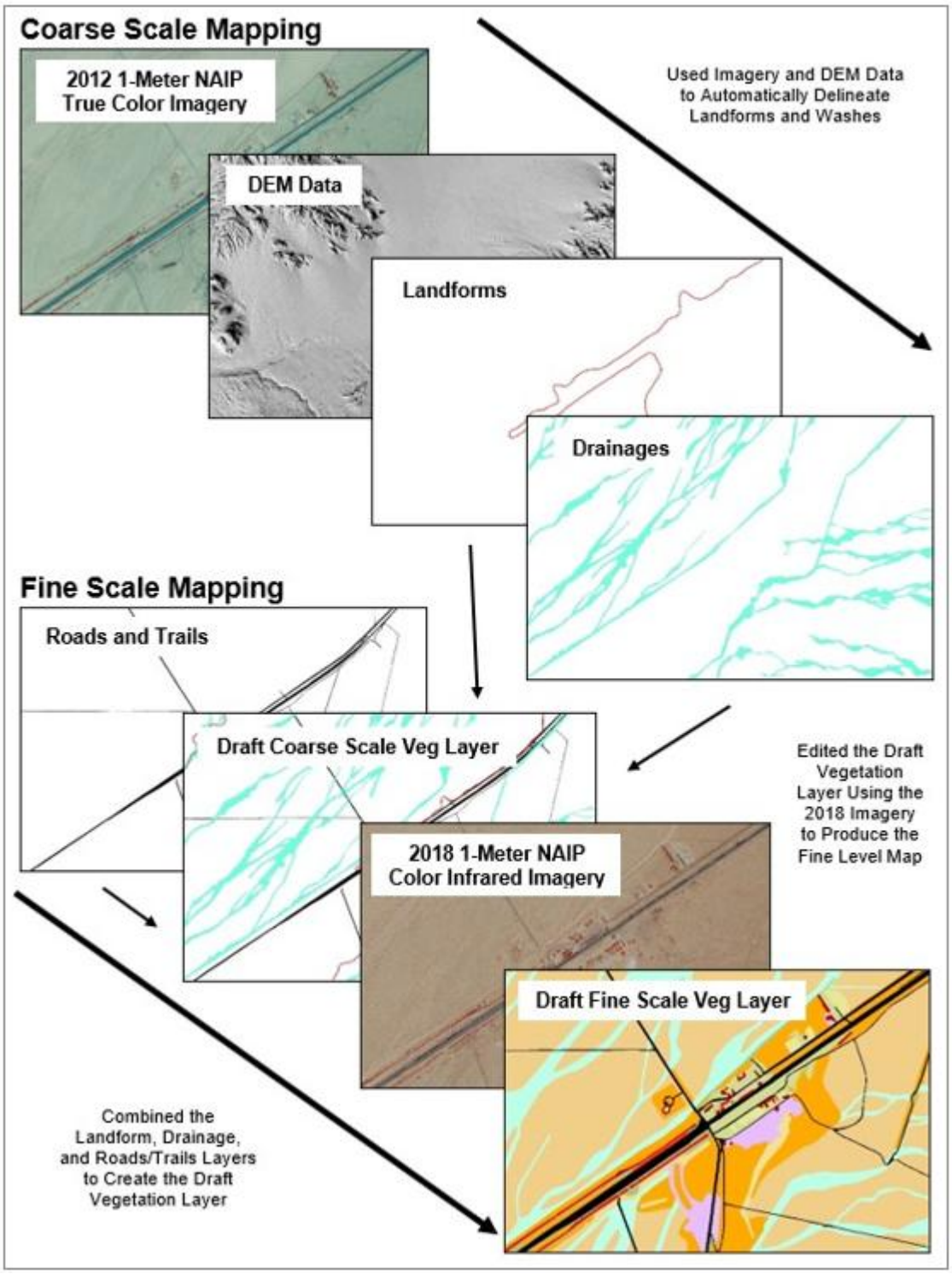


**Figure 13.** Mapping flow diagram. NPS / CTI

Ground-truthing or verifying the vegetation by the mapping team occurred during two field trips. The first started once a draft layer was completed in 2017, and the other was conducted in 2019 after CAMO was added to the project. During these trips, the preliminary MOJA/CAMO vegetation layer was checked on the ground by CNPS and CTI staff. Representative polygons were visited, and the map lines and labels were verified against the actual vegetation on the ground. During these trips, 505 sites were recorded using GPS receivers to document both unique and representative stands of vegetation (Figure 14).

After each verification trip, adjustments were made on both individual polygons and across the whole project if warranted. Common issues included mislabeled polygons, too heterogeneous or mixed map units, or combining map units that were too finely split. Site-specific changes included changing the polygon label, merging neighboring polygons, or creating new polygons. Park-wide changes included adding new map classes, merging similar map classes, or expanding/restricting the extent of map classes based on field observations.

The fine-level MOJA/CAMO vegetation map was considered completed in 2019–2020 after the verification was completed and when the vegetation classification was finalized. In most cases, the preliminary, placeholder map unit names and labels were simply changed to reflect the current rUSNVC alliance/association or equivalent name. Due to the limitations of the imagery and the complex mixing of the vegetation, some map units contained multiple alliances/associations. This was addressed by grouping similar types into broader map units. MOJA/CAMO special map units were also created for rare tree types, disturbed vegetation, and to separate broad alliances into finer-scale units (especially for the wooded and wooded shrub types). To round out the mapping scheme, additional map units were added for land-use types based on a mapping system developed by Anderson et al. (1976). This included land-use and land-cover types not in the rUSNVC, such as roads and facilities.

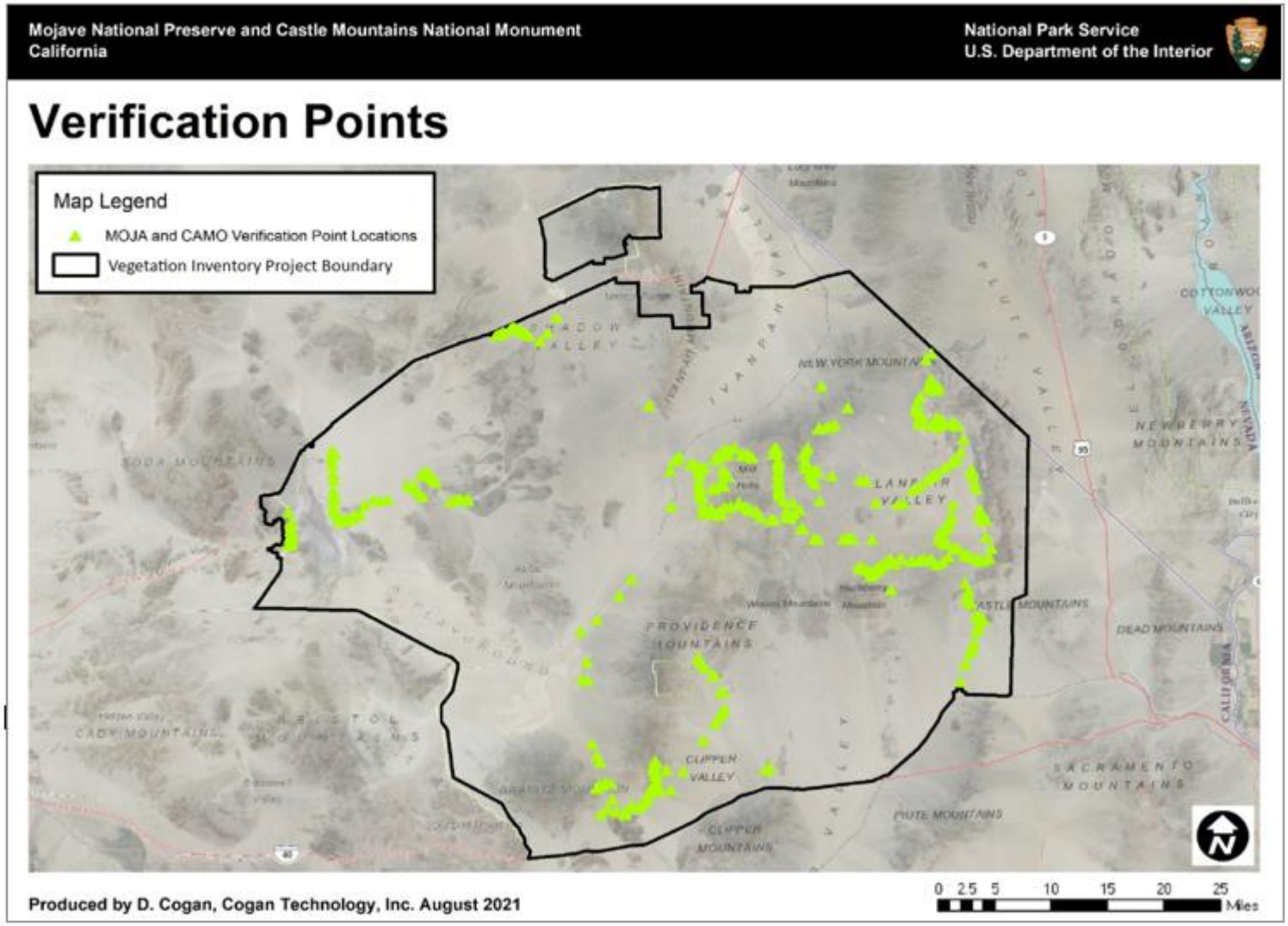


**Figure 14.** Map of the verification point locations at MOJA and CAMO. NPS / CTI

In addition to the map unit names and codes, other polygon-specific data or modifiers were added to the map layer (Table 2). Polygon modifiers included physical quantifiers such as the average height of the vegetation, the average density of the vegetation, and the general pattern/shape of the vegetation. Topographic and landscape modifiers were also added for each polygon by extracting data from existing spatial datasets through GIS analysis routines. Finally, the vegetation layer was converted to a geodatabase, and all of the common rUSNVC data contained in the final MOJA/CAMO plant classification were joined using relationship classes.

**Table 2.** Polygon attribute items and descriptions.

| Attribute | Description |
|---|---|
| SHAPE [A] | Map layer shapes = polygons |
| AREA [A] | Surface area of the polygon in meters squared |
| PERIMETER [A] | Perimeter of the polygon in meters |
| MOJAVEG [A] | Unique code for each polygon |
| MOJAVEG_ID [A] | Unique identification code for each polygon |
| MAP_CODE | Final map unit codes–project-specific |
| MAP_DESC | Map unit scientific description name–project-specific |
| MAP_CDESC | Map unit common description name–project-specific |
| DENS_MOD | Modifier–percent cover of the upper stratum layer in the polygon<br>• Sparse = < 10%<br>• Open = 10–25%<br>• Intermediate = 25–50%<br>• Discontinuous = 50–75%<br>• Closed = 75–100% |
| PTRN_MOD | Modifier–vegetation pattern within the polygon<br>• Evenly Dispersed = Homogeneous<br>• Grouped Stands of Vegetation = Bunched / Clumped<br>• String of Vegetation = Linear<br>• Varying densities and gradients of vegetation = Gradational |
| HT_MOD | Modifier–height range of the dominant vegetation layer<br>Height classes: < 1, 1–3, 3–5, 5–15, and > 15 Meters |
| ASPECT | General aspect (direction) of the polygon in degrees |
| ASPECT_DIR | General aspect direction of the polygon |
| SLOPE | General slope of the polygon in degrees |
| ELEV_FT | Average elevation in the polygon (feet) |
| ELEV_MTRS | Average elevation in the polygon (meters) |
| TOPOLOGY | General geographic topology of the polygon |
| LANDFORM | General landform of the polygon |
| GROUP_VEG | USNVC group level of the polygons vegetation |
| PHYS_VEG | General physical vegetation–based on Thomas et al. 2012 |

[A] Represent ArcGIS default attributes and values.

**Table 2 (continued).** Polygon attribute items and descriptions.

| Attribute | Description |
|---|---|
| BPS_VEG | General Biophysical Vegetation |
| GEOLOGY | Dominant geological formation for each polygon–based on the current MOJA geology layer |
| COMMENTS | Additional comments about the vegetation for individual polygons |
| ACRES | Surface area of the polygon in acres |
| HECTARES | Surface area of the polygon in hectares |

[A] Represent ArcGIS default attributes and values.

## Accuracy Assessment

Typically, in mapping exercises, both thematic or attribute map accuracy and positional or polygon line accuracy are considered. In the case of the NPS VMI, positional accuracy is usually omitted since vegetation rarely splits on discrete edges that can be positively located in the field. The subjectivity involved in this effort, plus the high resolution and accuracy of NAIP imagery, allows for the assumption that all products derived from them are within the National Map Accuracy Standards for 1:12,000-scale maps (±30 feet).

The thematic accuracy of the vegetation map was assessed using the methodology provided by the NPS VMI (TNC; ESRI 1994c; Lea and Curtis 2010). The revised protocols included a four-step AA process consisting of a (1) sample design, (2) sample site selection, (3) data collection, and (4) data analysis. The design of the AA process followed the three possible scenarios provided in the field manual, with stratified random targets placed in each map class based on their respective frequency and abundance (Table 3).

**Table 3.** Standard sample size allocations for AA points based on map unit area.

| Map Class Total Area [A] | Number of Observations Per Map Class [B] |
|---|---|
| > 50 hectares | 30 |
| 8.33 to 50 hectares | 0.6 per hectare |
| < 8.33 hectares | 5 |

[A] As measured before buffering for cost surface (access buffer) or for map class boundary buffer.

[B] As many spatially independent (non-overlapping) observation sites as map class area, MMU size and other considerations will allow.

A simple random sampling design, weighted by polygon size (to spread out the AA targets), was used to allocate potential assessment sites across MOJA. Very small polygons, private property (approximately 5.7% of MOJA), and the Providence Mountains State Recreation Area (approximately 0.4% of MOJA) were excluded from the sampling design. Initially, only areas within an access buffer of 300 horizontal meters from any road were included in the sampling to account for the added cost of traveling by foot to distant sites. Types not occurring within this buffer were then added in an expanding stepwise process until a minimum of 10% of the polygons for each type were

covered. Further buffering was used to ensure that AA target locations were at least 40 meters away from any polygon boundary and 85 meters away from any previously sampled location (i.e., plots and observation points). Map classes representing non-vegetated areas (e.g., roads, buildings, ponds) and some cultural vegetation (e.g., agriculture, lawns) were not included in the sampling design.

The AA sample size parameters were loaded into a custom GIS program along with the vegetation layer to perform the stratified random sample site selection and produce the potential AA target locations. To complete the sampling, additional target points were added to long linear riparian polygons and rare types that were missed. An additional set of independent backup AA targets was also created in case the original targets could not be reached. During the AA fieldwork, difficult or hazardous targets were replaced with backup targets for safety and economic reasons as determined by the field crews.

The MOJA/CAMO AA data collection process was started once the draft vegetation layer, the AA target point locations, the key to the associations and their corresponding map units, and all associated digital GIS files were turned over to Coast to Coast Botany (CCB) and the Rio Grande Institute (RBI), CTI sub-contractors. For safety and efficiency reasons, field crews consisted of both an experienced ecologist familiar with the flora of MOJA/CAMO and an assistant. AA data were collected at 720 locations in MOJA during September and October 2019 and again in February 2020. Detailed reports on the MOJA/CAMO AA selection process and fieldwork can be found in DataStore in the accompanying digital files for this project.

Accuracy assessment data collection at MOJA and CAMO. NPS / CBB / RGI

At most AA points, the observation area was a circle with a radius of 131 feet (40 m), which was equal to the MMU of 0.5 hectares. Smaller observation areas of 0.25 hectares or 0.1 hectares were used for smaller stands of vegetation when appropriate. If the assessment area was located in more than one vegetation type, the field crews moved the target location into the largest stand. Once the targets were located in the field, the ecologist recorded the dominant vegetation by cover class on a standard NPS VMI AA form and used the vegetation key to determine the primary and secondary rUSNVC alliance/association. After determining the plant community, the field crews also noted the level of fitness for the vegetation key and collected supplemental data about the species composition. Species names and abundance and geographic data for each AA point were entered into the PLOTS database and reviewed by the field teams (Figure 15).

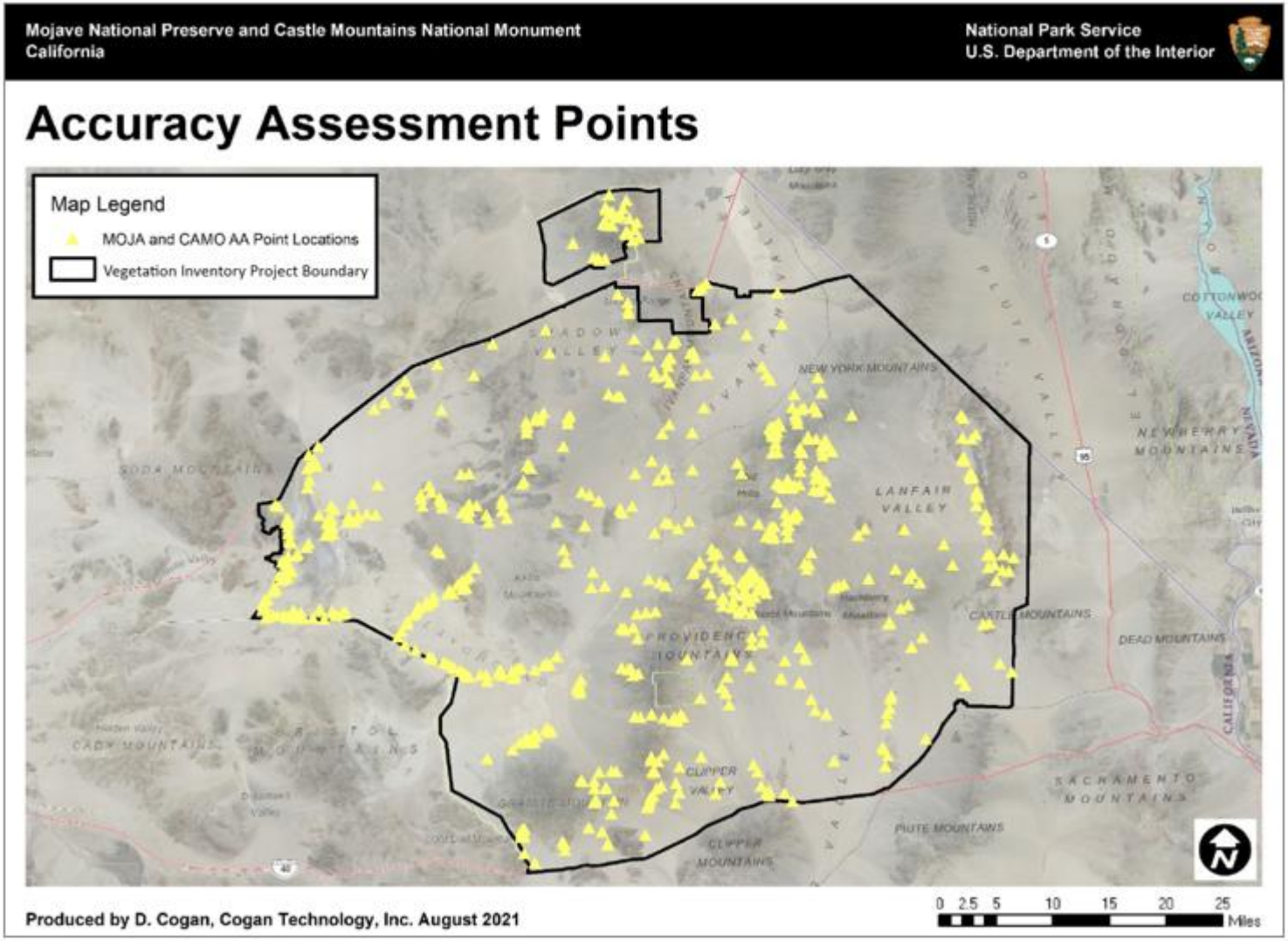


**Figure 15.** Map of the accuracy assessment point locations at MOJA and CAMO. NPS / CTI

For the AA analysis, the AA field data were exported into a GIS point file and then overlain on the final vegetation map. The field call to the vegetation alliance/association (reference data) was visually compared to its corresponding vegetation polygon map unit name (predicted data) during two stages of evaluation. In the first review stage, the original AA point data were matched by its rUSNVC name to the corresponding map unit. If more than one alliance/association was listed on the AA form, the best map unit determination was made based on location, geology/substrate, dominant species, and foliar cover values. A preliminary contingency table was then generated after all of the AA point data to highlight any errors.

The second evaluation step involved examining the AA points that differed from the predicted polygon labels by reviewing the field forms in question. Errors were evaluated based on the following criteria: 1) incorrect UTM coordinates (handwriting/transcription errors on the datasheet vs. the actual GPS waypoint location), 2) incomplete and/or incorrect field calls (corrected based on actual species and cover data), 3) discrepancies in the field key (i.e., the wrong couplet was used), or 4) data were collected in a polygon that was obviously labeled incorrectly (e.g., a vegetated polygon labeled as a road). Changes were made if appropriate and recorded in the comments field of the AA point layer.

Once the data were reviewed, the final AA analysis was conducted using custom CTI GIS programs and AA templates supplied by the NPS VMI. Through this automated process, the final map units in the AA layer were compared to the map unit designations for their corresponding polygons. All statistics and calculations used to analyze these data are described at length in the program manuals (TNC; ESRI 1994c; Lea and Curtis 2010). The final percent accuracy for each of the map classes was recorded using contingency tables (error matrices).

# Results

## Vegetation Classification

The MOJA and CAMO classification resulted in 67 alliances and 2 landform types from approximately 1,230 legacy and new field samples (Evans et al. 2020). Further, using the alliance descriptions and the field sample data, approximately 136 associations were identified (Table 4). The naming of each alliance/association uses the current scientific species names as described by the USDA–NRCS (2018). All of the MOJA/CAMO alliances/associations follow the rUSNVC naming methodology that includes using parentheses "( )" in the name to indicate that the species may or may not be present, a dash "-" between species to indicate species occurring in the same vegetation layer (i.e., stratum), and a slash "/" to indicate species that occur in different vegetation layers (i.e., canopy/understory). More information about each of the plant communities can be found in the classification report (Evans et al. 2020) or by querying them on NatureServe Explorer.

Summarized by physiognomic class, this study found 10 woodland, 1 wooded shrubland, 40 shrubland and scrub, 9 grassland/herbaceous vegetation, and 7 sparse vegetation alliances. The associations totaled 17 woodland, 10 wooded shrubland, 85 shrubland and scrub, 14 grassland/herbaceous vegetation, and 10 sparse vegetation types. The vast majority of the MOJA/CAMO alliances/associations were dominated by native species, with only four alliances (six associations) considered to be either non-native or planted types.

**Table 4.** Summary of rUSNVC plant alliances/associations for MOJA and CAMO.

| Category | Plant Alliance (common name) | Plant Alliance (scientific name) | Alliance rUSNVC Element Code | Plant Association (common name) | Plant Association (scientific name) | Association rUSNVC Element Code |
|---|---|---|---|---|---|---|
| Pinyon-Juniper and High-Elevation Woodlands | Canyon Live Oak - California Black Oak Forest and Woodland Alliance | *Quercus chrysolepis - Quercus kelloggii* Forest and Woodland Alliance | A3349 | Canyon Live Oak / Hollyleaf Redberry Woodland | *Quercus chrysolepis / Rhamnus ilicifolia* Woodland | CEPP006750 |
| Pinyon-Juniper and High-Elevation Woodlands | Dry White Fir Dry Forest and Woodland Alliance | *Abies concolor* Dry Forest and Woodland Alliance | A3420 | No White Fir Association Described for MOJA/CAMO | No White Fir Association Described for MOJA/CAMO | N/A |
| Pinyon-Juniper and High-Elevation Woodlands | Pinyon Pine - Utah Juniper Woodland / Shrub Woodland Alliance | *Pinus monophylla - Juniperus osteosperma* / Shrub Woodland Alliance | A2108 | Pinyon Pine / Eastern Mojave Buckwheat Woodland | *Pinus monophylla / Eriogonum fasciculatum* Woodland | CEPP006732 |
| Pinyon-Juniper and High-Elevation Woodlands | Pinyon Pine - Utah Juniper Woodland / Shrub Woodland Alliance | *Pinus monophylla - Juniperus osteosperma* / Shrub Woodland Alliance | A2108 | Pinyon Pine - Utah Juniper Woodland / Sparse Understory Woodland | *Pinus monophylla - Juniperus osteosperma* / Sparse Understory Woodland | CEGL000829 |
| Pinyon-Juniper and High-Elevation Woodlands | Pinyon Pine - Utah Juniper Woodland / Shrub Woodland Alliance | *Pinus monophylla - Juniperus osteosperma* / Shrub Woodland Alliance | A2108 | Singleleaf Pinyon / Ashy Silktassel Woodland | *Pinus monophylla / Garrya flavescens* | CEGL005771 |
| Pinyon-Juniper and High-Elevation Woodlands | Pinyon Pine - Utah Juniper Woodland / Shrub Woodland Alliance | *Pinus monophylla - Juniperus osteosperma* / Shrub Woodland Alliance | A2108 | Singleleaf Pinyon / Desert Almond - Skunkbush Sumac Woodland | *Pinus monophylla / Prunus facisculata* | CEGL005772 |
| Pinyon-Juniper and High-Elevation Woodlands | Pinyon Pine - Utah Juniper Woodland / Shrub Woodland Alliance | *Pinus monophylla - Juniperus osteosperma* / Shrub Woodland Alliance | A2108 | Singleleaf Pinyon - Utah Juniper / Big Sagebrush Woodland | *Pinus monophylla - Juniperus osteosperma / Artemisia tridentata* Woodland | CEGL000832 |
| Pinyon-Juniper and High-Elevation Woodlands | Pinyon Pine - Utah Juniper Woodland / Shrub Woodland Alliance | *Pinus monophylla - Juniperus osteosperma* / Shrub Woodland Alliance | A2108 | Singleleaf Pinyon - Utah Juniper / Blackbrush Woodland | *Pinus monophylla - Juniperus osteosperma / Coleogyne ramosissima* Woodland | CEGL002971 |
| Pinyon-Juniper and High-Elevation Woodlands | Pinyon Pine - Utah Juniper Woodland / Shrub Woodland Alliance | *Pinus monophylla - Juniperus osteosperma* / Shrub Woodland Alliance | A2108 | Singleleaf Pinyon - Utah Juniper / Sonoran Scrub Oak Woodland | *Pinus monophylla - Juniperus osteosperma / Quercus turbinella* Woodland | CEGL002941 |
| Pinyon-Juniper and High-Elevation Woodlands | Pinyon Pine - Utah Juniper Woodland / Shrub Woodland Alliance | *Pinus monophylla - Juniperus osteosperma* / Shrub Woodland Alliance | A2108 | Singleleaf Pinyon - Utah Juniper / Stansbury Cliff Rose Woodland | *Pinus monophylla - Juniperus osteosperma / Purshia stansburiana* Woodland | CEGL005397 |

**Table 4 (continued).** Summary of rUSNVC plant alliances/associations for MOJA and CAMO.

| Category | Plant Alliance (common name) | Plant Alliance (scientific name) | Alliance rUSNVC Element Code | Plant Association (common name) | Plant Association (scientific name) | Association rUSNVC Element Code |
|---|---|---|---|---|---|---|
| Pinyon-Juniper and High-Elevation Woodlands (continued) | Pinyon Pine - Utah Juniper Woodland / Shrub Woodland Alliance | *Pinus monophylla - Juniperus osteosperma* / Shrub Woodland Alliance | A2108 | Singleleaf Pinyon - (Utah Juniper) / Littleleaf Mountain-mahogany Woodland | *Pinus monophylla - (Juniperus osteosperma) / Cercocarpus intricatus* Woodland | CEGL005437 |
| Pinyon-Juniper and High-Elevation Woodlands (continued) | Two-needle Pinyon - Utah Juniper Colorado Plateau Shrubby Open Woodland Alliance | *Pinus edulis - Juniperus osteosperma* Colorado Plateau Shrubby Open Woodland Alliance | A3573 | Two-needle Pinyon - Utah Juniper / Sonoran Scrub Oak Woodland | *Pinus edulis - Juniperus osteosperma / Quercus turbinella* Woodland | CEGL004007 |
| Juniper and Foothill Woodlands | California Juniper Mojave Scrub Alliance | *Juniperus californica* Mojave Scrub Alliance | A0502 | California Juniper / Blackbrush Mojave Scrub | *Juniperus californica / Coleogyne ramosissima* Woodland | CEPP006713 |
| Juniper and Foothill Woodlands | California Juniper Mojave Scrub Alliance | *Juniperus californica* Mojave Scrub Alliance | A0502 | California Juniper / Mojave Yucca / Big Galleta Mojave Scrub | *Juniperus californica / Yucca schidigera / Pleuraphis rigida* Woodland | CEPP006715 |
| Juniper and Foothill Woodlands | Utah Juniper / Shrub Understory Woodland Alliance | *Juniperus osteosperma* / Shrub Understory Woodland Alliance [Montane Mixed Chaparral] | A3496 | Utah Juniper / Basin Big Sagebrush Woodland | *Juniperus osteosperma / Artemisia tridentata ssp. tridentata* Woodland | CEGL002360 |
| Juniper and Foothill Woodlands | Utah Juniper / Shrub Understory Woodland Alliance | *Juniperus osteosperma* / Shrub Understory Woodland Alliance [Montane Mixed Chaparral] | A3496 | Utah Juniper / Blackbrush Woodland | *Juniperus osteosperma / Coleogyne ramosissima* Woodland | CEGL002909 |
| Juniper and Foothill Woodlands | Utah Juniper / Shrub Understory Woodland Alliance | *Juniperus osteosperma* / Shrub Understory Woodland Alliance [Montane Mixed Chaparral] | A3496 | Utah Juniper / Eastern Mojave Buckwheat - Banana Yucca Woodland | *Juniperus osteosperma / Eriogonum fasciculatum - Yucca baccata* Woodland | CEGL005754 |
| Juniper and Foothill Woodlands | Utah Juniper / Shrub Understory Woodland Alliance | *Juniperus osteosperma* / Shrub Understory Woodland Alliance [Montane Mixed Chaparral] | A3496 | Utah Juniper / Snakeweed Woodland | *Juniperus osteosperma / Gutierrezia microcephala* Woodland | CEPP006716 |
| Chaparral and High-Elevation Shrublands | Sonoran Scrub Oak Chaparral Alliance | *Quercus turbinella* Chaparral Alliance | A0793 | Sonoran Scrub Oak - Desert Baccharis Shrubland | *Quercus turbinella - Baccharis sergiloides* Shrubland | CEPP006751 |
| Chaparral and High-Elevation Shrublands | Utah Serviceberry - Alderleaf Mountain-mahogany - Littleleaf Mountain-mahogany Shrubland Alliance | *Amelanchier utahensis - Cercocarpus montanus - Cercocarpus intricatus* Shrubland Alliance | A3732 | Littleleaf Mountain-mahogany Montane Shrubland | *Cercocarpus intricatus* Montane Shrubland | CEGL002587 |

**Table 4 (continued).** Summary of rUSNVC plant alliances/associations for MOJA and CAMO.

| Category | Plant Alliance (common name) | Plant Alliance (scientific name) | Alliance rUSNVC Element Code | Plant Association (common name) | Plant Association (scientific name) | Association rUSNVC Element Code |
|---|---|---|---|---|---|---|
| High-Elevation Wash Shrublands | Apache Plume Desert Wash Scrub Alliance | *Fallugia paradoxa* Desert Wash Scrub Alliance | A3259 | Apache Plume Grand Canyon Desert Wash Shrubland | *Fallugia paradoxa* Grand Canyon Desert Wash Shrubland | CEGL005298 |
| High-Elevation Wash Shrublands | Skunkbush Sumac - River Hawthorn - Stretchberry Shrubland Alliance | *Rhus trilobata - Crataegus rivularis - Forestiera pubescens* Shrubland Alliance | A3799 | Stretchberry Wet Shrubland | *Forestiera pubescens* Wet Shrubland | CEGL001168 |
| Joshua Tree Wooded Shrublands | Joshua Tree Wooded Shrubland Alliance | *Yucca brevifolia* Wooded Shrubland Alliance | A3148 | Joshua Tree Wooded Shrubland | *Yucca brevifolia* Wooded Shrubland | CEGL003116 |
| Joshua Tree Wooded Shrublands | Joshua Tree Wooded Shrubland Alliance | *Yucca brevifolia* Wooded Shrubland Alliance | A3148 | Joshua Tree / (Banana Yucca) / James' Galleta - Black Grama Wooded Shrubland | *Yucca brevifolia / (Yucca baccata) / Pleuraphis jamesii - Bouteloua eriopoda* Wooded Shrubland | CEPP006862 |
| Joshua Tree Wooded Shrublands | Joshua Tree Wooded Shrubland Alliance | *Yucca brevifolia* Wooded Shrubland Alliance | A3148 | Joshua Tree / Big Galleta Wooded Grassland | *Yucca brevifolia / Pleuraphis rigida* Wooded Grassland | CEGL002725 |
| Joshua Tree Wooded Shrublands | Joshua Tree Wooded Shrubland Alliance | *Yucca brevifolia* Wooded Shrubland Alliance | A3148 | Joshua Tree / Blackbrush Wooded Shrubland | *Yucca brevifolia / Coleogyne ramosissima* Wooded Shrubland | CEGL00529 |
| Joshua Tree Wooded Shrublands | Joshua Tree Wooded Shrubland Alliance | *Yucca brevifolia* Wooded Shrubland Alliance | A3148 | Joshua Tree / (Big Sagebrush - Shadscale Saltbush) Wooded Shrubland | *Yucca brevifolia / (Artemisia tridentata - Atriplex confertifolia) Wooded Shrubland* | CEPP0068544 |
| Joshua Tree Wooded Shrublands | Joshua Tree Wooded Shrubland Alliance | *Yucca brevifolia* Wooded Shrubland Alliance | A3148 | Joshua Tree / Buckhorn Cholla Wooded Shrubland | *Yucca brevifolia / Cylindropuntia acanthocarpa* Wooded Shrubland | CEGL005779 |
| Joshua Tree Wooded Shrublands | Joshua Tree Wooded Shrubland Alliance | *Yucca brevifolia* Wooded Shrubland Alliance | A3148 | Joshua Tree / Creosotebush - Mojave Yucca / Big Galleta Wooded Shrubland | *Yucca brevifolia / Larrea tridentata - Yucca schidigera / Pleuraphis rigida* Wooded Shrubland | CEGL005777 |
| Joshua Tree Wooded Shrublands | Joshua Tree Wooded Shrubland Alliance | *Yucca brevifolia* Wooded Shrubland Alliance | A3148 | Joshua Tree / (Desert Almond - Mexican Bladdersage) Wooded Shrubland | *Yucca brevifolia / (Prunus fasciculata - Salazaria mexicana)* Wooded Shrubland | CEGL005776 |
| Joshua Tree Wooded Shrublands | Joshua Tree Wooded Shrubland Alliance | *Yucca brevifolia* Wooded Shrubland Alliance | A3148 | Joshua Tree - Utah Juniper / Big Sagebrush Wooded Shrubland | *Yucca brevifolia - Juniperus osteosperma / Artemisia tridentata* Wooded Shrubland | CEGL002744 |

**Table 4 (continued).** Summary of rUSNVC plant alliances/associations for MOJA and CAMO.

| Category | Plant Alliance (common name) | Plant Alliance (scientific name) | Alliance rUSNVC Element Code | Plant Association (common name) | Plant Association (scientific name) | Association rUSNVC Element Code |
|---|---|---|---|---|---|---|
| Joshua Tree Wooded Shrublands (continued) | Joshua Tree Wooded Shrubland Alliance | *Yucca brevifolia* Wooded Shrubland Alliance | A3148 | Joshua Tree / Water Jacket - Nevada Joint-fir Wooded Shrubland | *Yucca brevifolia / Lycium andersonii - Ephedra nevadensis* Wooded Shrubland | CEGL005778 |
| Mid-Elevation Semi-Desert Scrub and Shrublands | Antelope Bitterbrush - Big Sagebrush Mesic Steppe and Shrubland Alliance | *Purshia tridentata - Artemisia tridentata* Mesic Steppe and Shrubland Alliance | A3179 | Desert Bitterbrush Shrubland | *Purshia glandulosa* Shrubland | CEPP006747 |
| Mid-Elevation Semi-Desert Scrub and Shrublands | Blackbrush Mojave Desert Scrub Alliance | *Coleogyne ramosissima* Mojave Desert Scrub Alliance | A3144 | Blackbrush - Green Rabbitbrush Shrubland | *Coleogyne ramosissima - Ericameria teretifolia* Shrubland | CEPP005999 |
| Mid-Elevation Semi-Desert Scrub and Shrublands | Blackbrush Mojave Desert Scrub Alliance | *Coleogyne ramosissima* Mojave Desert Scrub Alliance | A3144 | Blackbrush - Joint-fir species Warm Desert Shrubland | *Coleogyne ramosissima - Ephedra* | CEGL005297 |
| Mid-Elevation Semi-Desert Scrub and Shrublands | Blackbrush Mojave Desert Scrub Alliance | *Coleogyne ramosissima* Mojave Desert Scrub Alliance | A3144 | Blackbrush - Water Jacket Mojave Desert Shrubland | *Coleogyne ramosissima - Lycium andersonii* Mojave Desert Shrubland | CEGL005746 |
| Mid-Elevation Semi-Desert Scrub and Shrublands | Big Sagebrush - Mixed Shrub Dry Steppe and Shrubland Alliance | *Artemisia tridentata* - Mixed Shrub Dry Steppe and Shrubland Alliance | A3198 | Big Sagebrush Shrubland | *Artemisia tridentata* Shrubland | CEGL000991 |
| Mid-Elevation Semi-Desert Scrub and Shrublands | Buckhorn Cholla / Big Galleta Grass Shrubland Alliance | *Cylindropuntia acanthocarpa / Pleuraphis rigida* Shrubland Alliance | A4156 | Colorado Buckhorn Cholla Shrubland | *Cylindropuntia acanthocarpa* var. *coloradensis Shrubland* | CEPP006729 |
| Mid-Elevation Semi-Desert Scrub and Shrublands | Buckhorn Cholla / Big Galleta Grass Shrubland Alliance | *Cylindropuntia acanthocarpa / Pleuraphis rigida* Shrubland Alliance | A4156 | Big Galleta / (Rayless Goldenhead, Cooper's Goldenbush) Shrubland | *Pleuraphis rigida / (Acamptopappus sphaerocephalus, Ericameria cooperi)* Shrubland | CEPP006733 |
| Mid-Elevation Semi-Desert Scrub and Shrublands | Death Valley Joint-Fir Shrubland Alliance | *Ephedra funerea* Shrubland Alliance | A4157 | Death Valley Joint-fir Shrubland | *Ephedra funereal* Shrubland | CEGL005750 |
| Mid-Elevation Semi-Desert Scrub and Shrublands | Green Rabbitbrush Shrubland Alliance | *Ericameria teretifolia* Shrubland Alliance | A2540 | Green Rabbitbrush Shrubland | *Ericameria teretifolia* Shrubland | CEGL002963 |
| Mid-Elevation Semi-Desert Scrub and Shrublands | Mojave Yucca Shrubland Alliance | *Yucca schidigera* Shrubland Alliance | A3147 | Mojave Yucca - Blackbrush Shrubland | *Yucca schidigera - Coleogyne ramosissima* Shrubland | CEGL005780 |
| Mid-Elevation Semi-Desert Scrub and Shrublands | Mormon-tea Colorado Plateau Shrubland Alliance | *Ephedra viridis* Colorado Plateau Shrubland Alliance | A3201 | Mormon-tea Shrubland | *Ephedra viridis* Shrubland | CEPP006703 |

**Table 4 (continued).** Summary of rUSNVC plant alliances/associations for MOJA and CAMO.

| Category | Plant Alliance (common name) | Plant Alliance (scientific name) | Alliance rUSNVC Element Code | Plant Association (common name) | Plant Association (scientific name) | Association rUSNVC Element Code |
|---|---|---|---|---|---|---|
| Mid-Elevation Semi-Desert Scrub and Shrublands | Mormon-tea - Yellow Rabbitbrush - Skunkbush Sumac Talus Sparse Scrub Alliance | *Ephedra viridis - Chrysothamnus viscidiflorus - Rhus trilobata* Talus Sparse Scrub Alliance | A4050 | Cliff Goldenbush Shrubland | *Ericameria cuneata* var. *spathulate Shrubland* | CEPP006704 |
| Mid-Elevation Semi-Desert Scrub and Shrublands | Nevada Joint-fir - Water Jacket - Spiny Hopsage Scrub Alliance | *Ephedra nevadensis - Lycium andersonii - Grayia spinosa* Scrub Alliance | A4245 | Nevada Joint-fir - Cooper's Goldenbush Shrubland | *Ephedra nevadensis - Ericameria cooperi* Shrubland | CEGL001253 |
| Mid-Elevation Semi-Desert Scrub and Shrublands | Nevada Joint-fir - Water Jacket - Spiny Hopsage Scrub Alliance | *Ephedra nevadensis - Lycium andersonii - Grayia spinosa* Scrub Alliance | A4245 | Nevada Joint-fir - (Mexican Bladdersage, Burrobrush) Shrubland | *Ephedra nevadensis* - (*Salazaria mexicana, Hymenoclea salsola*) Shrubland | CEGL005751 |
| Mid-Elevation Semi-Desert Scrub and Shrublands | Nevada Joint-fir - Water Jacket - Spiny Hopsage Scrub Alliance | *Ephedra nevadensis - Lycium andersonii - Grayia spinosa* Scrub Alliance | A4245 | Peach-thorn Shrubland | *Lycium cooperi* Shrubland | CEPP006726 |
| Mid-Elevation Semi-Desert Scrub and Shrublands | Nevada Joint-fir - Water Jacket - Spiny Hopsage Scrub Alliance | *Ephedra nevadensis - Lycium andersonii - Grayia spinosa* Scrub Alliance | A4245 | Spiny Hopsage - Creosotebush Shrubland | *Grayia spinosa - Larrea tridentata Shrubland* | CEGL001271 |
| Mid-Elevation Semi-Desert Scrub and Shrublands | Nevada Joint-fir - Water Jacket - Spiny Hopsage Scrub Alliance | *Ephedra nevadensis - Lycium andersonii - Grayia spinosa* Scrub Alliance | A4245 | Spiny Hopsage - Water Jacket Shrubland | *Grayia spinosa - Lycium andersonii Shrubland* | CEGL001347 |
| Mid-Elevation Semi-Desert Scrub and Shrublands | Nevada Joint-fir - Water Jacket - Spiny Hopsage Scrub Alliance | *Ephedra nevadensis - Lycium andersonii - Grayia spinosa* Scrub Alliance | A4245 | Water Jacket Shrubland | *Lycium andersonii* Shrubland | CEGL006857 |
| Mid-Elevation Semi-Desert Scrub and Shrublands | Stansbury Cliff Rose Scrub Alliance | *Purshia stansburiana* Scrub Alliance | A0833 | Blackbrush - Stansbury's Cliffrose Shrubland | *Coleogyne ramosissima - Purshia stansburiana* Shrubland | CEGL002720 |
| Mid-Elevation Semi-Desert Scrub and Shrublands | Stansbury Cliff Rose Scrub Alliance | *Purshia stansburiana* Scrub Alliance | A0833 | Stansbury's Cliffrose - Utah Agave Shrubland | *Purshia stansburiana - Agave utahensis* Shrubland | CEPP006748 |
| Mid-Elevation Semi-Desert Scrub and Shrublands | Utah Mortonia Scrub Alliance | *Mortonia utahensis* Scrub Alliance | A4158 | Utah Mortonia Shrubland | *Mortonia utahensis* Shrubland | CEGL005153 |

**Table 4 (continued).** Summary of rUSNVC plant alliances/associations for MOJA and CAMO.

| Category | Plant Alliance (common name) | Plant Alliance (scientific name) | Alliance rUSNVC Element Code | Plant Association (common name) | Plant Association (scientific name) | Association rUSNVC Element Code |
|---|---|---|---|---|---|---|
| Mid-Elevation Riparian and Wash Shrublands | California Joint-Fir Desert Wash Scrub Alliance | *Ephedra californica - Ephedra trifurca Desert Wash Scrub Alliance* | A2536 | California Joint-fir - Burrobrush Desert Wash Shrubland | *Ephedra californica - Hymenoclea Salsola* Desert Wash Shrubland | CEGL002958 |
| Mid-Elevation Riparian and Wash Shrublands | Desert Almond - Mexican Bladdersage Northern Mojave Desert Wash Scrub Alliance | *Prunus fasciculata - Salazaria Mexicana* Northern Mojave Desert Wash Scrub Alliance | A4185 | Burrobrush - Mexican Bladdersage Shrubland | *Hymenoclea salsola - Salazaria Mexicana* Shrubland | CEGL002703 |
| Mid-Elevation Riparian and Wash Shrublands | Desert Almond - Mexican Bladdersage Northern Mojave Desert Wash Scrub Alliance | *Prunus fasciculata - Salazaria Mexicana* Northern Mojave Desert Wash Scrub Alliance | A4185 | Desert Almond Shrubland | *Prunus fasciculata* Shrubland | CEGL002704 |
| Mid-Elevation Riparian and Wash Shrublands | Desert Almond - Mexican Bladdersage Northern Mojave Desert Wash Scrub Alliance | *Prunus fasciculata - Salazaria Mexicana* Northern Mojave Desert Wash Scrub Alliance | A4185 | Desert Almond - (Stansbury's Cliffrose, Netvein Goldeneye) Desert Wash Shrubland | *Prunus fasciculata - (Purshia stansburiana, Viguiera reticulata)* Desert Wash Shrubland | CEGL006863 |
| Mid-Elevation Riparian and Wash Shrublands | Desert Almond - Mexican Bladdersage Northern Mojave Desert Wash Scrub Alliance | *Prunus fasciculata - Salazaria Mexicana* Northern Mojave Desert Wash Scrub Alliance | A4185 | Desert Almond - Skunkbush Sumac Desert Wash Shrubland | *Prunus fasciculata - Ambrosia eriocentra* Desert Wash Shrubland | CEGL005773 |
| Mid-Elevation Riparian and Wash Shrublands | Desert Almond - Mexican Bladdersage Northern Mojave Desert Wash Scrub Alliance | *Prunus fasciculata - Salazaria Mexicana* Northern Mojave Desert Wash Scrub Alliance | A4185 | Desert Almond - Skunkbush Sumac Desert Wash Shrubland | *Prunus fasciculata - Rhus trilobata Desert Wash Shrubland* | CEPP006741 |
| Mid-Elevation Riparian and Wash Shrublands | Desert Almond - Mexican Bladdersage Northern Mojave Desert Wash Scrub Alliance | *Prunus fasciculata - Salazaria Mexicana* Northern Mojave Desert Wash Scrub Alliance | A4185 | Mexican Bladdersage Shrubland | *Salazaria Mexicana* Shrubland | CEGL005293 |
| Mid-Elevation Riparian and Wash Shrublands | Desert Almond - Mexican Bladdersage Northern Mojave Desert Wash Scrub Alliance | *Prunus fasciculata - Salazaria Mexicana* Northern Mojave Desert Wash Scrub Alliance | A4185 | Mojave Desert Plum Desert Wash Shrubland | *Prunus eremophila* Desert Wash Shrubland | CEPP006740 |
| Mid-Elevation Riparian and Wash Shrublands | Desert Almond - Mexican Bladdersage Northern Mojave Desert Wash Scrub Alliance | *Prunus fasciculata - Salazaria Mexicana* Northern Mojave Desert Wash Scrub Alliance | A4185 | Purple Sage Desert Wash Shrubland | *Salvia dorrii Desert* Wash Shrubland | CEGL005774 |
| Mid-Elevation Riparian and Wash Shrublands | Desert Almond - Mexican Bladdersage Northern Mojave Desert Wash Scrub Alliance | *Prunus fasciculata - Salazaria Mexicana* Northern Mojave Desert Wash Scrub Alliance | A4185 | Snapdragon Penstemon - Desert Almond Desert Wash Shrubland | *Keckiella antirrhinoides - Prunus fasciculata* Desert Wash Shrubland | CEPP006717 |

**Table 4 (continued).** Summary of rUSNVC plant alliances/associations for MOJA and CAMO.

| Category | Plant Alliance (common name) | Plant Alliance (scientific name) | Alliance rUSNVC Element Code | Plant Association (common name) | Plant Association (scientific name) | Association rUSNVC Element Code |
|---|---|---|---|---|---|---|
| Mid-Elevation Riparian and Wash Shrublands (continued) | Mojave - Sonoran Burrobrush - Sweetbush Desert Wash Alliance | *Hymenoclea salsola - Bebbia juncea* Mojave - Sonoran Desert Wash Alliance | A4188 | Woolly-fruit Bur-ragweed - Brickellbush species Sparse Desert Wash | *Ambrosia eriocentra - Brickellia* spp. Sparse Desert Wash | CEPP005790 |
| Mid-Elevation Riparian and Wash Shrublands (continued) | Sugarberry - Skunkbush Sumac Wet Shrubland Alliance | *Celtis laevigata - Rhus trilobata* Wet Shrubland Alliance | A1033 | No Sugarberry Associations Described for MOJA/CAMO | No Sugarberry Associations Described for MOJA/CAMO | N/A |
| Mid-Elevation Grasslands and Herbaceous Vegetation | James' Galleta Grassland Alliance | *Pleuraphis jamesii* Grassland Alliance | A1287 | Burrograss - James' Galleta - Black Grama Grassland | *Scleropogon brevifolius - Pleuraphis jamesii - Bouteloua eriopoda* Grassland | CEGL006755 |
| Riparian and Ruderal Woodland and Shrublands | Fremont Cottonwood - Velvet Ash - Goodding's Willow Flooded Forest and Woodland Alliance | *Populus fremontii - Fraxinus velutina - Salix gooddingii* Flooded Forest and Woodland Alliance | A3803 | Fremont Cottonwood / Desert Baccharis Woodland | *Populus fremontii / Baccharis sergiloides* Woodland | CEPP006735 |
| Riparian and Ruderal Woodland and Shrublands | Goodding's Willow - Red Willow Riparian Forest Alliance | *Salix gooddingii - Salix laevigata Riparian Forest Alliance* | A3752 | Goodding's Willow Riparian Woodland | *Salix gooddingii* Riparian Woodland | CEGL002743 |
| Riparian and Ruderal Woodland and Shrublands | Ruderal Date Palm - California Fan Palm Riparian Woodland Alliance | *Phoenix dactylifera - Washingtonia filifera* Ruderal Woodland Alliance | A4161 | Date Palm Ruderal Woodland | *Phoenix dactylifera* Ruderal Woodland | CEPP006859 |
| Riparian and Ruderal Woodland and Shrublands | Ruderal Date Palm - California Fan Palm Riparian Woodland Alliance | *Phoenix dactylifera - Washingtonia filifera* Ruderal Woodland Alliance | A4161 | California Fan Palm / Spring Ruderal Woodland | Washingtonia filifera / Spring Ruderal Woodland | CEPP006845 |
| Riparian and Ruderal Woodland and Shrublands | North American Desert Tree Garden Cultural Type Alliance | (N/A) | (N/A) | Athel Tamarisk Planted Woodland | *Tamarix aphylla* Planted Woodland | CST006759 |
| Riparian and Ruderal Woodland and Shrublands | Tamarisk species Ruderal Riparian Scrub Alliance | *Tamarix* spp. Ruderal Riparian Scrub Alliance | A0842 | Tamarisk species Ruderal Riparian Shrubland | *Tamarix* spp. Ruderal Riparian Shrubland | CEGL003114 |
| Low-Elevation Desert Scrub and Shrublands | Creosotebush - Burrobush Bajada and Valley Desert Scrub Alliance | *Larrea tridentata - Ambrosia dumosa* Bajada and Valley Desert Scrub Alliance | A3277 | Creosotebush - Burrobush / Big Galleta Desert Shrubland | *Larrea tridentata - Ambrosia dumosa / Pleuraphis rigida* Desert Shrubland | CEGL005764 |
| Low-Elevation Desert Scrub and Shrublands | Creosotebush - Burrobush Bajada and Valley Desert Scrub Alliance | *Larrea tridentata - Ambrosia dumosa* Bajada and Valley Desert Scrub Alliance | A3277 | Creosotebush - Burrobush Shrubland | *Larrea tridentata - Ambrosia Dumosa Shrubland* | CEGL002954 |

**Table 4 (continued).** Summary of rUSNVC plant alliances/associations for MOJA and CAMO.

| Category | Plant Alliance (common name) | Plant Alliance (scientific name) | Alliance rUSNVC Element Code | Plant Association (common name) | Plant Association (scientific name) | Association rUSNVC Element Code |
|---|---|---|---|---|---|---|
| Low-Elevation Desert Scrub and Shrublands (continued) | Creosotebush - Burrobush Bajada and Valley Desert Scrub Alliance | *Larrea tridentata - Ambrosia dumosa* Bajada and Valley Desert Scrub Alliance | A3277 | Creosotebush - Burrobush - Burrobrush Desert Shrubland | *Larrea tridentata - Ambrosia dumosa - Hymenoclea salsola* Desert Shrubland | CEGL005761 |
| Low-Elevation Desert Scrub and Shrublands (continued) | Creosotebush - Burrobush Bajada and Valley Desert Scrub Alliance | *Larrea tridentata - Ambrosia dumosa* Bajada and Valley Desert Scrub Alliance | A3277 | Creosotebush - Burrobush / Cryptogamic Crust Desert Shrubland | *Larrea tridentata - Ambrosia dumosa* / Cryptogamic Crust Desert Shrubland | CEGL005763 |
| Low-Elevation Desert Scrub and Shrublands (continued) | Creosotebush - Burrobush Bajada and Valley Desert Scrub Alliance | *Larrea tridentata - Ambrosia dumosa* Bajada and Valley Desert Scrub Alliance | A3277 | Creosotebush - Burrobush - (Cottontop Cactus - Beavertail Prickly-pear) Desert Shrubland | *Larrea tridentata - Ambrosia dumosa - (Echinocactus polycephalus - Opuntia basilaris)* Desert Shrubland | CEPP006718 |
| Low-Elevation Desert Scrub and Shrublands (continued) | Creosotebush - Burrobush Bajada and Valley Desert Scrub Alliance | *Larrea tridentata - Ambrosia dumosa* Bajada and Valley Desert Scrub Alliance | A3277 | Creosotebush - Burrobush - Death Valley Joint-fir Desert Shrubland | *Larrea tridentata - Ambrosia dumosa - Ephedra funereal* Desert Shrubland | CEGL005759 |
| Low-Elevation Desert Scrub and Shrublands (continued) | Creosotebush - Burrobush Bajada and Valley Desert Scrub Alliance | *Larrea tridentata - Ambrosia dumosa* Bajada and Valley Desert Scrub Alliance | A3277 | Creosotebush - Burrobush - Eastern Mojave Buckwheat Desert Shrubland | *Larrea tridentata - Ambrosia dumosa - Eriogonum fasciculatum* Desert Shrubland | CEGL005760 |
| Low-Elevation Desert Scrub and Shrublands (continued) | Creosotebush - Burrobush Bajada and Valley Desert Scrub Alliance | *Larrea tridentata - Ambrosia dumosa* Bajada and Valley Desert Scrub Alliance | A3277 | Creosotebush - Burrobush - Fremont's Chaffbush Desert Shrubland | *Larrea tridentata - Ambrosia dumosa - Amphipappus fremontii* Desert Shrubland | CEGL005756 |
| Low-Elevation Desert Scrub and Shrublands (continued) | Creosotebush - Burrobush Bajada and Valley Desert Scrub Alliance | *Larrea tridentata - Ambrosia dumosa* Bajada and Valley Desert Scrub Alliance | A3277 | Creosotebush - Burrobush - (Littleleaf Ratany, White Ratany) Shrubland | *Larrea tridentata - Ambrosia dumosa - Krameria (erecta, grayi)* Shrubland | CEGL005137 |
| Low-Elevation Desert Scrub and Shrublands (continued) | Creosotebush - Burrobush Bajada and Valley Desert Scrub Alliance | *Larrea tridentata - Ambrosia dumosa* Bajada and Valley Desert Scrub Alliance | A3277 | Creosotebush - Burrobush - Mojave Yucca Desert Shrubland | *Larrea tridentata - Ambrosia dumosa - Yucca schidigera* Desert Shrubland | CEGL005762 |
| Low-Elevation Desert Scrub and Shrublands (continued) | Creosotebush - Burrobush Bajada and Valley Desert Scrub Alliance | *Larrea tridentata - Ambrosia dumosa* Bajada and Valley Desert Scrub Alliance | A3277 | Creosotebush - Burrobush - (Nevada Joint-fir, Water Jacket) Desert Shrubland | *Larrea tridentata - Ambrosia dumosa - (Ephedra nevadensis, Lycium andersonii)* Desert Shrubland | CEGL005755 |
| Low-Elevation Desert Scrub and Shrublands (continued) | Creosotebush - Burrobush Bajada and Valley Desert Scrub Alliance | *Larrea tridentata - Ambrosia dumosa* Bajada and Valley Desert Scrub Alliance | A3277 | Creosotebush - Cattle Saltbush Desert Shrubland | *Larrea tridentata - Atriplex polycarpa Desert Shrubland* | CEGL005765 |

**Table 4 (continued).** Summary of rUSNVC plant alliances/associations for MOJA and CAMO.

| Category | Plant Alliance (common name) | Plant Alliance (scientific name) | Alliance rUSNVC Element Code | Plant Association (common name) | Plant Association (scientific name) | Association rUSNVC Element Code |
|---|---|---|---|---|---|---|
| Low-Elevation Desert Scrub and Shrublands (continued) | Creosotebush—(Ocotillo) Upper Bajada and Rock Outcrop Desert Scrub Alliance | *Larrea tridentata—(Fouquieria splendens)* Upper Bajada and Rock Outcrop Desert Scrub Alliance | A3278 | Creosotebush Shrubland | *Larrea tridentata* Shrubland | CEGL005145 |
| Low-Elevation Desert Scrub and Shrublands (continued) | Creosotebush—(Ocotillo) Upper Bajada and Rock Outcrop Desert Scrub Alliance | *Larrea tridentata—(Fouquieria splendens)* Upper Bajada and Rock Outcrop Desert Scrub Alliance | A3278 | Creosotebush / Big Galleta Desert Shrubland | *Larrea tridentata / Pleuraphis rigida Desert Shrubland* | CEGL005768 |
| Low-Elevation Desert Scrub and Shrublands (continued) | Creosotebush—(Ocotillo) Upper Bajada and Rock Outcrop Desert Scrub Alliance | *Larrea tridentata—(Fouquieria splendens)* Upper Bajada and Rock Outcrop Desert Scrub Alliance | A3278 | Creosotebush - Brittlebush Shrubland | *Larrea tridentata - Encelia farinose Shrubland* | CEGL002955 |
| Low-Elevation Desert Scrub and Shrublands (continued) | Creosotebush—(Ocotillo) Upper Bajada and Rock Outcrop Desert Scrub Alliance | *Larrea tridentata—(Fouquieria splendens)* Upper Bajada and Rock Outcrop Desert Scrub Alliance | A3278 | Creosotebush - Brittlebush - Burrobush Desert Shrubland | *Larrea tridentata - Encelia farinosa - Ambrosia dumosa* Desert Shrubland | CEGL005766 |
| Low-Elevation Desert Scrub and Shrublands (continued) | Creosotebush—(Ocotillo) Upper Bajada and Rock Outcrop Desert Scrub Alliance | *Larrea tridentata—(Fouquieria splendens)* Upper Bajada and Rock Outcrop Desert Scrub Alliance | A3278 | Creosotebush - Brittlebush - Sweetbush Desert Shrubland | *Larrea tridentata - Encelia farinosa - Bebbia juncea* Desert Shrubland | CEPP006723 |
| Low-Elevation Desert Scrub and Shrublands (continued) | Creosotebush—(Ocotillo) Upper Bajada and Rock Outcrop Desert Scrub Alliance | *Larrea tridentata—(Fouquieria splendens)* Upper Bajada and Rock Outcrop Desert Scrub Alliance | A3278 | Creosotebush - Brittlebush - Bush Arrowleaf Desert Shrubland | *Larrea tridentata - Encelia farinosa - Pleurocoronis pluriseta* Desert Shrubland | CEGL005767 |
| Low-Elevation Desert Scrub and Shrublands (continued) | Creosotebush—(Ocotillo) Upper Bajada and Rock Outcrop Desert Scrub Alliance | *Larrea tridentata—(Fouquieria splendens)* Upper Bajada and Rock Outcrop Desert Scrub Alliance | A3278 | Creosotebush - Nevada Joint-fir Shrubland | *Larrea tridentata - Ephedra nevadensis* Shrubland | CEGL001268 |
| Low-Elevation Desert Scrub and Shrublands (continued) | Rubber Rabbitbrush Steppe and Shrubland Alliance | *Ericameria nauseosa* Steppe and Shrubland Alliance | A3196 | Nevada Broomsage Shrubland | *Lepidospartum latisquamum Shrubland* | CEPP006725 |
| Low-Elevation Desert Scrub and Shrublands (continued) | Rubber Rabbitbrush Steppe and Shrubland Alliance | *Ericameria nauseosa* Steppe and Shrubland Alliance | A3196 | Rubber Rabbitbrush Shrubland | *Ericameria nauseosa* Shrubland | CEGL002713 |
| Low-Elevation Desert Scrub and Shrublands (continued) | Snakeweed Scrub Dwarf-shrubland Alliance | *Gutierrezia sarothrae - Gutierrezia microcephala* Dwarf-shrubland Alliance | A3203 | Broom Snakeweed / Big Galleta - Desert Globemallow Shrub Grassland | *Gutierrezia sarothrae / Pleuraphis rigida - Sphaeralcea ambigua* Shrub Grassland | CEGL001543 |

**Table 4 (continued).** Summary of rUSNVC plant alliances/associations for MOJA and CAMO.

| Category | Plant Alliance (common name) | Plant Alliance (scientific name) | Alliance rUSNVC Element Code | Plant Association (common name) | Plant Association (scientific name) | Association rUSNVC Element Code |
|---|---|---|---|---|---|---|
| Low-Elevation Desert Scrub and Shrublands (continued) | White Bursage Scrub Alliance | *Ambrosia dumosa* Desert Dwarf Scrub Alliance | A3279 | Burrobush Dwarf-shrubland | *Ambrosia dumosa* Dwarf-shrubland | CEGL005074 |
| Low Desert Riparian and Wash Shrublands | Arroyo Willow Warm Desert Wet Shrubland Alliance | *Salix lasiolepis* Warm Desert Wet Shrubland Alliance | A3878 | Arroyo Willow / Barren Ground Wet Shrubland | *Salix lasiolepis* / Barren Ground Wet Shrubland | CEGL001216 |
| Low Desert Riparian and Wash Shrublands | Catclaw Acacia - Desert-lavender - Beloperone Desert Wash Scrub Alliance | *Senegalia greggii - Hyptis emoryi - Justicia californica* Desert Wash Scrub Alliance | A4187 | Catclaw Acacia - California Buckwheat Shrubland | *Acacia greggii - Eriogonum fasciculatum* Shrubland | CEPP005785 |
| Low Desert Riparian and Wash Shrublands | Catclaw Acacia - Desert-lavender - Beloperone Desert Wash Scrub Alliance | *Senegalia greggii - Hyptis emoryi - Justicia californica* Desert Wash Scrub Alliance | A4187 | Catclaw Acacia - Creosotebush - Burrobrush Desert Wash Shrubland | *Acacia greggii - Larrea tridentata - Hymenoclea salsola* Wash Shrubland | CEGL009522 |
| Low Desert Riparian and Wash Shrublands | Catclaw Acacia - Desert-lavender - Beloperone Desert Wash Scrub Alliance | *Senegalia greggii - Hyptis emoryi - Justicia californica* Desert Wash Scrub Alliance | A4187 | Catclaw Acacia - (Woolly-fruit Bur-ragweed, Purple Sage) Desert Wash Shrubland | *Acacia greggii - (Ambrosia eriocentra, Salvia dorrii)* Desert Wash Shrubland | CEGL005737 |
| Low Desert Riparian and Wash Shrublands | Desert-willow - Smoketree Desert Wash Scrub Alliance | *Chilopsis linearis - Psorothamnus spinosus* Desert Wash Scrub Alliance | A1044 | Desert-willow Shrubland | *Chilopsis linearis* Shrubland | CEGL001164 |
| Low Desert Riparian and Wash Shrublands | Desert-willow - Smoketree Desert Wash Scrub Alliance | *Chilopsis linearis - Psorothamnus spinosus* Desert Wash Scrub Alliance | A1044 | Desert-willow / Burrobrush Desert Wash Scrub | *Chilopsis linearis / Hymenoclea salsola* Desert Wash Scrub | CEGL005744 |
| Low Desert Riparian and Wash Shrublands | Desert-willow - Smoketree Desert Wash Scrub Alliance | *Chilopsis linearis - Psorothamnus spinosus* Desert Wash Scrub Alliance | A1044 | Desert-willow / Desert Almond Desert Wash Scrub | *Chilopsis linearis / Prunus fasciculata Desert Wash Scrub* | CEGL005745 |
| Low Desert Riparian and Wash Shrublands | Desert-willow - Smoketree Desert Wash Scrub Alliance | *Chilopsis linearis - Psorothamnus spinosus* Desert Wash Scrub Alliance | A1044 | Desert-willow / Mojave Rabbitbrush Desert Wash Scrub | *Chilopsis linearis / Ericameria paniculata* Desert Wash Scrub | CEGL005743 |
| Low Desert Riparian and Wash Shrublands | Desert-willow - Smoketree Desert Wash Scrub Alliance | *Chilopsis linearis - Psorothamnus spinosus* Desert Wash Scrub Alliance | A1044 | Desert-willow / (Woolly-fruit Bur-ragweed, Purple Sage) Desert Wash Scrub | *Chilopsis linearis / (Ambrosia eriocentra, Salvia dorrii)* Desert Wash Scrub | CEGL005742 |

**Table 4 (continued).** Summary of rUSNVC plant alliances/associations for MOJA and CAMO.

| Category | Plant Alliance (common name) | Plant Alliance (scientific name) | Alliance rUSNVC Element Code | Plant Association (common name) | Plant Association (scientific name) | Association rUSNVC Element Code |
|---|---|---|---|---|---|---|
| Low Desert Riparian and Wash Shrublands (continued) | Desert-willow - Smoketree Desert Wash Scrub Alliance | *Chilopsis linearis - Psorothamnus spinosus* Desert Wash Scrub Alliance | A1044 | Smoketree / Burrobrush - (Sweetbush - California Joint-fir) Desert Wash Scrub | *Psorothamnus spinosus / Hymenoclea salsola - (Bebbia juncea - Ephedra californica)* Desert Wash Scrub | CEPP006745 |
| Low Desert Riparian and Wash Shrublands (continued) | Emory's Baccharis - Desert Baccharis Wet Shrubland Alliance | *Salix lasiolepis* Warm Desert Wet Shrubland Alliance | A3874 | Desert Baccharis / (Deergrass - Southern Cattail) Shrubland | *Baccharis sergiloides / (Muhlenbergia rigens - Typha domingensis)* Shrubland | CEPP005846 |
| Low Desert Riparian and Wash Shrublands (continued) | Fourwing Saltbush - Rubber Rabbitbrush Desert Wash Alliance | *Atriplex canescens - Ericameria nauseosa* Desert Wash Alliance | A3266 | Rubber Rabbitbrush Desert Wash Shrubland | *Ericameria nauseosa* Desert Wash Shrubland | CEGL002261 |
| Low Desert Riparian and Wash Shrublands (continued) | Honey Mesquite - Velvet Mesquite - Screwbean Mesquite Wet Scrub Alliance | *Prosopis glandulosa - Prosopis velutina - Prosopis pubescens* Wet Scrub Alliance | A3877 | Honey Mesquite / (Saltbush species, Mojave Seablite) Mojave Desert Shrubland | *Prosopis glandulosa / (Atriplex spp.- Suaeda moquinii)* Desert Shrubland | CEGL006861 |
| Low Desert Riparian and Wash Shrublands (continued) | Honey Mesquite - Velvet Mesquite - Screwbean Mesquite Wet Scrub Alliance | *Prosopis glandulosa - Prosopis velutina - Prosopis pubescens* Wet Scrub Alliance | A3877 | Western Honey Mesquite Wet Scrub | *Prosopis glandulosa* var. *torreyana Wet Scrub* | CEGL001381 |
| Low Desert Riparian and Wash Shrublands (continued) | Honey Mesquite - Velvet Mesquite - Screwbean Mesquite Wet Scrub Alliance | *Prosopis glandulosa - Prosopis velutina - Prosopis pubescens* Wet Scrub Alliance | A3877 | Honey Mesquite - (Narrowleaf Willow, Arroyo Willow) Wet Scrub | *Prosopis glandulosa - (Salix exigua, Salix lasiolepis)* Wet Scrub | CEPP006860 |
| Low Desert Riparian and Wash Shrublands (continued) | Mojave Rabbitbrush Desert Wash Scrub Alliance | *Ericameria paniculata* Mojave Desert Wash Scrub Alliance | A2509 | Mojave Rabbitbrush Desert Wash Shrubland | *Ericameria paniculata* Desert Wash Shrubland | CEGL002706 |
| Low Desert Riparian and Wash Shrublands (continued) | Mojave Rabbitbrush Desert Wash Scrub Alliance | *Ericameria paniculata* Mojave Desert Wash Scrub Alliance | A2509 | Mojave Rabbitbrush - Burrobrush Desert Wash Shrubland | *Ericameria paniculata - Hymenoclea salsola* Desert Wash Shrubland | CEPP006864 |
| Low Desert Riparian and Wash Shrublands (continued) | Mojave - Sonoran Burrobrush - Sweetbush Desert Wash Alliance | *Hymenoclea salsola - Bebbia juncea* Mojave - Sonoran Desert Wash Alliance | A4188 | Woolly-fruit Bur-ragweed - Brickellbush species Sparse Desert Wash | *Ambrosia eriocentra - Brickellia* spp. Sparse Desert Wash | CEPP005790 |
| Low Desert Riparian and Wash Shrublands (continued) | Narrowleaf Willow Warm Desert Wet Shrubland Alliance | *Salix exigua* Warm Desert Wet Shrubland Alliance | A0947 | Narrowleaf Willow - Desert Baccharis Shrubland | *Salix exigua - Baccharis sergiloides Shrubland* | CEPP006753 |

**Table 4 (continued).** Summary of rUSNVC plant alliances/associations for MOJA and CAMO.

| Category | Plant Alliance (common name) | Plant Alliance (scientific name) | Alliance rUSNVC Element Code | Plant Association (common name) | Plant Association (scientific name) | Association rUSNVC Element Code |
|---|---|---|---|---|---|---|
| Marsh and Wetland Herbaceous Vegetation | Southern Cattail - Broadleaf Cattail - American Common Reed Western Marsh Alliance | *Typha domingensis - Typha latifolia - Typha angustifolia* Western Marsh Alliance | A3896 | American Common Reed Native Western Marsh | *Phragmites australis ssp. Americanus Native Western Marsh* | CEGL006866 |
| Marsh and Wetland Herbaceous Vegetation | Southern Cattail - Broadleaf Cattail - American Common Reed Western Marsh Alliance | *Typha domingensis - Typha latifolia - Typha angustifolia* Western Marsh Alliance | A3896 | (Broadleaf Cattail, Narrowleaf Cattail) Western Marsh | *Typha (latifolia, angustifolia)* Western Marsh | CEGL002010 |
| Marsh and Wetland Herbaceous Vegetation | Southern Cattail - Broadleaf Cattail - American Common Reed Western Marsh Alliance | *Typha domingensis - Typha latifolia - Typha angustifolia* Western Marsh Alliance | A3896 | Chairmaker's Bulrush Western Marsh | *Schoenoplectus americanus* Western Marsh | CEGL001841 |
| Playa and Alkali Sink Shrublands and Scrub | Cattle Saltbush Shrubland Alliance | *Atriplex polycarpa* Shrubland Alliance | A3174 | Cattle Saltbush Shrubland | *Atriplex polycarpa* Shrubland | CEGL001318 |
| Playa and Alkali Sink Shrublands and Scrub | Fourwing Saltbush Scrub Alliance | *Atriplex canescens* Scrub Alliance | A0869 | Fourwing Saltbush Shrubland | *Atriplex canescens* Shrubland | CEGL001281 |
| Playa and Alkali Sink Shrublands and Scrub | Iodine Bush Wet Shrubland Alliance | *Allenrolfea occidentalis* Shrubland Alliance | A0866 | Iodinebush / Saltgrass Wet Shrubland | *Allenrolfea occidentalis / Distichlis spicata* Wet Shrubland | CEPP005788 |
| Playa and Alkali Sink Shrublands and Scrub | Mojave Seablite - Red Swampfire - Alkali Goldenbush Alkaline Wet Scrub Alliance | *Suaeda moquinii - Salicornia rubra - Isocoma acradenia* Alkaline Wet Scrub Alliance | A3880 | Alkali Goldenbush Desert Scrub | *Isocoma acradenia* Desert Scrub | CEGL005465 |
| Playa and Alkali Sink Shrublands and Scrub | Mojave Seablite - Red Swampfire - Alkali Goldenbush Alkaline Wet Scrub Alliance | *Suaeda moquinii - Salicornia rubra - Isocoma acradenia* Alkaline Wet Scrub Alliance | A3880 | Mojave Seablite Wet Shrubland | *Suaeda moquinii* Wet Shrubland | CEGL001991 |
| Playa and Alkali Sink Shrublands and Scrub | Winterfat Dwarf-shrubland and Dwarf-shrub Herbaceous Alliance | *Krascheninnikovia lanata* Dwarf-shrubland and Dwarf-shrub Herbaceous Alliance | A3202 | Winterfat Dwarf-shrubland | *Krascheninnikovia lanata* Dwarf-shrubland | CEGL001320 |
| Playa and Alkali Sink Grasslands and Herbaceous Vegetation | Alkali Sacaton - Scratchgrass - Alkali Cordgrass Alkaline Wet Meadow Alliance | *Sporobolus airoides - Muhlenbergia asperifolia - Spartina gracilis* Alkaline Wet Meadow | A1334 | Alkali Sacaton Monotype Wet Meadow | *Sporobolus airoides* Monotype Wet Meadow | CEGL001688 |
| Playa and Alkali Sink Grasslands and Herbaceous Vegetation | Saltgrass Alkaline Wet Meadow Alliance | *Distichlis spicata* Alkaline Wet Meadow Alliance | A1332 | Cooper's Rush Alkaline Wet Meadow | *Juncus cooperi* Alkaline Wet Meadow | CEPP006712 |
| Playa and Alkali Sink Grasslands and Herbaceous Vegetation | Saltgrass Alkaline Wet Meadow Alliance | *Distichlis spicata* Alkaline Wet Meadow Alliance | A1332 | Saltgrass Alkaline Wet Meadow | *Distichlis spicata* Alkaline Wet Meadow | CEGL001770 |

**Table 4 (continued).** Summary of rUSNVC plant alliances/associations for MOJA and CAMO.

| Category | Plant Alliance (common name) | Plant Alliance (scientific name) | Alliance rUSNVC Element Code | Plant Association (common name) | Plant Association (scientific name) | Association rUSNVC Element Code |
|---|---|---|---|---|---|---|
| Playa and Alkali Sink Grasslands and Herbaceous Vegetation (continued) | Saltgrass Alkaline Wet Meadow Alliance | *Distichlis spicata* Alkaline Wet Meadow Alliance | A1332 | Saltgrass - Shoreline Rush Wet Meadow | *Distichlis spicata - Juncus balticus* var. *littoralis* Wet Meadow | CEPP006700 |
| Dune Grasslands and Herbaceous Vegetation | Big Galleta Desert Grassland Alliance | *Pleuraphis rigida* Desert Grassland Alliance | A3170 | Big Galleta Dune Grassland | *Pleuraphis rigida* Dune Grassland | CEPP006858 |
| Dune Grasslands and Herbaceous Vegetation | Big Galleta Desert Grassland Alliance | *Pleuraphis rigida* Desert Grassland Alliance | A3170 | Burrobush / Big Galleta Dwarf-shrubland | *Ambrosia dumosa / Pleuraphis rigida Dwarf-shrubland* | CEGL000955 |
| Dune Grasslands and Herbaceous Vegetation | Desert Twinbugs - Desert Sand-verbena - Desert Panicgrass Dune Alliance | *Dicoria canescens - Abronia villosa - Panicum urvilleanum* Dune Alliance | A4026 | Birdcage Evening Primrose - Cat's-eye species Dune | *Oenothera deltoides - Cryptantha* spp. Dune | CEPP006728 |
| Dune Grasslands and Herbaceous Vegetation | Desert Twinbugs - Desert Sand-verbena - Desert Panicgrass Dune Alliance | *Dicoria canescens - Abronia villosa - Panicum urvilleanum* Dune Alliance | A4026 | Desert Panicgrass Dune Grassland | *Panicum urvilleanum* Dune Grassland | CEPP006730 |
| Dune Grasslands and Herbaceous Vegetation | Desert Twinbugs - Desert Sand-verbena - Desert Panicgrass Dune Alliance | *Dicoria canescens - Abronia villosa - Panicum urvilleanum* Dune Alliance | A4026 | Desert Twinbugs Dune Sparse Vegetation | *Dicoria canescens* Dune Sparse Vegetation | CEGL005747 |
| Dune Grasslands and Herbaceous Vegetation | Desert Twinbugs - Desert Sand-verbena - Desert Panicgrass Dune Alliance | *Dicoria canescens - Abronia villosa - Panicum urvilleanum* Dune Alliance | A4026 | Thurber's Sandpaper Plant Dune | *Petalonyx thurberi* Dune | CEPP006731 |
| Disturbed and Non-Native Grasslands and Herbaceous Vegetation | Desert Globemallow - Scarlet Globemallow - Small-leaf Globemallow Dry Meadow Alliance | *Sphaeralcea (ambigua, coccinea, parvifolia)* Dry Meadow Alliance | A4216 | Desert Globemallow Dry Meadow | *Sphaeralcea ambigua* Dry Meadow | CEPP009532 |
| Disturbed and Non-Native Grasslands and Herbaceous Vegetation | Menzies' Fiddleneck - Bristly Fiddleneck - Phacelia species Meadow Alliance | *Amsinckia menziesii - Amsinckia tessellata - Phacelia* spp. Herbaceous Alliance | A4182 | Bristly Fiddleneck - Redstem Stork's-bill Meadow | *Amsinckia tessellata - Erodium cicutarium* Meadow | CEPP005792 |

**Table 4 (continued).** Summary of rUSNVC plant alliances/associations for MOJA and CAMO.

| Category | Plant Alliance (common name) | Plant Alliance (scientific name) | Alliance rUSNVC Element Code | Plant Association (common name) | Plant Association (scientific name) | Association rUSNVC Element Code |
|---|---|---|---|---|---|---|
| Disturbed and Non-Native Grasslands and Herbaceous Vegetation (continued) | Red Brome - Arabian Schismus - Common Mediterranean Grass Ruderal Desert Grassland Alliance | *Bromus rubens - Schismus arabicus - Schismus barbatus* Ruderal Herbaceous Alliance | A4121 | Red Brome - Redstem Stork's-bill - Pincushion species Ruderal Desert Grassland | *Bromus rubens - Erodium cicutarium - Chaenactis* spp. Ruderal Desert Grassland | CEPP005876 |
| Disturbed and Non-Native Grasslands and Herbaceous Vegetation (continued) | Red Brome - Arabian Schismus - Common Mediterranean Grass Ruderal Desert Grassland Alliance | *Bromus rubens - Schismus arabicus - Schismus barbatus* Ruderal Herbaceous Alliance | A4121 | (Arabian Schismus, Common Mediterranean Grass) - (Flat-crown Buckwheat) Ruderal Grassland | *Schismus (arabicus, barbatus) - (Eriogonum deflexum)* Ruderal Grassland | CEPP009691 |
| Disturbed and Non-Native Grasslands and Herbaceous Vegetation (continued) | Broom Snakeweed - Threadleaf Snakeweed Dwarf-shrubland Alliance | *Gutierrezia sarothrae - Gutierrezia microcephala* Dwarf-shrubland Alliance | A3203 | Broom Snakeweed / Big Galleta - Desert Globemallow Shrub Grassland | *Gutierrezia sarothrae / Pleuraphis rigida - Sphaeralcea ambigua* Shrub Grassland | CEGL001543 |
| Disturbed and Non-Native Grasslands and Herbaceous Vegetation (continued) | Wright's Buckwheat - Heermann's Buckwheat - Utah Butterfly-bush Scrub Alliance | *Eriogonum wrightii - Eriogonum heermannii - Buddleja utahensis* Scrub Alliance | A4167 | (Utah Butterfly-bush, Heermann's Buckwheat) - Snakeweed species Limestone Scrub | *(Buddleja utahensis, Eriogonum heermannii) - Gutierrezia* spp. Limestone Scrub | CEPP005784 |
| Sparse Vegetation | Acton's Brittlebush - Virgin River Brittlebush - Netvein Goldeneye Desert Scrub Alliance | *Encelia actonii - Encelia virginensis - Viguiera reticulata* Shrubland Alliance | A4163 | Acton's Brittlebush Desert Shrubland | *Encelia actonii* Desert Shrubland | CEGL005748 |
| Sparse Vegetation | Blackbrush Mojave Desert Scrub Alliance | *Coleogyne ramosissima* Mojave Desert Scrub Alliance | A3144 | Eastern Mojave Buckwheat Rock Outcrop Shrubland | *Eriogonum fasciculatum* Rock Outcrop Shrubland | CEGL001260 |
| Sparse Vegetation | Brittle Bush Scrub Alliance | *Encelia farinosa* Desert Scrub Alliance | A4215 | Brittlebush Shrubland | *Encelia farinosa* Shrubland | CEGL001251 |
| Sparse Vegetation | Brittle Bush Scrub Alliance | *Encelia farinosa* Desert Scrub Alliance | A4215 | Burrobush - Brittlebush Dwarf-shrubland | *Ambrosia dumosa - Encelia farinosa* Dwarf-shrubland | CEGL005061 |
| Sparse Vegetation | Desert Holly Scrub Alliance | *Atriplex hymenelytra* Scrub Alliance | A0872 | Desert Holly Sparse Shrubland | *Atriplex hymenelytra* Sparse Shrubland | CEPP005798 |
| Sparse Vegetation | Devil's Spineflower - Hairy Desert-sunflower Desert Pavement Alliance | *Chorizanthe rigida - Geraea canescens* Desert Pavement Alliance | A4024 | Devil's Spineflower - Hairy Desert-sunflower Desert Pavement | *Chorizanthe rigida - Geraea canescens* Desert Pavement | CEGL009686 |
| Sparse Vegetation | Eastern Mojave Buckwheat - Parish's Goldeneye Scrub Alliance | *Eriogonum fasciculatum - Viguiera parishii* Shrubland Alliance | A3150 | Eastern Mojave Buckwheat - (Turpentine-bush, Narrowleaf Goldenbush) Desert Shrubland | *Eriogonum fasciculatum - Ericameria (laricifolia, linearifolia)* Desert Shrubland | CEPP006705 |
| Sparse Vegetation | Eastern Mojave Buckwheat - Parish's Goldeneye Scrub Alliance | *Eriogonum fasciculatum - Viguiera parishii* Shrubland Alliance | A3150 | Parish's Goldeneye Shrubland | *Viguiera parishii* Shrubland | CEGL002721 |

**Table 4 (continued).** Summary of rUSNVC plant alliances/associations for MOJA and CAMO.

| Category | Plant Alliance (common name) | Plant Alliance (scientific name) | Alliance rUSNVC Element Code | Plant Association (common name) | Plant Association (scientific name) | Association rUSNVC Element Code |
|---|---|---|---|---|---|---|
| Sparse Vegetation | Eastern Mojave Buckwheat - Parish's Goldeneye Scrub Alliance | *Eriogonum fasciculatum - Viguiera parishii* Shrubland Alliance | A3150 | Parish's Goldeneye - Eastern Mojave Buckwheat Desert Shrubland | *Viguiera parishii - Eriogonum fasciculatum* Desert Shrubland | CEGL005775 |
| Sparse Vegetation | Eastern Mojave Buckwheat - Parish's Goldeneye Scrub Alliance | *Eriogonum fasciculatum - Viguiera parishii* Shrubland Alliance | A3150 | Eastern Mojave Buckwheat Desert Wash Shrubland | *Eriogonum fasciculatum* Desert Wash Shrubland | CEPP006706 |
| Sparse Vegetation | Sparsely Vegetated Bedrock Cliff and Lava Field Alliance | *Aloysia wrightii - Pericome caudata - Ephedra nevadensis* Sparsely Vegetated Bedrock Cliff and Lava Field Alliance | A4025 | No Sparse Lava Field Association Described for MOJA/CAMO | No Sparse Lava Field Association Described for MOJA/CAMO | N/A |

## Digital Imagery and Mapping

For MOJA/CAMO, 87 map units (72 vegetated and 15 land-use/land-cover) were developed. An effort was made to crosswalk the final list of map classes/units to corresponding plant associations/alliances and land-use classes. When a direct rUSNVC link was not feasible, broader groupings of alliances/associations (complexes) or descriptive local or land-use map units were created. MOJA/CAMO map classes represent a compromise between the detail of the rUSNVC, resource management needs, and the limitations of the imagery. In addition, some of the more widespread alliances/associations occurred across multiple distinct landforms (e.g., similar vegetation on lava beds, rock outcrops, and alluvial fans) that were mapped separately to provide more detail.

Table 5 contains the final list of map units and their crosswalk to associations/alliances. Descriptions, distribution maps, and representative ground photographs for all the vegetation map units are available in DataStore with the additional project materials. A comprehensive map unit crosswalk reference to the rUSNVC is also contained in the accompanying digital files for this project (see MOJA_USNVC_Table).

**Table 5.** MOJA and CAMO map units and rUSNVC crosswalk.

| Category | Map Code | MOJA/CAMO Map Unit Common Name [MOJA/CAMO Map Unit Scientific Name] | rUSNVC Crosswalk Code |
|---|---|---|---|
| Woodlands and Wooded Shrublands | W_CJUN | California Juniper Mojave Scrub Woodland [*Juniperus californica* Mojave Scrub Woodland] | A0502 |
| Woodlands and Wooded Shrublands | W_COAK | Canyon Live Oak - California Black Oak Forest and Woodland [*Quercus chrysolepis - Quercus kelloggii* Forest and Woodland] | A3349 |
| Woodlands and Wooded Shrublands | W_CWD | Fremont Cottonwood - Velvet Ash - Goodding's Willow Flooded Forest and Woodland | A3803 |
| Woodlands and Wooded Shrublands | W_CWD | [*Populus fremontii - Fraxinus velutina - Salix gooddingii* | A3803 |
| Woodlands and Wooded Shrublands | W_CWD | Flooded Forest and Woodland] | A3803 |
| Woodlands and Wooded Shrublands | W_FIR | Dry White Fir Forest and Woodland [Abies concolor Dry Forest and Woodland] | A3420 |
| Woodlands and Wooded Shrublands | W_JT | Joshua Tree / Sparse Understory Wooded Shrubland [*Yucca brevifolia* / Sparse Understory Wooded Shrubland] | CEGL003116 |
| Woodlands and Wooded Shrublands | W_JTBB | Joshua Tree / Blackbrush - (Big Sagebrush) Wooded Shrubland [Yucca brevifolia / Coleogyne ramosissima - (Artemisia tridentata) Wooded Shrubland] | CEGL005294, CEPP006854 |
| Woodlands and Wooded Shrublands | W_JTCB | Joshua Tree / Creosotebush Wooded Shrubland [*Yucca brevifolia* / *Larrea tridentata* Wooded Shrubland] | CEGL005777 |
| Woodlands and Wooded Shrublands | W_JTDS | Joshua Tree / Mixed Desert Scrub Wooded Shrubland [*Yucca brevifolia* / Mixed Desert Scrub Wooded Shrubland] | CEGL005779, CEGL005778 |
| Woodlands and Wooded Shrublands | W_JTGRS | Joshua Tree / Mixed Grass Wooded Shrubland [Yucca brevifolia / Mixed Desert Scrub Wooded Shrubland] | CEGL002725 |

**Table 5 (continued).** MOJA and CAMO map units and rUSNVC crosswalk.

| Category | Map Code | MOJA/CAMO Map Unit Common Name [MOJA/CAMO Map Unit Scientific Name] | rUSNVC Crosswalk Code |
|---|---|---|---|
| Woodlands and Wooded Shrublands (continued) | W_JTMS | Joshua Tree / Mixed Shrub and Grass Wooded Shrubland [*Yucca brevifolia* / Mixed Shrub and Grass Wooded Shrubland] | CEPP006862, CEGL005776 |
| Woodlands and Wooded Shrublands (continued) | W_JTMY | Joshua Tree / Mojave Yucca Wooded Shrubland [Yucca brevifolia / Yucca schidigera Wooded Shrubland] | CEGL005777 |
| Woodlands and Wooded Shrublands (continued) | W_JTUJ | Joshua Tree - Utah Juniper Wooded Shrubland [Yucca brevifolia - Juniperus osteosperma Wooded Shrubland] | CEGL002744 |
| Woodlands and Wooded Shrublands (continued) | W_JUN | Utah Juniper / Sparse Shrub Understory Woodland Complex [*Juniperus osteosperma* / Sparse Shrub Understory Woodland Complex] | CEGL005754 |
| Woodlands and Wooded Shrublands (continued) | W_JUNBB | Utah Juniper / Blackbrush Woodland [Juniperus osteosperma / Coleogyne ramosissima Woodland] | CEGL002360, CEGL002909 |
| Woodlands and Wooded Shrublands (continued) | W_LJTDS | Joshua Tree / Mixed Desert Scrub Lava and Cinder Wooded Shrubland [Yucca brevifolia / Mixed Desert Scrub Lava and Cinder Wooded Shrubland] | CEGL005779, CEGL005778 |
| Woodlands and Wooded Shrublands (continued) | W_MEQ | Mesquite Riparian Forest, Woodland, and Shrubland [*Prosopis glandulosa - Prosopis velutina - Prosopis pubescens* Riparian Forest, Woodland, and Shrubland] | CEGL006861, CEGL001381, CEPP006860 |
| Woodlands and Wooded Shrublands (continued) | W_ORN | Mixed Ornamental and Semi-Natural Woodland | (N/A) |
| Woodlands and Wooded Shrublands (continued) | W_PALM | Date Palm - California Fan Palm Ruderal Woodland [Phoenix dactylifera - Washingtonia filifera Ruderal Woodland] | A4161 |
| Woodlands and Wooded Shrublands (continued) | W_PJ | Pinyon Pine - Utah Juniper Woodland / Sparse Understory Woodland [*Pinus monophylla - Juniperus osteosperma* / Sparse Understory Woodland] | CEGL000829 |
| Woodlands and Wooded Shrublands (continued) | W_PJ2 | Two-needle Pinyon - Utah Juniper / Sonoran Scrub Oak Woodland [*Pinus edulis - Juniperus osteosperma* / *Quercus turbinella* Woodland] | CEGL004007 |
| Woodlands and Wooded Shrublands (continued) | W_PJBB | Singleleaf Pinyon - Utah Juniper / Big Sagebrush - Blackbrush - Stansbury Cliff Rose Woodland Complex [*Pinus monophylla - Juniperus osteosperma* / *Artemisia tridentata - Coleogyne ramosissima - Purshia stansburiana* Woodland Complex] | CEGL005397, CEGL000832, CEGL002971 |
| Woodlands and Wooded Shrublands (continued) | W_PJDS | Singleleaf Pinyon - Utah Juniper / Mixed Dry Shrub and Grass Understory Woodland [*Pinus monophylla - Juniperus osteosperma* / Mixed Dry Shrub and Grass Understory Woodland] | CEPP006732 |
| Woodlands and Wooded Shrublands (continued) | W_PJMS | Singleleaf Pinyon - Utah Juniper / Mixed Upland Shrub Understory Woodland Complex [*Pinus monophylla - Juniperus osteosperma* / Mixed Upland Shrub Understory Woodland Complex] | CEGL005772, CEGL002941 |

**Table 5 (continued).** MOJA and CAMO map units and rUSNVC crosswalk.

| Category | Map Code | MOJA/CAMO Map Unit Common Name [MOJA/CAMO Map Unit Scientific Name] | rUSNVC Crosswalk Code |
|---|---|---|---|
| Woodlands and Wooded Shrublands (continued) | W_PJWASH | Pinyon Pine - Utah Juniper Woodland Wash [*Pinus monophylla - Juniperus osteosperma* Woodland Wash] | CEGL005771 |
| Woodlands and Wooded Shrublands (continued) | W_TAM | Tamarisk species Ruderal Riparian Woodland and Scrub [*Tamarix* spp. Ruderal Riparian Woodland and Scrub] | CST006759, CEGL003114 |
| Woodlands and Wooded Shrublands (continued) | W_WIL | Goodding's Willow - Red Willow Riparian Forest [*Salix gooddingii - Salix laevigata* Riparian Forest] | A3752 |
| Shrublands and Scrub | S_ABIT | Antelope Bitterbrush - Big Sagebrush Mesic Steppe and Shrubland [*Purshia tridentata - Artemisia tridentata* Mesic Steppe and Shrubland] | A3179 |
| Shrublands and Scrub | S_AWASH | Catclaw Acacia - Desert-lavender - Beloperone Desert Wash Shrubland [*Senegalia greggii - Hyptis emoryi - Justicia californica* Desert Wash Scrub] | A4187 |
| Shrublands and Scrub | S_BLK | Blackbrush Mojave Desert Scrub [*Coleogyne ramosissima* Mojave Desert Scrub] | A3144 |
| Shrublands and Scrub | S_BSG | Big Sagebrush - Mixed Shrub Dry Steppe and Shrubland [*Artemisia tridentata* - Mixed Shrub Dry Steppe and Shrubland] | A3198 |
| Shrublands and Scrub | S_BWIL | North American Warm Desert Riparian Low Bosque and Shrubland Complex | A0947, A3878, A3874 A1033 |
| Shrublands and Scrub | S_CB | Creosotebush Desert Scrub [*Larrea tridentata* Desert Scrub] | CEGL005145, CEGL005765, CEGL001268 |
| Shrublands and Scrub | S_CBB | Creosotebush - Brittle Bush Desert Scrub [*Larrea tridentata - Encelia farinosa* Desert Scrub] | CEGL002955, CEGL005766, CEPP006723, CEGL005767 |
| Shrublands and Scrub | S_CBDN | Creosotebush - Burrobush / Big Galleta Dune Desert Scrub [*Larrea tridentata - Ambrosia dumosa* / *Pleuraphis rigida* Dune Desert Scrub] | CEGL005764, CEGL005768 |
| Shrublands and Scrub | S_CBWB | Creosotebush - Burrobush Bajada and Valley Desert Scrub [*Larrea tridentata - Ambrosia dumosa* Bajada and Valley Desert Scrub] | A3277 |
| Shrublands and Scrub | S_CHAP | Sonoran Scrub Oak - Mixed Shrub Chaparral [*Quercus turbinella* - Mixed Shrub Chaparral] | A0793, A3732 |
| Shrublands and Scrub | S_DWASH | Desert-willow - Smoketree Desert Wash Scrub [*Chilopsis linearis - Psorothamnus spinosus* Desert Wash Scrub] | A1044 |
| Shrublands and Scrub | S_FIRE | Post-Fire and Disturbed Shrubland Complex | A3179, A3196, A4187, A4185, A3203 |
| Shrublands and Scrub | S_FWASH | Post-Fire Desert Wash and Drainage Shrubland | A3266 |

**Table 5 (continued).** MOJA and CAMO map units and rUSNVC crosswalk.

| Category | Map Code | MOJA/CAMO Map Unit Common Name [MOJA/CAMO Map Unit Scientific Name] | rUSNVC Crosswalk Code |
|---|---|---|---|
| Shrublands and Scrub (continued) | S_HWASH | High Elevation Shrub and Herbaceous Vegetation Wash | A3259, A3799 |
| Shrublands and Scrub (continued) | S_IOD | Iodinebush Wet Shrubland [*Allenrolfea occidentalis* Shrubland] | A0866 |
| Shrublands and Scrub (continued) | S_LMDS | Basalt, Lava, and Cinders Mixed Desert Shrub Complex | A4156, A4157, A3278, A4245 |
| Shrublands and Scrub (continued) | S_LSALT | Cattle Saltbush Lava and Cinders Shrubland [*Atriplex polycarpa* Lava and Cinders Shrubland] | A3174 |
| Shrublands and Scrub (continued) | S_LWASH | Low Bosque and Shrubland Wash | A3277, A4188 |
| Shrublands and Scrub (continued) | S_MDS | Mid-Elevation Mixed Desert Shrub Complex | A4156, A4157, A4185, A3278, A4245, A3203, A3201, A4158, A0833 |
| Shrublands and Scrub (continued) | S_MSBLT | Mojave Seablite - Red Swampfire Alkaline Wet Scrub [*Suaeda moquinii - Salicornia rubra - Isocoma acradenia* Alkaline Wet Scrub] | A3880 |
| Shrublands and Scrub (continued) | S_MWASH | Semi-Desert Mid-Elevation Mixed Shrub and Herbaceous Vegetation Wash Complex | A4185, A2536, A4188 |
| Shrublands and Scrub (continued) | S_MY | Mojave Yucca Scrub [*Yucca schidigera* Scrub] | A3147 |
| Shrublands and Scrub (continued) | S_RBT | Rabbitbrush Desert Shrubland [*Ericameria nauseosa* Desert Shrubland] | A3196 |
| Shrublands and Scrub (continued) | S_RWASH | Rabbitbrush Desert Wash Shrubland [*Ericameria* (spp.) Mojave Desert Wash Scrub] | A3266, A2509 |
| Shrublands and Scrub (continued) | S_SALT | Cattle Saltbush Shrubland [*Atriplex polycarpa* Shrubland] | A3174 |
| Shrublands and Scrub (continued) | S_WFAT | Winterfat Steppe and Dwarf-shrubland [*Krascheninnikovia lanata* Dwarf-shrubland and Dwarf-shrub Herbaceous Vegetation] | A3202 |
| Shrublands and Scrub (continued) | S_WING | Fourwing Saltbush Scrub [*Atriplex canescens* Scrub] | A0869 |
| Herbaceous Vegetation | H_BG | Big Galleta Desert Grassland [*Pleuraphis rigida* Desert Grassland] | A3170 |
| Herbaceous Vegetation | H_DUNE | Desert Twinbugs - Desert Sand-verbena - Desert Panicgrass Dune Herbaceous Vegetation [*Dicoria canescens - Abronia villosa - Panicum urvilleanum* Dune Herbaceous Vegetation] | A4026 |
| Herbaceous Vegetation | H_FIRE | Post-Fire Herbaceous Vegetation Complex | A4167, A4216, A4182 |
| Herbaceous Vegetation | H_GDUNE | Desert Panicgrass Dune Grassland [*Panicum urvilleanum* Dune Grassland] | CEPP006730 |

**Table 5 (continued).** MOJA and CAMO map units and rUSNVC crosswalk.

| Category | Map Code | MOJA/CAMO Map Unit Common Name [MOJA/CAMO Map Unit Scientific Name] | rUSNVC Crosswalk Code |
|---|---|---|---|
| Herbaceous Vegetation (continued) | H_GRS | Intermountain Semi-Desert Sparse Scrub and Grassland Complex | A3203, A1287 |
| Herbaceous Vegetation (continued) | H_MGRS | Mixed Desert Ruderal and Annual Grassland and Forb Meadow Herbaceous Vegetation Complex | A4182, A4121 |
| Herbaceous Vegetation (continued) | H_MRSH | Arid West Emergent Marsh Herbaceous Vegetation Complex | A1334, A3896 |
| Herbaceous Vegetation (continued) | H_SALT | Saltgrass Alkaline Wet Meadow [*Distichlis spicata* Alkaline Wet Meadow] | A1332 |
| Sparse Vegetation | SV_BAD | Badlands Sparse Vegetation | (N/A) |
| Sparse Vegetation | SV_CNDR | Cinders and Cinder Cone Sparse Vegetation | (N/A) |
| Sparse Vegetation | SV_DS | Sparse Desert Pavement Dwarf Scrub Complex | A4024, A0872, A3279 |
| Sparse Vegetation | SV_DUNE | Mojave - Sonoran Dune Sparse Vegetation | A4026 |
| Sparse Vegetation | SV_FIRE | Post-Fire Sparse Vegetation | A3144 |
| Sparse Vegetation | SV_LAVA | Lava Field Sparse Vegetation | (N/A) |
| Sparse Vegetation | SV_LDS | Semi-Desert Lava, Basalt, and Cinders Sparse Scrub Complex | A2540, A3279, A4245, A4163, A4156, A4215, A3150 |
| Sparse Vegetation | SV_PLYA | Desert Playa and Old Lake Bed Sparse Vegetation | (N/A) |
| Sparse Vegetation | SV_RCK | Bedrock and Cliff Outcrop Sparse Vegetation Complex | A4050, A4215, A3279, A0872, A3144, A4157 |
| Sparse Vegetation | SV_SDS | Semi-Desert Rock, Talus, and Steep Slope Sparse Scrub Complex | A4025, A3279, A4245, A4163, A4156, A4215, A3150 |
| Sparse Vegetation | SV_WASH | Desert Wash and River Bottom Sparse Vegetation | A3150 |
| Land-Use and Land-Cover | L_AGRI | Agricultural Business / Ranches | (N/A) |
| Land-Use and Land-Cover | L_CANL | Canal / Ditch / Berm | (N/A) |
| Land-Use and Land-Cover | L_COML | Commercial Developments | (N/A) |
| Land-Use and Land-Cover | L_COMM | Communications and Utilities | (N/A) |
| Land-Use and Land-Cover | L_FACL | NPS Facilities | (N/A) |
| Land-Use and Land-Cover | L_FIELD | Planted / Cultivated Fields | (N/A) |
| Land-Use and Land-Cover | L_LAWN | Lawns and Maintained Areas | (N/A) |
| Land-Use and Land-Cover | L_LOT | Parking Lot | (N/A) |
| Land-Use and Land-Cover | L_MINE | Quarries / Strip Mines / Gravel Pits | (N/A) |
| Land-Use and Land-Cover | L_POND | Pond | (N/A) |
| Land-Use and Land-Cover | L_RESD | Residential | (N/A) |

| Category | Map Code | MOJA/CAMO Map Unit Common Name [MOJA/CAMO Map Unit Scientific Name] | rUSNVC Crosswalk Code |
|---|---|---|---|
| Land-Use and Land-Cover (continued) | L_ROAD | Roads and Transportation Structures | (N/A) |
| Land-Use and Land-Cover (continued) | L_TRAN | Transitional Area | (N/A) |
| Land-Use and Land-Cover (continued) | L_TRL | Trails and Tracks | (N/A) |
| Land-Use and Land-Cover (continued) | L_URB | Urban Area | (N/A) |

### *Vegetation Map*

The final MOJA and CAMO vegetation map layer is available in the accompanying digital project files in DataStore and contains 55,893 polygons with an average polygon size of about 30 acres (12 ha). The relatively small polygons are due in part to the detailed mapping, the importance of delineating rare vegetation types, dividing the woodland types by understory species, and the arbitrary splitting of continuous polygons into smaller areas due to intersecting roads, trails, washes, and the project boundary. The mapping is also finely detailed since the NAIP imagery was of high resolution (1-meter pixels), allowing for mapping of some individual plant associations.

Based on the final vegetation layer, less than 1% (11,381 acres) of the project area was developed. Of the vegetated total, 28% (451,481 acres) was wooded or wooded shrubland, 57% (923,369 acres) were shrublands or scrub, 4% (70,750 acres) were dominated by herbaceous species, and about 10% (159,597 acres) contained sparse or no vegetation. The largest single map unit was the Creosotebush - Burrobush Bajada and Valley Desert Scrub (S_CBWB), covering 24% (395,620 acres) of the project area. Other general mapping trends include: 5% (72,819 acres) was mapped as either a pinyon-juniper or a juniper woodland type, 23% (377,721 acres) was mapped as a Joshua tree type, 10% (147,281 acres) as a drainage or wash feature, 4% (58,578 acres) represent recently burned or post-fire recovery vegetation, about 1% (23,332 acres) were on dune or sand deposits, 3% (45,207 acres) were on playas or alkaline sinks, and 2% (39,942 acres) were on volcanic cinders or lava beds.

For further vegetation analysis, the full vegetation spatial database can be explored and manipulated using the additional linked databases and polygon attributes such as density, height, pattern, landform, and geology in a GIS program such as ArcMap or ArcPro. Using queries and other geospatial routines, the extensive geospatial data can be combined in many different ways and at various scales to produce additional useful products.

For example, fine-scale mapping efforts that use the alliances/association map units might be more suitable for detailed site-specific studies such as road and trail development or potential wildlife monitoring locations (Figure 16). Coarser vegetation classes will produce a less-detailed vegetation map that might be more applicable for reports or broader assessments. Conversely, coarse-scale maps can be created by scaling up the rUSNVC hierarchy to the group level or by selecting the physical vegetation or biophysical vegetation attributes (Figure 17). Additional habitat studies can also be performed by querying the spatial database for various indicators such as canopy densities and

heights of the vegetation, types occurring in washes/drainages, or map units that occur on certain geologic formations. A statistical summary for the MOJA and CAMO map class polygons is listed in Table 6.

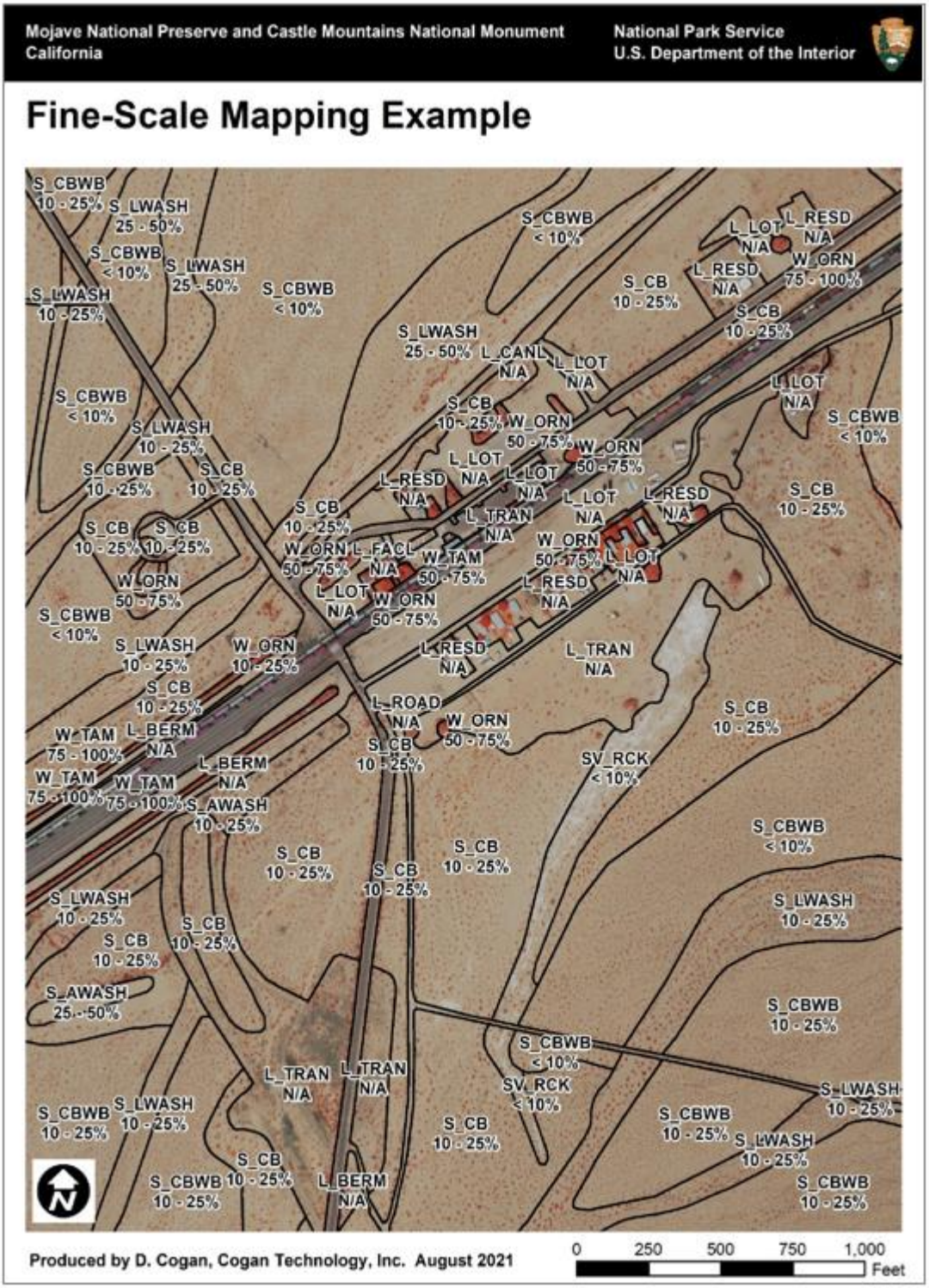


**Figure 16.** Example of a fine-scale vegetation map for MOJA and CAMO. NPS / CTI

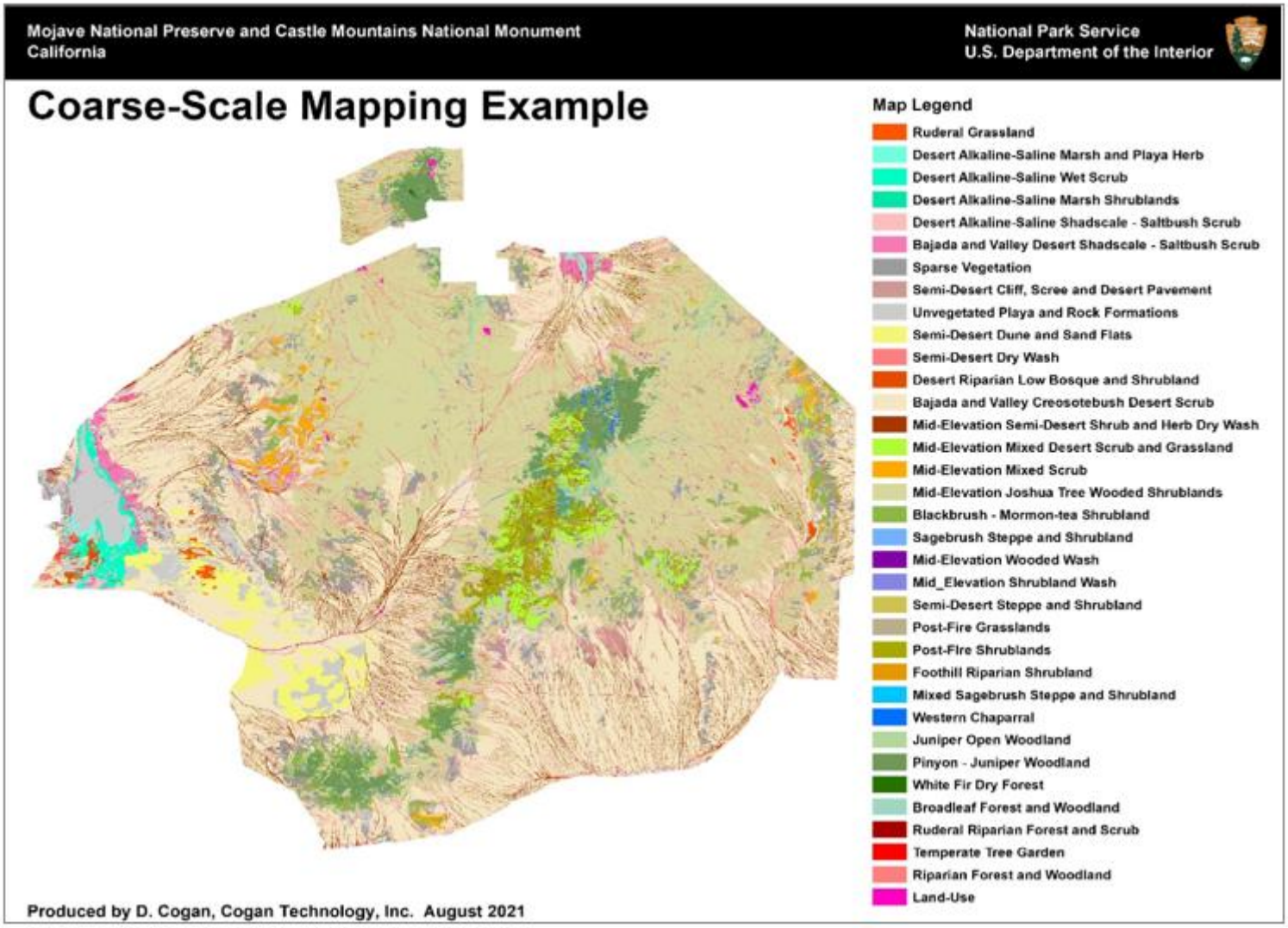


**Figure 17.** Example of a coarse-scale vegetation map for MOJA and CAMO. NPS / CTI

**Table 6.** Summary statistics for the MOJA and CAMO map class polygons.

| Map Code | Map Unit Common Name | Polygons | Acres | Hectares |
|---|---|---|---|---|
| W_CJUN | California Juniper Mojave Scrub Woodland | 85 | 1,368 | 554 |
| W_COAK | Canyon Live Oak - California Black Oak Forest and Woodland | 157 | 622 | 251 |
| W_CWD | Fremont Cottonwood - Velvet Ash - Goodding's Willow Flooded Forest and Woodland | 12 | 8 | 3 |
| W_FIR | Dry White Fir Forest and Woodland | 9 | 204 | 83 |
| W_JT | Joshua Tree / Sparse Understory Wooded Shrubland | 366 | 7,030 | 2,845 |
| W_JTBB | Joshua Tree / Blackbrush - (Big Sagebrush) Wooded Shrubland | 1,131 | 32,526 | 13,163 |
| W_JTCB | Joshua Tree / Creosotebush Wooded Shrubland | 2,226 | 79,062 | 31,995 |
| W_JTDS | Joshua Tree / Mixed Desert Scrub Wooded Shrubland | 2,350 | 111,851 | 45,265 |
| W_JTGRS | Joshua Tree / Mixed Grass Wooded Shrubland | 1,100 | 34,529 | 13,973 |
| W_JTMS | Joshua Tree / Mixed Shrub and Grass Wooded Shrubland | 74 | 27,113 | 10972 |
| W_JTMY | Joshua Tree / Mojave Yucca Wooded Shrubland | 1,190 | 53,804 | 21,774 |
| W_JTUJ | Joshua Tree - Utah Juniper Wooded Shrubland | 601 | 21,879 | 8,854 |
| W_JUN | Utah Juniper / Sparse Shrub Understory Woodland Complex | 544 | 9,977 | 4038 |
| W_JUNBB | Utah Juniper / Blackbrush Woodland | 147 | 3,765 | 1,524 |
| W_LJTDS | Joshua Tree / Mixed Desert Scrub Lava and Cinder Wooded Shrubland | 244 | 9,927 | 4,017 |
| W_MEQ | Mesquite Riparian Forest, Woodland, and Shrubland | 151 | 2,864 | 1,159 |
| W_ORN | Mixed Ornamental and Semi-Natural Woodland | 52 | 21 | 9 |
| W_PALM | Date Palm - California Fan Palm Ruderal Woodland | 4 | 2 | 1 |
| W_PJ | Pinyon Pine - Utah Juniper Woodland / Sparse Understory Woodland | 532 | 8,263 | 3,344 |
| W_PJ2 | Two-needle Pinyon - Utah Juniper / Sonoran Scrub Oak Woodland | 12 | 677 | 274 |
| W_PJBB | Singleleaf Pinyon - Utah Juniper / Big Sagebrush - Blackbrush Woodland Complex | 472 | 11,585 | 4,689 |
| W_PJDS | Singleleaf Pinyon - Utah Juniper / Mixed Dry Shrub and Grass Understory Woodland | 483 | 16,376 | 6,627 |

**Table 6 (continued).** Summary statistics for the MOJA and CAMO map class polygons.

| Map Code | Map Unit Common Name | Polygons | Acres | Hectares |
|---|---|---|---|---|
| W_PJMS | Singleleaf Pinyon - Utah Juniper / Mixed Upland Shrub Understory Woodland Complex | 366 | 15,297 | 6,191 |
| W_PJWASH | Pinyon Pine - Utah Juniper Woodland Wash | 399 | 2,623 | 1,061 |
| W_TAM | Tamarisk species Ruderal Riparian Woodland and Scrub | 58 | 106 | 43 |
| W_WIL | Goodding's Willow - Red Willow Riparian Forest | 2 | 1 | 0 |
| S_ABIT | Antelope Bitterbrush - Big Sagebrush Mesic Steppe and Shrubland | 128 | 338 | 137 |
| S_AWASH | Catclaw Acacia - Desert-lavender - Beloperone Desert Wash Shrubland | 1,016 | 15,946 | 6,453 |
| S_BLK | Blackbrush Mojave Desert Scrub | 1,131 | 21,420 | 8,668 |
| S_BSG | Big Sagebrush - Mixed Shrub Dry Steppe and Shrubland | 219 | 1,173 | 475 |
| S_BWIL | North American Warm Desert Riparian Low Bosque and Shrubland Complex | 133 | 345 | 139 |
| S_CB | Creosotebush Desert Scrub | 2,339 | 62,352 | 25,233 |
| S_CBB | Creosotebush - Brittle Bush Desert Scrub | 537 | 14,262 | 5,771 |
| S_CBDN | Creosotebush - Burrobush Dune / Big Galleta Desert Scrub | 379 | 48,910 | 19,793 |
| S_CBWB | Creosotebush - Burrobush Bajada and Valley Desert Scrub | 11,191 | 395,620 | 160,101 |
| S_CHAP | Sonoran Scrub Oak - Mixed Shrub Chaparral | 98 | 1,080 | 437 |
| S_DWASH | Desert-willow - Smoketree Desert Wash Shrubland | 264 | 5,190 | 2,100 |
| S_FIRE | Post-Fire and Disturbed Shrubland Complex | 851 | 28,096 | 11,370 |
| S_FWASH | Post-Fire Desert Wash and Drainage Shrubland | 322 | 2,331 | 943 |
| S_HWASH | High Elevation Shrub and Herbaceous Vegetation Wash | 347 | 2,444 | 989 |
| S_IOD | Iodine Bush Wet Shrubland | 22 | 3,493 | 1,414 |
| S_LMDS | Basalt, Lava, and Cinders Mixed Desert Shrub Complex | 549 | 17,001 | 6,880 |
| S_LSALT | Cattle Saltbush Lava and Cinders Shrubland | 67 | 1,244 | 503 |
| S_LWASH | Low-Elevation Shrubland Wash | 2,288 | 59,091 | 23,913 |
| S_MDS | Mid-Elevation Mixed Desert Shrub Complex | 1,409 | 37,279 | 15,086 |
| S_MSBLT | Mojave Seablite - Red Swampfire Alkaline Wet Scrub | 64 | 7,001 | 2,833 |
| S_MWASH | Semi-Desert Mid-Elevation Mixed Shrub and Herbaceous Vegetation Wash Complex | 3,862 | 52,958 | 21,431 |
| S_MY | Mojave Yucca Scrub | 3,741 | 131,295 | 53,133 |

**Table 6 (continued).** Summary statistics for the MOJA and CAMO map class polygons.

| Map Code | Map Unit Common Name | Polygons | Acres | Hectares |
|---|---|---|---|---|
| S_RBT | Rabbitbrush Desert Shrubland | 37 | 82 | 33 |
| S_RWASH | Rabbitbrush Desert Wash Shrubland | 188 | 2,117 | 857 |
| S_SALT | Cattle Saltbush Shrubland | 251 | 11,190 | 4,528 |
| S_WFAT | Winterfat Steppe and Dwarf-shrubland | 5 | 103 | 42 |
| S_WING | Fourwing Saltbush Scrub | 39 | 1,009 | 408 |
| H_BG | Big Galleta Desert Grassland | 94 | 25,685 | 10,394 |
| H_DUNE | Desert Twinbugs - Desert Sand-verbena - Desert Panicgrass Dune Herbaceous Vegetation | 11 | 448 | 181 |
| H_FIRE | Post-Fire Herbaceous Vegetation Complex | 770 | 23,332 | 9,442 |
| H_GDUNE | Desert Panicgrass Dune Grassland | 84 | 9,955 | 4,029 |
| H_GRS | Intermountain Semi-Desert Sparse Scrub and Grassland Complex | 352 | 5,290 | 2,141 |
| H_MGRS | Mixed Desert Ruderal and Annual Grassland and Forb Meadow Herbaceous Vegetation Complex | 222 | 3,594 | 1,454 |
| H_MRSH | Arid West Emergent Marsh Herbaceous Vegetation Complex | 31 | 175 | 71 |
| H_SALT | Saltgrass Alkaline Wet Meadow | 41 | 2,271 | 919 |
| SV_BAD | Badlands Sparse Vegetation | 8 | 294 | 119 |
| SV_CNDR | Cinders and Cinder Cone Sparse Vegetation | 78 | 1,411 | 571 |
| SV_DS | Sparse Desert Pavement Dwarf Scrub Complex | 776 | 12,731 | 5,152 |
| SV_DUNE | Mojave - Sonoran Dune Sparse Vegetation | 152 | 16,060 | 6,499 |
| SV_FIRE | Post-Fire Sparse Vegetation | 320 | 4,818 | 1,950 |
| SV_LAVA | Lava Field Sparse Vegetation | 509 | 4,315 | 1,746 |
| SV_LDS | Semi-Desert Lava, Basalt, and Cinders Sparse Scrub Complex | 290 | 6,994 | 2,831 |
| SV_PLYA | Desert Playa and Old Lake Bed Sparse Vegetation | 165 | 18,896 | 7,647 |
| SV_RCK | Bedrock and Cliff Outcrop Sparse Vegetation Complex | 3,276 | 37,421 | 15,143 |
| SV_SDS | Semi-Desert Rock, Talus, and Steep Slope Sparse Scrub Complex | 1,993 | 54,751 | 22,157 |
| SV_WASH | Desert Wash and River Bottom Sparse Vegetation | 204 | 1,906 | 771 |
| L_ABUS | Agricultural Business / Ranches | 83 | 83 | 34 |
| L_AGRI | Agricultural Fields | 1 | 11 | 4 |
| L_BERM | Berms and Ditches | 131 | 726 | 294 |
| L_CANL | Canals and Other Man-made Watercourses | 15 | 52 | 21 |

**Table 6 (continued).** Summary statistics for the MOJA and CAMO map class polygons.

| Map Code | Map Unit Common Name | Polygons | Acres | Hectares |
|---|---|---|---|---|
| L_COM | Commercial, Churches, and Other Light Industrial Sites | 12 | 14 | 6 |
| L_COMM | Communications and Utilities | 813 | 127 | 51 |
| L_FACL | NPS Facilities | 91 | 33 | 13 |
| L_LAWN | Lawns and Maintained Areas | 2 | 6 | 2 |
| L_LOT | Parking Lots | 27 | 60 | 24 |
| L_MINE | Quarries, Mines, and Pits | 185 | 1,183 | 479 |
| L_POND | Ponds and Lakes | 45 | 56 | 23 |
| L_RESD | Residential Areas | 263 | 139 | 56 |
| L_ROAD | Roads and Transportation Structures | 55 | 7,892 | 3,194 |
| L_TRAN | Transitional Area | 430 | 707 | 286 |
| L_TRL | Trails and Tracks | 120 | 291 | 118 |
| **Subtotal Woodlands** | **–** | **12,767** | **451,481** | **182,708** |
| **Subtotal Shrublands** | **–** | **31,477** | **923,369** | **373,674** |
| **Subtotal Herbaceous Vegetation** | **–** | **1,605** | **70,750** | **28,631** |
| **Subtotal Sparse Vegetation** | **–** | **7,771** | **159,597** | **64,586** |
| **Subtotal Land-Use and Land-Cover** | **–** | **2,273** | **11,381** | **4,605** |
| **Subtotal All Vegetation and Sparse Areas** | **–** | **53,620** | **1,605,196** | **649,600** |
| **TOTALS** | **–** | **55,893** | **1,616,577** | **654,206** |

## Accuracy Assessment

A total of 720 AA target points were sampled by the field crews and distributed throughout the MOJA and CAMO project area. After the fieldwork, the resulting AA data were entered into the PLOTS database and reviewed. Based on the undescribed vegetation encountered at a few of the remote AA sites, the MOJA and CAMO classification was updated and finalized to include this new information. The AA points were then exported to a geospatial shapefile and overlain on the vegetation map layer.

A review of the AA geospatial data revealed seven points that were located too close together or were double-sampled by multiple field teams. These were removed from further analyses yielding a final sample size of 714 AA points. Seven map units were not assessed in the field for the following reasons. The SV_WASH was not included as a map unit at the time of the fieldwork and was added later to better define large barren drainages. Similarly, the W_JUNBB type was added later to help distinguish juniper woodlands with a blackbrush understory component. The W_WIL, W_CJUN,

W_ORN, S_BWIL, and S_RBT types were all very rare, and no previously un-sampled locations were available or could be safely reached by the field crews.

During two rounds of analyses, the AA points were overlaid on the vegetation map, and the field calls were compared to polygon labels. For both evaluations, two types of contingency tables (error matrices) were prepared to help review the results. A sample contingency table was created using just the raw AA data, and then a population table was made after weighing each type based on the proportional size of the study area. The contingency tables for MOJA/CAMO present the predicted values (polygon map labels) from the vegetation map layer as rows and the reference data values (field calls) as columns. The individual cell values represent the number of map units mapped in each class that were found to be of a specific class in the field. The values on the diagonal represent correct map units, whereas those off the diagonal represent mismatched or incorrect types. Digital copies of both the final sample and population contingency tables can be found in the accompanying project files in DataStore.

Errors in the mapping can be reviewed in the tables on both sides of the diagonal and represent both the user's and producer's error rates. The user's accuracy, or percent error of commission, relates to how polygons for each map unit were labeled when compared to the actual plant communities in the field data. Low user accuracy (high commission error) can be thought of as an over-mapping of a type; in other words, more of this type was mapped than actually occurs on the ground. Producer's accuracy, or the percent error of omission, relates to how many polygons for that type were left off the map. Low producer's accuracy (high omission error) can be thought of as under-mapping a type in that this type was mapped as other map units, and not enough of it was included in the map.

For the first analysis, only the primary call field call was used, resulting in an initial overall accuracy of 75%. During the second stage, the secondary and tertiary field calls were incorporated, and some corrections to the plant community determinations were made after a thorough review of the actual data sheets. This resulted in a final overall accuracy of 91%. The results of the sample contingency analysis showing both the user's and producer's accuracy rates are summarized in Table 7. The overall results of the population analysis are presented in Table 8.

**Table 7.** Sample accuracy assessment results for MOJA and CAMO.

| Map Code | Total | Correct | User's Accuracy | 90% Conf. Interval | Total | Correct | Producer's Accuracy | 90% Conf. Interval |
|---|---|---|---|---|---|---|---|---|
| H_BG | 27 | 27 | 100% | 2% | 29 | 27 | 93% | 10% |
| H_DUNE | 5 | 5 | 100% | 10% | 10 | 5 | 50% | 47% |
| H_FIRE | 9 | 9 | 100% | 6% | 9 | 9 | 100% | 6% |
| H_GDUNE | 9 | 8 | 89% | 25% | 8 | 8 | 100% | 6% |
| H_GRS | 8 | 8 | 100% | 6% | 8 | 8 | 100% | 6% |
| H_MGRS | 17 | 17 | 100% | 3% | 18 | 17 | 94% | 12% |
| H_MRSH | 3 | 3 | 100% | 17% | 3 | 3 | 100% | 17% |

**Table 7 (continued).** Sample accuracy assessment results for MOJA and CAMO.

| Map Code | Total | Correct | User's Accuracy | 90% Conf. Interval | Total | Correct | Producer's Accuracy | 90% Conf. Interval |
|---|---|---|---|---|---|---|---|---|
| H_SALT | 2 | 2 | 100% | 25% | 1 | 1 | 100% | 25% |
| SV_BAD | 1 | 1 | 100% | 50% | 1 | 1 | 100% | 50% |
| SV_CNDR | 2 | 2 | 100% | 25% | 2 | 2 | 100% | 25% |
| SV_DS | 13 | 12 | 92% | 17% | 15 | 12 | 80% | 23% |
| SV_DUNE | 15 | 15 | 100% | 3% | 6 | 15 | 94% | 14% |
| SV_LAVA | 7 | 4 | 57% | 53% | 4 | 4 | 100% | 13% |
| SV_LDS | 4 | 4 | 100% | 13% | 4 | 4 | 100% | 13% |
| SV_PLYA | 15 | 14 | 93% | 15% | 14 | 14 | 100% | 4% |
| SV_RCK | 17 | 13 | 76% | 23% | 13 | 13 | 100% | 4% |
| SV_SDS | 49 | 45 | 92% | 8% | 50 | 45 | 90% | 8% |
| S_ABIT | 4 | 4 | 100% | 13% | 4 | 4 | 100% | 13% |
| S_AWASH | 5 | 4 | 80% | 45% | 5 | 4 | 80% | 15% |
| S_BLK | 32 | 32 | 100% | 2% | 32 | 32 | 97% | 7% |
| S_BSG | 4 | 4 | 100% | 13% | 4 | 4 | 100% | 13% |
| S_CB | 19 | 19 | 100% | 3% | 24 | 19 | 79% | 18% |
| S_CBB | 7 | 3 | 43% | 64% | 4 | 3 | 75% | 58% |
| S_CBDN | 18 | 15 | 83% | 19% | 15 | 15 | 100% | 3% |
| S_CBWB | 90 | 86 | 96% | 4% | 92 | 86 | 93% | 5% |
| S_CHAP | 21 | 21 | 100% | 2% | 22 | 21 | 85% | 10% |
| S_DWASH | 18 | 15 | 83% | 19% | 16 | 15 | 94% | 14% |
| S_FIRE | 12 | 12 | 100% | 4% | 14 | 13 | 87% | 19% |
| S_FWASH | 1 | 1 | 100% | 50% | 1 | 1 | 100% | 50% |
| S_HWASH | 1 | 1 | 100% | 50% | 1 | 1 | 100% | 50% |
| S_IOD | 4 | 3 | 75% | 58% | 4 | 3 | 75% | 58% |
| S_LMDS | 14 | 14 | 100% | 4% | 17 | 14 | 82% | 20% |
| S_LSALT | 3 | 3 | 100% | 17% | 4 | 3 | 75% | 58% |
| S_LWASH | 6 | 6 | 100% | 8% | 6 | 6 | 100% | 8% |
| S_MDS | 32 | 27 | 84% | 13% | 28 | 27 | 96% | 8% |
| S_MSBLT | 12 | 12 | 100% | 4% | 13 | 12 | 92% | 17% |
| S_MWASH | 8 | 7 | 88% | 28% | 8 | 7 | 88% | 28% |
| S_MY | 26 | 25 | 96% | 8% | 26 | 25 | 96% | 8% |
| S_RWASH | 3 | 3 | 100% | 17% | 3 | 3 | 100% | 17% |
| S_SALT | 13 | 10 | 77% | 27% | 10 | 10 | 100% | 5% |
| S_WFAT | 1 | 1 | 100% | 50% | 1 | 1 | 100% | 50% |
| S_WING | 6 | 5 | 83% | 37% | 7 | 5 | 71% | 43% |
| W_COAK | 6 | 5 | 83% | 37% | 5 | 5 | 100% | 10% |

**Table 7 (continued).** Sample accuracy assessment results for MOJA and CAMO.

| Map Code | Total | Correct | User's Accuracy | 90% Conf. Interval | Total | Correct | Producer's Accuracy | 90% Conf. Interval |
|---|---|---|---|---|---|---|---|---|
| W_CWD | 1 | 1 | 100% | 50% | 1 | 1 | 100% | 50% |
| W_FIR | 5 | 5 | 100% | 10% | 5 | 5 | 100% | 10% |
| W_JT | 5 | 4 | 80% | 45% | 4 | 4 | 100% | 13% |
| W_JTBB | 4 | 3 | 75% | 58% | 3 | 3 | 100% | 17% |
| W_JTCB | 6 | 6 | 100% | 8% | 6 | 6 | 100% | 8% |
| W_JTDS | 10 | 8 | 80% | 30% | 9 | 8 | 89% | 25% |
| W_JTGRS | 7 | 5 | 71% | 43% | 6 | 5 | 83% | 37% |
| W_JTMS | 7 | 7 | 100% | 7% | 7 | 7 | 100% | 5% |
| W_JTMY | 4 | 4 | 100% | 13% | 5 | 4 | 80% | 45% |
| W_JTUJ | 10 | 10 | 100% | 5% | 10 | 10 | 100% | 5% |
| W_JUN | 22 | 22 | 100% | 2% | 22 | 20 | 91% | 13% |
| W_LJTDS | 2 | 1 | 50% | 100% | 1 | 1 | 100% | 50% |
| W_MEQ | 7 | 7 | 100% | 7% | 7 | 7 | 100% | 7% |
| W_PALM | 1 | 1 | 100% | 50% | 1 | 1 | 100% | 5% |
| W_PJ | 14 | 11 | 79% | 25% | 11 | 11 | 100% | 5% |
| W_PJ2 | 1 | 1 | 100% | 50% | 1 | 1 | 100% | 50% |
| W_PJBB | 13 | 13 | 100% | 22% | 17 | 13 | 76% | 23% |
| W_PJDS | 11 | 8 | 73% | 4% | 9 | 8 | 89% | 25% |
| W_PJMS | 8 | 8 | 100% | 6% | 11 | 8 | 73% | 32% |
| W_PJWASH | 3 | 2 | 67% | 80% | 2 | 2 | 100% | 25% |
| W_TAM | 3 | 3 | 100% | 17% | 3 | 3 | 100% | 17% |

**Table 8.** Overall population accuracy assessment results for MOJA and CAMO.

| Accuracy Assessment Statistic | Value |
|---|---|
| TOTAL AA SITES (SAMPLES) | 714 |
| TOTAL MATCHES | 655 |
| SAMPLE OVERALL ACCURACY | 91% |
| POPULATION OVERALL ACCURACY (Pc) | 91% |
| LOWER LIMIT, 90% CONFIDENCE INTERVAL | 89% |
| UPPER LIMIT, 90% CONFIDENCE INTERVAL | 93% |
| KAPPA (K) | 92% |
| LOWER LIMIT, 90% CONFIDENCE INTERVAL | 90% |
| UPPER LIMIT, 90% CONFIDENCE INTERVAL | 94% |

Reviewing the AA data shows that most of the map units had both high user and producer accuracy (> 80%) and had 12 map units with acceptable error rates (80–60%) as defined by the NPS VMI standard (Lea and Curtis 2010). The map units below 60% and their likely sources of error are presented in Table 9. Overall, the AA shows that some of the rare and infrequent types at MOJA/CAMO had relatively small sample sizes that fell below the NPS VMI standards. The low numbers are likely due to the difficult logistics and financial constraints limiting the number of targets that could be safely visited and the oversampling for various unknown reasons in the common map units. The AA results for these map units (1–5 samples) present either a highly inflated or a highly deflated value when compared to map units with more robust sample sizes. More sampling in the under-sampled types in the future would better reflect the true individual map class accuracy and reduce the corresponding confidence intervals.

**Table 9.** Marginal level map classes and sources of error.

| Map Code | Producers Accuracy | Users Accuracy | Results and Likely Error Explanations |
|---|---|---|---|
| W_LJTDS | 50% | 100% | Under mapped as L_MDS (both occurred on similar landforms and substrates, making it hard to determine the amount of Joshua tree vs. mixed shrub cover) |
| S_CBB | 43% | 75% | Under mapped as S_CBWB (both similar creosotebush types that are difficult to separate) |
| H_DUNE | 100% | 50% | Over mapped - need more W_DWIL (especially when desert-willow trees occur outside of washes and drainages) and S_IOD and SV_PLYA (high sand reflectance, occurred on similar landforms and substrates, hard to determine the amount of herbaceous cover vs. bare ground and other short herbaceous species) |
| SV_LAVA | 57% | 100% | Under mapped as L_MDS (both occurred on similar landforms and substrates, making it hard to determine the amount of shrub cover vs. bare lava) |

Other general sources of error can likely be explained by the difficulty in resolving the differences in scale and perspective between viewing the vegetation on the imagery and assessing it on the ground. For example, sampling could have occurred in large inclusions of shrubs or herbaceous vegetation that were actually part of a larger sparse desert scrub type. In addition, the fine delineation of closely related mapping units likely led to confusion, especially when map units shared the same dominant species. Finally, some of the more common species, especially creosotebush and Mojave yucca, occurred across multiple landforms (e.g., bajadas vs. drainages vs. hillslopes), making for difficult determinations using the field key.

# Discussion

The rugged landscape and sheer size of MOJA and CAMO made for many unique obstacles to the vegetation mapping inventory project. Challenges included many logistical considerations due to travel distances, heat exposure, abbreviated growing seasons, working on steep slopes, negotiating thorny and thick vegetation, and working on foot from limited roads, trails, and other access points. In addition to the difficulty of doing fieldwork, the natural mixing of the vegetation and the overlap of similar dominant species made for both a challenging classification process and a complex mapping effort. Through it all, the inventory and mapping project team preserved, and the following are some of the project achievements, limitations, and future considerations.

### Field Surveys

Overall, the combination of legacy, plot, observation point, rapid assessment, verification, and AA points represent a very large geo-located dataset of over 2,300 individual samples for MOJA and CAMO. This large dataset covers most of the project area. In a GIS platform, most of the data can be quickly queried by dominant species, species cover, and plant community type, and direct hyperlinks can be provided to the representative ground photos.

### Vegetation Classification

As the plot data were being collected, the vegetation classification also evolved. The preliminary plant associations were greatly refined, expanded, and modified to incorporate as much of the variation as possible. While the alliances/associations were created primarily from the plot data, the subsequent AA and other observational data were also used to augment or otherwise improve the written descriptions. Classification highlights include the documentation of a variety of rare alliances/associations and some new additions to the rUSNVC and the Manual of California Vegetation (see Evans et al. 2020). The often confusing mixed desert and mid-elevation scrub and shrublands were also greatly refined and broadened by the data collected during this project.

### Digital Imagery and Mapping

The vegetation map for MOJA/CAMO was based primarily on the 2018 NAIP imagery, and as such, the MOJA/CAMO vegetation map layer should be considered a snapshot in time. As the data were used, it should be remembered that fires, droughts, and other changes to the landscape since 2018 are not included in this product. In the future, it might be beneficial to update the map with newer imagery and use GPS receivers to collect coordinates in the field after major events (e.g., polygons for wildfire perimeters, points for insect infestations, lines for social trails, etc.).

It is also important to understand that the mapping portion of this project is primarily a remotely sensed exercise, and the fieldwork was conducted on-site; therefore, all resulting products are scale-dependent. As a rule, the mapping portions should be considered as a broad overview, and the field data should be site-specific. An analyst can enlarge the imagery beyond the 1:12,000 scale using GIS software to see more detail. However, the actual interpretation/mapping was conducted at a 1:12,000 scale, and as such, any work performed with this product at a finer scale (enlargements) could lead to some uncertainty. In contrast, the fieldwork was conducted at individual locations at one specific

time, and any extrapolation using these locations to represent outlying areas or using them to determine species presence at different times/seasons is less reliable. Database users should recognize scale limitations and balance research and modeling projects accordingly.

### Accuracy Assessment

A formal accuracy assessment is critical to determining the overall usefulness of the vegetation map and its ability to predict the size, shape, and location of individual map units on the landscape. Users should evaluate the map and understand its sources of error. Some key factors to consider include:

- Field Surveys–the thoroughness of the sampling to reach all areas of interest.
- Field Crews–level of expertise at the time to consistently identify and record species and cover values.
- Classification–ability to describe ecotones and the full variation of each association.
- Field Key–its ability to reliably and consistently identify and separate unique associations.
- Date Entry–consistent maintenance of data with minimal errors.
- Base Map Imagery–ability to provide consistent vegetation signatures.
- Vegetation Stability–little, if any, changes occurred between the timing of the imagery and when the fieldwork occurred.

Although the accuracy for the MOJA/CAMO vegetation layer is high, improvements can be made. Specific areas that could benefit from more investigation or future efforts include: 1) under-represented types, 2) difficult-to-reach areas, 3) transition zones (especially life zone interfaces like Joshua tree and blackbrush), 3) drainages/washes to better describe the patchiness of these complex networks, and 4) landform extents including accurately surveying the boundaries of playas, cinder cones, sand dunes, badland, and other important formations.

### Approaches that Worked Well

Having access to existing vegetation data at MOJA helped speed up the classification process and allowed for targeted sampling into unvisited areas. Field data collection occurred over multiple years with continued review by knowledgeable experts. This approach allowed for gaps in the data to be quickly identified and for subsequent data collections to be focused on the missing plant communities. Both early spring and late fall field efforts helped minimize the dangers of heat exposure while still allowing for accurate plant identification. Timely and high-resolution base imagery was essential to producing detailed and accurate maps, and the NAIP imagery was of sufficient quality and resolution compared to more expensive commercial options. Finally, having imagery with 4-bands and the ability to view the vegetation in color infrared format was essential to the detailed and accurate mapping of the vegetation.

### Areas for Improvement

NPS vegetation inventory projects are, by design, lengthy projects that incorporate numerous cooperators and partners. Having more than one group working on the project can lead to a loss of

intuitional knowledge and an overlap in responsibilities. Streamlining the number of people working on the project, creating clear roles for each partner, mandating project reports, standardizing interim products, and having designated project leads would help economize and make future projects more efficient.

Inherent to all vegetation mapping projects is the need to produce both a complete and up-to-date vegetation classification and an rUSNVC-relatable set of map units. In the future, it may be possible to supplement the MOJA/CAMO classification by collecting additional field data that may help remove the rUSNVC provisional status. Similarly, more fieldwork may also allow for more detailed ground-truthing and/or create new or more refined map classes. More targeted sampling in unvisited areas may help find potentially new types and/or complete the range of variation for existing types. Ultimately, new advances in aerial imagery acquisition (e.g., drones, new sensors, higher resolutions, etc.) and other remotely sensed data (e.g., LIDAR, hyperspectral, etc.) may allow for more precise mapping of the vegetation.

### Future Recommendations and Opportunities

The vegetation inventory project for MOJA and CAMO represents the best efforts put forth by many dedicated experts over a relatively short period of time. In order to create the best possible long-term product, this project should not be viewed as final but rather as the starting point for an ongoing effort. MOJA/CAMO staff and researchers should continue to explore the preserve and monument areas and document the vegetation diversity. Improvements and updates to the products presented in this report should be made as needed and on a periodic basis. Present and future researchers should be encouraged to scrutinize the vegetation communities, sample more of the rare and under-represented types, modify the classification and field key to better document the full range of variation, update and improve the GIS layers, and be ever vigilant to record any recent changes or new types that may have been overlooked.

Data could be collected on a standard field form, stored, and then used to update the GIS layer on a regular basis. Map classes with low accuracy should be examined to determine whether they could be improved with future studies using more ground-truthing or improved remote sensing approaches. Landscape modeling may help to tease out the locations of rare types based on specific habitat information such as deep soil types, unique geologic formations, and distance from water sources. For some applications, it may make sense to combine map classes into broader units, such as rUSNVC groups or biophysical types and create new products specifically designed at that scale.

**Recent Wildfires:** Of special importance to MOJA are the recent wildfires that have occurred in the preserve and throughout the Mojave Desert ecosystem. During this project, the devastating Cima Dome Fire consumed a total of 43,273 acres of important Joshua tree habitat in the north-central portion of the preserve. Although the burned area is not directly reflected in this product (due to the timing of the basemap imagery), the post-burn and disturbed map classes could be used to efficiently update the map once new imagery is available. Also, the burn perimeter could be used to clip the vegetation layer to extract the pre-fire conditions to help monitor and direct rehabilitation efforts.

**Monitoring:** Non-native species encroachment/eradication, drought die-offs, native plant restoration, water diversions, and long-term climate change are some of the potential threats to the vegetation communities at MOJA and CAMO. The data presented in this project could be used as a reference to identify critical habitat areas, transitional sites, and other areas of importance. For monitoring purposes, change over time could be addressed by conducting similar remote sensing projects and overlaying the new map layers for comparison purposes.

**Drainages/Washes:** Desert washes and drainages provide critical water resources and wildlife habitat. Mapping and classifying the vegetation in these often narrow and diverse networks can be extremely challenging due to their complexity, patchiness, and rapid changes in plant diversity. New mapping concepts, such as those being developed by the California Department of Fish and Wildlife and the California Energy Commission (Vyverberg and Brady 2013), may hopefully address this problem. Washes and drainages presented in this project could be revisited and further refined as new methods and standards are created, tested, and approved.

**Research:** On the inventory and classification side, research could include setting up photo-monitoring projects that periodically retake plot photographs. This would help to document vegetation change over time. Another option would be to data mine the PLOTS database for locations of species of concern for both rare plants and problematic invasive species. These locations could be used as the basis for more rare plant surveys, distribution mapping, and/or analyzing their habitats for vulnerabilities (flash flooding, erosion, non-native species invasion, etc.).

On the mapping side, having an accurate and current vegetation map in a geodatabase presents many new and exciting opportunities, including expanding or linking the GIS layer to derive other information such as fire models, wildlife habitat monitoring locations, habitat structural analyses, and inventorying areas that are likely invasive species vectors. The map could also be enhanced by overlaying other existing GIS layers, including hydrology, elevation, and soils. In this manner, complex interactions could be examined and yield important information about growth rates, regeneration after disturbance, biomass distribution, and stream morphology. Through innovative analyses, the vegetation layer could be used as a baseline for other ecological and climate-related studies, including examining how the vegetation is impacted by global warming events and how it interacts with soil chemistry, pollution, paleontological/archeological sites, insect infestations, and weather patterns.

Having consistent ecological and digital map data for plant associations across a large geographical span (e.g., Central Mojave Desert, DEVA, LAKE, PARA, Grand Canyon National Park, Clark County, Nevada) could create some exciting opportunities for ecoregion analysis. Plant communities could be examined to see when dominant species occur or drop out and what the driving factors behind this are. Investigations could examine the distribution, health, and vigor of common species (such as creosotebush) as it relates to drought, flooding, or human activities. For example, are desert-adapted plants spreading east and closer to the Colorado River? Are they moving upslopes, or are other species, such as salt cedar, spreading? These and other research opportunities could result from linking the regional vegetation data into one master classification and a seamless map.

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