



Vegetation Mapping Inventory Project

Death Valley National Park



Joshua Trees with mixed desert understory shrubs in the Last Chance Mountain Range at Death Valley National Park.

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Vegetation mapping inventory project: Death Valley National Park

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Abstract

This study presents a comprehensive vegetation mapping inventory project undertaken in Death Valley National Park (DEVA) within the National Park Service's Mojave Desert Network (MOJN). Spanning 3.4 million acres across California and Nevada, DEVA is the largest national park in the contiguous United States. Renowned for its harsh environment—characterized by intense heat, aridity, and low elevation—DEVA encompasses a variety of landscapes, including playas, alluvial fans, sand dunes, and mountain ranges. Despite its desolate appearance, the park harbors a diverse array of vegetation, with plant communities adapted to the park's varying elevation, moisture, salinity, and substrate conditions. The project, which began in 2011, was initiated by the National Park Service's (NPS) Vegetation Mapping Inventory (VMI), aimed to document and classify the plant communities within DEVA.

The ten-year project, divided into six phases, began with a thorough review of legacy data and a summary of plant communities. In collaboration with the California Native Plant Society (CNPS) and the University of Nevada, Las Vegas (UNLV), field data were collected across the park, including 111 classification plots and 518 observation points. This data, along with 1,242 samples from previous studies, were entered into the NPS VMI-specific PLOTS database.

The CNPS analyzed the collected data to classify 85 plant alliances according to the revised US National Vegetation Classification (rUSNVC) standard, leading to the identification of 186 plant associations within DEVA. Cogan Technology, Inc., then developed a digital vegetation map layer covering the entire park, using a combination of manual and automated mapping techniques. This map was based on imagery from the National Agriculture Imagery Program (NAIP) and field data, resulting in the delineation of 90 map units (74 vegetated and 16 land-use/land-cover units).

The map's overall thematic accuracy was assessed at 82%, with a Kappa value of 89%. The final products, including the spatial geodatabase, digital vegetation map layer, field photos, metadata, classification report, and a field key to the vegetation alliances, were delivered to the NPS VMI. These resources provide a comprehensive overview of DEVA's vegetation and support ongoing conservation and management efforts within this unique and challenging landscape.

Executive Summary

Death Valley National Park (DEVA) is an extensive, 3.4-million-acre (1.4-million-ha) unit of the National Park Service (NPS) located in California on the eastern border with Nevada. DEVA is the hottest, driest, and lowest of all the national parks in the United States and is the largest unit of the NPS in the lower 48 states. As its name implies, DEVA is a desolate and arid place. Contained within its borders are playas, broad alluvial fans, desert washes, sand dunes, volcanic formations, badlands, and mountain ranges. Although DEVA is known for its seemingly barren vistas, the vegetation at DEVA is quite diverse and widespread. Low- and mid-elevations support vast expanses of shrubs common to the Mojave Desert and Great Basin ecosystems. The vegetation at high elevations is robust and contains stands of pinyon-juniper woodlands and subalpine limber and bristlecone pine forests. Throughout the park are plant communities uniquely adapted to the various conditions that sort themselves into life forms primarily based on elevation, moisture, salinity, and substrates. To better understand and document the vegetation diversity occurring at DEVA, the National Park Service's Vegetation Mapping Inventory (VMI)¹ and Mojave Desert Network (MOJN) initiated a vegetation inventory effort in 2010.

Work began in 2011 on a ten-year, six-phase project with the creation of a work plan that included a thorough legacy data review and plant community summary. 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 111 classification plots and 518 observation points across the landscape. Field data were then entered into the VMI-specific PLOTS database along with an additional 1,242 samples from a variety of past studies. In phase three, CNPS analyzed the PLOTS data to classify 85 plant alliances using the revised US National Vegetation Classification (rUSNVC) standard. From this list, 186 plant associations were estimated to occur at DEVA. During phase four, Cogan Technology, Inc. (CTI) created the digital vegetation map layer for the project area that covered 3,430,818 acres (1,389,486 ha). In the accuracy assessment (AA) phase, contracted field crews collected data at 919 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 2020 (California) and 2019 (Nevada) 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, 90 map units (74 vegetated and 16 land-use/land-cover) were developed and used to delineate the plant communities. The interpreted vegetation polygons were then digitized into a Geographic

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.

Information System (GIS) layer that was field-tested, reviewed, and revised. The final DEVA vegetation map layer was assessed for overall thematic accuracy at 82% with a Kappa value of 89%.

Products developed for DEVA are described and presented in this report and stored in the accompanying project digital files. Project deliverables include the final report, the spatial geodatabase, digital field photos, metadata, a classification report, and a field key to the vegetation alliances. For a full list of the DEVA products available for download, please visit the NPS [Inventory & Monitoring Vegetation Mapping Inventory](#).

Acknowledgments

The vegetation inventory, classification, and mapping products presented here 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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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 for examining 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 those of other agencies and organizations. The inventory uses the revised US National Vegetation Classification (rUSNVC) standard version 2, 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; 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 United States are normally produced in the Universal Transverse Mercator (UTM) projection, the North American 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) and Environmental Research Systems Institute (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, and in 2008, the FGDC formally endorsed the revised USNVC (rUSNVC).

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 systematic inventory and classification of the nation's biological resources, assisting with efficient stewardship and prioritizing conservation efforts. The rUSNVC is being used for vegetation classification and mapping projects throughout the 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 and 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.
	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.
	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.
	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.
	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.
	L8 – Association	Diagnostic species, usually from multiple growth forms or layers, and more narrowly similar compositions 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 plants 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 (ESA; 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 ensures that map units are not based on confusing local or common plant names or site-specific habitats. Future researchers using vegetation data can reference the rUSNVC descriptions for timely and accurate information on common species and habitats. Having the ability to cross-reference the vegetation map units with the rUSNVC types also allows for efficient comparison with 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 NPS 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 Death Valley National Park (DEVA), Mojave National Preserve (MOJA), Castle Mountains National Monument (CAMO), 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 wide variety of federal and state agencies, private organizations, and universities.

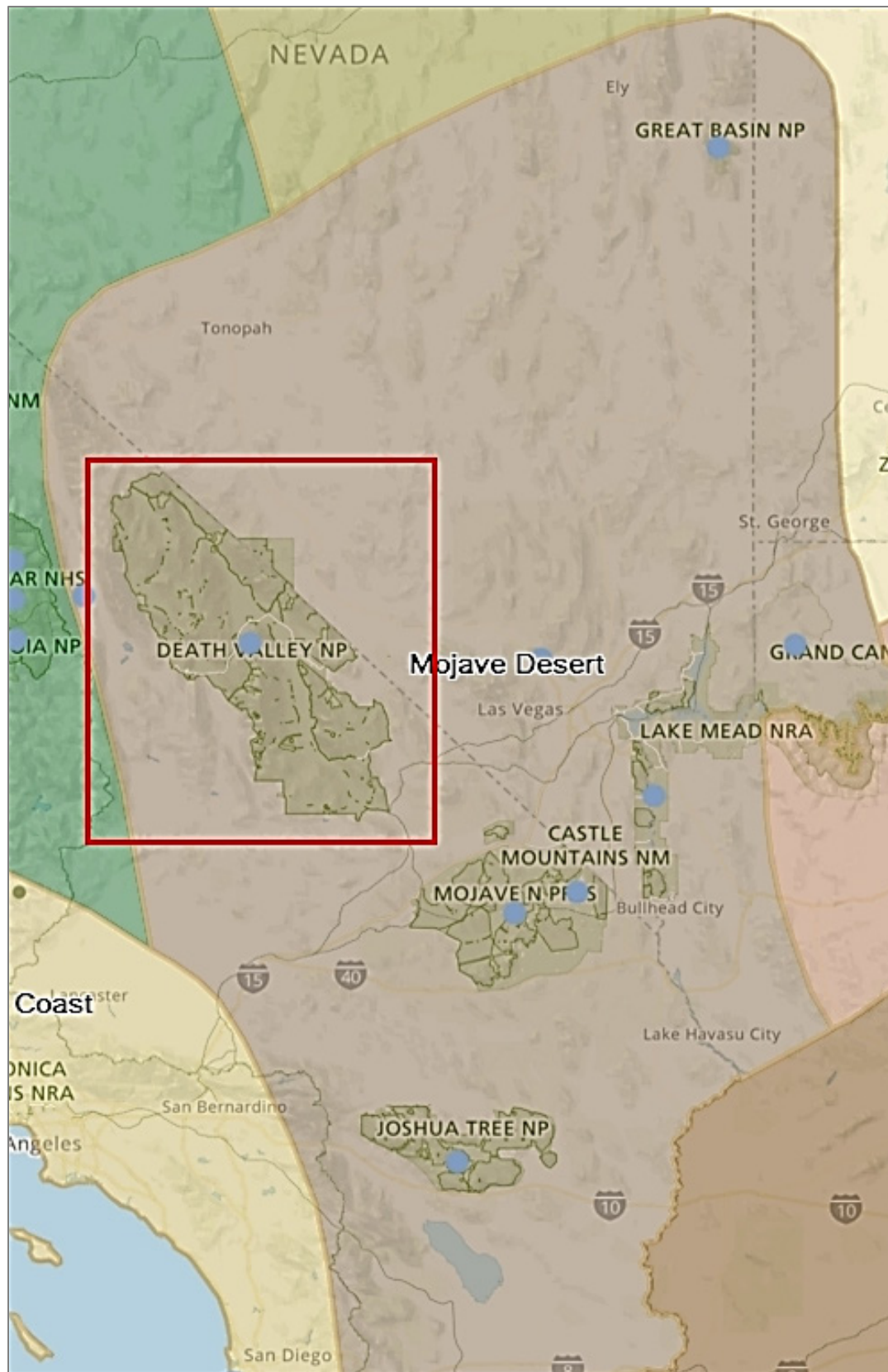
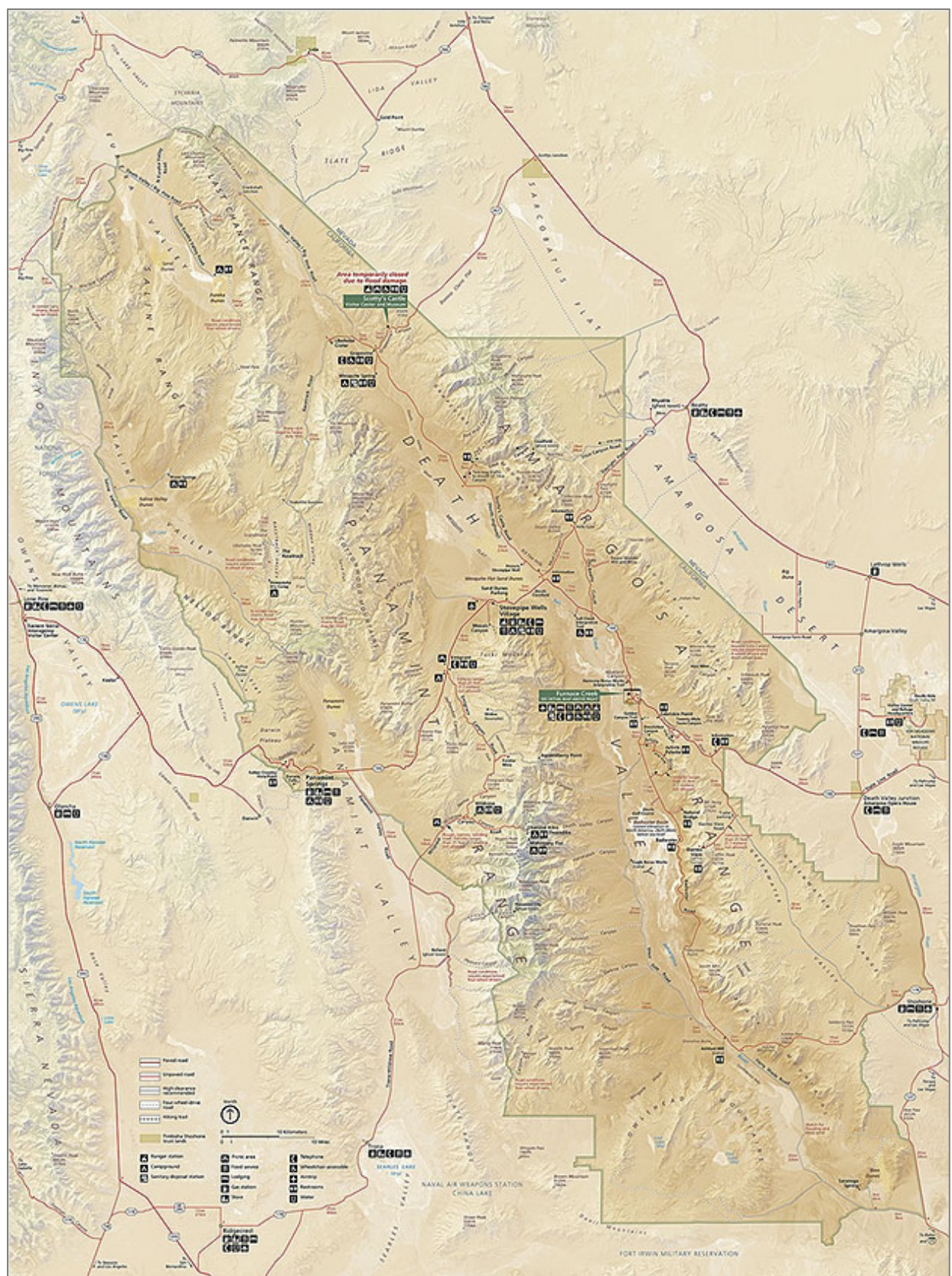


Figure 1. The Mojave Desert Inventory and Monitoring Network map. NPS / MOJN

Death Valley National Park

Death Valley National Park (DEVA) is the largest unit of the NPS in the contiguous United States and is located on the California–Nevada border to the east of the Sierra Nevada and Inyo mountains. It was established by presidential proclamation in 1993 as Death Valley National Monument. The monument was subsequently enlarged by Congress in 1994 under the California Desert Protection Act to 3.4 million acres (1.4 million ha) and changed to Death Valley National Park. Most of DEVA is in two California counties (San Bernardino and Inyo), and about 100,000 acres (40,468 ha) is in the Nevada counties of Nye and Esmeralda (Figure 2). Separate and to the east of the main park unit, the 40-acre (16-ha) Devils Hole unit in Nevada’s Ash Meadows National Wildlife Refuge was added in 1952 to protect the endangered Devils Hole pupfish (NPS 2022a).



DEVA has a wide variety of unique landforms, including many low-elevation playas (dry lake beds), desert washes, bajadas (alluvial fans), valleys, canyons, low hills, sand dunes, volcanic formations, badlands, and various mountains and mountain ranges. Natural attractions include Racetrack Playa, Badwater Basin Salt Flats, Mesquite Flat, Eureka Sand Dunes, Ubehebe Crater, Darwin Falls, and the Artist's Palette formations. The Golden, Mosaic, Titus, Natural Bridge, and Twenty Mule Team canyons are popular hiking routes, and scenic photo spots include the Zabriskie, Dante's, and Father Crowley overlooks. Notable amenities include Stovepipe Wells Village, Devil's Golf Course, Scotty's Castle Museum, Furnace Creek Visitor Center, and the Inn at Death Valley complex.

DEVA is a large park with a variety of natural environments based in part on geology, soils, hydrology, topographic location, elevation, and landform. Nearly 92% of the park is designated as wilderness areas with limited paved and improved roads (NPS 2022b). The major access road is California State Route 190, which crosses the park from east to west. Significant fires have occurred in DEVA and impacted the natural settings by removing vegetation and historic structures. Human activity has also altered the landscape due to surrounding private lands, abandoned and active mines, two-track roads/social trails, and introduced burro grazing.

Natural Setting and Vegetation

DEVA contains the lowest point in North America, and the park is also known for its dry climate, high temperatures, landscape patterns, and complex geology. The main valley, Death Valley, is the central feature that runs approximately 156 miles (250 km) northwest to southeast following the course of the dry Amargosa River. Other prominent valleys in the park include the northern section of the Panamint Valley (west), Saline Valley (northeast), Greenwater Valley (southeast), and the Eureka Valley (north). Most of the major low-elevation valleys at DEVA contain various interesting and unique landforms, including playas, salt flats, and sand dunes (NPS 2022).

On either side of the valleys are high mountain ranges, including the Panamint (west and southwest), Nelson (west), Last Chance (north), Saline (northwest), Owshead (south), Greenwater (southeast), and the Amargosa and Bullfrog Hills (east). Major formations within these ranges include the Funeral, Grapevine, Cottonwood, and Black mountains. Various montane canyons, valleys, springs, and washes are common. These include the Racetrack, Wildrose, and Hidden valleys, and the Hanging Rock, Marble, Wildrose, Jayhawker, Cottonwood, and Echo canyons. Between the mountains and valleys are broad alluvial fans (bajadas), which create a transition from the exposed rocky slopes to the flat, dry basins. The bajadas contain various networks of dry drainages and washes that dissect large areas of desert pavement and badland formations.

DEVA is known for its extreme temperatures that can range from 86°F (30°C) in July to 43°F (6°C) in December (as recorded at Furnace Creek). Temperatures in the mountains are colder and decrease by 3 to 5°F (2 to 3°C) with every thousand-foot (300 m) gain in vertical elevation (NPS 2022). Heat in the summer often exceeds 120°F (49°C), and the world record of 134°F (57°C) was recorded in 1913. Annual precipitation varies from 1.9 inches (4.8 cm) on the valley floor to over 15 inches (38 cm) in the mountains (USGS 2022). Infrequent spring rains and wet years have been known to cover the DEVA landscape with dramatic blooms of desert wildflowers (NPS 2022).

The geology at DEVA is complex and involves different types of [fault](#) activity and crustal sinking. The park is in a rift valley caused by eons of [block faulting](#). This has resulted in uplifts of various rock formations of mudstone, limestone, siltstone, shale, gneiss, granite, and other materials (Britannica 2020). Past [volcanic activity](#) has also occurred, as evidenced by the basalt outcrops, cinder fields, volcanic talus slopes, and the Ubehebe Crater, which is located at the north end of the Panamint Range. The soils at DEVA are typically derived from the erosion of these higher parent materials and consist of sand, gravel, and silt deposited in the valleys and basin floors. Higher elevations often have thinner soils, and areas with bare rock and shale are common (Sharp and Glazner 1997).

The elevational gradient for DEVA starts at Telescope Peak in the Panamint Range at 11,049 feet (3,368 m) above sea level and drops within 15 miles (24 km) to the Badwater Basin at 282 feet (86 m) below sea level. This sudden topographic relief results in a wide range of ecological niches that support a wide variety of plants and animals, including bighorn sheep, desert tortoises, and jackrabbits. Dominant plant species at DEVA include representatives from both the Great Basin and Mojave Desert ecoregions, with some higher-elevation species common to the Intermountain and Colorado Plateau ecoregions (NatureServe 2022). DEVA's vegetation has also been characterized as being from three biotic life zones, including the Lower Sonoran, the Canadian, and the arctic/alpine/boreal (Hunt and Durell 1966; Munz and Keck 1968). DEVA is often considered to be in a vegetation transition zone between the Mojave, Great Basin, and Sonoran Desert ecosystems (Parish 1930).

The unique mix of topography, elevation, climate, and geology has led to past vegetation studies at DEVA. Recent and comparable efforts include a summary report on the plant assemblages by vegetation type (Gardner 2007). This report lists seven main plant types and five subtypes for the entire Mojave Desert region. From 1997 to 1999, the Central Mojave Desert Vegetation Mapping Project (Thomas et al. 2004) mapped parts of DEVA using 30 dominant plant types within 13 vegetation systems. Other vegetation classifications for DEVA usually describe 7 to 12 major plant communities. These consist of alkali sink, saltbush scrub, creosotebush scrub, desert dune, Joshua tree woodland, blackbrush scrub, shadscale scrub, sagebrush scrub, desert riparian, desert dry wash, pinyon-juniper woodland, and subalpine forest with some variations based on microhabitats and naming conventions (Munz and Keck 1968).

Historic plant studies at DEVA have also concentrated on low-elevation plant communities in relation to growth and germination (Went and Westergaard 1949), environmental gradients such as salt concentration and water availability (Bradley 1979), and locations like salt pans, sand belts, and gravel fans (Hunt 1966). These studies identified creosotebush and desert holly as widespread plant communities. Less common types included Perry's saltbush, fourwing saltbush, salt cedar, iodine bush, inland saltgrass, alkali sacaton grass, honey mesquite, reed grass, and bulrush/rush types.

Other inventories have been conducted on individual sites and within specific life zones. These include a floral inventory of the Funeral Mountains (Annable 1985) that classified the vegetation using seven plant associations across two life zones. Associations included the creosote zone (desert

holly, creosotebush, creosotebush - white bursage, creosotebush - desert holly, and creosotebush - white bursage - shadscale plant associations) and the mixed shrub zone (shadscale and blackbrush associations). Cross-zone or azonal types from this study included both a rock outcrop and a desert wash community type. A similar study in the Cottonwood Mountains looked at soil analysis to predict the occurrence of plant communities (Leary and Peterson 1984). This study listed nine unique plant communities: rock outcrop, creosotebush - white bursage, creosotebush - desert holly, blackbrush - joint-fir, shadscale, black sagebrush, big sagebrush, singleleaf pinyon pine, and buckwheat - desert bitterbrush for this portion of DEVA.

The Pinyon-Juniper Life Zone has also been classified across California into four broad categories (Bolsinger 1989). These include the Juniper and Pinyon Savanna, Juniper and Pinyon Trees in Chaparral, Juniper and Pinyon Trees in Conifer Timber Stands, and Juniper Trees in Oak Woodlands. This study estimated that pinyon-juniper woodlands cover about 29,000 acres (11,735 ha) of land in DEVA. Another study described the pinyon-juniper types as having a dominant shrub layer of big sagebrush, antelope bitterbrush, and Gambel oak in the Intermountain areas of California, compared to a more xeric mix of understory species (manzanita, scrub live oak, and yucca) in southwestern California (Evans 1988).

Using the previous studies as a guide, a predictive vegetative pattern can be created for DEVA based in part on moisture levels, salt/alkaline concentrations, elevation, and landform. In general, undisturbed plants with unique adaptations and requirements tend to sort themselves into natural plant communities by life zone. These life zones are mostly driven by elevation but can differ based on localized conditions. Chief among these conditions are water availability and salt concentrations. Representative examples of these variations include: 1) plant species on alkaline soils versus non-saline sites, 2) denser growth on protected slopes versus sparse vegetation on exposed slopes and ridges, and 3) unique wetland and riparian types in and around washes, seeps, and springs.

A summary of the general life zones at DEVA starts at the lowest elevation with barren salt pans and playas. These are often ringed by bands of salt-tolerant short trees, shrubs, and grasses, including Mojave seablite, cattle saltbush, iodine bush, arrow-weed, salt cedar, and mesquite. Within these areas are unique sand dunes and sand sheet formations with sparse grasses and dwarf shrubs, including creosotebush, desert twinbugs, Thurber's sandpaper plant, and Indian ricegrass. Next are desert pavement and dissected rocky plains with sparse desert holly, burrobrush (white bursage), and creosotebush. The low-elevation desert plains/floors, valleys, bajadas, and low slopes are dominated by creosotebush and burrobrush. Dry drainages and washes at low to mid-elevation support a mix of Mexican bladdersage, burrobrush, Mojave rabbitbrush, creosotebush, desert almond, and other shrubs. More mesic washes and springs contain patches of willow, wild grape, and desert baccharis, and some rare sites have hanging garden vegetation or cottonwood, willow, and/or palm trees.

Mid-elevations at DEVA support a wide variety of shrubs, including sparse shadscale on shale and alkaline formations and a mix of semi-desert shrubs, including brittlebush, yellow rabbitbrush, buckwheat, devil's spineflower, and mortonia on dry slopes. Mid-elevation areas with developed soils often contain a mixture of spiny menodora, joint-firs, water jacket, and spiny hopsage shrubs.

Protected slopes on older rock formations can have extensive blackbrush stands. Joshua tree wooded shrublands occur along a high-elevation transition throughout DEVA and contain various understory shrubs and grasses. Sparse juniper trees can also be found on rocky slopes as elevation increases.

Blackbrush, big sagebrush, and desert bitterbrush continue from the mid-elevations up into the mountains as both shrublands and understory elements. Higher up, chaparral shrubs consisting of desert whitethorn and littleleaf mountain-mahogany are present on dry mountain slopes and in post-fire locations. High-elevation mesic areas and drainages support thick stands of Apache plume, Woods' rose, and Rocky Mountain maple shrubs. Pinyon pine and juniper trees cover large areas of the high mountains. At the highest elevations, rare limber and bristlecone pine trees can be found in the Panamint Mountain Range. Other unique vegetation types can be found at almost all elevations and include pockets of marsh-like wetlands around seeps, springs, ponds, and disturbed areas with non-native grasses, weedy shrubs, salt cedar, and palm trees.

This outline, although not definitive, provides a general framework for sorting the vegetation into convenient categories. The following list describes the 16 unique life zones.

General DEVA Vegetated Life Zones (from high to low elevation)

For each life zone (*with corresponding landforms 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) High-Elevation Woodlands and Forests (highest-elevation mountains)

Elevation Range: > 7,000 feet (> 2,100 m)

Past Project Equivalents: Subalpine Forest (Munz & Keck 1968); Pinyon-Juniper Woodland (Gardner 2007); Limber Pine/Bristlecone Pine Woodland, Sparsely Vegetated, and High Elevation Wash System (Thomas et al. 2004)

Dominant Vegetation by Topographic Position:

- Protected slopes: Mesic woodlands = bristlecone and limber pine trees, Whitethorn chaparral shrubs (post-fire). Understory = desert bitterbrush, big sagebrush, and black sagebrush shrubs.
- Exposed slopes: Dry woodlands = pinyon pine and juniper trees. Understory = sparse, blackbrush, big sagebrush, and mixed grasses. Shrublands = big sagebrush, black sagebrush, and littleleaf mountain-mahogany.
- Canyons and high washes: Trees and tall shrubs = rocky mountain maple, pinyon pine, and juniper trees. Understory = Apache plume, woods rose, stretchberry, and mixed deciduous shrubs. Herbaceous vegetation = Douglas' sedge and Baltic rush.
- Ridges, rock outcrops, and talus: Mixed high-elevation shrubs = outside ring and crevices. Sparse vegetation = interior and on bare rock.

2) Pinyon-Juniper Woodlands (upper mountains)

Elevation Range: 5,000–9,000 feet (1,525–2,740 m)

Past Project Equivalents: Pinyon-Juniper Woodland (Munz & Keck 1968 and Gardner 2007); Juniper Wooded Shrubland, Pinyon-Juniper Woodland, Sparsely Vegetated, and High Elevation Wash System (Thomas et al. 2004)

Dominant Vegetation by Topographic Position:

- Protected slopes: open woodlands = pinyon pine, Utah juniper trees, and desert bitterbrush (post-fire). Understory = blackbrush, big sagebrush, desert bitterbrush shrubs, and mixed grasses.
- Exposed slopes: sparse woodlands and dense upland shrubs = short pinyon pine and Utah juniper trees, tall Joshua trees, dense blackbrush, and big sagebrush shrubs. Understory = mixed semi-desert shrubs (woodlands), dwarf shrubs and grasses (shrublands).
- Canyons and washes: Sparse trees and medium-sized shrubs = short Utah juniper and pinyon pine trees, desert Baccharis, and narrowleaf willow shrubs.
- Rock outcrops and talus: Mixed mid-elevation shrubs = outside ring and crevices. Sparse vegetation = interior rocks.

3) Sagebrush Shrublands (mid-elevation) (high mountain slopes, hills, valleys, and alluvial fans)

Elevation Range: 4,000–9,000 feet (1,220–2,750 m)

Past Project Equivalents: Sagebrush Scrub (Munz & Keck 1968); Big Sagebrush Shrubland, and Mid-Elevation Wash System (Thomas et al. 2004)

Dominant Vegetation by Topographic Position:

- High valleys and low protected slopes: Dense shrublands = mountain big sagebrush, desert bitterbrush, short Joshua trees, and occasional pinyon pine and Utah juniper trees. Understory = mixed grasses and other mid-elevation shrubs.
- Dry, exposed slopes: Sparse and open shrublands = sparse mountain big sagebrush, black sagebrush, and little sagebrush. Understory = high bare rock cover, mixed grasses, and dwarf 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 and grasses.

4) Blackbrush Shrublands (mid-elevation) (mid-mountain slopes, hills, valleys, and alluvial fans)

Elevation Range: 3,000–8,000 feet (915–2,440 m)

Past Project Equivalents: Blackbrush Scrub (Gardner 2007); Blackbrush Shrubland, and Mid-Elevation Wash System (Thomas et al. 2004)

Dominant Vegetation by Topographic Position:

- High valleys and low protected slopes: Dense shrublands = blackbrush, short Joshua trees, desert bitterbrush, and occasional pinyon pine and Utah juniper trees. Understory = mixed grasses and other mid-elevation shrubs.
- Dry, exposed slopes: Sparse and open shrublands = sparse blackbrush, spiny hopsage, menodora, and joint-firs. Understory = high bare rock cover, mixed grasses, and dwarf shrubs.
- Washes and drainages: Dense, short- to medium-sized shrubs = rabbitbrush, mortonia, cliff rose, Mexican bladdersage, and other mid-elevation shrubs.
- Rock outcrops and talus: Sparse vegetation = mixed sparse dwarf desert shrubs and grasses.

5) Joshua Tree Wooded Shrublands (mid-elevation) (mid to low mountains, hills, valleys, alluvial fans)

Elevation Range: 2,500–6,000 feet (760–1,830 m)

Past Project Equivalents: Joshua Tree Woodland (Munz & Keck 1968; 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, pinyon pine, and Utah juniper trees. Understory = blackbrush and big sagebrush shrubs.
- Dry, exposed slopes: Sparse and tall shrublands = sparse Joshua trees, mixed mid-elevation shrubs, and creosotebush (low elevations). Understory = sparse blackbrush, joint-firs, and desert shrubs.
- Washes and drainages: Dense, short- to medium-sized shrubs = desert almond, Mexican bladdersage, burrobrush, and other tall mid-elevation shrubs.
- Rock outcrops and talus: Sparse vegetation = mixed sparse dwarf desert shrubs, buckwheat, yellow rabbitbrush, and succulents.

6) Lava Beds and Basalt (various volcanic formations)

Elevation Range: 1,000–9,000 feet (305–2,750 m)

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

Dominant Vegetation by Topographic Position:

- High elevation: Sparse woodlands and shrublands = pinyon and juniper trees. Understory = high bare rock cover.
- Mid-elevation slopes: Sparse mixed mid-elevation desert scrub = Nevada joint-fir, spiny hopsage, Utah buckhorn cholla, and other shrubs. Understory = dwarf shrubs and high bare rock cover.

- Low-elevation slopes: Low-elevation desert scrub = saltbush, white burrobush, and creosotebush. Understory = sparse grasses and high bare rock cover.
- Bare basalt and cinders: Sparse vegetation = little (if any) vegetation.

7) Mid-Elevation Semi-Desert Shrublands (mid to low mountains, hills, valleys, alluvial fans)

Elevation Range: 2,000–4,000 feet (610–1,220 m)

Past Project Equivalents: Galleta Grassland, Hopsage Shrubland, Menodora Shrubland, Mojave Yucca Shrubland, and Nevada Joint-fir Shrubland (Thomas et al. 2004)

Dominant Vegetation by Topographic Position:

- Mesic alluvial slopes, fans, and valleys: Dense mid-elevation shrublands = occasional Joshua trees, dense Mormon-tea, water jacket, spiny hopsage, spiny menodora, Utah mortonia, and joint-firs. Understory = mixed mid-elevation desert shrubs, galleta, and other grasses.
- Dry alluvial plains: Open and sparse mid-elevation shrublands = Mormon-tea, water jacket, spiny hopsage, spiny menodora, Utah mortonia, and joint-firs. Understory = mixed mid-elevation desert shrubs, galleta, and other grasses.
- Grasslands: Desert needlegrass, burrograss, James' galleta, and black grama grasses.
- Washes and drainages: Medium-sized shrubs = desert almond, Mexican bladdersage, burrobush, and purple sage. Understory = galleta and other grasses.
- Rock outcrop and rocky slopes: Sparse vegetation = brittlebush, white burrobush, rabbitbrush, creosotebush, and grasses.

8) Low and Mid-Elevation Desert Washes (washes, valley bottoms, creek beds, and old river channels)

Elevation Range: –280–3,500 feet (–85–1,070 m)

Past Project Equivalents: Desert Wash Woodland and Microphyll Woodland (Gardner 2007); Mid-Elevation Wash System, Low-Elevation Wash System, And Mesquite Bosque (Thomas et al. 2004)

Dominant Vegetation by Topographic Position:

- Mid-elevation mesic wash: Dense shrubs and herbaceous vegetation = narrowleaf willow, desert baccharis, and wild grape shrubland. Understory = rushes and marsh vegetation.
- Mid-elevation dry wash: Short shrubs and sparse vegetation = desert almond, Mexican bladdersage, burrobrush, desert senna, and sweetbush.
- Low-elevation mesic wash: Open tall and short shrubs = mesquite, smoketrees, and arroyo willow (tall shrubs), creosotebush, rabbitbrush, desert almond, white burrobush short shrubs. Understory = creosotebush and white burrobush (tall shrubs), dwarf shrubs, and sparse grasses (short shrubs).

- Low-elevation dry wash: Sparse and open vegetation = creosotebush, brittlebush, burrobrush, rabbitbrush, and Mojave buckwheat.
- Sparse drainages: Sparse vegetation.

9) Shadscale Scrub (shale, saline, and alkaline mountain slopes, hills, valleys, alluvial fans)

Elevation Range: 2,500–6,000 feet (760–1,830 m)

Past Project Equivalents: Shadscale Scrub (Munz & Keck 1968; Gardner 2007); Shadscale Shrubland (Thomas et al. 2004)

Dominant Vegetation by Topographic Position:

- Dry, exposed slopes: Sparse dwarf shrublands = shadscale.
- Alluvial fans: Mix of short and dwarf-shrubland = open shadscale, winterfat, spiny hopsage, burrobrush, and Mormon-tea.
- Rock outcrops and badlands: Sparse (if any) vegetation.

10) Creosotebush Shrublands (low valleys, floors, alluvial fans and plains)

Elevation Range: –280–3,500 feet (–85–1,070 m)

Past Project Equivalents: Creosote Bush Scrub (Munz & Keck 1968; Gardner 2007), Creosote Shrubland, White Burrobrush Shrubland, Creosote-Brittlebush Shrubland (Thomas et al. 2004)

Dominant Vegetation by Topographic Position:

- Low valleys and alluvial fans: Open to dense desert shrublands and scrub = creosotebush and cattle saltbush. Understory = white burrobrush, cholla, desert mallow, snakeweed, brome grasses, and Mojave buckwheat.
- Low rocky slopes: Sparse desert shrublands and scrub = creosotebush. Understory = brittlebush, cholla, rabbitbrush, snakeweed, brome grasses, and Mojave buckwheat.

11) Low-Elevation Desert Scrub and Pavement (low basins, badlands, alluvial fans and plains)

Elevation Range: –280–3,500 feet (–85–1,070 m)

Past Project Equivalents: Sparsely Vegetated and Desert Holly Shrubland (Thomas et al. 2004)

Dominant Vegetation by Topographic Position:

- Alluvial fans: Sparse desert vegetation = desert holly, devil's spineflower, creosotebush, broom snakeweed, and eastern Mojave buckwheat.
- Desert pavement: Very sparse vegetation = desert holly, devil's spineflower, brittlebush, and white burrobrush.

12) Sand Dunes (active and stabilized sand dunes, sand sheets, and sand ramps)

Elevation Range: –280–3,500 feet (–85–1,070 m)

Past Project Equivalents: Desert Dune (Munz & Keck 1968; Gardner 2007), Dunes and Interior Dunes (Thomas et al. 2004)

Dominant Vegetation by Topographic Position:

- Stable dunes: Herbaceous vegetation = creosotebush, saltbushes, Indian ricegrass, 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: Sparse desert scrub = creosotebush and saltbushes.

13) Saltbush Scrub (borders of dry lake beds and flats)

Elevation Range: –280–3,000 feet (–85–915 m)

Past Project Equivalents: Saltbush Scrub (Gardner 2007); Saltbush Scrub, Alkali Meadow/Sink, Iodine Bush-Bush Seepweed (Thomas et al. 2004)

Dominant Vegetation by Topographic Position:

- Moderately alkaline flats: Low desert scrub = arrow-weed, parry's saltbush, 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.

14) Alkali Sinks and Playas (dry lake beds and flats)

Elevation Range: –280–2,000 feet (–85–610 m)

Past Project Equivalents: Alkali Sink (Munz & Keck 1968; Gardner 2007); Playa and Desert Sink (Thomas et al. 2004)

Dominant Vegetation by Topographic Position:

- Playas, Salt Crusts, and Alkali Sinks. Sparse Vegetation = Little (if any) Vegetation.

15) Desert Riparian and Marsh Areas (Seeps, Springs, and Ponds)

Elevation Range: Cross-zone (upper mid to low elevations)

Past Project Equivalents: Palm Oasis and Desert Riparian (Gardner 2007); Mesquite Bosque (Thomas et al. 2004)

Dominant Vegetation by Topographic Position:

- Seeps, springs, and wet drainages: 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.

16) Post-Fire and Disturbed Areas (all landforms)

Elevation Range: Cross-zone (upper to low elevations)

Past Project Equivalents: Invasive Species (Gardner 2007); Mining, Rural Development, Urban, and Land Use (Thomas et al. 2004)

Dominant Vegetation by Topographic Position:

- High-elevation burns: Chaparral shrublands = whitethorn and littleleaf mountain-mahogany shrublands.
- Older mid-elevation burns: Recovering mid-elevation shrublands = desert bitterbrush, Nevada broomsage, and rabbitbrush. Understory = broom snakeweed, brome grasses, and seedling shrubs and trees.
- Recent and severely burned areas: Dwarf shrubs and grasses = broom snakeweed, globemallows, and eastern Mojave buckwheat. Understory = brome and other grasses.
- Other disturbed areas: Shrubs and grasses = broom snakeweed, rubber rabbitbrush, salt cedar, Athel's tamarisk. Understory = brome grasses, schismus grass, and various weedy plants.

Figure 3 gives a broad aerial overview of the general life zone locations on the ground. Figures 4–7 show generalized landform profiles, while Figures 8 and 9 present representative ground photographs for each of the common types.

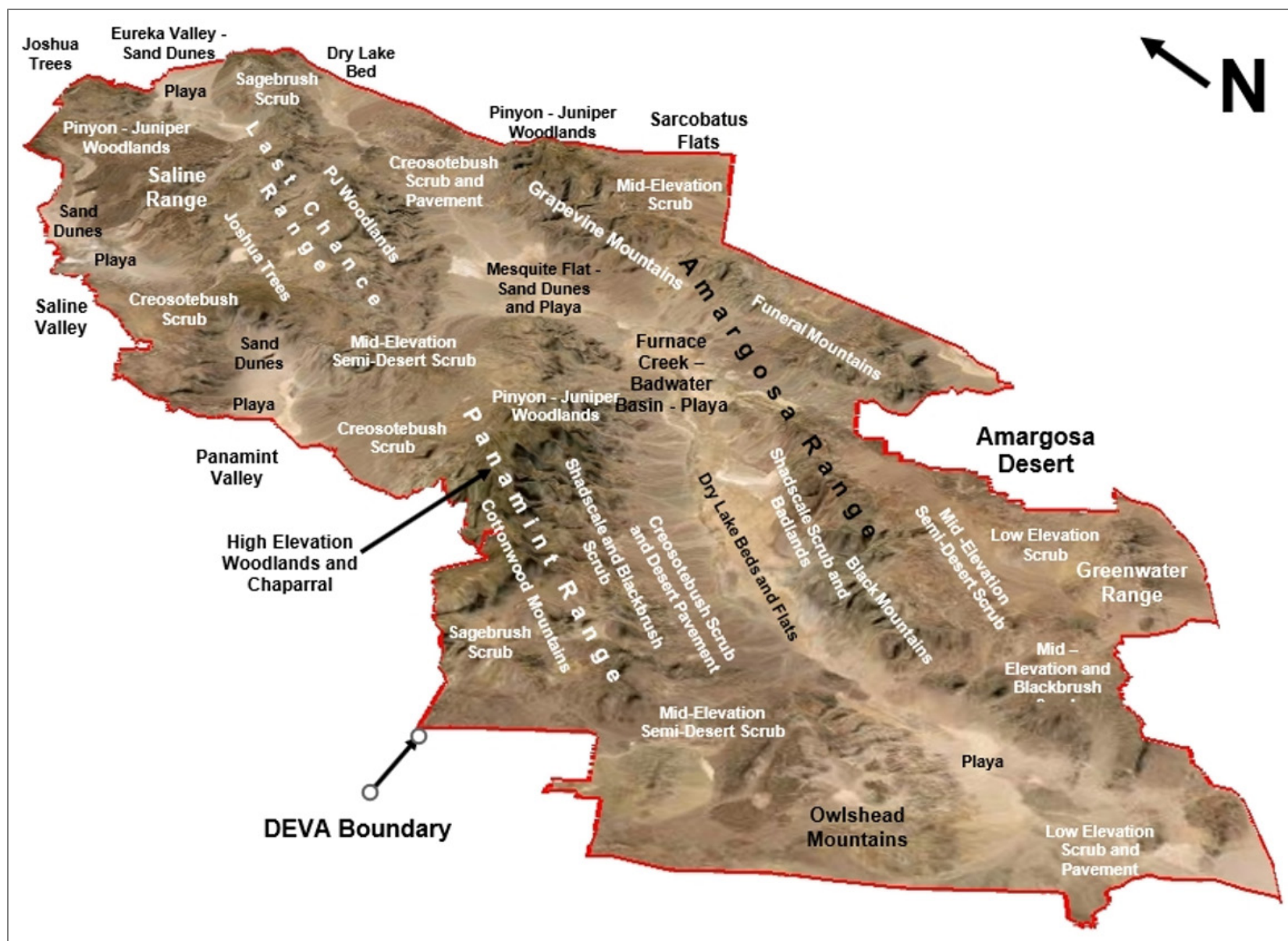


Figure 3. Overview of the vegetation patterns at DEVA. NPS / CTI

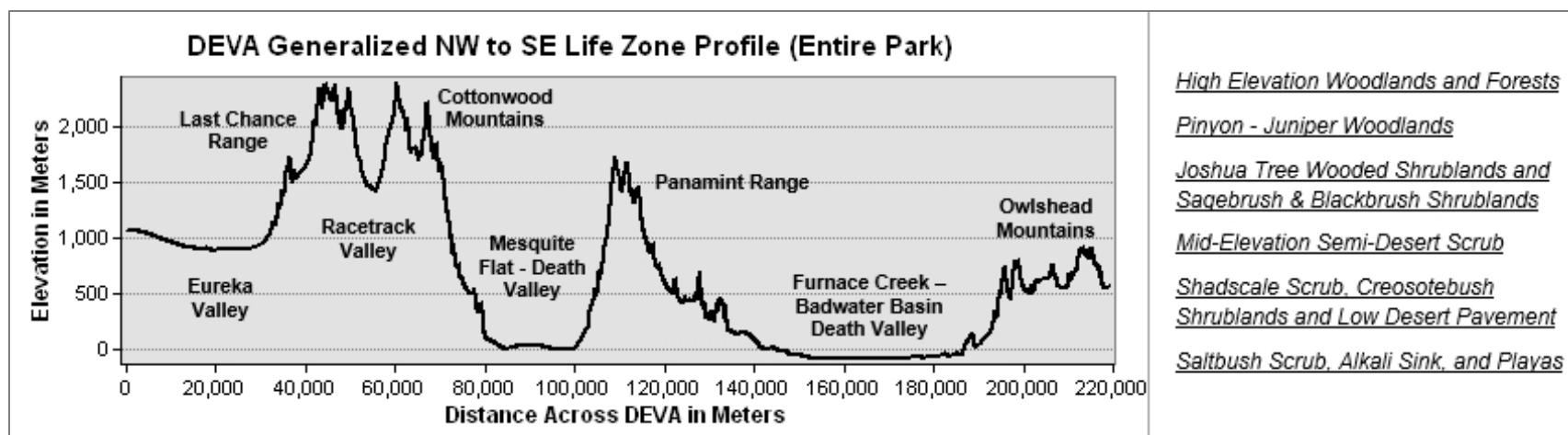


Figure 4. DEVA generalized representative northwest-to-southeast life zone cross-section profile. NPS / CTI

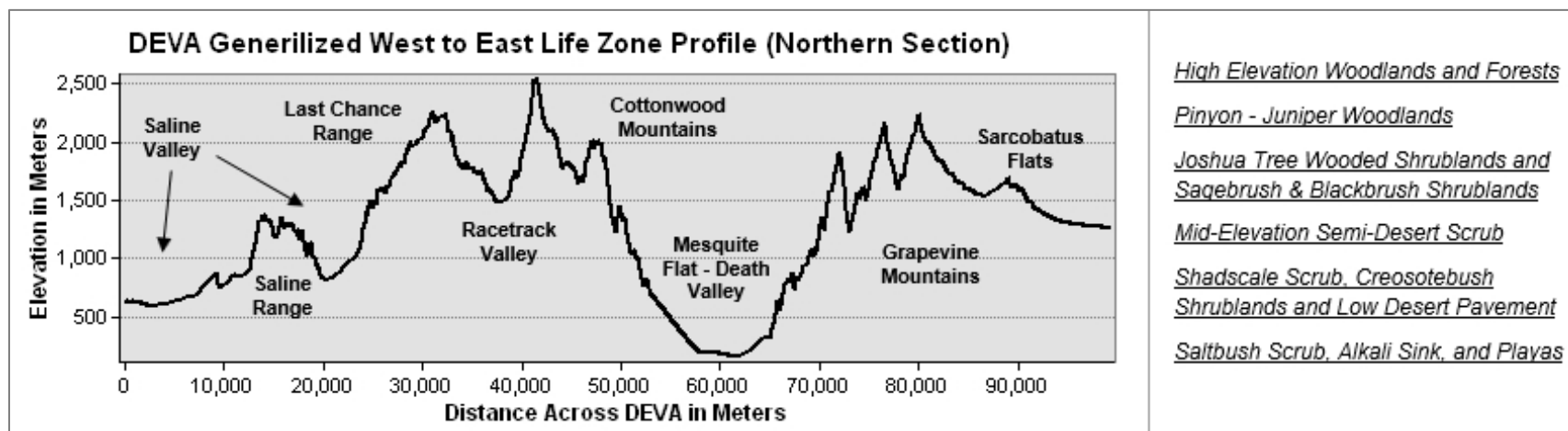


Figure 5. DEVA generalized representative (northern) west-to-east life zone cross-section profile. NPS / CTI

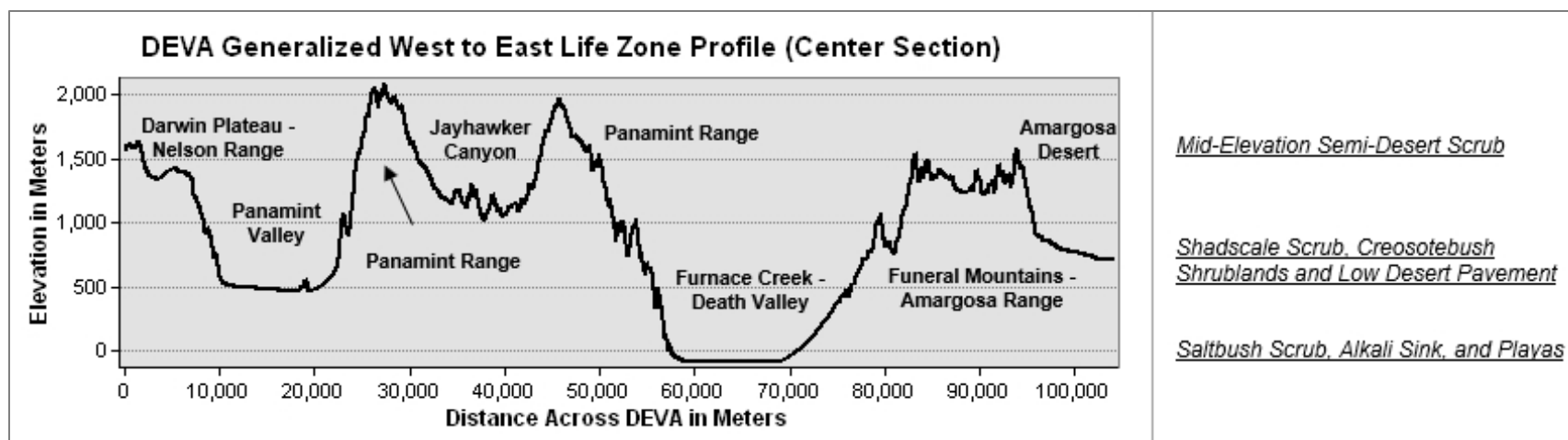


Figure 6. DEVA generalized representative (center) west-to-east life zone profile cross-section. NPS / CTI

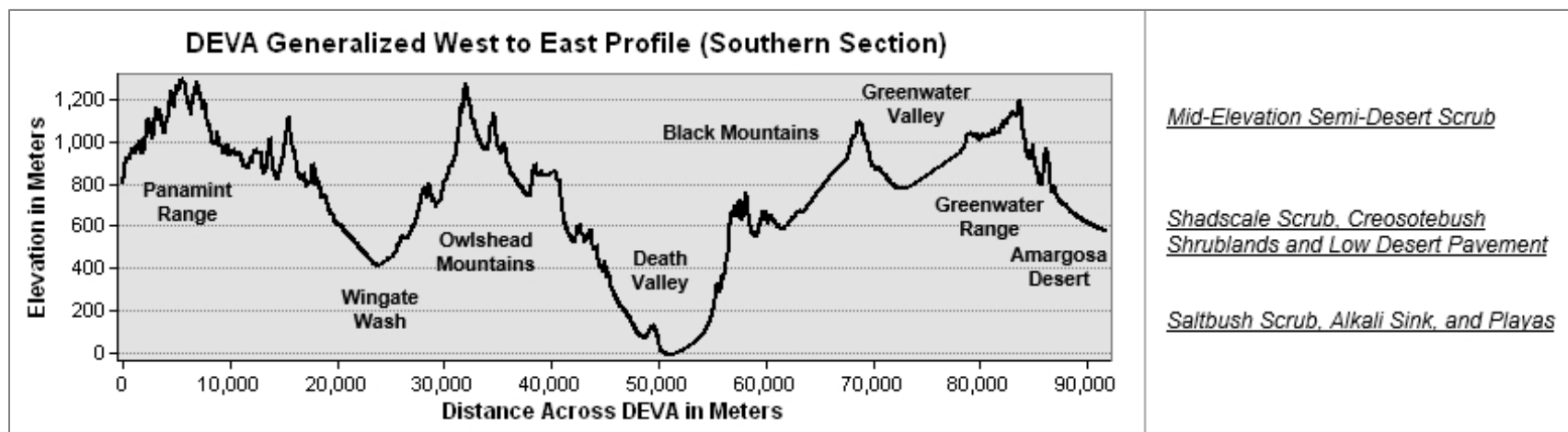


Figure 7. DEVA generalized representative (southern) west-to-east life cycle cross-section profile. NPS / CTI

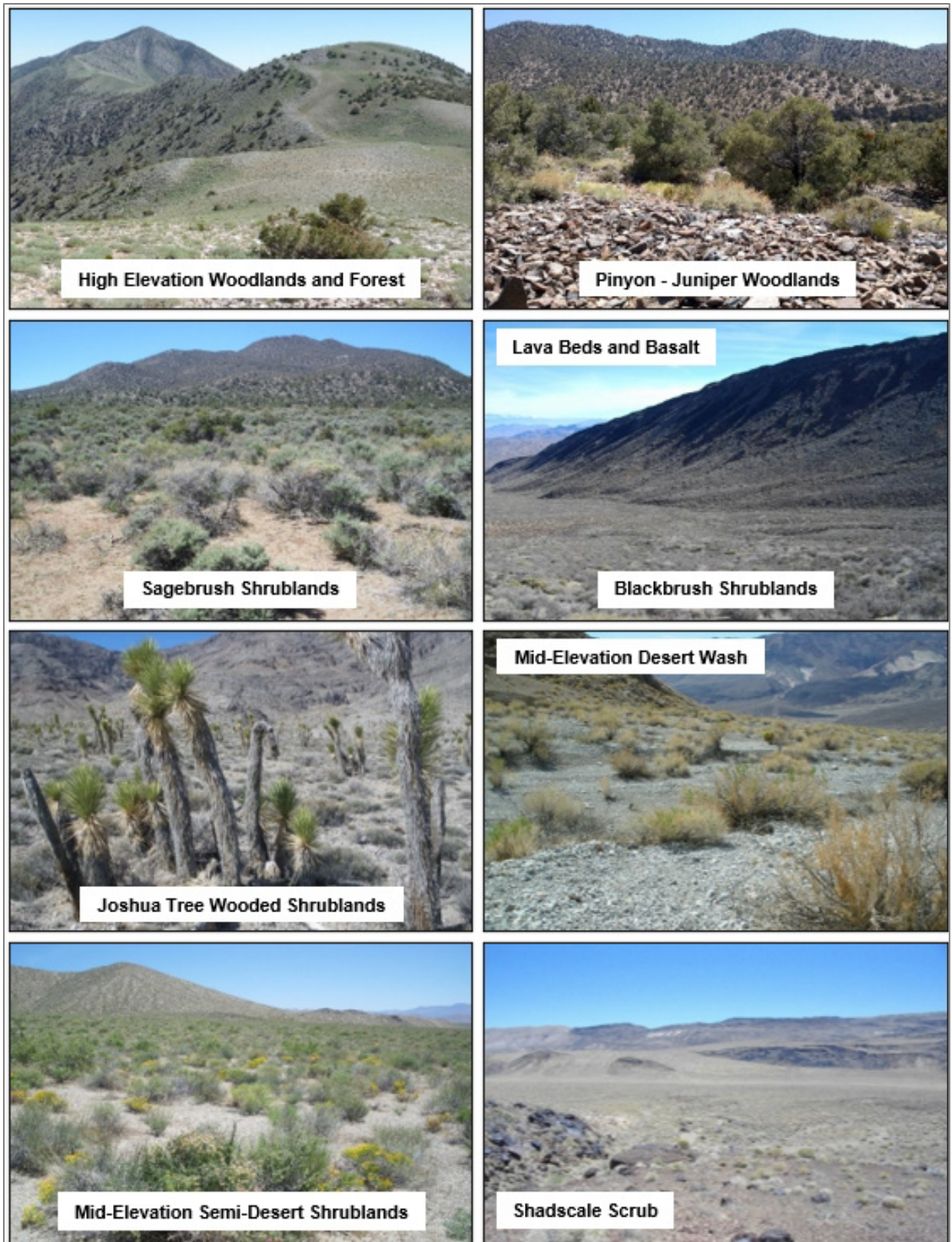


Figure 8. DEVA high and mid-elevation life zones. NPS / CTI / CNPS



Figure 9. DEVA low-elevation life zones. NPS / CTI / CNPS

Eight separate photos appear, two across and four down. The upper left photo is of a creosotebush shrublands. The upper right photo is of a low-elevation desert wash. The next two photos are of sand dunes with a rock outcrop and sparse vegetation, and sand dunes with saltbush scrub. The next two photos are of low-elevation desert scrub (Badlands) and low-elevation desert scrub (pavement). The lower left photo is alkali sink playa(saltpan). The lower right photo is of desert riparian and marsh.

Vegetation Inventory Project

The decision to inventory, classify, and map the vegetation at DEVA was initially made in response to guidelines set forth by the NPS VMI (NPS 2009) and was made in cooperation with MOJN and the local NPS staff. Work started at DEVA in 2011, when CTI was contracted to develop a work plan for vegetation inventories in all the MOJN park units. Using the guidance set forth in the work plan, the NPS VMI 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 DEVA 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 2016. In 2017, DEVA staff requested additional lands be added to the project area (mainly in the southern and northern parts) to better reflect the current park boundary. Once completed, the expanded DEVA vegetation map was evaluated for thematic accuracy by CTI subcontracted ecologists in 2020. Data from the accuracy assessment (AA) effort was then used to evaluate the draft products, and the results were sent to the NPS VMI for review and approval from 2020 to 2022.

Project Scope

All vegetation inventory work for DEVA occurred within the administrative boundary as provided in a digital GIS layer by the NPS VMI and Land Resource Division. The DEVA boundary layer was later updated and enlarged by DEVA staff. The original project size for DEVA was 3,396,892 acres (1,374,673 ha), and the final boundary for the mapping project was expanded by about 35,000 acres (14,000 ha) to 3,432,213 acres (1,389,016 ha). All mapping and fieldwork were done on NPS-managed lands within the final DEVA project boundary, including the detached 40-acre (16 ha) Devils Hole unit (Figure 10). As a team, the DEVA, NPS VMI, MOJN, CTI, CNPS, and various other subcontractors worked together to meet all the project objectives. The results presented in this report and accompanying digital files represent all the final products as outlined in the NPS VMI guidance documents (NPS 2009) and NPS VMI final product guidelines (Cook 2016). No future efforts related to this project are planned at the time of this report.



Project Boundary

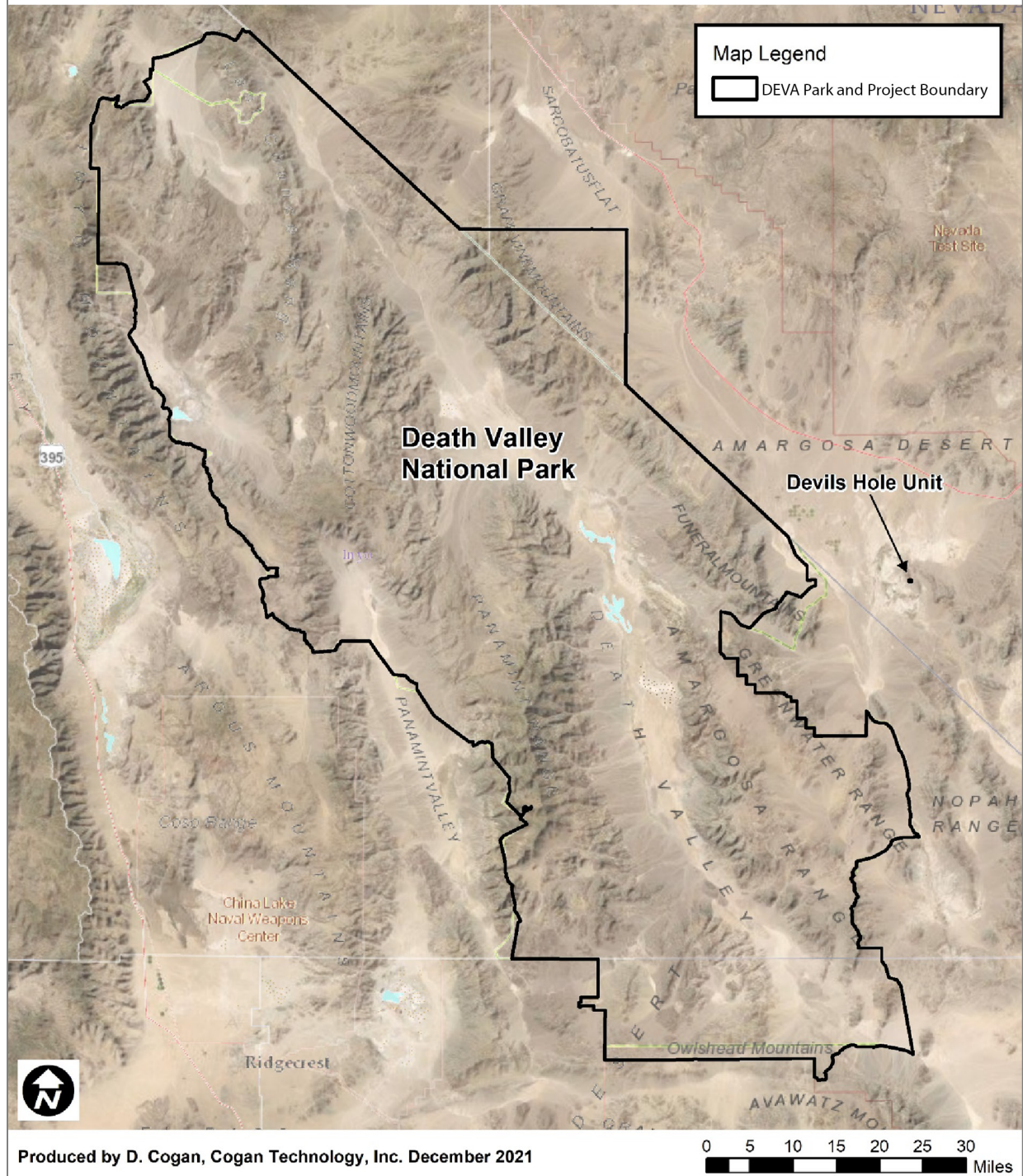


Figure 10. Map of the DEVA Park and Vegetation Inventory Project boundary. NPS / CTI

Methods

All protocols and methods for this project, as outlined in the following sections of this report, can be found in the original program documents produced by the Nature Conservancy 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 DEVA 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 DEVA 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 based on the rUSNVC 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 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 began in 2009, and numerous on-site meetings and conference calls were attended by representatives from CTI, NPS VMI, DEVA, 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, tasks were delegated, or contracts were established with various entities, including CNPS for the vegetation fieldwork and CTI for the mapping and AA portions.



Plot data collection by CNPS ecologists and staff and students from UNLV at DEVA. NPS / CNPS / UNLV

Field Surveys

In 2009, CNPS started the field work at DEVA by obtaining, reviewing, and compiling all legacy datasets. CNPS reviewed 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 at DEVA. 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.

The legacy surveys for DEVA included a total of 1,242 samples from a variety of past studies at DEVA (Thomas et al. 2004; Figure 11). New comprehensive vegetation plot data were acquired at 111 sites (Figure 12). Less detailed vegetation data were also obtained using observation and rapid assessment forms at 518 sites by CNPS/UNLV in 2011, with another three observations added by CTI in 2020 during the AA data collection stage (Figure 13). Combined, the DEVA field data covers much of the site and represents a detailed accounting of the vegetation plant communities at 1,874 sites. A detailed accounting of all the field survey methods can be found in the companion Vegetation Classification Report (Evans et al. 2020).



Legacy Data

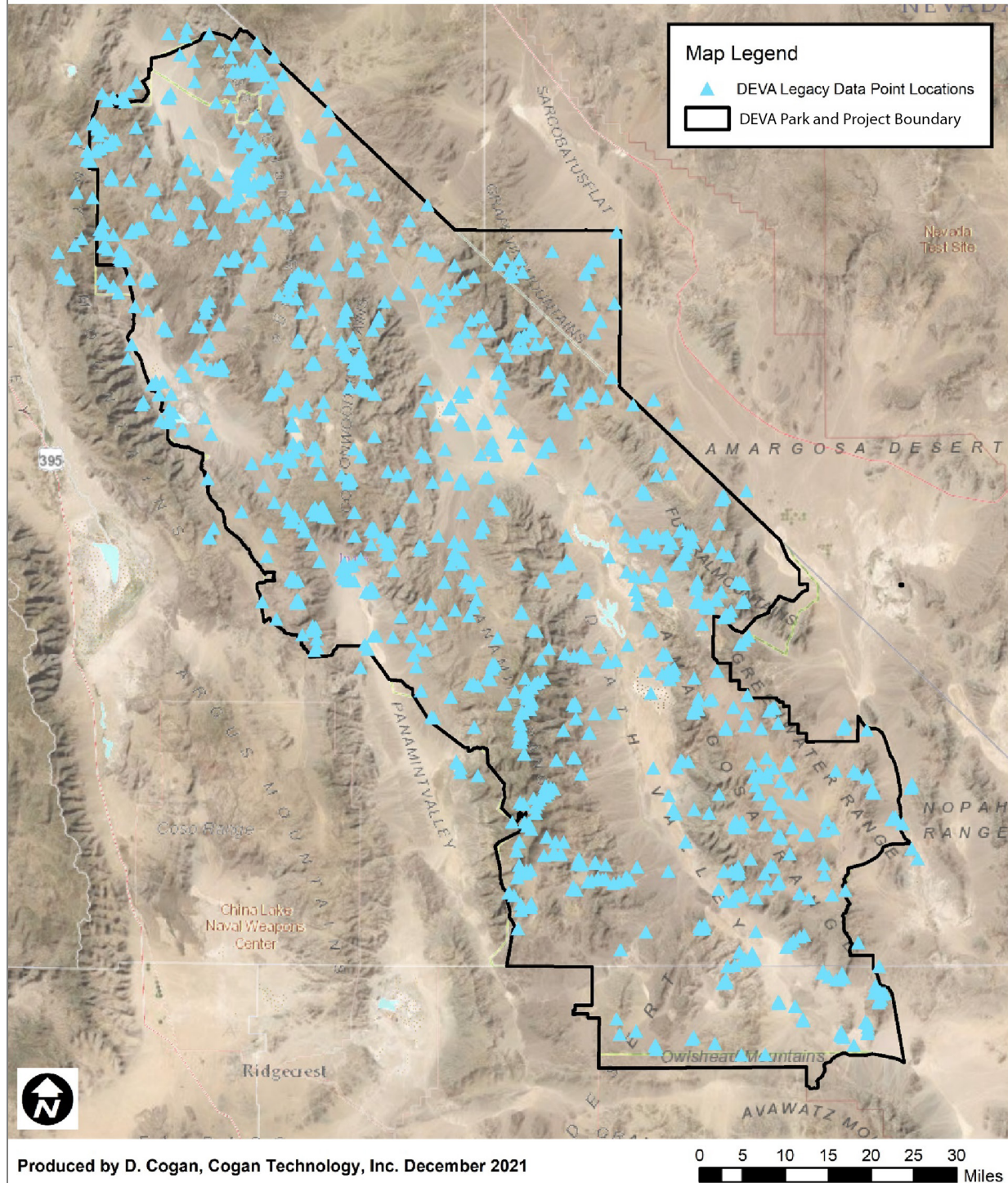


Figure 11. Map of the legacy data locations at DEVA. NPS / CTI



Field Sample Plots

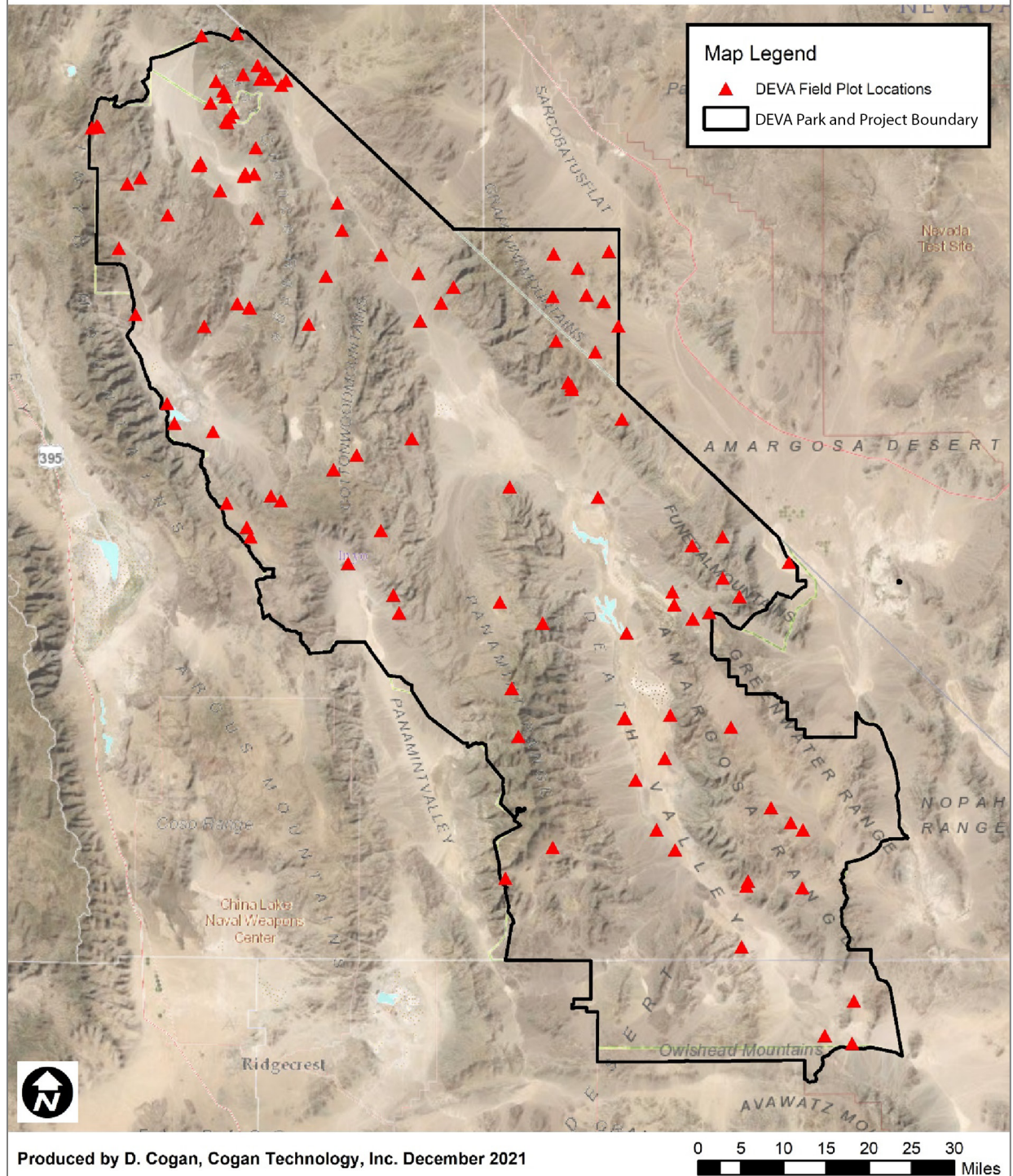


Figure 12. Map of the vegetation field sample plot locations at DEVA. NPS / CTI



Observation Points

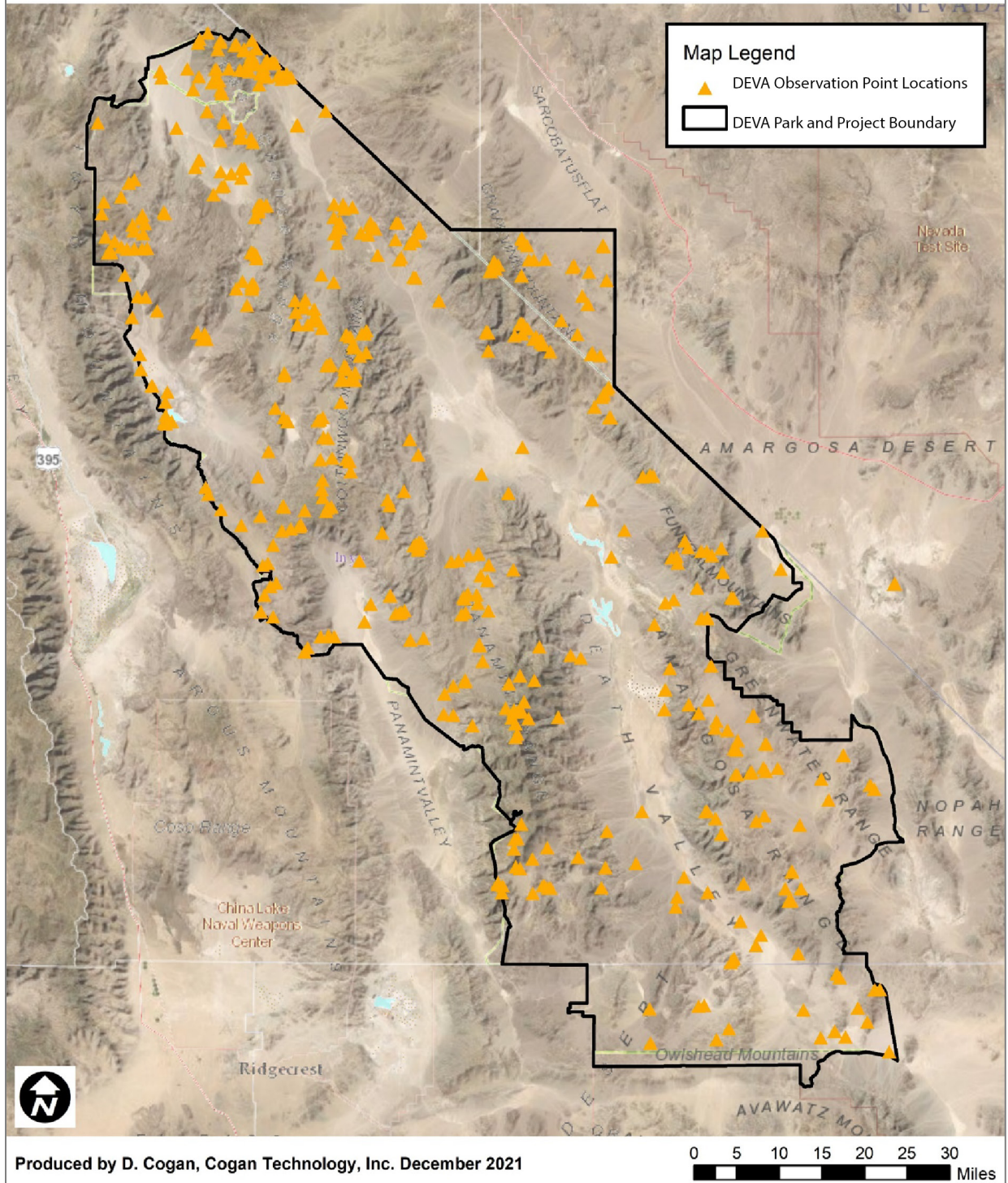


Figure 13. Map of the observation point locations at DEVA. NPS / CTI

Vegetation Classification

In 2013, CNPS staff combined and compiled the existing legacy data and all new data from the DEVA field surveys. The total data set was populated with approximately 4,000 data points that included similar vegetation communities found at LAKE and MOJA. The data were then matched to existing vegetation types known from other desert vegetation classifications. Next, CNPS made corrections, simplifications, and used guidelines to resolve any plant identification, taxonomic, and other data 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 DEVA 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 alliances, 2) any new associations, and 3) any associations that had a sample size of at least three. The DEVA 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 at least one supporting literature citation. NatureServe also assigned associations with database codes as either CEG (community element global) or CEPP (community element proposed or provisional associations) for all DEVA plant 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 DEVA project area warranted the use of a modified or hybrid mapping approach. Early discussions determined the need for 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 for other desert sites, 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 acquired all National Elevation Dataset (NED) 10-meter Digital Elevation Models (DEM) 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.

CTI 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 (DOQQ). The NAIP DOQQ 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 9-by-9 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 (e.g., mountain, hill, basin) 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 DEVA landform polygons.

To delineate the intricate network of drainages and washes at DEVA, 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 by general landscape position. All classified segments were then manually reviewed and edited to correct any commission or 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 DEVA basemap. The most favorable was the USDA NAIP imagery for California and Nevada. The corresponding 2014, 2016, 2018 (California), and 2013, 2015, 2017 (Nevada) NAIP 4-band (3 true color + 1 color infrared band) 1-meter DOQQ for the DEVA project area were downloaded. These were used in combination during the early mapping stages. In 2021, the NAIP 2019 (Nevada) and 2020 (California) imagery became available and was downloaded. All fine-scale mapping were switched to these more recent basemaps (Figure 14) and are available at the [California Department of Fish and Wildlife Map Services Database](#) and at the [University of Nevada, Reno, Imagery Inventory](#).

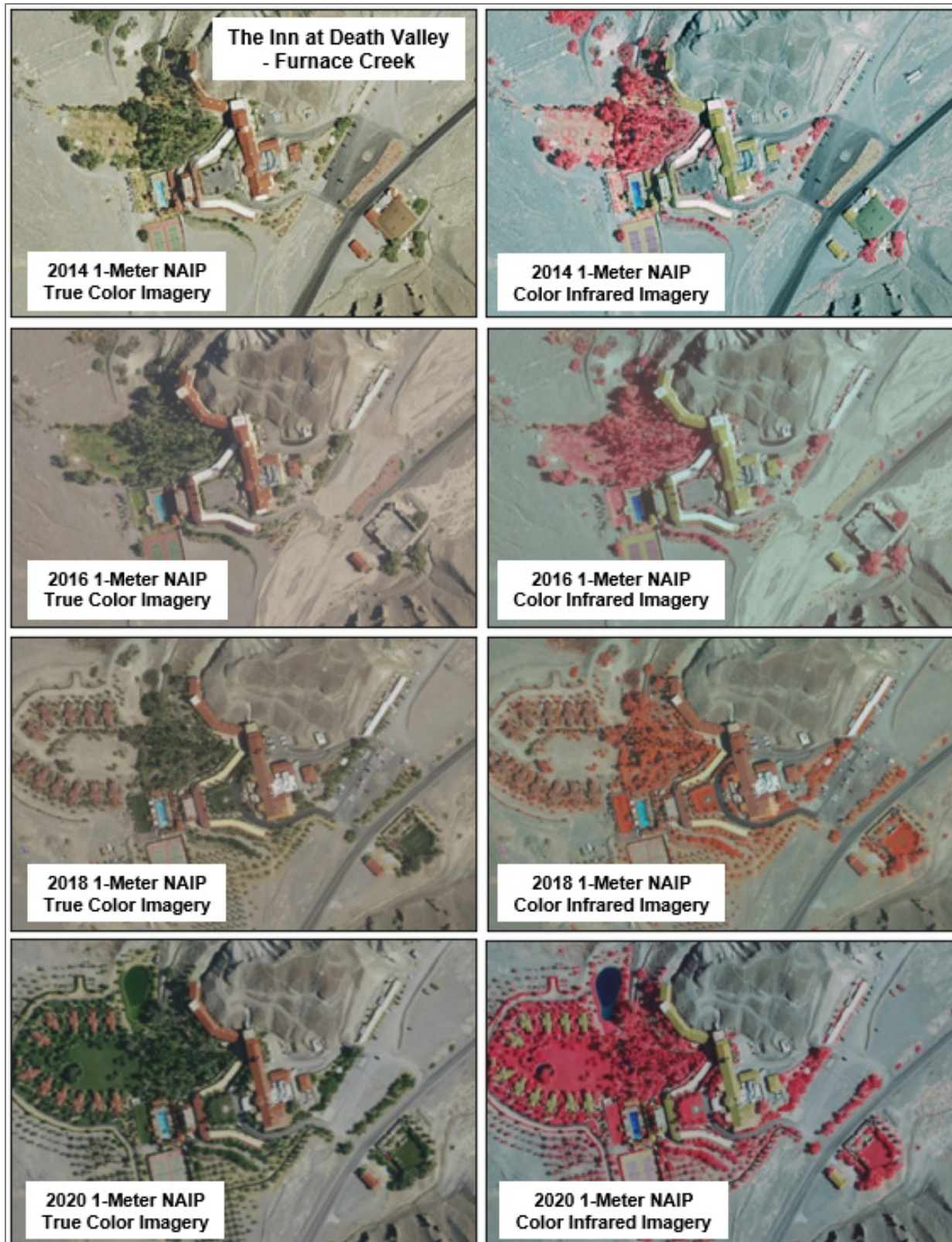


Figure 14. Examples of NAIP true color and color infrared imagery of the Inn at Death Valley, Furnace Creek, in 2014, 2016, 2018, and 2020. NPS / CTI

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 15 summarizes the mapping stages and the spatial layers used or produced during the vegetation mapping process.

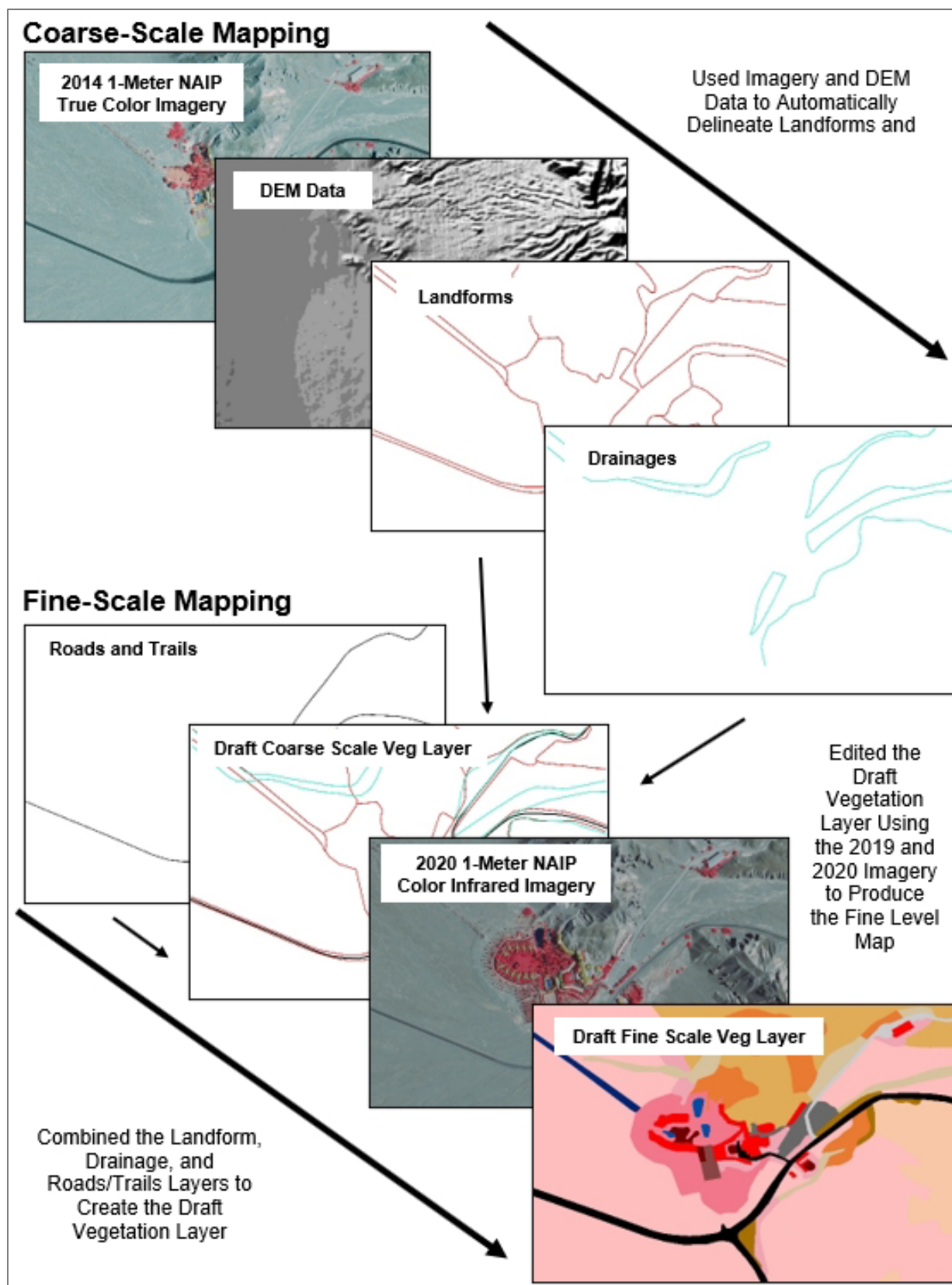


Figure 15. Mapping Flow Diagram. NPS / CTI

In the first step, all the final coarse-level landform and drainage/wash polygons were combined and edited into one layer. Next, the existing DEVA 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 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 2019 and 2020 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.

Ground-truthing, or verifying the vegetation by the mapping team, occurred in 2017 once a draft layer was completed. During this trip, the preliminary DEVA 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. A total of 143 verification sites were recorded using GPS receivers to document both unique and representative stands of vegetation (Figure 16).



Verification Points

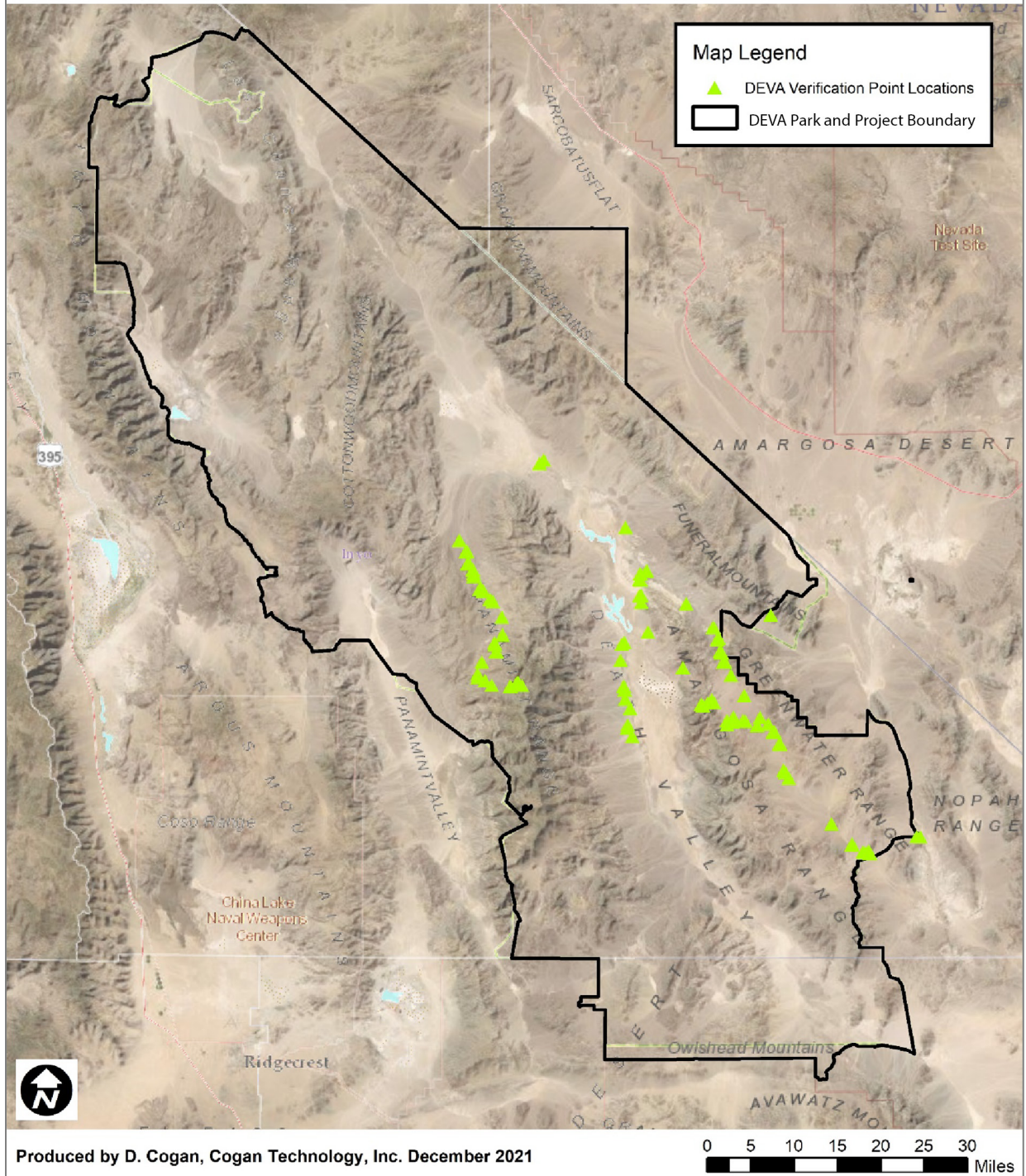


Figure 16. Map of the Verification Point Locations at DEVA. NPS / CTI

After the 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 the field observations.

The fine-level DEVA vegetation map was considered completed in 2020 after the verification changes were made. In most cases, the preliminary, placeholder map unit names and labels were simply altered 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. The DEVA special map units were also created for rare tree types and 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.

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 average height of the vegetation, 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 DEVA 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
DEVAVEG ^A	Unique code for each polygon
DEVAVEG_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 • Sparse = < 10%, • Open = 10–25%, • Intermediate = 25–50%, • Discontinuous = 50–75%, • Closed = 75–100%

^A Represent ArcGIS default attributes and values.

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

Attribute	Description
PTRN_MOD	Modifier—vegetation pattern within the polygon • Evenly dispersed = homogeneous, • Grouped stands of vegetation = bunched / clumped, • String of vegetation = linear, • Varying densities and gradients of vegetation = gradational
HT_MOD	Modifier—height range of the dominant vegetation layer Height classes: < 1, 1–3, 3–5, 5–15, and > 15 meters
LANDFORM	General landform of the polygon—based on national elevation data
PHYS_VEG	General physical vegetation—based on Thomas et al. 2012
GEOLOGY	Dominant geological formation for each polygon—based on the current DEVA 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 as well as the positional (or polygon line) accuracy are considered. In the case of the NPS VMI, the positional accuracy is usually omitted since rarely does vegetation split on discrete edges that can be positively located in the field. The subjectivity involved in this effort, combined with 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). A significant deviation from this methodology was incorporated into the sampling design used at DEVA. Due to time constraints, the AA sampling frames were delineated and plots distributed using a draft version of the polygon map and not the final version. This led to issues that are discussed in the results section.

The thematic accuracy of the vegetation map was assessed using the methodology provided by the NPS VMI (TNC and 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
> 50 hectares	30 ^B
8.33 to 50 hectares	0.6 per hectare
< 8.33 hectares	5 ^B

^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 DEVA. Very small polygons and private lands were excluded from the sampling design. Initially, only areas within an access buffer of 300 horizontal meters from any road were included in the sample frame 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 was included in the sample frame. 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 (e.g., 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 resulting polygon features accounted for approximately 7.5% (1049 km²) of the park's total area.

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 created in case the original targets could not be reached. During the AA fieldwork, difficult or hazardous targets were replaced with the backup targets for safety and economic reasons as determined by the field crews.

The DEVA 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 and the Rio Grande Institute (CTI subcontractors). For safety and efficiency reasons, field crews consisted of both an experienced ecologist familiar with the flora of DEVA and an assistant. AA data were collected at 919 locations in DEVA throughout 2020 (Figure 17). Detailed reports on the DEVA AA selection process and fieldwork can be found in the supplemental folder in the accompanying digital files for this project.



Accuracy Assessment Points

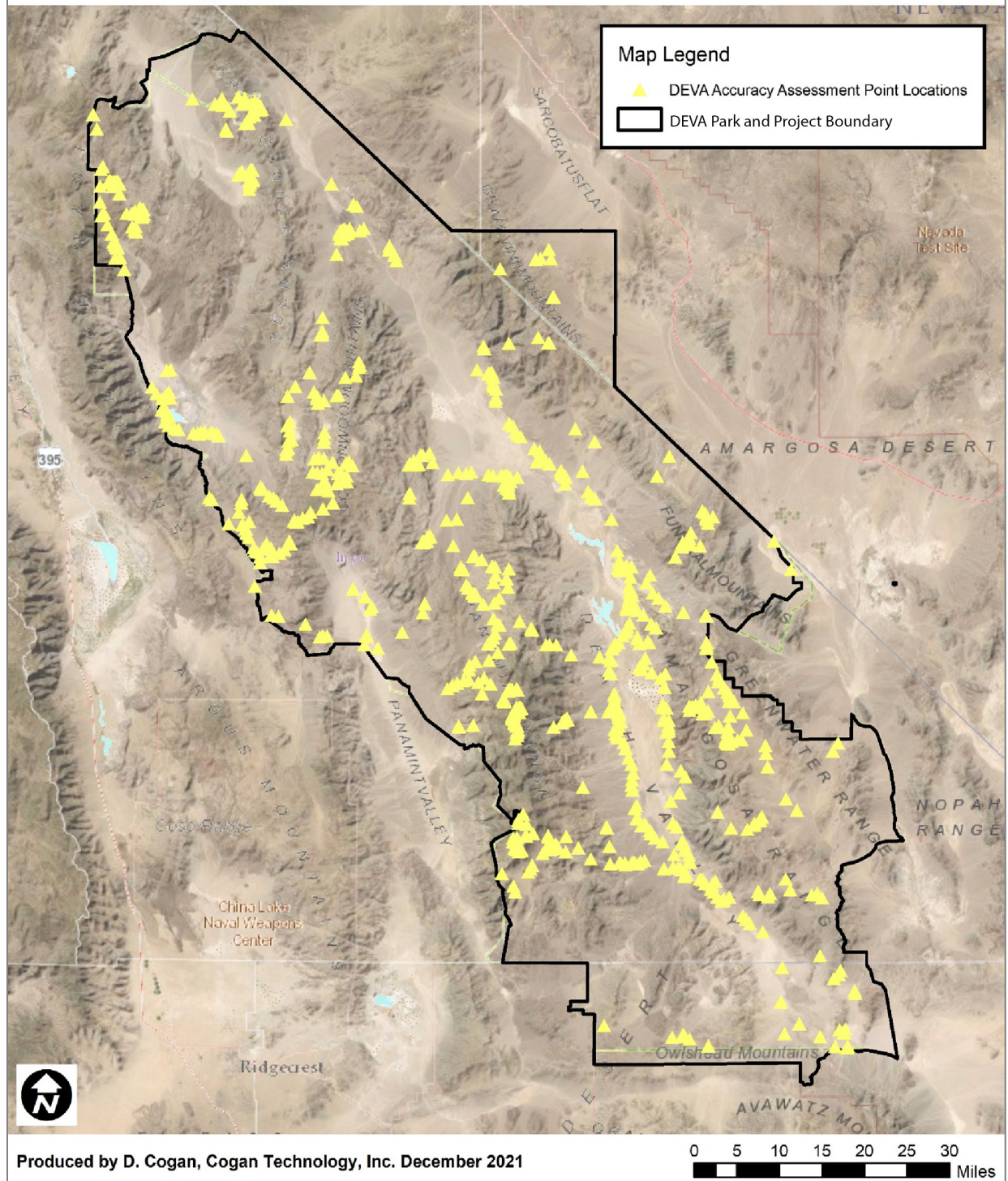


Figure 17. Map of the Accuracy Assessment Point Locations at DEVA. NPS / CTI

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 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.

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 and ESRI 1994c; Lea and Curtis 2010). The final percent accuracy for each of the map classes was recorded using contingency tables (error matrices).



Accuracy assessment data collection at DEVA. NPS / CBB / RGI

Results

Vegetation Classification

The DEVA classification resulted in 85 plant alliances from approximately 1,385 legacy and new field samples, including plots, observations, rapid assessments, and verification points (Evans et al. 2020). Further, using the alliance descriptions and the field sample data, 186 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 the DEVA 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 11 woodland or wooded shrubland, 47 shrubland and scrub, 17 grassland/herbaceous vegetation, and 10 sparse vegetation alliances. The associations totaled 29 woodland or wooded shrubland, 111 shrubland and scrub, 22 grassland/herbaceous vegetation, and 24 sparse vegetation types. Most of the DEVA alliances/associations were dominated by native species, with only six alliances (eight associations) considered to be either non-native or planted types.

Table 4. Summary of rUSNVC plant alliances/associations for DEVA.

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 and Pinyon- Juniper Woodlands	Bristlecone Pine Forest and Woodland Alliance	<i>Pinus longaeva</i> Forest and Woodland Alliance	A0518	Great Basin Bristlecone Pine / (White-stem Goldenbush, Gooseberry Currant) Woodland	<i>Pinus longaeva</i> / (<i>Ericameria discoidea</i> , <i>Ribes montigenum</i>) Woodland	CEGL005447
	Limber Pine Intermountain Basins Forest and Woodland Alliance	<i>Pinus flexilis</i> Intermountain Basins Forest and Woodland Alliance	A2035	Limber Pine / Big Sagebrush Woodland	<i>Pinus flexilis</i> / <i>Artemisia tridentata</i> Woodland	CEPP009588
	Singleleaf Pinyon Pine - Utah Juniper Woodland / Shrub Understory Woodland Alliance	<i>Pinus monophylla</i> - <i>Juniperus osteosperma</i> / Shrub Woodland Alliance	A2108	Singleleaf Pinyon / Desert Gooseberry Woodland	<i>Pinus monophylla</i> / <i>Ribes velutinum</i> Woodland	CEGL003153
	Singleleaf Pinyon Pine - Utah Juniper Woodland / Shrub Understory Woodland Alliance	<i>Pinus monophylla</i> - <i>Juniperus osteosperma</i> / Shrub Woodland Alliance	A2108	Singleleaf Pinyon - Utah Juniper / Big Sagebrush Woodland	<i>Pinus monophylla</i> - <i>Juniperus osteosperma</i> / <i>Artemisia tridentata</i> Woodland	CEGL000832
	Singleleaf Pinyon Pine - Utah Juniper Woodland / Shrub Understory Woodland Alliance	<i>Pinus monophylla</i> - <i>Juniperus osteosperma</i> / Shrub Woodland Alliance	A2108	Singleleaf Pinyon - Utah Juniper / Black Sagebrush Woodland	<i>Pinus monophylla</i> - <i>Juniperus osteosperma</i> / <i>Artemisia nova</i> Woodland	CEGL000831
	Singleleaf Pinyon Pine - Utah Juniper Woodland / Shrub Understory Woodland Alliance	<i>Pinus monophylla</i> - <i>Juniperus osteosperma</i> / Shrub Woodland Alliance	A2108	Singleleaf Pinyon - Utah Juniper / Blackbrush Woodland	<i>Pinus monophylla</i> - <i>Juniperus osteosperma</i> / <i>Coleogyne ramosissima</i> Woodland	CEGL002971
	Singleleaf Pinyon Pine - Utah Juniper Woodland / Shrub Understory Woodland Alliance	<i>Pinus monophylla</i> - <i>Juniperus osteosperma</i> / Shrub Woodland Alliance	A2108	Singleleaf Pinyon - Utah Juniper / Curl-leaf Mountain-mahogany Woodland	<i>Pinus monophylla</i> - <i>Juniperus osteosperma</i> / <i>Cercocarpus ledifolius</i> Woodland	CEGL000828
	Singleleaf Pinyon Pine - Utah Juniper Woodland / Shrub Understory Woodland Alliance	<i>Pinus monophylla</i> - <i>Juniperus osteosperma</i> / Shrub Woodland Alliance	A2108	Singleleaf Pinyon - (Utah Juniper) / Littleleaf Mountain-mahogany Woodland	<i>Pinus monophylla</i> - (<i>Juniperus osteosperma</i>) / <i>Cercocarpus intricatus</i> Woodland	CEGL005437
	Singleleaf Pinyon Pine - Utah Juniper Woodland / Shrub Understory Woodland Alliance	<i>Pinus monophylla</i> - <i>Juniperus osteosperma</i> / Shrub Woodland Alliance	A2108	Pinyon Pine / Eastern Mojave Buckwheat Woodland	<i>Pinus monophylla</i> / <i>Eriogonum fasciculatum</i> Woodland	CEPP006732

Table 4 (continued). Summary of rUSNVC plant alliances/associations for DEVA.

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 and Pinyon- Juniper Woodlands (continued)	Singleleaf Pinyon Pine - Utah Juniper Woodland / Shrub Understory Woodland Alliance	<i>Pinus monophylla</i> - <i>Juniperus osteosperma</i> / Shrub Woodland Alliance	A2108	Pinyon Pine - Utah Juniper Woodland / Sparse Understory Woodland	<i>Pinus monophylla</i> - <i>Juniperus osteosperma</i> / Sparse Understory Woodland	CEGL000829
Juniper and Foothill Woodlands	Curl-leaf Mountain-mahogany Shrubby Woodland Alliance	<i>Cercocarpus ledifolius</i> Shrubby Woodland Alliance	A3622	Curl-leaf Mountain-mahogany / Big Sagebrush Woodland	<i>Cercocarpus ledifolius</i> / <i>Artemisia tridentata</i> Woodland	CEGL003151
	Sierra Western Juniper - Whitebark Pine Woodland Alliance	<i>Juniperus grandis</i> - <i>Pinus albicaulis</i> Woodland Alliance	A3622	Western Juniper / Big Sagebrush Woodland	<i>Juniperus grandis</i> / <i>Artemisia tridentata</i> Woodland	CEGL003151
	Utah Juniper / Shrub Understory Woodland Alliance	<i>Juniperus osteosperma</i> / Shrub Understory Woodland Alliance [Montane Mixed Chaparral]	A3496	Utah Juniper / Blackbrush Woodland	<i>Juniperus osteosperma</i> / <i>Coleogyne ramosissima</i> Woodland	CEGL002909
	Utah Juniper / Shrub Understory Woodland Alliance	<i>Juniperus osteosperma</i> / Shrub Understory Woodland Alliance [Montane Mixed Chaparral]	A3496	Utah Juniper / Snakeweed Woodland	<i>Juniperus osteosperma</i> / <i>Gutierrezia microcephala</i> Woodland	CEPP006716
Chaparral and High-Elevation Shrublands	Pointleaf Manzanita - Pringle's Manzanita - Desert Ceanothus Chaparral Alliance	<i>Arctostaphylos pungens</i> - <i>Arctostaphylos pringlei</i> - <i>Ceanothus greggii</i> Chaparral Alliance	A3790	Mojave Desert Whitethorn Shrubland	<i>Ceanothus greggii</i> var. <i>vestitus</i> Shrubland	CEPP005938
	Utah Serviceberry - Alderleaf Mountain-mahogany - Littleleaf Mountain-mahogany Shrubland Alliance	<i>Amelanchier utahensis</i> - <i>Cercocarpus montanus</i> - <i>Cercocarpus intricatus</i> Shrubland Alliance	A3732	Littleleaf Mountain-mahogany Montane Shrubland	<i>Cercocarpus intricatus</i> Montane Shrubland	CEGL002587
High-Elevation Wash Shrublands	Apache Plume Desert Wash Scrub Alliance	<i>Fallugia paradoxa</i> Desert Wash Scrub Alliance	A3259	Apache Plume Grand Canyon Desert Wash Shrubland	<i>Fallugia paradoxa</i> Grand Canyon Desert Wash Shrubland	CEGL005298
	Himalayan Blackberry - Rattlebox - Edible Fig Ruderal Riparian Scrub Alliance	<i>Rubus armeniacus</i> - <i>Sesbania punicea</i> - <i>Ficus carica</i> Ruderal Riparian Scrub Alliance	A4160	Edible Fig Ruderal Riparian Scrub	<i>Ficus carica</i> Ruderal Riparian Scrub	CEPP006709

Table 4 (continued). Summary of rUSNVC plant alliances/associations for DEVA.

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 (continued)	Red-osier Dogwood - Shrubby- cinquefoil - Currant species Wet Shrubland Alliance	<i>Cornus sericea</i> - <i>Dasiphora fruticosa</i> - <i>Ribes</i> spp. Wet Shrubland Alliance	A3773	Woods' Rose Wet Shrubland	<i>Rosa woodsia</i> Wet Shrubland	CEGL001126
	Skunkbush Sumac - River Hawthorn - Stretchberry Shrubland Alliance	<i>Rhus trilobata</i> - <i>Crataegus rivularis</i> - <i>Forestiera pubescens</i> Shrubland Alliance	A3799	Stretchberry Wet Shrubland	<i>Forestiera pubescens</i> Wet Shrubland	CEGL001168
	Subalpine Fir - Quaking Aspen / Rocky Mountain Maple Central Rocky Mountain Avalanche Chute Shrubland Alliance	<i>Abies lasiocarpa</i> - <i>Populus</i> <i>tremuloides</i> / <i>Acer glabrum</i> Central Rocky Mountain Avalanche Chute Shrub Alliance	A3968	Rocky Mountain Maple Drainage Bottom Wet Shrubland	<i>Acer glabrum</i> Drainage Bottom Wet Shrubland	CEGL001062
High-Elevation Herbaceous Vegetation	Joshua Tree Wooded Shrubland Alliance	<i>Yucca brevifolia</i> Wooded Shrubland Alliance	A3148	Joshua Tree Wooded Shrubland	<i>Yucca brevifolia</i> Wooded Shrubland	CEGL003116
	Joshua Tree Wooded Shrubland Alliance	<i>Yucca brevifolia</i> Wooded Shrubland Alliance	A3148	Joshua Tree / (Big Sagebrush - Shadscale Saltbush) Wooded Shrubland	<i>Yucca brevifolia</i> / (<i>Artemisia tridentata</i> - <i>Atriplex confertifolia</i>) Wooded Shrubland	CEPP006854
	Joshua Tree Wooded Shrubland Alliance	<i>Yucca brevifolia</i> Wooded Shrubland Alliance	A3148	Joshua Tree / Blackbrush Wooded Shrubland	<i>Yucca brevifolia</i> / <i>Coleogyne</i> <i>ramosissima</i> Wooded Shrubland	CEGL00529
	Joshua Tree Wooded Shrubland Alliance	<i>Yucca brevifolia</i> Wooded Shrubland Alliance	A3148	Joshua Tree / Creosotebush - (Mojave Yucca) / Big Galleta Wooded Shrubland	<i>Yucca brevifolia</i> / <i>Larrea tridentata</i> - (<i>Yucca schidigera</i>) / <i>Pleuraphis rigida</i> Wooded Shrubland	CEGL005777
	Joshua Tree Wooded Shrubland Alliance	<i>Yucca brevifolia</i> Wooded Shrubland Alliance	A3148	Joshua Tree / (Desert Almond - Mexican Bladdersage) Wooded Shrubland	<i>Yucca brevifolia</i> / (<i>Prunus fasciculata</i> - <i>Salazaria mexicana</i>) Wooded Shrubland	CEGL005776
	Joshua Tree Wooded Shrubland Alliance	<i>Yucca brevifolia</i> Wooded Shrubland Alliance	A3148	Joshua Tree - Utah Juniper / Big Sagebrush Wooded Shrubland	<i>Yucca brevifolia</i> - <i>Juniperus</i> <i>osteosperma</i> / <i>Artemisia tridentata</i> Wooded Shrubland	CEGL002744
	Joshua Tree Wooded Shrubland Alliance	<i>Yucca brevifolia</i> Wooded Shrubland Alliance	A3148	Joshua Tree / Water Jacket - Nevada Joint-fir Wooded Shrubland	<i>Yucca brevifolia</i> / <i>Lycium andersonii</i> - <i>Ephedra nevadensis</i> Wooded Shrubland	CEGL005778

Table 4 (continued). Summary of rUSNVC plant alliances/associations for DEVA.

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	Antelope Bitterbrush - Big Sagebrush Mesic Steppe and Shrubland Alliance	<i>Purshia tridentata</i> - <i>Artemisia tridentata</i> Mesic Steppe and Shrubland Alliance	A3179	Desert Bitterbrush Shrubland	<i>Purshia glandulosa</i> Shrubland	CEPP006747
	Antelope Bitterbrush - Big Sagebrush Mesic Steppe and Shrubland Alliance	<i>Purshia tridentata</i> - <i>Artemisia tridentata</i> Mesic Steppe and Shrubland Alliance	A3179	Desert Bitterbrush- Big Sagebrush Shrubland	<i>Purshia glandulosa</i> - <i>Artemisia tridentata</i> Shrubland	CEPP006746
	Blackbrush Mojave Desert Scrub Alliance	<i>Coleogyne ramosissima</i> Mojave Desert Scrub Alliance	A3144	Blackbrush Shrubland	<i>Coleogyne ramosissima</i> Shrubland	CEGL001332
	Blackbrush Mojave Desert Scrub Alliance	<i>Coleogyne ramosissima</i> Mojave Desert Scrub Alliance	A3144	Blackbrush - Eastern Mojave Buckwheat Shrubland	<i>Coleogyne ramosissima</i> - <i>Eriogonum fasciculatum</i> Shrubland	CEGL001333
	Blackbrush Mojave Desert Scrub Alliance	<i>Coleogyne ramosissima</i> Mojave Desert Scrub Alliance	A3144	Blackbrush - Green Rabbitbrush Shrubland	<i>Coleogyne ramosissima</i> - <i>Ericameria teretifolia</i> Shrubland	CEPP005999
	Blackbrush Mojave Desert Scrub Alliance	<i>Coleogyne ramosissima</i> Mojave Desert Scrub Alliance	A3144	Blackbrush - Joint-fir species Warm Desert Shrubland	<i>Coleogyne ramosissima</i> - <i>Ephedra</i> spp. Warm Desert Shrubland	CEGL005297
	Blackbrush Mojave Desert Scrub Alliance	<i>Coleogyne ramosissima</i> Mojave Desert Scrub Alliance	A3144	Blackbrush - Water Jacket Mojave Desert Shrubland	<i>Coleogyne ramosissima</i> - <i>Lycium andersonii</i> Mojave Desert Shrubland	CEGL005746
	Blackbrush Mojave Desert Scrub Alliance	<i>Coleogyne ramosissima</i> Mojave Desert Scrub Alliance	A3144	Creosotebush - Blackbrush Shrubland	<i>Larrea tridentata</i> - <i>Coleogyne ramosissima</i> Shrubland	CEGL002717
	Black Sagebrush Steppe and Shrubland Alliance	<i>Artemisia nova</i> Steppe and Shrubland Alliance	A3222	Black Sagebrush Shrubland	<i>Artemisia nova</i> Shrubland	CEGL001417
	Big Sagebrush - Mixed Shrub Dry Steppe and Shrubland Alliance	<i>Artemisia tridentata</i> - Mixed Shrub Dry Steppe and Shrubland Alliance	A3198	Big Sagebrush Shrubland	<i>Artemisia tridentata</i> Shrubland	CEGL000991
	Big Sagebrush - Mixed Shrub Dry Steppe and Shrubland Alliance	<i>Artemisia tridentata</i> - Mixed Shrub Dry Steppe and Shrubland Alliance	A3198	Big Sagebrush - Green Rabbitbrush Shrubland	<i>Artemisia tridentata</i> - <i>Ericameria teretifolia</i> Shrubland	CEPP005793
	Big Sagebrush - Mixed Shrub Dry Steppe and Shrubland Alliance	<i>Artemisia tridentata</i> - Mixed Shrub Dry Steppe and Shrubland Alliance	A3198	Big Sagebrush / James' Galleta Shrubland	<i>Artemisia tridentata</i> / <i>Pleuraphis jamesii</i> Shrubland	CEGL001005
	Big Sagebrush - Mixed Shrub Dry Steppe and Shrubland Alliance	<i>Artemisia tridentata</i> - Mixed Shrub Dry Steppe and Shrubland Alliance	A3198	Big Sagebrush - Nevada Joint-fir Shrubland	<i>Artemisia tridentata</i> - <i>Ephedra nevadensis</i> Shrubland	CEGL001002

Table 4 (continued). Summary of rUSNVC plant alliances/associations for DEVA.

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 (continued)	Big Sagebrush - Mixed Shrub Dry Steppe and Shrubland Alliance	<i>Artemisia tridentata</i> - Mixed Shrub Dry Steppe and Shrubland Alliance	A3198	Big Sagebrush / Rubber Rabbitbrush Shrubland	<i>Artemisia tridentata</i> - <i>Ericameria nauseosa</i> Shrubland	CEGL000998
	Big Sagebrush - Mixed Shrub Dry Steppe and Shrubland Alliance	<i>Artemisia tridentata</i> - Mixed Shrub Dry Steppe and Shrubland Alliance	A3198	Big Sagebrush / Yellow Rabbitbrush / (Sandberg Bluegrass) Shrubland	<i>Artemisia tridentata</i> - <i>Chrysothamnus viscidiflorus</i> / (<i>Poa secunda</i>) Shrubland	CEGL000999
	Death Valley Joint-Fir Shrubland Alliance	<i>Ephedra funerea</i> Shrubland Alliance	A4157	Death Valley Joint-fir Shrubland	<i>Ephedra funerea</i> Shrubland	CEGL005750
	Green Rabbitbrush Shrubland Alliance	<i>Ericameria teretifolia</i> Shrubland Alliance	A2540	Green Rabbitbrush Shrubland	<i>Ericameria teretifolia</i> Shrubland	CEGL002963
	Little Sagebrush Steppe and Shrubland Alliance	<i>Artemisia arbuscula</i> ssp. <i>arbuscula</i> Steppe and Shrubland Alliance	A3219	No Little Sagebrush Associations Described for DEVA	No Little Sagebrush Associations Described for DEVA	N/A
	Mormon-tea Colorado Plateau Shrubland Alliance	<i>Ephedra viridis</i> Colorado Plateau Shrubland Alliance	A3201	Mormon-tea Shrubland	<i>Ephedra viridis</i> Shrubland	CEPP006703
	Mormon-tea - Yellow Rabbitbrush - Skunkbush Sumac Talus Sparse Scrub Alliance	<i>Ephedra viridis</i> - <i>Chrysothamnus viscidiflorus</i> - <i>Rhus trilobata</i> Talus Sparse Scrub Alliance	A4050	Cliff Goldenbush Shrubland	<i>Ericameria cuneata</i> var. <i>spathulata</i> Shrubland	CEPP006704
	Mountain Big Sagebrush - Mixed Steppe and Shrubland Alliance	<i>Artemisia tridentata</i> ssp. <i>vaseyana</i> - Mixed Steppe and Shrubland Alliance	A3208	Mountain Big Sagebrush Shrubland	<i>Artemisia tridentata</i> ssp. <i>vaseyana</i> Shrubland	CEPP005794
	Mountain Big Sagebrush - Mixed Steppe and Shrubland Alliance	<i>Artemisia tridentata</i> ssp. <i>vaseyana</i> - Mixed Steppe and Shrubland Alliance	A3208	Mountain Big Sagebrush - Joint-fir species Shrubland	<i>Artemisia tridentata</i> ssp. <i>vaseyana</i> - <i>Ephedra</i> spp. Shrubland	CEPP006702
	Nevada Joint-fir - Water Jacket - Spiny Hopsage Scrub Alliance	<i>Ephedra nevadensis</i> - <i>Lycium andersonii</i> - <i>Grayia spinosa</i> Scrub Alliance	A4245	Nevada Joint-fir - Cooper's Goldenbush Shrubland	<i>Ephedra nevadensis</i> - <i>Ericameria cooperi</i> Shrubland	CEGL001253
	Nevada Joint-fir - Water Jacket - Spiny Hopsage Scrub Alliance	<i>Ephedra nevadensis</i> - <i>Lycium andersonii</i> - <i>Grayia spinosa</i> Scrub Alliance	A4245	Nevada Joint-fir - (Mexican Bladdersage, Burrobrush) Shrubland	<i>Ephedra nevadensis</i> - (<i>Salazaria mexicana</i> , <i>Hymenoclea salsola</i>) Shrubland	CEGL005751
	Nevada Joint-fir - Water Jacket - Spiny Hopsage Scrub Alliance	<i>Ephedra nevadensis</i> - <i>Lycium andersonii</i> - <i>Grayia spinosa</i> Scrub Alliance	A4245	Nevada Joint-fir - Water Jacket Shrubland	<i>Ephedra nevadensis</i> - <i>Lycium andersonii</i> Shrubland	CEGL005752

Table 4 (continued). Summary of rUSNVC plant alliances/associations for DEVA.

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 (continued)	Nevada Joint-fir - Water Jacket - Spiny Hopsage Scrub Alliance	<i>Ephedra nevadensis</i> - <i>Lycium andersonii</i> - <i>Grayia spinosa</i> Scrub Alliance	A4245	Spiny Hopsage Shrubland	<i>Grayia spinosa</i> Shrubland	CEGL002358
	Nevada Joint-fir - Water Jacket - Spiny Hopsage Scrub Alliance	<i>Ephedra nevadensis</i> - <i>Lycium andersonii</i> - <i>Grayia spinosa</i> Scrub Alliance	A4245	Spiny Hopsage / Bud Sagebrush Shrubland	<i>Grayia spinosa</i> / <i>Picrothamnus desertorum</i> Shrubland	CEGL001345
	Nevada Joint-fir - Water Jacket - Spiny Hopsage Scrub Alliance	<i>Ephedra nevadensis</i> - <i>Lycium andersonii</i> - <i>Grayia spinosa</i> Scrub Alliance	A4245	Spiny Hopsage - Creosotebush Shrubland	<i>Grayia spinosa</i> - <i>Larrea tridentata</i> Shrubland	CEGL001271
	Nevada Joint-fir - Water Jacket - Spiny Hopsage Scrub Alliance	<i>Ephedra nevadensis</i> - <i>Lycium andersonii</i> - <i>Grayia spinosa</i> Scrub Alliance	A4245	Spiny Hopsage - Water Jacket Shrubland	<i>Grayia spinosa</i> - <i>Lycium andersonii</i> Shrubland	CEGL001347
	Nevada Joint-fir - Water Jacket - Spiny Hopsage Scrub Alliance	<i>Ephedra nevadensis</i> - <i>Lycium andersonii</i> - <i>Grayia spinosa</i> Scrub Alliance	A4245	Water Jacket Shrubland	<i>Lycium andersonii</i> Shrubland	CEGL006857
	Spiny Menodora Scrub Alliance	<i>Menodora spinescens</i> Scrub Alliance	A2515	Spiny Menodora - Shadscale Saltbush Scrub	<i>Menodora spinescens</i> - <i>Atriplex confertifolia</i> Scrub	CEGL005769
	Spiny Menodora Scrub Alliance	<i>Menodora spinescens</i> Scrub Alliance	A2515	Spiny Menodora - (Nevada Joint-fir) Dwarf-shrubland	<i>Menodora spinescens</i> - (<i>Ephedra nevadensis</i>) Dwarf-shrubland	CEGL002767
	Stansbury Cliff Rose Scrub Alliance	<i>Purshia stansburiana</i> Scrub Alliance	A0833	Blackbrush - Stansbury's Cliffrose Shrubland	<i>Coleogyne ramosissima</i> - <i>Purshia stansburiana</i> Shrubland	CEGL002720
	Stansbury Cliff Rose Scrub Alliance	<i>Purshia stansburiana</i> Scrub Alliance	A0833	Stansbury's Cliffrose Shrubland	<i>Purshia stansburiana</i> Shrubland	CEGL002957
	Stansbury Cliff Rose Scrub Alliance	<i>Purshia stansburiana</i> Scrub Alliance	A0833	Stansbury's Cliffrose - Big Sagebrush Shrubland	<i>Purshia stansburiana</i> - <i>Artemisia tridentata</i> Shrubland	CEPP006749
	Utah Mortonia Scrub Alliance	<i>Mortonia utahensis</i> Scrub Alliance	A4158	Utah Mortonia Shrubland	<i>Mortonia utahensis</i> Shrubland	CEGL005153
	Yellow Rabbitbrush Steppe and Shrubland Alliance	<i>Chrysothamnus viscidiflorus</i> Steppe and Shrubland Alliance	A3195	Yellow Rabbitbrush Shrub Grassland	<i>Chrysothamnus viscidiflorus</i> Shrub Grassland	CEGL002530

Table 4 (continued). Summary of rUSNVC plant alliances/associations for DEVA.

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	Desert Almond - Mexican Bladdersage Northern Mojave Desert Wash Scrub Alliance	<i>Prunus fasciculata</i> - <i>Salazaria mexicana</i> Northern Mojave Desert Wash Scrub Alliance	A4185	Burrobrush - Mexican Bladdersage Shrubland	<i>Hymenoclea salsola</i> - <i>Salazaria mexicana</i> Shrubland	CEGL002703
	Desert Almond - Mexican Bladdersage Northern Mojave Desert Wash Scrub Alliance	<i>Prunus fasciculata</i> - <i>Salazaria mexicana</i> Northern Mojave Desert Wash Scrub Alliance	A4185	Desert Almond - (Stansbury's Cliffrose, Netvein Goldeneye) Desert Wash Shrubland	<i>Prunus fasciculata</i> - (<i>Purshia stansburiana</i> , <i>Viguiera reticulata</i>) Desert Wash Shrubland	CEGL006863
	Desert Almond - Mexican Bladdersage Northern Mojave Desert Wash Scrub Alliance	<i>Prunus fasciculata</i> - <i>Salazaria mexicana</i> Northern Mojave Desert Wash Scrub Alliance	A4185	Mexican Bladdersage Shrubland	<i>Salazaria mexicana</i> Shrubland	CEGL005293
	Mojave - Sonoran Burrobrush - Sweetbush Desert Wash Alliance	<i>Hymenoclea salsola</i> - <i>Bebbia juncea</i> Mojave - Sonoran Desert Wash Alliance	A4188	Burrobrush Wash Shrubland	<i>Hymenoclea salsola</i> Wash Shrubland	CEGL005398
	Mojave - Sonoran Burrobrush - Sweetbush Desert Wash Alliance	<i>Hymenoclea salsola</i> - <i>Bebbia juncea</i> Mojave - Sonoran Desert Wash Alliance	A4188	Burrobrush - Creosotebush Desert Wash Shrubland	<i>Hymenoclea salsola</i> - <i>Larrea tridentata</i> Desert Wash Shrubland	CEGL005753
	Mojave - Sonoran Burrobrush - Sweetbush Desert Wash Alliance	<i>Hymenoclea salsola</i> - <i>Bebbia juncea</i> Mojave - Sonoran Desert Wash Alliance	A4188	Desert Senna - Burrobrush Desert Wash Shrubland	<i>Senna armata</i> - <i>Hymenoclea salsola</i> Desert Wash Shrubland	CEPP005790
	Mojave - Sonoran Burrobrush - Sweetbush Desert Wash Alliance	<i>Hymenoclea salsola</i> - <i>Bebbia juncea</i> Mojave - Sonoran Desert Wash Alliance	A4188	Sweetbush Shrubland	<i>Bebbia juncea</i> Shrubland	CEGL005391
	Narrowleaf Willow Warm Desert Wet Shrubland Alliance	<i>Salix exigua</i> Warm Desert Wet Shrubland Alliance	A0947	Narrowleaf Willow - Desert Baccharis Shrubland	<i>Salix exigua</i> - <i>Baccharis sergiloides</i> Shrubland	CEPP006753
	Narrowleaf Willow Warm Desert Wet Shrubland Alliance	<i>Salix exigua</i> Warm Desert Wet Shrubland Alliance	A0947	Narrowleaf Willow / Barren Warm Desert Riparian Shrubland	<i>Salix exigua</i> / Barren Warm Desert Wet Shrubland	CEGL005655
	Wild Grape Desert Shrubland Alliance	<i>Vitis arizonica</i> - <i>Vitis girdiana</i> Shrubland Alliance	A4162	Wild Grape Shrubland	<i>Vitis girdiana</i> Shrubland	CEPP006842

Table 4 (continued). Summary of rUSNVC plant alliances/associations for DEVA.

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 Grasslands and Herbaceous Vegetation	Desert Needlegrass Grassland Alliance	<i>Achnatherum speciosum</i> Grassland Alliance	A1290	Desert Needlegrass Shrub Grassland	<i>Achnatherum speciosum</i> Shrub Grassland	CEGL003113
Riparian And Ruderal Woodland and Shrublands	Fremont Cottonwood - Velvet Ash - Goodding's Willow Flooded Forest and Woodland Alliance	<i>Populus fremontii</i> - <i>Fraxinus velutina</i> - <i>Salix gooddingii</i> Flooded Forest and Woodland Alliance	A3803	Fremont Cottonwood / (Emory's Baccharis, Willow Baccharis) Riparian Woodland	<i>Populus fremontii</i> / <i>Baccharis (emoryi, salicina)</i> Riparian Woodland	CEGL002946
	Fremont Cottonwood - Velvet Ash - Goodding's Willow Flooded Forest and Woodland Alliance	<i>Populus fremontii</i> - <i>Fraxinus velutina</i> - <i>Salix gooddingii</i> Flooded Forest and Woodland Alliance	A3803	Fremont Cottonwood - Goodding's Willow Riparian Woodland	<i>Populus fremontii</i> - <i>Salix gooddingii</i> Riparian Woodland	CEGL000944
	Fremont Cottonwood - Velvet Ash - Goodding's Willow Flooded Forest and Woodland Alliance	<i>Populus fremontii</i> - <i>Fraxinus velutina</i> - <i>Salix gooddingii</i> Flooded Forest and Woodland Alliance	A3803	Fremont Cottonwood - Red Willow Riparian Woodland	<i>Populus fremontii</i> - <i>Salix laevigata</i> Riparian Woodland	CEGL005308
	Goodding's Willow - Red Willow Riparian Forest Alliance	<i>Salix gooddingii</i> - <i>Salix laevigata</i> Riparian Forest Alliance	A3752	Goodding's Willow Riparian Woodland	<i>Salix gooddingii</i> Riparian Woodland	CEGL002743
	Goodding's Willow - Red Willow Riparian Forest Alliance	<i>Salix gooddingii</i> - <i>Salix laevigata</i> Riparian Forest Alliance	A3752	Red Willow Riparian Woodland	<i>Salix laevigata</i> Riparian Woodland	CEGL002952
	Ruderal Date Palm - California Fan Palm Riparian Woodland Alliance	<i>Phoenix dactylifera</i> - <i>Washingtonia filifera</i> Ruderal Woodland Alliance	A4161	Date Palm Ruderal Woodland	<i>Phoenix dactylifera</i> Ruderal Woodland	CEPP006859
	Ruderal Date Palm - California Fan Palm Riparian Woodland Alliance	<i>Phoenix dactylifera</i> - <i>Washingtonia filifera</i> Ruderal Woodland Alliance	A4161	California Fan Palm / Spring Ruderal Woodland	<i>Washingtonia filifera</i> / Spring Ruderal Woodland	CEPP006845
	North American Desert Tree Garden Cultural Type Alliance	No Scientific Name or rUSNVC Code Available	N/A	Athel Tamarisk Planted Woodland	<i>Tamarix aphylla</i> Planted Woodland	CST006759
	Tamarisk species Ruderal Riparian Scrub Alliance	<i>Tamarix</i> spp. Ruderal Riparian Scrub Alliance	A0842	Tamarisk species Ruderal Riparian Shrubland	<i>Tamarix</i> spp. Ruderal Riparian Shrubland	CEGL003114

Table 4 (continued). Summary of rUSNVC plant alliances/associations for DEVA.

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	Creosotebush - Burrobush Bajada and Valley Desert Scrub Alliance	<i>Larrea tridentata</i> - <i>Ambrosia dumosa</i> Bajada and Valley Desert Scrub Alliance	A3277	Creosotebush - Burrobush Shrubland	<i>Larrea tridentata</i> - <i>Ambrosia dumosa</i> Shrubland	CEGL002954
	Creosotebush - Burrobush Bajada and Valley Desert Scrub Alliance	<i>Larrea tridentata</i> - <i>Ambrosia dumosa</i> Bajada and Valley Desert Scrub Alliance	A3277	Creosotebush - Burrobush - Burrobrush Desert Shrubland	<i>Larrea tridentata</i> - <i>Ambrosia dumosa</i> - <i>Hymenoclea salsola</i> Desert Shrubland	CEGL005761
	Creosotebush - Burrobush Bajada and Valley Desert Scrub Alliance	<i>Larrea tridentata</i> - <i>Ambrosia dumosa</i> Bajada and Valley Desert Scrub Alliance	A3277	Creosotebush - Burrobush / Cryptogamic Crust Desert Shrubland	<i>Larrea tridentata</i> - <i>Ambrosia dumosa</i> / Cryptogamic Crust Desert Shrubland	CEGL005763
	Creosotebush - Burrobush Bajada and Valley Desert Scrub Alliance	<i>Larrea tridentata</i> - <i>Ambrosia dumosa</i> Bajada and Valley Desert Scrub Alliance	A3277	Creosotebush - Burrobush - (Cottontop Cactus - Beavertail Prickly-pear) Desert Shrubland	<i>Larrea tridentata</i> - <i>Ambrosia dumosa</i> - (<i>Echinocactus polycephalus</i> - <i>Opuntia basilaris</i>) Desert Shrubland	CEPP006718
	Creosotebush - Burrobush Bajada and Valley Desert Scrub Alliance	<i>Larrea tridentata</i> - <i>Ambrosia dumosa</i> Bajada and Valley Desert Scrub Alliance	A3277	Creosotebush - Burrobush - Death Valley Joint-fir Desert Shrubland	<i>Larrea tridentata</i> - <i>Ambrosia dumosa</i> - <i>Ephedra funerea</i> Desert Shrubland	CEGL005759
	Creosotebush - Burrobush Bajada and Valley Desert Scrub Alliance	<i>Larrea tridentata</i> - <i>Ambrosia dumosa</i> Bajada and Valley Desert Scrub Alliance	A3277	Creosotebush - Burrobush - Desert holly Desert Shrubland	<i>Larrea tridentata</i> - <i>Ambrosia dumosa</i> - <i>Atriplex hymenelytra</i> Desert Shrubland	CEGL005758
	Creosotebush - Burrobush Bajada and Valley Desert Scrub Alliance	<i>Larrea tridentata</i> - <i>Ambrosia dumosa</i> Bajada and Valley Desert Scrub Alliance	A3277	Creosotebush - Burrobush - Eastern Mojave Buckwheat Desert Shrubland	<i>Larrea tridentata</i> - <i>Ambrosia dumosa</i> - <i>Eriogonum fasciculatum</i> Desert Shrubland	CEGL005760
	Creosotebush - Burrobush Bajada and Valley Desert Scrub Alliance	<i>Larrea tridentata</i> - <i>Ambrosia dumosa</i> Bajada and Valley Desert Scrub Alliance	A3277	Creosotebush - Burrobush - Fremont's Chaffbush Desert Shrubland	<i>Larrea tridentata</i> - <i>Ambrosia dumosa</i> - <i>Amphipappus fremontii</i> Desert Shrubland	CEGL005756
	Creosotebush - Burrobush Bajada and Valley Desert Scrub Alliance	<i>Larrea tridentata</i> - <i>Ambrosia dumosa</i> Bajada and Valley Desert Scrub Alliance	A3277	Creosotebush - Burrobush - (Littleleaf Ratany, White Ratany) Shrubland	<i>Larrea tridentata</i> - <i>Ambrosia dumosa</i> - <i>Krameria (erecta, grayi)</i> Shrubland	CEGL005137
	Creosotebush - Burrobush Bajada and Valley Desert Scrub Alliance	<i>Larrea tridentata</i> - <i>Ambrosia dumosa</i> Bajada and Valley Desert Scrub Alliance	A3277	Creosotebush - Burrobush - (Mojave Indigobush, Fremont's Smokebush) Desert Shrubland	<i>Larrea tridentata</i> - <i>Ambrosia dumosa</i> - <i>Psoralea (arborescens, fremontii)</i> Desert Shrubland	CEPP006720

Table 4 (continued). Summary of rUSNVC plant alliances/associations for DEVA.

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	<i>Larrea tridentata</i> - <i>Ambrosia dumosa</i> Bajada and Valley Desert Scrub Alliance	A3277	Creosotebush - Burrobush - (Nevada Joint-fir, Water Jacket) Desert Shrubland	<i>Larrea tridentata</i> - <i>Ambrosia dumosa</i> - (<i>Ephedra nevadensis</i> , <i>Lycium andersonii</i>) Desert Shrubland	CEGL005755
	Creosotebush - Burrobush Bajada and Valley Desert Scrub Alliance	<i>Larrea tridentata</i> - <i>Ambrosia dumosa</i> Bajada and Valley Desert Scrub Alliance	A3277	Creosotebush - Burrobush - Shadscale Saltbush Desert Shrubland	<i>Larrea tridentata</i> - <i>Ambrosia dumosa</i> - <i>Atriplex confertifolia</i> Desert Shrubland	CEGL005767
	Rubber Rabbitbrush Steppe and Shrubland Alliance	<i>Ericameria nauseosa</i> Steppe and Shrubland Alliance	A3196	Nevada Broomsage Shrubland	<i>Lepidospartum latisquamum</i> Shrubland	CEPP006725
	Rubber Rabbitbrush Steppe and Shrubland Alliance	<i>Ericameria nauseosa</i> Steppe and Shrubland Alliance	A3196	Rubber Rabbitbrush Shrubland	<i>Ericameria nauseosa</i> Shrubland	CEGL002713
	Shadscale Saltbush Scrub Alliance	<i>Atriplex confertifolia</i> Scrub Alliance	A0870	Shadscale Saltbush - Burrobush Shrubland	<i>Atriplex confertifolia</i> - <i>Ambrosia dumosa</i> Shrubland	CEGL005739
	Shadscale Saltbush Scrub Alliance	<i>Atriplex confertifolia</i> Scrub Alliance	A0870	Shadscale Saltbush / Bud Sagebrush Shrubland	<i>Atriplex confertifolia</i> - <i>Picrothamnus desertorum</i> Shrubland	CEGL001295
	Shadscale Saltbush Scrub Alliance	<i>Atriplex confertifolia</i> Scrub Alliance	A0870	Shadscale Saltbush - Fremont's Pepper-grass Shrubland	<i>Atriplex confertifolia</i> - <i>Lepidium fremontii</i> Shrubland	CEPP005796
	Shadscale Saltbush Scrub Alliance	<i>Atriplex confertifolia</i> Scrub Alliance	A0870	Shadscale Saltbush - Fourwing Saltbush	<i>Atriplex confertifolia</i> - <i>Atriplex canescens</i> Shrubland	CEPP005795
	Shadscale Saltbush Scrub Alliance	<i>Atriplex confertifolia</i> Scrub Alliance	A0870	Shadscale Saltbush Great Basin Shrubland	<i>Atriplex confertifolia</i> Great Basin Shrubland	CEGL001294
	Shadscale Saltbush Scrub Alliance	<i>Atriplex confertifolia</i> Scrub Alliance	A0870	Shadscale Saltbush - Nevada Joint-fir Shrubland	<i>Atriplex confertifolia</i> - <i>Ephedra nevadensis</i> Shrubland	CEGL001303
	Shadscale Saltbush Scrub Alliance	<i>Atriplex confertifolia</i> Scrub Alliance	A0870	Shadscale Saltbush - Water Jacket Shrubland	<i>Atriplex confertifolia</i> - <i>Lycium andersonii</i> Shrubland	CEGL001308
	Shadscale Saltbush Scrub Alliance	<i>Atriplex confertifolia</i> Scrub Alliance	A0870	Shadscale Saltbush - Winterfat Shrubland	<i>Atriplex confertifolia</i> - <i>Krascheninnikovia lanata</i> Shrubland	CEGL001301

Table 4 (continued). Summary of rUSNVC plant alliances/associations for DEVA.

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)	Snakeweed Scrub Dwarf-shrubland Alliance	<i>Gutierrezia sarothrae</i> - <i>Gutierrezia microcephala</i> Dwarf-shrubland Alliance	A3203	Broom Snakeweed / Big Galleta - Desert Globemallow Shrub Grassland	<i>Gutierrezia sarothrae</i> / <i>Pleuraphis rigida</i> - <i>Sphaeralcea ambigua</i> Shrub Grassland	CEGL001543
	White Bursage Scrub Alliance	<i>Ambrosia dumosa</i> Desert Dwarf Scrub Alliance	A3279	Burrobush Dwarf-shrubland	<i>Ambrosia dumosa</i> Dwarf-shrubland	CEGL005074
Low Desert Riparian, Spring, and Wash Shrublands	Arroyo Willow Warm Desert Wet Shrubland Alliance	<i>Salix lasiolepis</i> Warm Desert Wet Shrubland Alliance	A3878	Arroyo Willow / Barren Ground Wet Shrubland	<i>Salix lasiolepis</i> / Barren Ground Wet Shrubland	CEGL001216
	Arroyo Willow Warm Desert Wet Shrubland Alliance	<i>Salix lasiolepis</i> Warm Desert Wet Shrubland Alliance	A3878	Arroyo Willow / Woods' Rose / Mixed Herbs Wet Shrubland	<i>Salix lasiolepis</i> / <i>Rosa woodsia</i> / Mixed Herbs Wet Shrubland	CEGL001217
	Emory's Baccharis - Desert Baccharis Wet Shrubland Alliance	<i>Baccharis emoryi</i> - <i>Baccharis sergiloides</i> Wet Shrubland Alliance	A3874	Desert Baccharis Wet Shrubland	<i>Baccharis sergiloides</i> Wet Shrubland	CEGL002953
	Fremont's Smokebush - Nevada Smokebush Desert Wash Scrub Alliance	<i>Psoralea fremontii</i> - <i>Psoralea polydenius</i> Desert Wash Scrub Alliance	A4186	Nevada Smokebush / Indian Ricegrass Shrubland	<i>Psoralea polydenius</i> var. <i>polydenius</i> / <i>Achnatherum hymenoides</i> Shrubland	CEGL001353
	Fourwing Saltbush - Rubber Rabbitbrush Desert Wash Alliance	<i>Atriplex canescens</i> - <i>Ericameria nauseosa</i> Desert Wash Alliance	A3266	Rubber Rabbitbrush Desert Wash Shrubland	<i>Ericameria nauseosa</i> Desert Wash Shrubland	CEGL002261
	Honey Mesquite - Velvet Mesquite - Screwbean Mesquite Wet Scrub Alliance	<i>Prosopis glandulosa</i> - <i>Prosopis velutina</i> - <i>Prosopis pubescens</i> Wet Scrub Alliance	A3877	Honey Mesquite / (Saltbush species, Mojave Seablite) Mojave Desert Shrubland	<i>Prosopis glandulosa</i> / (<i>Atriplex</i> spp.- <i>Suaeda moquinii</i>) Desert Shrubland	CEGL006861
	Honey Mesquite - Velvet Mesquite - Screwbean Mesquite Wet Scrub Alliance	<i>Prosopis glandulosa</i> - <i>Prosopis velutina</i> - <i>Prosopis pubescens</i> Wet Scrub Alliance	A3877	Honey Mesquite / Arrow-weed Wet Scrub	<i>Prosopis glandulosa</i> / <i>Pluchea sericea</i> Wet Scrub	CEPP006737
	Honey Mesquite - Velvet Mesquite - Screwbean Mesquite Wet Scrub Alliance	<i>Prosopis glandulosa</i> - <i>Prosopis velutina</i> - <i>Prosopis pubescens</i> Wet Scrub Alliance	A3877	Screwbean Mesquite / Desert Baccharis Wet Scrub	<i>Prosopis pubescens</i> / <i>Baccharis sergiloides</i> Wet Scrub	CEPP006738
	Honey Mesquite - Velvet Mesquite - Screwbean Mesquite Wet Scrub Alliance	<i>Prosopis glandulosa</i> - <i>Prosopis velutina</i> - <i>Prosopis pubescens</i> Wet Scrub Alliance	A3877	Screwbean Mesquite / Arrow-weed Alkaline Spring Wet Scrub	<i>Prosopis pubescens</i> / <i>Pluchea sericea</i> Alkaline Spring Wet Scrub	CEPP006739

Table 4 (continued). Summary of rUSNVC plant alliances/associations for DEVA.

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, Spring, and Wash Shrublands (continued)	Honey Mesquite - Velvet Mesquite - Screwbean Mesquite Wet Scrub Alliance	<i>Prosopis glandulosa</i> - <i>Prosopis velutina</i> - <i>Prosopis pubescens</i> Wet Scrub Alliance	A3877	Western Honey Mesquite Wet Scrub	<i>Prosopis glandulosa</i> var. <i>torreyana</i> Wet Scrub	CEGL001381
	Mojave Rabbitbrush Desert Wash Scrub Alliance	<i>Ericameria paniculata</i> Mojave Desert Wash Scrub Alliance	A2509	Mojave Rabbitbrush Desert Wash Shrubland	<i>Ericameria paniculata</i> Desert Wash Shrubland	CEGL002706
	Mojave Rabbitbrush Desert Wash Scrub Alliance	<i>Ericameria paniculata</i> Mojave Desert Wash Scrub Alliance	A2509	Mojave Rabbitbrush - Burrobrush Desert Wash Shrubland	<i>Ericameria paniculata</i> - <i>Hymenoclea salsola</i> Desert Wash Shrubland	CEPP006864
Marsh, Spring, and Wetland Herbaceous Vegetation	Ditch Reedgrass - Bushy Bluestem Hanging Garden Alliance	<i>Calamagrostis scopulorum</i> - <i>Andropogon glomeratus</i> Hanging Garden Alliance	A2655	Bushy Bluestem - Black Bogrush Seep Hanging Garden	<i>Andropogon glomeratus</i> - <i>Schoenus nigricans</i> Seep Hanging Garden	CEGL005466
	Southern Cattail - Broadleaf Cattail - American Common Reed Western Marsh Alliance	<i>Typha domingensis</i> - <i>Typha latifolia</i> - <i>Typha angustifolia</i> Western Marsh Alliance	A3896	American Common Reed Native Western Marsh	<i>Phragmites australis</i> ssp. <i>americanus</i> Native Western Marsh	CEGL006866
	Southern Cattail - Broadleaf Cattail - American Common Reed Western Marsh Alliance	<i>Typha domingensis</i> - <i>Typha latifolia</i> - <i>Typha angustifolia</i> Western Marsh Alliance	A3896	(Broadleaf Cattail, Narrowleaf Cattail) Western Marsh	<i>Typha (latifolia, angustifolia)</i> Western Marsh	CEGL002010
	Southern Cattail - Broadleaf Cattail - American Common Reed Western Marsh Alliance	<i>Typha domingensis</i> - <i>Typha latifolia</i> - <i>Typha angustifolia</i> Western Marsh Alliance	A3896	Chairmaker's Bulrush Western Marsh	<i>Schoenoplectus americanus</i> Western Marsh	CEGL001841
Playa and Alkali Sink Shrublands and Scrub	Arrow-weed Wet Shrubland Alliance	<i>Pluchea sericea</i> Wet Shrubland Alliance	A0798	Arrow-weed Wet Shrubland	<i>Pluchea sericea</i> Wet Shrubland	CEGL003080
	Cattle Saltbush Shrubland Alliance	<i>Atriplex polycarpa</i> Shrubland Alliance	A3174	Cattle Saltbush Shrubland	<i>Atriplex polycarpa</i> Shrubland	CEGL001318
	Fourwing Saltbush Scrub Alliance	<i>Atriplex canescens</i> Scrub Alliance	A0869	Fourwing Saltbush Shrubland	<i>Atriplex canescens</i> Shrubland	CEGL001281
	Fourwing Saltbush Scrub Alliance	<i>Atriplex canescens</i> Scrub Alliance	A0869	Fourwing Saltbush Desert Wash Shrubland	<i>Atriplex canescens</i> Desert Wash Shrubland	CEGL003470
	Fourwing Saltbush Scrub Alliance	<i>Atriplex canescens</i> Scrub Alliance	A0869	Fourwing Saltbush - Winterfat Shrubland	<i>Atriplex canescens</i> - <i>Krascheninnikovia lanata</i> Shrubland	CEGL003470

Table 4 (continued). Summary of rUSNVC plant alliances/associations for DEVA.

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 Shrublands and Scrub (continued)	Greasewood Intermountain Wet Shrubland Alliance	<i>Sarcobatus vermiculatus</i> Intermountain Wet Shrubland Alliance	A1046	Greasewood / Basin Wildrye Wet Shrubland	<i>Sarcobatus vermiculatus</i> / <i>Leymus cinereus</i> Wet Shrubland	CEGL001366
	Iodine Bush Wet Shrubland Alliance	<i>Allenrolfea occidentalis</i> Shrubland Alliance	A0866	Iodinebush Wet Shrubland	<i>Allenrolfea occidentalis</i> Wet Shrubland	CEGL000988
	Iodine Bush Wet Shrubland Alliance	<i>Allenrolfea occidentalis</i> Shrubland Alliance	A0866	Iodinebush / Saltgrass Wet Shrubland	<i>Allenrolfea occidentalis</i> / <i>Distichlis spicata</i> Wet Shrubland	CEPP005788
	Iodine Bush Wet Shrubland Alliance	<i>Allenrolfea occidentalis</i> Shrubland Alliance	A0866	Iodinebush - Mojave Seablite Wet Shrubland	<i>Allenrolfea occidentalis</i> - <i>Suaeda moquinii</i> Wet Shrubland	CEPP005787
	Mojave Seablite - Red Swampfire - Alkali Goldenbush Alkaline Wet Scrub Alliance	<i>Suaeda moquinii</i> - <i>Salicornia rubra</i> - <i>Isocoma acradenia</i> Alkaline Wet Scrub Alliance	A3880	Mojave Seablite Wet Shrubland	<i>Suaeda moquinii</i> Wet Shrubland	CEGL001991
	Mojave Seablite - Red Swampfire - Alkali Goldenbush Alkaline Wet Scrub Alliance	<i>Suaeda moquinii</i> - <i>Salicornia rubra</i> - <i>Isocoma acradenia</i> Alkaline Wet Scrub Alliance	A3880	Mojave Seablite - Fourwing Saltbush Alkaline Wet Shrubland	<i>Suaeda moquinii</i> - <i>Atriplex canescens</i> Alkaline Wet Shrubland	CEPP006758
	Parry's Saltbush Wet Shrubland Alliance	<i>Atriplex parryi</i> Wet Shrubland Alliance	A2507	Parry's Saltbush Wet Shrubland	<i>Atriplex parryi</i> Wet Shrubland	CEGL002711
	Winterfat Dwarf-shrubland and Dwarf-shrub Herbaceous Alliance	<i>Krascheninnikovia lanata</i> Dwarf-shrubland and Dwarf-shrub Herbaceous Alliance	A3202	Winterfat Dwarf-shrubland	<i>Krascheninnikovia lanata</i> Dwarf-shrubland	CEGL001320
Playa And Alkali Sink Grasslands and Herbaceous Vegetation	Alkali Sacaton - Scratchgrass - Alkali Cordgrass Alkaline Wet Meadow Alliance	<i>Sporobolus airoides</i> - <i>Muhlenbergia asperifolia</i> - <i>Spartina gracilis</i> Alkaline Wet Meadow	A1334	Alkali Sacaton Monotype Wet Meadow	<i>Sporobolus airoides</i> Monotype Wet Meadow	CEGL001688
	Common Spikerush - Beaked Spikerush Alkaline-Saline Marsh Alliance	<i>Eleocharis palustris</i> - <i>Eleocharis rostellata</i> Alkaline-Saline Marsh Alliance	A3930	Beaked Spikerush Marsh	<i>Eleocharis rostellata</i> Marsh	CEGL003428
	Saltgrass Alkaline Wet Meadow Alliance	<i>Distichlis spicata</i> Alkaline Wet Meadow Alliance	A1332	Saltgrass Alkaline Wet Meadow	<i>Distichlis spicata</i> Alkaline Wet Meadow	CEGL001770
	Saltgrass Alkaline Wet Meadow Alliance	<i>Distichlis spicata</i> Alkaline Wet Meadow Alliance	A1332	Saltgrass - Cooper's Rush Alkaline Wet Meadow	<i>Distichlis spicata</i> - <i>Juncus cooperi</i> Alkaline Wet Meadow	CEPP006701

Table 4 (continued). Summary of rUSNVC plant alliances/associations for DEVA.

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	<i>Distichlis spicata</i> Alkaline Wet Meadow Alliance	A1332	Saltgrass - Shoreline Rush Wet Meadow	<i>Distichlis spicata</i> - <i>Juncus balticus</i> var. <i>littoralis</i> Wet Meadow	CEPP006700
	Yerba Mansa - Nuttall's Sunflower - Nevada Goldenrod Alkaline Wet Meadow Alliance	<i>Anemopsis californica</i> - <i>Helianthus nuttallii</i> - <i>Solidago spectabilis</i> Alkaline Wet Meadow Alliance	A4247	Nevada Goldenrod Alkaline Wet Meadow	<i>Solidago</i> (<i>spectabilis</i> var. <i>confinis</i> , <i>spectabilis</i> var. <i>spectabilis</i>) Alkaline Wet Meadow	CEPP006757
Dune Grasslands and Herbaceous Vegetation	Desert Twinbugs - Desert Sand-verbena - Desert Panicgrass Dune Alliance	<i>Dicoria canescens</i> - <i>Abronia villosa</i> - <i>Panicum urvilleanum</i> Dune Alliance	A4026	Desert Twinbugs Dune Sparse Vegetation	<i>Dicoria canescens</i> Dune Sparse Vegetation	CEGL005747
	Desert Twinbugs - Desert Sand-verbena - Desert Panicgrass Dune Alliance	<i>Dicoria canescens</i> - <i>Abronia villosa</i> - <i>Panicum urvilleanum</i> Dune Alliance	A4026	Eureka Dunegrass Sparse Vegetation	<i>Swallenia alexandrae</i> Sparse Vegetation	CEGL005468
	Desert Twinbugs - Desert Sand-verbena - Desert Panicgrass Dune Alliance	<i>Dicoria canescens</i> - <i>Abronia villosa</i> - <i>Panicum urvilleanum</i> Dune Alliance	A4026	Thurber's Sandpaper Plant Dune	<i>Petalonyx thurberi</i> Dune	CEPP006731
	Indian Ricegrass - Bluebunch Wheatgrass - Sandhill Muhly Grassland Alliance	<i>Achnatherum hymenoides</i> - <i>Pseudoroegneria spicata</i> - <i>Muhlenbergia pungens</i> Grassland Alliance	A1262	Indian Ricegrass Colorado Plateau Grassland	<i>Achnatherum hymenoides</i> Colorado Plateau Grassland	CEGL002343
Disturbed And Non-Native Grasslands and Herbaceous Vegetation	Cheatgrass - Medusa-head Ruderal Annual Grassland Alliance	<i>Bromus tectorum</i> - <i>Taeniatherum caput-medusae</i> Ruderal Annual Grassland Alliance	A1814	Cheatgrass Ruderal Grassland	<i>Bromus tectorum</i> Ruderal Grassland	CEGL003019
	Desert Globemallow - Scarlet Globemallow - Small-leaf Globemallow Dry Meadow Alliance	<i>Sphaeralcea</i> (<i>ambigua</i> , <i>coccinea</i> , <i>parvifolia</i>) Dry Meadow Alliance	A4216	Desert Globemallow Dry Meadow	<i>Sphaeralcea ambigua</i> Dry Meadow	CEPP009532
	Menzies' Fiddleneck - Bristly Fiddleneck - Phacelia species Meadow Alliance	<i>Amsinckia menziesii</i> - <i>Amsinckia tessellata</i> - <i>Phacelia</i> spp. Herbaceous Alliance	A4182	Bristly Fiddleneck - Redstem Stork's-bill Meadow	<i>Amsinckia tessellata</i> - <i>Erodium cicutarium</i> Meadow	CEPP005792
	Red Brome - Arabian Schismus - Common Mediterranean Grass Ruderal Desert Grassland Alliance	<i>Bromus rubens</i> - <i>Schismus arabicus</i> - <i>Schismus barbatus</i> Ruderal Herbaceous Alliance	A4121	Red Brome - Redstem Stork's-bill - Pincushion species Ruderal Desert Grassland	<i>Bromus rubens</i> - <i>Erodium cicutarium</i> - <i>Chaenactis</i> spp. Ruderal Desert Grassland	CEPP005876

Table 4 (continued). Summary of rUSNVC plant alliances/associations for DEVA.

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	<i>Bromus rubens</i> - <i>Schismus arabicus</i> - <i>Schismus barbatus</i> Ruderal Herbaceous Alliance	A4121	(Arabian Schismus, Common Mediterranean Grass) - (Flat-crown Buckwheat) Ruderal Grassland	<i>Schismus (arabicus, barbatus)</i> - (<i>Eriogonum deflexum</i>) Ruderal Grassland	CEPP009691
Sparse Vegetation	Acton's Brittlebush - Virgin River Brittlebush - Netvein Goldeneye Desert Scrub Alliance	<i>Encelia actonii</i> - <i>Encelia virginensis</i> - <i>Viguiera reticulata</i> Shrubland Alliance	A4163	Acton's Brittlebush Desert Shrubland	<i>Encelia actonii</i> Desert Shrubland	CEGL005748
	Acton's Brittlebush - Virgin River Brittlebush - Netvein Goldeneye Desert Scrub Alliance	<i>Encelia actonii</i> - <i>Encelia virginensis</i> - <i>Viguiera reticulata</i> Shrubland Alliance	A4163	Virgin River Brittlebush Shrubland	<i>Encelia virginensis</i> Shrubland	CEGL001335
	Acton's Brittlebush - Virgin River Brittlebush - Netvein Goldeneye Desert Scrub Alliance	<i>Encelia actonii</i> - <i>Encelia virginensis</i> - <i>Viguiera reticulata</i> Shrubland Alliance	A4163	Netvein Goldeneye Shrubland	<i>Viguiera reticulata</i> Shrubland	CEGL002962
	Brittle Bush Scrub Alliance	<i>Encelia farinosa</i> Desert Scrub Alliance	A4215	Brittlebush Shrubland	<i>Encelia farinosa</i> Shrubland	CEGL001251
	Brittle Bush Scrub Alliance	<i>Encelia farinosa</i> Desert Scrub Alliance	A4215	Burrobush - Brittlebush Dwarf- shrubland	<i>Ambrosia dumosa</i> - <i>Encelia farinosa</i> Dwarf-shrubland	CEGL005061
	Brittle Bush Scrub Alliance	<i>Encelia farinosa</i> Desert Scrub Alliance	A4215	Brittlebush - Schott's Pygmy-cedar Desert Shrubland	<i>Encelia farinosa</i> - <i>Peucephyllum</i> <i>schottii</i> Desert Shrubland	CEGL005749
	Desert Holly Scrub Alliance	<i>Atriplex hymenelytra</i> Scrub Alliance	A0872	Desert Holly Shrubland	<i>Atriplex hymenelytra</i> Shrubland	CEGL001317
	Desert Holly Scrub Alliance	<i>Atriplex hymenelytra</i> Scrub Alliance	A0872	Desert Holly Sparse Shrubland	<i>Atriplex hymenelytra</i> Sparse Shrubland	CEPP005798
	Desert Holly Scrub Alliance	<i>Atriplex hymenelytra</i> Scrub Alliance	A0872	Desert Holly - Burrobush Shrubland	<i>Atriplex hymenelytra</i> - <i>Ambrosia</i> <i>dumosa</i> Shrubland	CEGL005740
	Desert Holly Scrub Alliance	<i>Atriplex hymenelytra</i> Scrub Alliance	A0872	Desert Holly - Arizona Honeysweet Shrubland	<i>Atriplex hymenelytra</i> - <i>Tidestromia</i> <i>oblongifolia</i> Shrubland	CEGL005741
	Desert Holly Scrub Alliance	<i>Atriplex hymenelytra</i> Scrub Alliance	A0872	Desert Holly - Creosotebush Shrubland	<i>Atriplex hymenelytra</i> - <i>Larrea</i> <i>tridentata</i> Shrubland	CEGL001264

Table 4 (continued). Summary of rUSNVC plant alliances/associations for DEVA.

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 (continued)	Devil's Spineflower - Hairy Desert-sunflower Desert Pavement Alliance	<i>Chorizanthe rigida</i> - <i>Geraea canescens</i> Desert Pavement Alliance	A4024	Devil's Spineflower - Hairy Desert-sunflower Desert Pavement	<i>Chorizanthe rigida</i> - <i>Geraea canescens</i> Desert Pavement	CEGL009686
	Eastern Mojave Buckwheat - Parish's Goldeneye Scrub Alliance	<i>Eriogonum fasciculatum</i> - <i>Viguiera parishii</i> Shrubland Alliance	A3150	Eastern Mojave Buckwheat Desert Wash Shrubland	<i>Eriogonum fasciculatum</i> Desert Wash Shrubland	CEPP006706
	Eastern Mojave Buckwheat - Parish's Goldeneye Scrub Alliance	<i>Eriogonum fasciculatum</i> - <i>Viguiera parishii</i> Shrubland Alliance	A3150	Eastern Mojave Buckwheat Rock Outcrop Shrubland	<i>Eriogonum fasciculatum</i> Rock Outcrop Shrubland	CEGL001260
	Eastern Mojave Buckwheat - Parish's Goldeneye Scrub Alliance	<i>Eriogonum fasciculatum</i> - <i>Viguiera parishii</i> Shrubland Alliance	A3150	Eastern Mojave Buckwheat - (Turpentine-bush, Narrowleaf Goldenbush) Desert Shrubland	<i>Eriogonum fasciculatum</i> - <i>Ericameria (laricifolia, linearifolia)</i> Desert Shrubland	CEPP006705
	Eastern Mojave Buckwheat - Parish's Goldeneye Scrub Alliance	<i>Eriogonum fasciculatum</i> - <i>Viguiera parishii</i> Shrubland Alliance	A3150	Parish's Goldeneye Shrubland	<i>Viguiera parishii</i> Shrubland	CEGL002721
	Eastern Mojave Buckwheat - Parish's Goldeneye Scrub Alliance	<i>Eriogonum fasciculatum</i> - <i>Viguiera parishii</i> Shrubland Alliance	A3150	Parish's Goldeneye - Eastern Mojave Buckwheat Desert Shrubland	<i>Viguiera parishii</i> - <i>Eriogonum fasciculatum</i> Desert Shrubland	CEGL005775
	Fremont's Chaffbush - Funeral Sage Scrub Alliance	<i>Amphipappus fremontii</i> - <i>Salvia funerea</i> Shrubland Alliance	A4159	Fremont's Chaffbush Shrubland	<i>Amphipappus fremontii</i> Shrubland	CEPP005791
	Fremont's Chaffbush - Funeral Sage Scrub Alliance	<i>Amphipappus fremontii</i> - <i>Salvia funerea</i> Shrubland Alliance	A4159	Funeral Sage Shrubland	<i>Salvia funerea</i> Shrubland	CEPP006754
	Mormon-tea - Yellow Rabbitbrush - Skunkbush Sumac Talus Sparse Scrub Alliance	<i>Ephedra viridis</i> - <i>Chrysothamnus viscidiflorus</i> - <i>Rhus trilobata</i> Talus Sparse Scrub Alliance	A4050	Cliff Goldenbush Shrubland	<i>Ericameria cuneata</i> var. <i>spathulata</i> Shrubland	CEPP006704
	Schott's Pygmy-cedar - Bush Arrowleaf Scrub Alliance	<i>Peucephyllum schottii</i> - <i>Pleurocoronis pluriseta</i> Scrub Alliance	A3143	Schott's Pygmy-cedar Shrubland	<i>Peucephyllum schottii</i> Shrubland	CEGL002722
	Schott's Pygmy-cedar - Bush Arrowleaf Scrub Alliance	<i>Peucephyllum schottii</i> - <i>Pleurocoronis pluriseta</i> Scrub Alliance	A3143	Schott's Pygmy-cedar - Desert Stingbush - Bush Arrowleaf Shrubland	<i>Peucephyllum schottii</i> - <i>Eucnide urens</i> - <i>Pleurocoronis pluriseta</i> Shrubland	CEGL005770
	Sparsely Vegetated Bedrock Cliff and Lava Field Alliance	<i>Aloysia wrightii</i> - <i>Pericome caudata</i> - <i>Ephedra nevadensis</i> Sparsely Vegetated Bedrock Cliff and Lava Field Alliance	A4025	No Sparse Lava Field Association Described for DEVA	No Sparse Lava Field Association Described for DEVA	N/A

Table 4 (continued). Summary of rUSNVC plant alliances/associations for DEVA.

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 (continued)	Wright's Buckwheat - Heermann's Buckwheat - Utah Butterfly-bush Scrub Alliance	<i>Eriogonum wrightii</i> - <i>Eriogonum heermannii</i> - <i>Buddleja utahensis</i> Scrub Alliance	A4167	Prickleleaf Shrubland	<i>Hecastocleis shockleyi</i> Shrubland	CEGL005467
	Wright's Buckwheat - Heermann's Buckwheat - Utah Butterfly-bush Scrub Alliance	<i>Eriogonum wrightii</i> - <i>Eriogonum heermannii</i> - <i>Buddleja utahensis</i> Scrub Alliance	A4167	(Utah Butterfly-bush, Heermann's Buckwheat) - Snakeweed species Limestone Scrub	(<i>Buddleja utahensis</i> , <i>Eriogonum heermannii</i>) - <i>Gutierrezia</i> spp. Limestone Scrub	CEPP005784

Vegetation Mapping

For DEVA, 90 map units (74 vegetated and 16 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. DEVA 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 contained in the accompanying digital files for this project (see DEVA_USNVC_Table).

Table 5. DEVA map units and rUSNVC crosswalk.

Category	Map Code	DEVA Map Unit Common Name [DEVA Map Unit Scientific Name]	rUSNVC Crosswalk Code
Forests, Woodlands, and Wooded Shrublands	W_CWD	Fremont Cottonwood - Velvet Ash - Goodding's Willow Flooded Forest and Woodland [<i>Populus fremontii</i> - <i>Fraxinus velutina</i> - <i>Salix gooddingii</i> Flooded Forest and Woodland]	A3803
	W_JT	Joshua Tree / Sparse Understory Wooded Shrubland [<i>Yucca brevifolia</i> / Sparse Understory Wooded Shrubland]	CEGL003116
	W_JTBB	Joshua Tree / Blackbrush - Big Sagebrush - Black Sagebrush Wooded Shrubland [<i>Yucca brevifolia</i> / <i>Coleogyne ramosissima</i> - (<i>Artemisia tridentata</i>) Wooded Shrubland]	CEGL005294, CEPP006854
	W_JTCB	Joshua Tree / Creosotebush Wooded Shrubland [<i>Yucca brevifolia</i> / <i>Larrea tridentata</i> Wooded Shrubland]	CEGL005777
	W_JTDS	Joshua Tree / Mixed Desert Scrub Wooded Shrubland [<i>Yucca brevifolia</i> / Mixed Desert Scrub Wooded Shrubland]	CEGL005776, CEGL005778
	W_JTGRS	Joshua Tree / Mixed Grass Wooded Shrubland [<i>Yucca brevifolia</i> / Mixed Desert Scrub Wooded Shrubland]	A3148
	W_JUN	Utah Juniper / Sparse Shrub Understory Woodland Complex [<i>Juniperus osteosperma</i> / Sparse Shrub Understory Woodland Complex]	CEGL003151, CEPP006716
	W_JUNBB	Utah Juniper / Blackbrush Woodland [<i>Juniperus osteosperma</i> / <i>Coleogyne ramosissima</i> Woodland]	CEGL002909, CEGL003151
	W_MEQ	Mesquite Riparian Forest, Woodland, and Shrubland [<i>Prosopis glandulosa</i> - <i>Prosopis velutina</i> - <i>Prosopis pubescens</i> Riparian Forest, Woodland, and Shrubland]	A3877

Table 5 (continued). DEVA map units and rUSNVC crosswalk.

Category	Map Code	DEVA Map Unit Common Name [DEVA Map Unit Scientific Name]	rUSNVC Crosswalk Code
Forests, Woodlands, and Wooded Shrublands (continued)	W_ORN	Mixed Ornamental and Semi-Natural Woodland	(N/A)
	W_PALM	Date Palm - California Fan Palm Ruderal Woodland [<i>Phoenix dactylifera</i> - <i>Washingtonia filifera</i> Ruderal Woodland]	A4161
	W_PINE	Limber Pine - Bristlecone Pine Woodland Complex [<i>Pinus flexilis</i> - <i>Pinus longaeva</i> Forest and Woodland Complex]	A0518, A2035
	W_PJ	Pinyon Pine - Utah Juniper Woodland / Sparse Understory Woodland [<i>Pinus monophylla</i> - <i>Juniperus osteosperma</i> / Sparse Understory Woodland]	CEGL000829
	W_PJBB	Singleleaf Pinyon - Utah Juniper / Big Sagebrush - Blackbrush - Stansbury Cliff Rose Woodland Complex [<i>Pinus monophylla</i> - <i>Juniperus osteosperma</i> / <i>Artemisia</i> <i>tridentata</i> - <i>Coleogyne ramosissima</i> - <i>Purshia stansburiana</i> Woodland Complex]	CEGL000831, CEGL000832, CEGL002971
	W_PJDS	Singleleaf Pinyon - Utah Juniper / Mixed Dry Shrub and Grass Understory Woodland [<i>Pinus monophylla</i> - <i>Juniperus osteosperma</i> / Mixed Dry Shrub and Grass Understory Woodland]	CEPP006732
	W_PJJT	Pinyon Pine - Utah Juniper - Joshua Tree Woodland [<i>Pinus monophylla</i> - <i>Juniperus osteosperma</i> - <i>Yucca brevifolia</i> Woodland]	CEGL002744
	W_PJMS	Singleleaf Pinyon - Utah Juniper / Mixed Upland Shrub Understory Woodland Complex [<i>Pinus monophylla</i> - <i>Juniperus osteosperma</i> / Mixed Upland Shrub Understory Woodland Complex]	CEGL000828, CEGL003153, CEGL005437
	W_PJWASH	Pinyon Pine - Utah Juniper Woodland Wash [<i>Pinus monophylla</i> - <i>Juniperus osteosperma</i> Woodland Wash]	A2108
	W_RMPL	Rocky Mountain Maple Drainage Bottom Wet Shrubland [<i>Acer glabrum</i> Drainage Bottom Wet Shrubland]	A3968
	W_TAM	Tamarisk species Ruderal Riparian Woodland and Scrub [<i>Tamarix</i> spp. Ruderal Riparian Woodland and Scrub]	CEGL003114, CST006759
	W_WIL	Goodding's Willow - Red Willow Riparian Forest [<i>Salix gooddingii</i> - <i>Salix laevigata</i> Riparian Forest]	A3752
Shrublands and Desert Scrub Vegetation	S_ARWD	Arrow-weed Wet Shrubland [<i>Pluchea sericea</i> Wet Shrubland]	A0798
	S_BIT	Desert Bitterbrush - (Big Sagebrush) Mesic Steppe and Shrubland [<i>Purshia glandulosa</i> - (<i>Artemisia tridentata</i>) Mesic Steppe and Shrubland]	A0833, A3179
	S_BKSG	Black Sagebrush - Little Sagebrush Shrubland [<i>Artemisia nova</i> - <i>Artemisia arbuscula</i> ssp. <i>arbuscula</i> Shrubland]	A3219, A3222

Table 5 (continued). DEVA map units and rUSNVC crosswalk.

Category	Map Code	DEVA Map Unit Common Name [DEVA Map Unit Scientific Name]	rUSNVC Crosswalk Code
Shrublands and Desert Scrub Vegetation (continued)	S_BLK	Blackbrush Mojave Desert Scrub [<i>Coleogyne ramosissima</i> Mojave Desert Scrub]	A0833, A3144, A3278
	S_BSG	Big Sagebrush - Mixed Shrub Dry Steppe and Shrubland [<i>Artemisia tridentata</i> - Mixed Shrub Dry Steppe and Shrubland]	A0833, A3198, A3208
	S_BWIL	Baccharis - Willow Warm Desert Riparian Low Bosque and Shrubland Complex [<i>Baccharis</i> (spp.) - <i>Salix</i> (spp.) Warm Desert Riparian Low Bosque and Shrubland Complex]	A0947, A3874, A3878
	S_CB	Creosotebush Desert Scrub [<i>Larrea tridentata</i> Desert Scrub]	CEGL001268, CEGL005145, CEGL005765, CEPP006724
	S_CBB	Creosotebush - Brittle Bush Desert Scrub [<i>Larrea tridentata</i> - <i>Encelia farinosa</i> Desert Scrub]	CEGL002955, CEGL005767, CEGL005766, CEPP006723
	S_CBDN	Creosotebush Desert Dune Scrub [<i>Larrea tridentata</i> Desert Dune Scrub]	CEGL005145
	S_CBWB	Creosotebush - Burrobush Bajada and Valley Desert Scrub [<i>Larrea tridentata</i> - <i>Ambrosia dumosa</i> Bajada and Valley Desert Scrub]	A3277
	S_CHAP	High-Elevation Mixed Shrublands and Shrub Chaparral	A0586, A3732 A3790
	S_FIRE	Post-Fire and Disturbed Shrubland Complex	A3179, A3203, A4216
	S_FWASH	Post-Fire Desert Wash and Drainage Shrubland	A3266
	S_GWD	Greasewood Intermountain Wet Shrubland [<i>Sarcobatus vermiculatus</i> Intermountain Wet Shrubland]	A1046
	S_GRP	Wild Grape Desert Shrubland [<i>Vitis arizonica</i> - <i>Vitis girdiana</i> Shrubland]	A4162
	S_HWASH	High-Elevation Shrub and Herbaceous Vegetation Wash Complex	A3259, A3773, A3799, A4160
	S_IOD	Iodinebush Wet Shrubland [<i>Allenrolfea occidentalis</i> Shrubland]	A0866
	S_LMDS	Basalt and Volcanic Talus Mixed Desert Shrub Complex	A3278, A4245
	S_LMTN	Littleleaf Mountain-mahogany Montane Shrubland [<i>Cercocarpus intricatus</i> Montane Shrubland]	A3732
	S_LSALT	Cattle Saltbush Lava and Cinders Shrubland [<i>Atriplex polycarpa</i> Lava and Cinders Shrubland]	A3174, A3277

Table 5 (continued). DEVA map units and rUSNVC crosswalk.

Category	Map Code	DEVA Map Unit Common Name [DEVA Map Unit Scientific Name]	rUSNVC Crosswalk Code
Shrublands and Desert Scrub Vegetation (continued)	S_LWASH	Desert and Riparian Low Shrubland Wash Complex	A0869, A3277, A3279, A4163, A4185, A4188
	S_MDS	Mid-Elevation Mixed Desert Shrub Complex	A0833, A2515, A2540, A3195, A3201, A3203, A4157, A4158, A4245
	S_MSBLT	Mojave Seablite - Red Swampfire Alkaline Wet Scrub [<i>Suaeda moquinii</i> - <i>Salicornia rubra</i> - <i>Isocoma acradenia</i> Alkaline Wet Scrub]	A3880
	S_MWASH	Semi-Desert Mid-Elevation Mixed Shrub and Herbaceous Vegetation Wash Complex	A4185, A4188
	S_RBT	Rabbitbrush Desert Shrubland [<i>Ericameria nauseosa</i> Desert Shrubland]	A3195, A3196
	S_RWASH	Rabbitbrush Desert Wash Shrubland [<i>Ericameria</i> (spp.) Mojave Desert Wash Scrub]	A2509, A3196, A3266
	S_SALT	Cattle Saltbush Shrubland [<i>Atriplex polycarpa</i> Shrubland]	A2507, A3174, A3277
	S_SHAD	Shadscale and Saltbush Scrub [<i>Atriplex confertifolia</i> - (<i>Atriplex parryi</i>) Scrub]	A0870, A2507
	S_SWASH	Nevada Smokebush Desert Wash Scrub [<i>Psoralea polydenius</i> Desert Wash Scrub]	A4186
	S_TALS	Intermountain Talus Shrubland and Scrub Vegetation	A4050
	S_WFAT	Winterfat Dwarf-shrubland and Dwarf-shrub Herbaceous Vegetation [<i>Krascheninnikovia lanata</i> Dwarf-shrubland and Dwarf-shrub Herbaceous Vegetation]	A3202
	S_WING	Fourwing Saltbush Scrub [<i>Atriplex canescens</i> Scrub]	A0869
Herbaceous Vegetation	H_DUNE	Desert Twinbugs - Desert Sand-verbena - Desert Panicgrass Dune Herbaceous Vegetation [<i>Dicoria canescens</i> - <i>Abronia villosa</i> - <i>Panicum urvilleanum</i> Dune Herbaceous Vegetation]	A4026
	H_FIRE	Post-Fire Herbaceous Vegetation Complex	A4182, A4216
	H_GDUNE	Indian Ricegrass Dune Grassland [<i>Achnatherum hymenoides</i> Dune Grassland]	A1262
	H_GRS	Intermountain Semi-Desert Sparse Scrub and Grassland Complex	A1290, A3203, A4167
	H_HGDN	Bushy Bluestem - Black Bogrush Seep Hanging Garden [<i>Andropogon glomeratus</i> - <i>Schoenus nigricans</i> Seep Hanging Garden]	A2655

Table 5 (continued). DEVA map units and rUSNVC crosswalk.

Category	Map Code	DEVA Map Unit Common Name [DEVA Map Unit Scientific Name]	rUSNVC Crosswalk Code
Herbaceous Vegetation (continued)	H_MEDW	Mesic Meadow Herbaceous Vegetation Complex	A1374, A4165
	H_MGRS	Mixed Desert Ruderal and Annual Grassland and Forb Meadow Herbaceous Vegetation Complex	A4121, A4182, A4184
	H_MRSH	Arid West Emergent Marsh Herbaceous Vegetation Complex	A3895, A3896
	H_SALT	Saltgrass Alkaline Wet Meadow [<i>Distichlis spicata</i> Alkaline Wet Meadow]	A1332
	H_SMRSH	Alkaline Wet Meadow Complex	A1334, A3930, A4164, A4247
Sparse Vegetation	SV_BAD	Badlands Sparse Vegetation	(N/A)
	SV_CNDR	Cinders and Cinder Cone Sparse Vegetation	(N/A)
	SV_DS	Desert Holly Sparse Desert Pavement Dwarf Scrub Complex [<i>Atriplex hymenelytra</i> Sparse Desert Pavement Dwarf Scrub Complex]	A0872, A3279, A4024
	SV_DUNE	Mojave - Sonoran Dune Sparse Vegetation	A4026
	SV_FIRE	Post-Fire Sparse Vegetation	A3144
	SV_LAVA	Volcanic and Lava Fields Sparse Vegetation	A4216
	SV_LDS	Semi-Desert Lava, Basalt, and Cinders Sparse Scrub Complex	A0872, A2540, A3150, A3279, A4215, A4245
	SV_PLYA	Desert Playa and Old Lake Bed Sparse Vegetation	(N/A)
	SV_RCK	Bedrock and Cliff Outcrop Sparse Vegetation Complex	A0872, A3143, A3144, A3150, A4025, A4050, A4159, A4163, A4167, A4215
	SV_SDS	Semi-Desert Rock, Talus, and Steep Slope Sparse Scrub Complex	A0872, A2540, A3143, A3144, A3150, A3195, A3279, A4159, A4163, A4167, A4215
	SV_WASH	Desert Wash and River Bottom Sparse Vegetation	A3150, A0872
Land Use and Land Cover	L_ARPT	Airport and Runways	(N/A)
	L_CAMP	Campgrounds and RV Parks	(N/A)
	L_CANL	Canal / Ditch / Berm	(N/A)
	L_COMM	Communications and Utilities	(N/A)
	L_FACL	NPS and Concession Facilities	(N/A)
	L_GOLF	Golf Courses and Facilities	(N/A)
	L_LAWN	Lawns and Maintained Areas	(N/A)

Table 5 (continued). DEVA map units and rUSNVC crosswalk.

Category	Map Code	DEVA Map Unit Common Name [DEVA Map Unit Scientific Name]	rUSNVC Crosswalk Code
Land Use and Land Cover (continued)	L_LOT	Parking Lot	(N/A)
	L_MINE	Quarries / Strip Mines / Gravel Pits	(N/A)
	L_NPSR	NPS Private and Retired Roads	(N/A)
	L_POND	Lake / Pond	(N/A)
	L_REC	Recreation Facilities	(N/A)
	L_RESD	Residential	(N/A)
	L_ROAD	Roads and Transportation Structures	(N/A)
	L_TRAN	Transitional Area	(N/A)
	L_TRL	Trails and Tracks	(N/A)

Vegetation Map

The [final DEVA vegetation map layer is available in DataStore](#) and contains 81,512 polygons with an average polygon size of about 42 acres (17 ha) (Table 6). 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 (Figure 18).

Table 6. Summary statistics for the DEVA map class polygons.

Map Code	Map Unit Common Name	Polygons	Acres	Hectares
W_CWD	Fremont Cottonwood - Velvet Ash - Goodding's Willow Flooded Forest and Woodland	10	15	6
W_JT	Joshua Tree / Sparse Understory Wooded Shrubland	546	13,567	5,495
W_JTBB	Joshua Tree / Blackbrush - Big Sagebrush - Black Sagebrush Wooded Shrubland Complex	411	17,926	7,260
W_JTCB	Joshua Tree / Creosotebush Wooded Shrubland	119	1,894	767
W_JTDS	Joshua Tree / Mixed Desert Scrub Wooded Shrubland	707	29,033	11,760
W_JTGRS	Joshua Tree / Mixed Grass Wooded Shrubland	2	80	32
W_JUN	Utah Juniper / Sparse Shrub Understory Woodland Complex	86	2,665	1,079
W_JUNBB	Utah Juniper / Blackbrush - Big Sagebrush - Black Sagebrush Woodland	78	2,557	1,036
W_MEQ	Mesquite Riparian Forest, Woodland, and Shrubland	717	16,537	6,696

Table 6 (continued). Summary statistics for the DEVA map class polygons.

Map Code	Map Unit Common Name	Polygons	Acres	Hectares
W_ORN	Mixed Ornamental and Semi-Natural Woodland	43	31	12
W_PALM	Date Palm - California Fan Palm Ruderal Woodland	31	49	20
W_PINE	Limber Pine - Bristlecone Pine Woodland Complex	53	1,909	773
W_PJ	Pinyon Pine - Utah Juniper Woodland / Sparse Understory Woodland	1,515	62,927	25,484
W_PJBB	Singleleaf Pinyon - Utah Juniper / Sagebrush - Blackbrush Woodland Complex	1,056	70,905	28,718
W_PJDS	Singleleaf Pinyon - Utah Juniper / Mixed Dry Shrub and Grass Understory Woodland	94	5,745	2,327
W_PJJT	Pinyon Pine - Utah Juniper - Joshua Tree Woodland	256	9,737	3,944
W_PJMS	Singleleaf Pinyon - Utah Juniper / Mixed Upland Shrub Understory Woodland Complex	56	10,061	4,075
W_PJWASH	Pinyon Pine - Utah Juniper Woodland Wash	144	2,205	893
W_RMPL	Rocky Mountain Maple Drainage Bottom Wet Shrubland	5	6	2
W_TAM	Tamarisk species Ruderal Riparian Woodland and Scrub	75	136	55
W_WIL	Goodding's Willow - Red Willow Riparian Forest	63	638	258
S_ARWD	Arrow-weed Wet Shrubland	47	4,246	1,719
S_BIT	Desert Bitterbrush - (Big Sagebrush) Mesic Steppe and Shrubland	232	7,924	3,210
S_BKSG	Black Sagebrush - Little Sagebrush Shrubland	94	3,425	1,387
S_BLK	Blackbrush Mojave Desert Scrub	4,137	190,070	76,979
S_BSG	Big Sagebrush - Mixed Shrub Dry Steppe and Shrubland	1,958	79,573	32,228
S_BWIL	Baccharis - Willow Warm Desert Riparian Low Bosque and Shrubland	69	149	60
S_CB	Creosotebush Desert Scrub	33,644	1,300,737	526,808
S_CBB	Creosotebush - Brittle Bush Desert Scrub	1,724	65,384	26,482
S_CBDN	Creosotebush Desert Dune Scrub	49	7,704	3,120
S_CBWB	Creosotebush - Burrobush Bajada and Valley Desert Scrub	4,151	175,665	71,144
S_CHAP	High-Elevation Mixed Shrublands and Shrub Chaparral	53	4,023	1,629
S_FIRE	Post-Fire and Disturbed Shrubland Complex	145	11,101	4,496
S_FWASH	Post-Fire Wash and Drainage Scrub	15	321	130
S_GRP	Wild Grape Desert Shrubland	16	39	16
S_GWD	Greasewood Intermountain Wet Shrubland	1	1	1

Table 6 (continued). Summary statistics for the DEVA map class polygons.

Map Code	Map Unit Common Name	Polygons	Acres	Hectares
S_HWASH	High-Elevation Shrub and Herbaceous Vegetation Wash Complex	246	2,973	1,204
S_IOD	Iodine Bush Wet Shrubland	262	19,347	7,835
S_LMDS	Basalt and Volcanic Talus Mixed Desert Shrub Complex	349	9,297	3,766
S_LMTN	Littleleaf Mountain-mahogany Montane Shrubland	22	2,209	894
S_LSALT	Cattle Saltbush Lava and Cinders Shrubland	15	656	266
S_LWASH	Desert and Riparian Low Shrubland Wash Complex	2,674	144,379	58,472
S_MDS	Mid-Elevation Mixed Desert Shrub Complex	4,670	201,678	81,680
S_MSBLT	Mojave Seablite - Red Swampfire Alkaline Wet Scrub	83	2,222	900
S_MWASH	Semi-Desert Mid-Elevation Mixed Shrub and Herbaceous Vegetation Wash Complex	1,486	32,628	13,215
S_RBT	Rabbitbrush Desert Shrubland	24	79	32
S_RWASH	Rabbitbrush Desert Wash Shrubland	48	842	341
S_SALT	Cattle Saltbush Shrubland	549	18,212	7,376
S_SHAD	Shadscale and Saltbush Scrub	2,713	120,662	48,869
S_SWASH	Nevada Smokebush Desert Wash Scrub Alliance	5	416	169
S_TALS	Intermountain Talus Shrubland and Scrub Vegetation	254	1,983	803
S_WFAT	Winterfat Dwarf-shrubland and Dwarf-shrub Herbaceous Vegetation	29	1,245	504
S_WING	Fourwing Saltbush Scrub	38	3,647	1,477
H_DUNE	Desert Dune Herbaceous Vegetation	6	331	134
H_FIRE	Post-Fire Herbaceous Vegetation Complex	110	7,388	2,992
H_GDUNE	Indian Ricegrass Dune Grassland	6	287	116
H_GRS	Intermountain Semi-Desert Sparse Scrub and Grassland Complex	50	1,756	712
H_HGDN	Bushy Bluestem - Black Bogrush Seep Hanging Garden	1	0	0
H_MEDW	Mesic Meadow Herbaceous Vegetation Complex	34	421	170
H_MGRS	Mixed Desert Ruderal and Annual Grassland and Forb Meadow Herbaceous Vegetation Complex	63	1,500	607
H_MRSH	Arid West Emergent Marsh Herbaceous Vegetation Complex	54	217	88
H_SALT	Saltgrass Alkaline Wet Meadow	64	2,408	975
H_SMRSH	Alkaline Wet Meadow Complex	7	9	4

Table 6 (continued). Summary statistics for the DEVA map class polygons.

Map Code	Map Unit Common Name	Polygons	Acres	Hectares
SV_BAD	Badlands Sparse Vegetation	763	30,938	12,529
SV_CNDR	Cinders and Cinder Cone Sparse Vegetation	2	41	17
SV_DS	Sparse Desert Pavement Dwarf Scrub Complex	4,265	148,787	60,258
SV_DUNE	Mojave - Sonoran Dune Sparse Vegetation	244	26,484	10,726
SV_FIRE	Post-Fire Sparse Vegetation	21	297	120
SV_LAVA	Volcanic and Lava Fields Sparse Vegetation	58	1,266	513
SV_LDS	Semi-Desert Basalt, Talus, and Cinders Sparse Scrub Complex	760	19,021	7,704
SV_PLYA	Desert Playa and Old Lake Bed Sparse Vegetation	848	136,248	55,181
SV_RCK	Bedrock and Cliff Outcrop Sparse Vegetation Complex	2,675	187,061	75,759
SV_SDS	Semi-Desert Rock, Talus, and Steep Slope Sparse Scrub Complex	4,170	185,277	75,037
SV_WASH	Desert Wash and Dry River Bottom Sparse Vegetation	468	12,445	5,040
L_ARPT	Airport and Runways	1	5	2
L_CAMP	Campgrounds and RV Parks	49	34	13
L_CANL	Canal / Ditch / Berm	4	14	6
L_COMM	Communications and Utilities	5	7	3
L_FACL	NPS and Concession Facilities	200	31	10
L_GOLF	Golf Courses and Facilities	2	65	26
L_LAWN	Lawns and Maintained Areas	17	9	3
L_LOT	Parking Lot	78	61	24
L_MINE	Quarries / Strip Mines / Gravel Pits	117	1,127	457
L_NPSR	NPS Non-public and Retired Roads	64	317	128
L_POND	Lake / Pond	16	17	7
L_REC	Recreation Facilities	4	3	1
L_RESD	Residential	66	20	7
L_ROAD	Roads and Transportation Structures	23	4,971	2,013
L_TRAN	Transitional Area	258	312	126
L_TRL	Trails and Tracks	70	189	77
Subtotal Woodlands	–	6,067	248,622	100,692
Subtotal Shrublands	–	59,802	2,412,835	977,210
Subtotal Herbaceous Vegetation	–	395	14,317	5,797
Subtotal Sparse Vegetation	–	14,274	747,866	302,885

Table 6 (continued). Summary statistics for the DEVA map class polygons.

Map Code	Map Unit Common Name	Polygons	Acres	Hectares
Subtotal Land-Use and Land-Cover	—	974	7,179	2,902
Subtotal All Vegetation and Sparse Areas	—	80,488	3,425,031	1,386,110
TOTALS	—	81,512	3,430,818	1,389,486

Map Legend

DEVA Vegetation Polygons

SV_DS SV_RCK SV_SDS SV_WASH L_CANL L_POND L_FACL L_LOT L_LAWN W_TAM W_PALM W_MEQ L_REC L_ROAD SV_DS

0 125 250 375 500 Feet

Produced by D. Cogan, Cogan Technology, Inc. December 2021

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Based on the vegetation layer, less than 1% (7,179 acres) of the project area was developed. Of the vegetated total, 7% (248,622 acres) was wooded or wooded shrubland; 70% (2,412,835 acres) were shrublands or scrub; less than 1% (14,317 acres) were dominated by herbaceous species; and about 22% (747,866 acres) contained sparse or no vegetation. The largest vegetation type consisted of the four map units dominated by creosotebush (S_CB, S_CBWB, S_CBB, and S_CBDN), covering 45% (1,551,268 acres) of the project area. Other notable mapping trends include: 5% was mapped as either a pinyon-juniper or a juniper woodland type; 2% was mapped as a Joshua tree type; 6% as a drainage or wash feature; 6% represent bare playa or alkaline sink vegetation, and about 1% were on dune or sand deposits.

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, extensive geospatial data can be combined in many ways and at various scales to produce additional useful products. For example, coarse-scale maps can be created by combining similar map units based on location (Figure 19) or by selecting the physical vegetation or biophysical vegetation attributes. Coarser vegetation classes will produce a less detailed vegetation map that might be more applicable for reports or broader assessments. Conversely, 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. 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.



Coarse-Scale Mapping Example

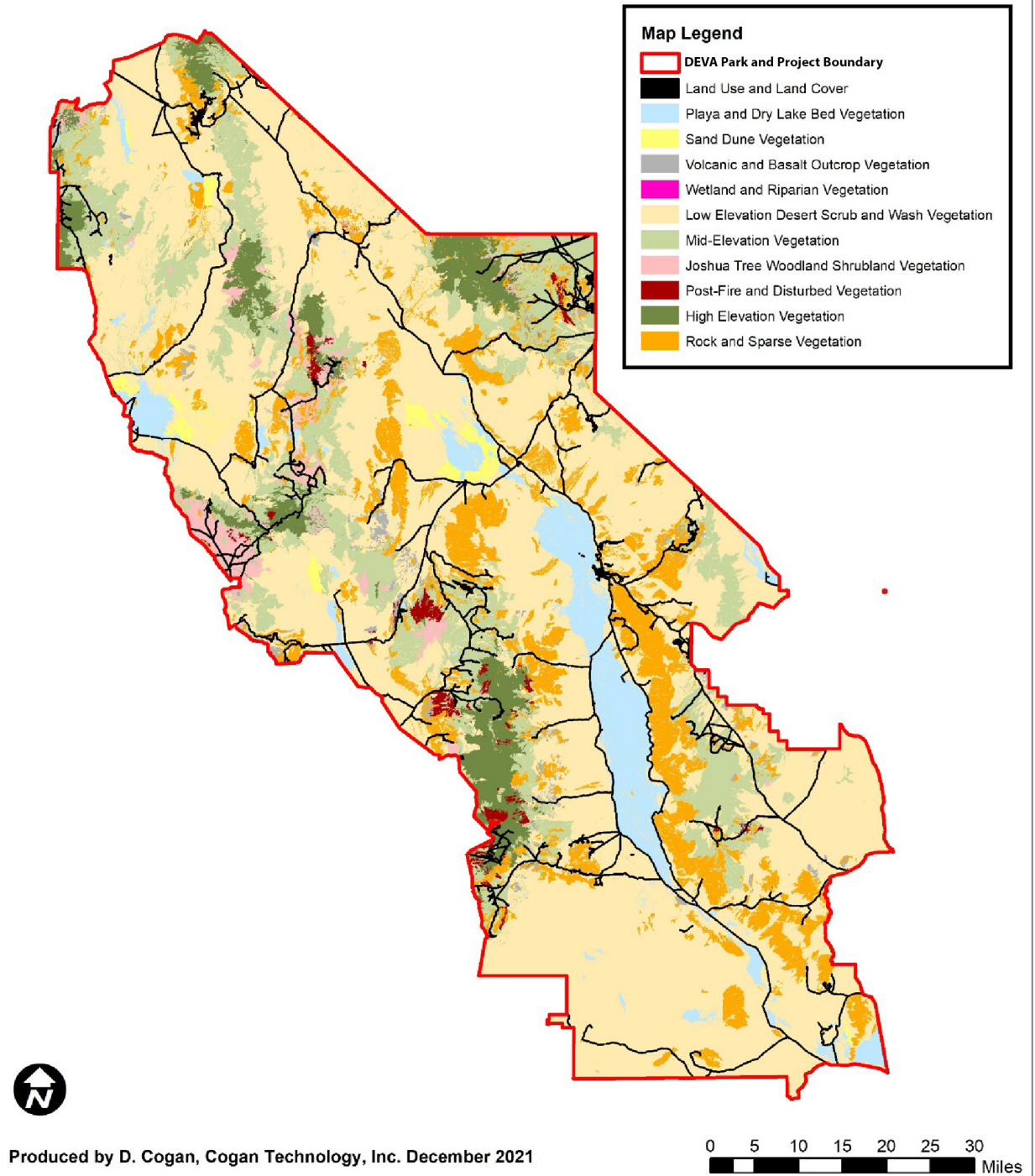


Figure 19. Example of a coarse-scale vegetation map for DEVA. NPS / CTI

Accuracy Assessment

A total of 919 AA target points were sampled by the field crews and distributed throughout the DEVA 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 DEVA classification was updated and finalized to include all new information. The AA points were then exported to a geospatial shapefile and overlain on the vegetation map layer.

As discussed in the methods section of this report, AA sampling locations were distributed using a draft version of the vegetation map. Time constraints necessitated the start of this phase at an earlier stage of the project. Following the distribution of AA sampling points, the draft map underwent large-scale changes. These changes included alterations to polygon boundaries (Table 7), as well as the addition, removal, and merging of vegetation associations and map classes. Changes to polygon boundaries resulted in AA plot sample sizes varying from their original size (Table 8) and encompassing points from multiple strata.

Table 7. Comparison of AA sampling frame area in hectares between the draft map and the final map. ^A

Map Code	Map Unit Common Name	Draft Map Sample Frame Area	Final Map Sample Frame Area	Area Difference
S_BLK	Blackbrush Shrubland	8876	4017	-4859
S_BSG	Big Sagebrush - (Antelope Bitterbrush) Shrubland Complex	2719	2864	145
S_CB	Creosote Bush Shrubland Complex	46093	28595	-17498
S_CBB	Brittlebush - (Creosote Bush) Shrubland Mosaic	326	1427	1101
S_CBWB	White Burrobush - (Creosote Bush) Shrubland	1690	9113	7423
S_HWASH	High-Elevation Shrubland Wash System	229	56	-172
S_IOD	Iodine Bush - Bush Seepweed Shrubland	1249	1388	139
S_LWASH	Low-Elevation Shrubland Wash System	3151	6309	3159
S_MWASH	Mid-Elevation Shrubland Wash System	938	1707	769
S_SALT	Alkaline and Saltbush Basin Scrub Shrubland Complex	3074	1852	-1222
SV_DS	Desert Pavement and Sparse Desert Vegetation	175	9605	9430
SV_DUNE	Semi-Desert Dunes and Sand Flats Sparse Vegetation	1530	395	-1135
SV_LAVA	Lava Beds and Cinder Cone Sparse Vegetation	269	83	-186
SV_PLYA	Mixed Desert Playa Sparse Vegetation	1993	2832	839
SV_RCK	Bare Rock Sparse Vegetation	5035	3781	-1255
W_PINE	Limber Pine - Bristlecone Pine Woodland Complex	287	226	-61
W_PJ	Pinyon Pine - (Utah Juniper) Woodland Complex	3979	306	-3672

^A Only map classes that appear in both the draft map and the final map are included.

Table 7 (continued). Comparison of AA sampling frame area in hectares between the draft map and the final map. ^A

Map Code	Map Unit Common Name	Draft Map Sample Frame Area	Final Map Sample Frame Area	Area Difference
W_PJBB	Pinyon Pine - (Utah Juniper) / Big Sagebrush - Blackbrush Woodland	396	2713.113	2317

^A Only map classes that appear in both the draft map and the final map are included.

Table 8. Comparison of AA plot sample size between the draft map and the final map. ^A

Map Code	Map Unit Common Name	Draft Map Sample Size	Final Map Sample Size	Sample Size Difference
S_BLK	Blackbrush Shrubland	36	30	-6
S_BSG	Big Sagebrush - (Antelope Bitterbrush) Shrubland Complex	25	38	13
S_CB	Creosote Bush Shrubland Complex	34	99	65
S_CBB	Brittlebush - (Creosote Bush) Shrubland Mosaic	30	14	-16
S_CBWB	White Burrobush - (Creosote Bush) Shrubland	32	63	31
S_HWASH	High-Elevation Shrubland Wash System	22	1	-21
S_IOD	Iodine Bush - Bush Seepweed Shrubland	32	14	-18
S_LWASH	Low-Elevation Shrubland Wash System	30	30	0
S_MWASH	Mid-Elevation Shrubland Wash System	30	7	-23
S_SALT	Alkaline and Saltbush Basin Scrub Shrubland Complex	30	24	-6
SV_DS	Desert Pavement and Sparse Desert Vegetation	22	100	78
SV_DUNE	Semi-Desert Dunes and Sand Flats Sparse Vegetation	28	4	-24
SV_LAVA	Lava Beds and Cinder Cone Sparse Vegetation	30	9	-21
SV_PLYA	Mixed Desert Playa Sparse Vegetation	27	58	31
SV_RCK	Bare Rock Sparse Vegetation	37	24	-13
W_PINE	Limber Pine - Bristlecone Pine Woodland Complex	39	20	-19
W_PJ	Pinyon Pine - (Utah Juniper) Woodland Complex	26	4	-22
W_PJBB	Pinyon Pine - (Utah Juniper) / Big Sagebrush - Blackbrush Woodland	4	45	41

^A Only map classes that appear in both the draft map and the final map are included.

The AA was well-designed, competently implemented, and based on established protocols (Lea and Curtis 2010); however, the decision to distribute points and sample plots prior to the finalization of the polygon map was detrimental. Various options were considered to provide some measure of

accuracy for the vegetation map. Ultimately, it was decided that any values calculated from these data would be difficult to interpret and may prove misleading to users of the vegetation map. The decision to exclude accuracy values is an honest assessment of the issues associated with the timing of the accuracy assessment.

If future funding is available, it is recommended that a formal accuracy assessment based on the final vegetation map be completed. This could be delayed until an eventual update is made to the vegetation map.

Discussion

The rugged landscape and sheer size of DEVA made for many unique obstacles to the vegetation 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 (especially in the sparse and mid-elevation types) made for both a challenging classification process and a complex mapping effort. Through it all, the inventory and mapping project team pushed on, and the following are some of the project achievements, limitations, and considerations for future efforts.

Field Surveys

Overall, the combination of legacy, plot, observation point, rapid assessment, verification, and AA points represents a very large geo-located dataset of almost 3,000 individual samples for DEVA. 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 can provide direct hyperlinks to the representative ground photos.

Vegetation Classification

As the plot data were being collected, the vegetation classification was also evolving. 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 data, 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 (Evans et al. 2020). The confusing, sparse 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 DEVA was based primarily on the 2019 (Nevada) and 2020 (California) NAIP imagery, and as such, the DEVA vegetation map layer should be considered a snapshot in time. As the data are used, it should be remembered that fires, droughts, and other changes to the landscape since 2019–2020 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.

Approaches that Worked Well

Having access to existing vegetation data at DEVA 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 produce 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, standardized 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 a rUSNVC-relatable set of map units. In the future, it may be possible to supplement the DEVA 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 DEVA 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. DEVA and NPS staff, volunteers, and researchers should continue to explore the park 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 alliances/associations, 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.

Any new or improved vegetation 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 if 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 soil types, unique geologic formations, and distance from water sources. For some applications, it may be worthwhile to combine map classes into broader units, such as rUSNVC groups or biophysical types, and create new products designed specifically at that scale.

If future funding is available, it is recommended that a formal accuracy assessment based on the final vegetation map be completed. This could, and likely should, be delayed until an eventual update is made to the vegetation map.

Wildfires: Of special importance to DEVA is the ongoing threat from wildfires. During this project, areas that appeared to be recovering from past burns were documented using broad, post-fire map classes. In the future, post-burn types could be refined to better reflect the actual dominant (successional) plant species. Once refined, the new associations/alliances and corresponding map classes could be used to both document changes at previously burned sites and map the vegetation after any new fires. This information could then be uploaded into a supplemental fire geodatabase that contains not only the location and extent of the wildfires but also the changes in plant species (occurrence/cover) and rate of recovery over time for monitoring and 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 DEVA. 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 with new imagery 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 rapidly changing plant diversity. New mapping concepts, such as those being developed by the California Department of Fish and Wildlife (CDFW) and the California Energy Commission (CEC) (Vyverberg and Brady 2013), may hopefully address this problem. The 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. These include expanding or linking the GIS layer to derive other information such as fire models, wildlife habitat monitoring locations, habitat structural analyses, and determining areas that are likely invasive species vectors. The large expanse of wilderness at DEVA may also benefit from these products by enhancing the current wilderness characterization study (Tricker et al. 2012).

The final vegetation map could be improved by overlaying other existing GIS layers, including hydrology, elevation, and soils, to examine potential and climax vegetation. Complex interactions could also be examined and yield important information about growth rates, regeneration after disturbance events, 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 and how it interacts with soil chemistry, pollution, paleontological/archeological sites, insect infestations, weather patterns, etc.

Having consistent ecological and digital map data for plant associations across a large geographical span (Central Mojave Desert Map, MOJA/CAMO, 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 are the driving factors behind this. 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 upslope? 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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