



Manzanar National Historic Site

Vegetation Classification and Mapping Project Report

Natural Resource Technical Report NPS/MANZ/NRTR— 2014/868



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Manzanar National Historic Site

Vegetation Classification and Mapping Project Report

Natural Resource Technical Report NPS/MANZ/NRTR— 2014/868

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Executive Summary

The National Park Service (NPS) established Manzanar National Historic Site (MANZ) in 1992 to help conserve and interpret the history of a former World War II relocation camp used to detain and house Japanese Americans. The historic site covers 330-hectares (814-acres) located in the Owens Valley in eastern California between the towns of Lone Pine and Independence along Highway 395. In addition to preserving the war relocation center, the Historic site also helps preserve part of the complete history of the valley starting with the Paiute Native American legacy, the fruit orchard farming and cattle ranching periods, and more recent water diversion efforts by the City of Los Angeles. Across this diverse background, the vegetation at MANZ has undergone numerous changes and now reflects both the natural and human history of the site. To better understand and document MANZ's vegetation and to establish a baseline for comparison to both past and future changes, the NPS and the NPS Mojave Desert Network Inventory and Monitoring Program (MOJN I&M) started a MANZ vegetation inventory effort in 2008.

A four-year, four-phase program was initiated to complete the task of classifying and mapping the vegetation at MANZ as part of the NPS Vegetation Inventory Program (NVIP). Phase one conducted by botanists and ecologists from MOJN I&M in 2008, collected data at 28 classification plots placed in representative vegetation stands. Field work was directed through the use of a preliminary vegetation map created by the U.S. Geological Survey (USGS). In addition to the classification plots, researchers also visited 253 preliminary vegetation polygons and recorded numerous observation point and verification waypoint data. In phase two, the MANZ field data was analyzed by MOJN I&M botanists to classify 13 unique plant alliances (11 associations) using the revised U.S. National Vegetation Classification (rUSNVC) system. Phase three, conducted by an ecology team based at Joshua Tree National Park (JOTR) sampled vegetation at 126 stratified random accuracy assessment (AA) points to create a preliminary assessment of the vegetation map in 2009. In phase four, Cogan Technology, Inc. (CTI) reviewed all of the existing data, made necessary up-dates, and finalized the project.

The final MANZ spatial database and map layer was produced by CTI from 2010 imagery using 21 map units that were directly cross-walked or matched to their corresponding rUSNVC plant association/alliance or land cover types. The final map layer was assessed for thematic accuracy by creating contingency tables and the final overall accuracy of the map layer was determined to be 96% with a Kappa value of 95%.

Products developed for MANZ are described and presented in this report, as well as stored on the accompanying DVD. These include:

- A *Final Report* that includes keys to the vegetation and imagery signatures, AA information, and all of the project methods and results;
- A *Spatial GIS Database* containing spatial data for the vegetation, plots, and AA points;
- *Digital Photos* from the field sampling efforts;
- *Metadata* for all spatial data (Federal Geographic Data Committee -compliant);

- *Vegetation Descriptions* of the associations/alliances, and;
- *Photo Signature Key* to the map classes.

Acknowledgments

The production of this vegetation inventory was inspired by the enthusiasm and energy of many people over several years. The authors gratefully acknowledge the dedication of all involved in the completion of this project and production of this report.

We would like to specifically thank Tom Leatherman (former MANZ superintendent) for providing information on the site history and information on the current vegetation, Les Inafuku (former MANZ superintendent) for his assistance to the field crews during the AA stage, and the various other MANZ staff for providing valuable insight on the Historic site during our numerous site visits.

We are grateful to the staff at the Mojave Desert Network Inventory and Monitoring Program and Lake Mead National Recreation Area, specifically Bob Truitt (data manager) and Nita Tallent (Network Program Manager), for their help with contracting, coordination, draft reviews, and general project support.

Special recognition goes to Karl Brown, Chris Lea (retired), and Tammy Cook with the National Park Service -Vegetation Inventory Program in Fort Collins, Colorado for prioritizing this project and providing funding. Without their financial support this project would not have been possible. We would also like to acknowledge Chris for helping to complete the vegetation classification analysis, generating the AA points, and writing the field key for the map accuracy assessment.

Numerous other parties have helped during the course of this project and include among others: Bob Waltermire of USGS (vegetation map preparation), Jason Van Warmerdam and Tasha LaDoux of Joshua Tree National Park (accuracy assessment field work), Jim Andre of Andre Botanical Consulting (plant identification expertise), and the staff at Cogan Technology, Inc. (final report and deliverable completion), and Alisa Lynch and Colin Smith of MANZ (reviews of the report manuscript).

Introduction

National Vegetation Inventory Program

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

In 1999, the Director of the NPS approved 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 270 parks with significant natural resources. The vegetation classification and mapping inventory is one of these 12 baseline inventories.

NVIP follows well-established procedures that are compatible with other agencies and organizations. The inventory uses the U.S. National Vegetation Classification version 2 (USNVCv2), a system that is integrated with the major scientific efforts in the taxonomic classification of vegetation, and is a Federal Geographic data Committee (FGDC) standard (FGDC 1997, 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 mapping project for a park follows a standard 12-step procedure (NPS 2009) and includes the following products:

- Detailed vegetation report
- Digital vegetation map
- Vegetation plot data
- Accuracy assessment data and analysis
- Dichotomous vegetation key
- Photo-interpretation key

Maps and other spatial data products for parks in the Continental United States are normally produced in Universal Transverse Mercator (UTM) projection, North America 1983 (NAD 83) datum, use meters for map and distance units, and have a nominal 1:24,000-scale with a minimum mapping unit (MMU) of 0.5 hectare (1.2 acres). The vegetation maps must meet the National Map Accuracy Standards for positional accuracy (TNC and ESRI 1994a & Lea and Curtis 2010), and the recently revised minimum map class accuracy goal across all vegetation and land cover classes of 60% percent at the finest scale (formerly 80%, NPS 2009).

National Vegetation Classification Standard

In 1994, NPS formed the NVIP to cooperatively inventory and map the vegetation in the United States National Parks. Shortly thereafter, the USGS joined into a partnership with the NPS to help fund, maintain, and distribute all of the data produced in the NVIP projects on various websites and computer servers. The goals of this program are to provide baseline ecological data for park resource managers, obtain data that can be examined in a regional and national context, and provide opportunities for future inventory, monitoring, and research activities. In the same year, the NVIP also adopted the U.S. 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 National Vegetation Classification Standard, Version 2 (rUSNVC, FGDC 2008).

Use of a standardized vegetation classification system, such as the rUSNVC helps ensure data compatibility throughout the NPS and other agencies (FGDC 2008). A standard system is critical for a systematic inventory and classification of the nation's biological resources for more efficient stewardship and to help prioritize conservation efforts. The rUSNVC is being used for vegetation classification and mapping projects throughout the Mojave Desert Network Inventory and Monitoring Program (MOJN I&M) and most of the other NPS Networks. The USNVC has been in existence for over two decades and has evolved from the original classification systems first developed jointly by The Nature Conservancy (TNC), NatureServe (NS), and various state Natural Heritage Program 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. These middle levels have been drafted and are undergoing peer review (Faber-Langendoen et al. 2010). The lower two levels (as in the original NVC) are the alliance and association that are distinguished by differences in local floristic composition (Grossman et al. 1998).

The broader alliances are physiognomically distinct groups of plant associations sharing one or more differential or diagnostic species (Mueller-Dombois and Ellenberg 1974). These are commonly the dominant(s) species found in the uppermost strata of vegetation. The plant association is the base unit of the classification and is defined as “a vegetation classification unit defined on the basis of a characteristic range of species composition, diagnostic species occurrence, habitat conditions, and physiognomy” (Jennings et al. 2009)

NatureServe maintains the rUSNVC content and it is currently being peer reviewed through collaboration with federal agencies and the Ecological Society of American (ESA) (Faber-Langendoen et al. 2009). The content is available to the public and is regularly updated through NatureServe Explorer (2012) (<http://www.natureserve.org/explorer>) and <http://www.usnvc.org>.

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

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.
Mid:	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 composition that reflect topo-edaphic climate, substrates, hydrology, and disturbance regimes.

Currently, content (list of types and descriptions) for the upper and middle levels of hierarchy (Formation to Group level) has largely been developed and is under review. The lower levels remain in flux with over 6,000 nationwide associations attributed to the Group level that have been screened for levels of confidence before being adopted into the new rUSNVC. The alliance level is undergoing a significant revision and review process to complete the initial content of the rUSNVC. Provisional rUSNVC alliance level units are being developed however, as part of ongoing NVIP projects for several park units in the MOJN I&M, Pacific Island Network, and Grand Canyon National Park. Until a comprehensive alliance revision and review is completed, the alliance level will be unevenly developed with possible changes.

Both rUSNVC associations and alliance are commonly used for map units or classes in NVIP projects to ensure compatibility and widespread use of the information throughout the NPS as well as by other federal and state agencies. These vegetation maps and associated ecological information support a wide variety of resource assessment, park management, and planning needs. In addition,

they can be used to provide a structure for framing and answering critical scientific questions about plant communities and their relationship to environmental conditions and ecological processes across the landscape.

Mojave Desert Network Inventory and Monitoring

MOJN I&M is composed of seven units managed by NPS in Arizona, California, and Nevada (Figure 1). MOJN I&M park units include: MANZ, Death Valley National Park (DEVA), Great Basin National Park (GRBA), Joshua Tree National Park (JOTR), Lake Mead National Recreation Area (LAKE), Mojave National Preserve (MOJA), and Grand Canyon - Parashant National Monument (PARA). The majority of network parks are within the Great Basin-Mojave Desert region located between the Sierra Nevada Mountains, the Transverse ranges, the Southern Rocky Mountains, and the Columbia and Colorado plateaus. The biota contained in these parks are diverse and contain elements of neighboring ecosystems, including the Sonoran Desert, the Southern California Mountains, the Great Basin, and the Colorado Plateau. Biological diversity across the network is concentrated primarily in riparian habitats (e.g. springs, oases, and stream corridors), montane islands, and specialized habitats (e.g. sand dunes). The network parks contain a variety of regionally, nationally, and globally significant resources.

The MOJN I&M was organized to inventory and monitor status and trends for selected natural resources (network organization facilitates collaboration, information sharing, and economies of scale in natural resource monitoring). The inventory and monitoring information is used by NPS and park unit resource managers to guide management decisions, to inform scientific research, and to provide public education. One goal of the NPS service-wide inventory and monitoring program is to collect and serve data to better understand the dynamic nature and condition of park-managed ecosystems and to provide reference points for comparisons with other management types and possibly with altered environments. The development of a vegetation classification to the vegetation alliance/plant association level and associated GIS map and database for each park is viewed as a high priority in reaching this goal. To help achieve this requirement, the MOJN I&M approached the NVIP for advice and support in 2007 and the MANZ project presented in this report and others at JOTR, GRBA, and LAKE have resulted.

For more information about MOJN I&M please visit their website at:

<http://science.nature.nps.gov/im/units/mojn>.

To view examples of other completed NVIP projects in MOJN I&M please access the NPS Data Store (URL: <http://irma.nps.gov>) or the USGS-NVIP website: <http://biology.usgs.gov/npsveg>.

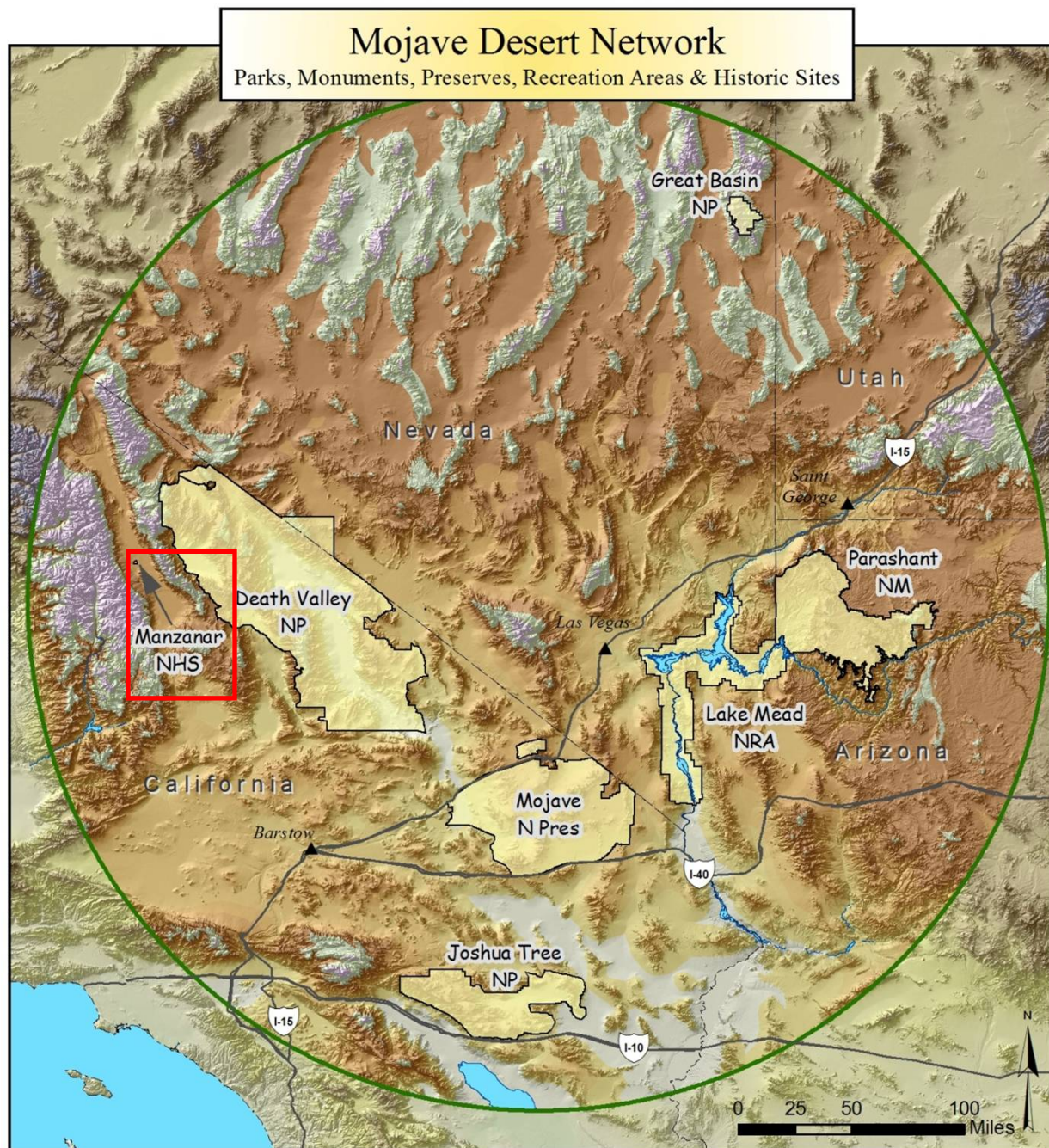


Figure 1. The Mojave Desert Network Inventory and Monitoring map. Source: NPS –MOJN I&M.

Manzanar National Historic Site

Manzanar National Historic Site (MANZ) was established by the NPS in 1992 to help conserve and protect a former World War II relocation camp used for detaining and housing Japanese Americans. The camp was created following Japan's surprise attack on Pearl Harbor on December 7, 1941. Shortly thereafter, the United States government began to forcibly move and relocate people of Japanese descent from the West Coast to one of 10 camps operated by the military. From 1942 to 1945 approximately 11,070 Japanese-Americans citizens and resident Japanese aliens were confined at MANZ in military-style barracks and facilities (NPS 2006). The original site encompassed about 2,500 hectares (6,200 acres) that was roughly square in shape and was encircled by barbed wire, manned guard posts and eight watchtowers (Figure 2). When it was running the camp contained a hospital, newspaper, cemetery, fire station, gardens, farms, ranches, and factories. After the war ended people at MANZ were forcibly removed from the camp, most of the building foundations, former gardens, portions of the road grid, an interpretive center (located in the former high school auditorium), restored and reproduced barracks, and numerous markers and memorials. In addition to the physical elements, MANZ most importantly preserves the stories of those interned and serves as an important reminder of the fragility of civil liberties (NPS 2007).



1-Entrance 2-Police Station 3-Newspaper 4-Administrative Section 5-Bachelor's Block 6-Manzanar High School 7-Auditorium 8-Fire Department 9-Typical Block 10-Catholic Church 11-Ranch 12-Orchards 13-Gardens 14-18-Hospital and Farm 19-Children's Village 20-Cemetery 21-Buddhist Temple 22-Garden 23-Net Factory

Figure 2. MANZ tour map with current facilities and interpretative areas. Source: NPS.

MANZ is located in the Owens Valley of eastern California along Highway 395 about 12 miles north of the town of Lone Pine and 5 miles south of the town of Independence (Figure 3). The current size of MANZ includes about 330 hectares (814 acres) that was acquired by NPS from the City of Los Angeles in 1997. The history of the Owens Valley is linked to the growth of Los Angeles and its increasing demand for water. Before the Los Angeles Department of Water and Power (LADWP) bought most of the land and water rights in the early 1900's, Owens Valley was known for its mining, fruit orchard farming, cattle ranches, and as the former home to the Owens Valley Paiute tribe and various other Native American peoples. The lands surrounding MANZ still contain numerous relicts and remnants of ranches, orchards, and the former settlements (NPS 2007). Today the flat central valley is owned and maintained primarily by LADWP and the foothills and slopes contain the Independence Creek, Symmes Creek, and Paiute Wilderness Study Areas managed by the Bureau of Land Management (BLM). Further upslope into mountains, the lands are part of the U.S. Forest Service (USFS) consisting of the Inyo National Forest and the John Muir and Inyo Mountain Wilderness Areas (Putman and Smith 1995) (Figure 3).

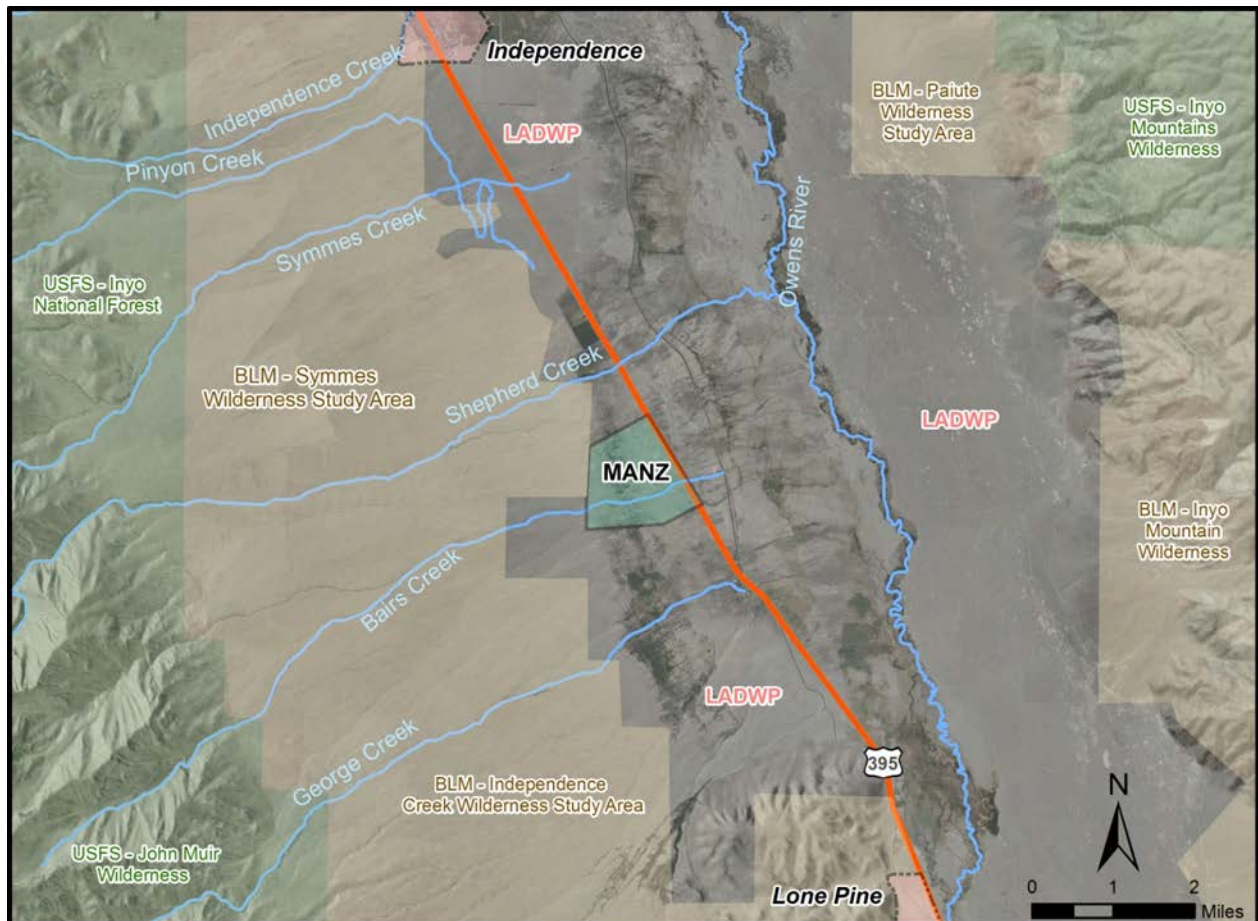


Figure 3. MANZ regional map. Source: CTI and ESRI National Data.

Natural Setting

Geographically the Owens Valley is bordered to the east by the Inyo and White Mountains and the Great Basin Desert. To the west is the eastern slope of Sierra Nevada Mountains and to the south is the Mojave Desert. The entire valley runs linearly northwest to southeast and the Owens River runs the length of the valley. The elevation of the valley floor is approximately 1,159 meters (3,800 feet) and some of the nearby mountains (including Mt. Whitney in the Sierras and White Mountain Peak in the White Mountains) reach over 4,267 meters (14,000 feet). The rain shadow created by the Sierra Nevada, Inyo, and White Mountains compounded by water diversions makes the land mostly arid and the Owens Valley is usually considered a high, dry desert valley (NPS 2006).

Moderate elevation, low humidity, and a dry climate can push summer temperatures at MANZ to over 100 °F (38°C) during the day with 60-70°F (16-21°C) nights. Winters are typically more moderate with highs around 40 °F (4°C) and lows at or slightly below freezing. The overall average annual temperature is about 59 °F (15°C). The rainy season for the Owens Valley occurs from December through March and the average precipitation totals about 4 inches (10 centimeters) per year coming in the form of rain and snow. Since the Owens Valley lies in the rain shadow of the Sierra Nevada Mountains most of the storms from the west deposit their precipitation on the mountain crest. Water is then gradually released into the valley as run-off during the spring and summer months. Depending on the levels of the snowpack, rainfall, and the amount of water diverted, Bairs Creek within MANZ can have substantial flows in the spring and summer and minimal or no flow during the fall and winter months (Figure 4). All of the water resources in the Owens Valley are closely monitored by the LADWP and water flowing in Bairs Creek can be diverted onto dry land if there is no demand. The release of water by LADWP into the ground likely raises or maintains the already high elevation water table at MANZ and may account for the presence of mesic riparian tree and shrub species like cottonwood and willow (personal communication, Tom Leatherman, former superintendent).



Figure 4. Views of Bairs Creek with flowing water at MANZ. Source: MOJN I&M and JOTR.

Topographically, MANZ is located at an interface between the Sierra Nevada bajada (a sloping, coalescing, spreading mass of gravel and sand extending from the mountain base into the surrounding valley) and the floor of the Owens Valley. Most of MANZ is flat with a slight increase in elevation as you travel west from the east side of the Historic site (Figure 5). The western edge of MANZ, outside of the core settlement area contains some gullies, arroyos, and dry washes. The majority of soils at MANZ are composed of alluvial materials deposited by erosional events from the Sierra Nevada Mountains. Soil materials are coarse and well-drained and consist of sand and gravel deposits that may be thousands of feet deep (NPS 2006).

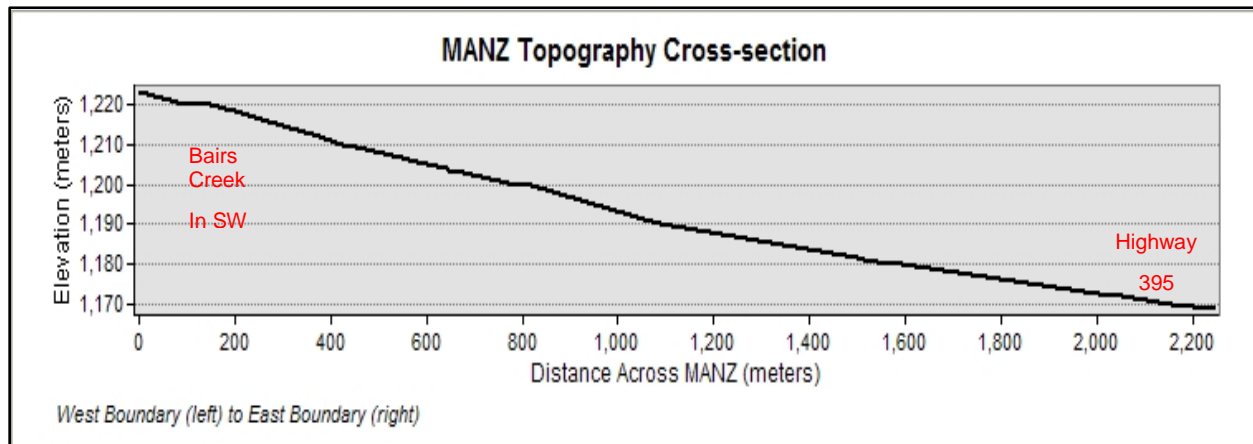


Figure 5. Representative MANZ topography cross-section. Source: CTI and USGS 30-Meter DEM.

Vegetation

MANZ represents a disturbed site that has been periodically inhabited and altered for nearly a century. Impacted by the continual manipulation of the water resources in the Owens Valley, the resulting vegetation at MANZ is comprised of a mixture of natural and semi-natural plant communities. The recent history of MANZ's current vegetation likely begins in 1942 with the creation of the camp and the blading of the site to remove all existing vegetation with the exception of a few large cottonwood trees and fruit orchards (personal communication, Tom Leatherman, former superintendent). During occupation, the internees again altered the site through the planting of gardens, trees, and crops. Following World War II and prior to MANZ being set aside as a national historic site, MANZ was used by the LADWP as a water diversion area during periods of high water run-off. Now as part of the NPS, MANZ's vegetation is largely being left to re-vegetate with both native and non-native species forming a mix of natural and semi-natural plant communities.

Temperature, climate, soils, hydrology and human settlement activities have all influenced the current vegetation at MANZ. Starting with the natural setting (before the site was turned into a settlement area), the vegetation at MANZ was probably a combination of dry Great Basin Desert scrublands with Mojave Desert upland and Rocky Mountain riparian influences. Some of these natural plant communities are still present or have returned to MANZ and include the following dominant desert scrub types:

1. Basin big sagebrush (*Artemisia tridentata* ssp. *tridentata*) that occur along the south and north sides of Bairs Creek and as smaller stands in north central MANZ;
2. Cattle saltbush or allsage (*Atriplex polycarpa*) along with small inclusions of shadscale saltbush (*Atriplex confertifolia*) that can be in the western portion of MANZ. Some smaller pockets also occur along the south and north boundaries; and
3. Rubber rabbitbrush (*Ericameria nauseosa*) that runs northeast to southwest through the center of the historic site.

In addition to the dry desert scrub plant communities (Figure 6), MANZ also supports a fairly undisturbed riparian corridor associated with Bairs Creek that runs almost parallel to MANZ's southern boundary. In this channel are stands of red willow (*Salix laevigata*), narrowleaf or coyote willow (*Salix exigua*), Rubber rabbitbrush (*Ericameria nauseosa*) and scattered individuals of Fremont cottonwood (*Populus fremontii*), Black locust (*Robinia pseudoacacia*) and Salt cedar (*Tamarix ramossisima*) (Andre 2006) (Figure 6). The channel is sparsely vegetated through most of its length with the exception of one dense stand of red willow (*Salix laevigata*) that occurs north of what was a chicken ranch during the camp period. Small stands of Wood's rose (*Rosa woodsii*) and narrowleaf or coyote willow (*Salix exigua*) occur on the banks above the creek channel.

Prior to the creation of the resettlement camp, the central portion of MANZ was previously planted between 1910 and 1920 with historic orchards consisting of pear and apple trees. Some of these orchards still exist today and are maintained by park staff. After establishment of the camp, the vegetation was again altered in various ways including the planting of black locust (*Robinia pseudoacacia*) and other ornamental trees for wind breaks and shade. Many of these plantings have thrived and spread across the central portion of the site in a northeast to southwest pattern. Left untended, these trees have grown into dense woodlands with some stands having canopy cover of nearly 100%. The understory in these woodlands receives little sunlight and only a few weedy species, like herb sophia (*Descurainia sophia*) a non-native forb, occur in the understory. Many of the stands are comprised primarily of black locust while others are a mix of black locust, Fremont cottonwood (*Populus fremontii*), red willow, tree of heaven (*Ailanthus altissima*), mulberry (*Morus alba*), southern catalpa (*Catalpa bignonioides*), Siberian elm (*Ulmus pumila*), and ornamental fig (*Ficus carica*) (Figure 6).

The most heavily impacted portion of the site occurs along MANZ's east boundary. In this central core area some of the former buildings including the auditorium have been continuously used by LADWP (and now NPS) and the flat areas were used in the past for storage and parking of department vehicles and equipment. The eastern portion, north of the park entrance road (and smaller stands interspersed throughout the site) contains large mixed herbaceous vegetation stands consisting of a variety of mostly native and non-native annual forbs (Figure 6). Tumbleweed or prickly Russian thistle (*Salsola tragus*) is one of the most common non-native species in these former high-use areas (Andre 2006). Similar to the mixed forblands but smaller in size are pockets of mixed grasses characterized by Mediterranean grass (*Schismus barbatus*), an abundant non-native, annual grass species that occurs in discrete patches within the larger forb stands. Native grasses at MANZ include

small patches of inland saltgrass (*Distichlis spicata*), Sandberg bluegrass (*Poa secunda*), and deergrass (*Muhlenbergia rigens*).

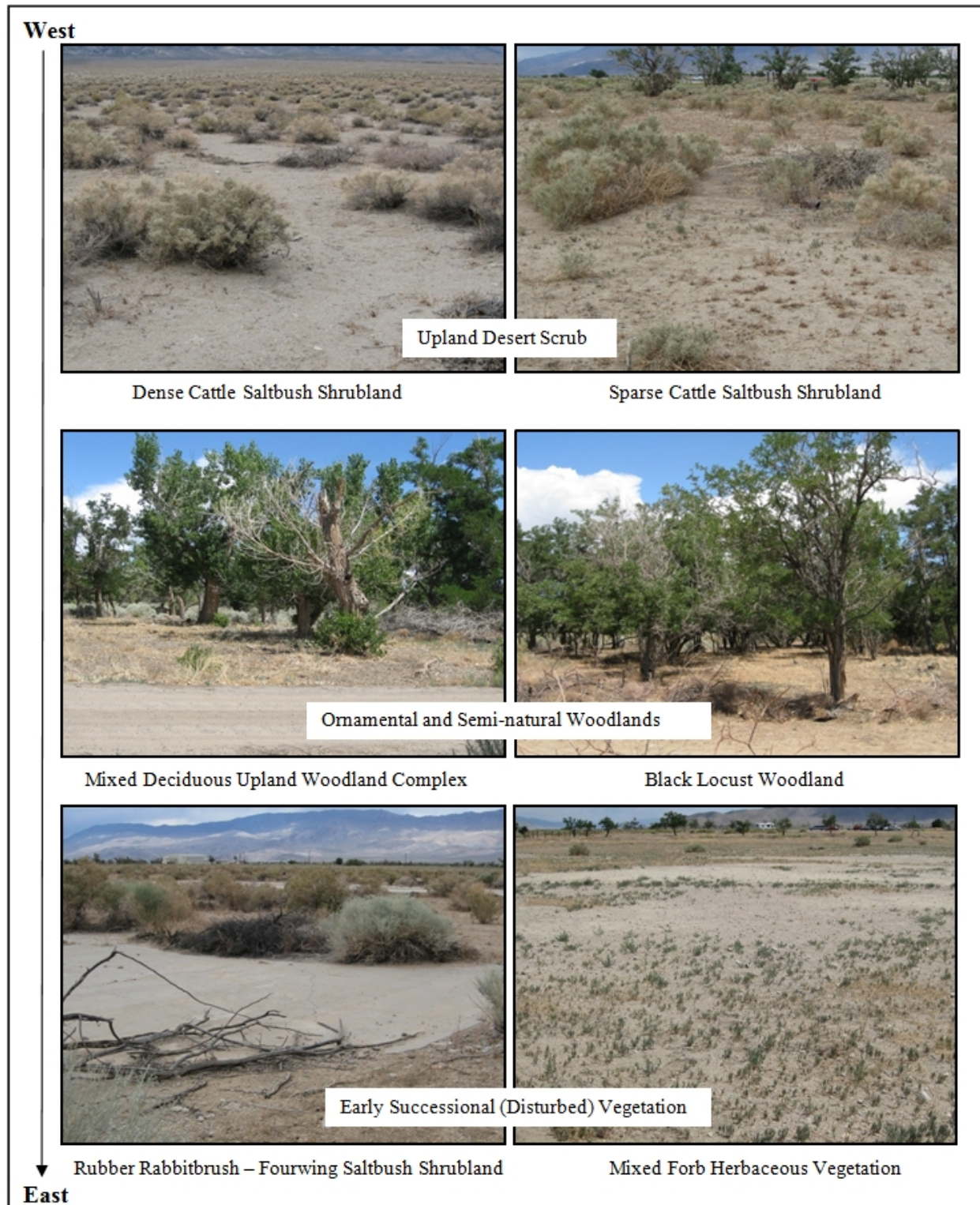


Figure 6. Common MANZ vegetation types. Source: MOJN I&M and NPS Photos.

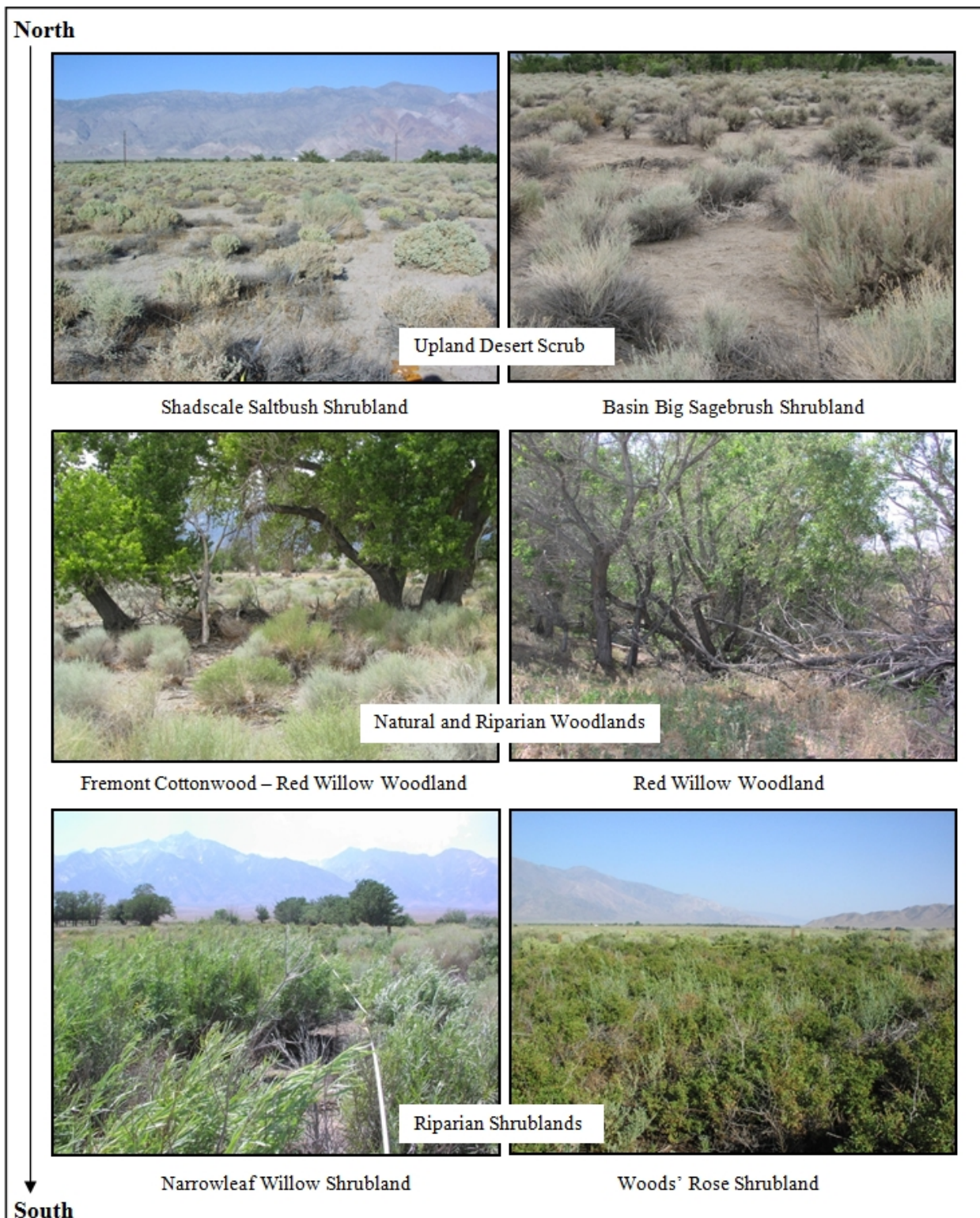


Figure 6. Common MANZ vegetation types (continued). Source: MOJN I&M and NPS Photos.

Likely driving the abundance and growth of the semi-natural and ornamental trees is the unique hydrologic area in the center of the historic site where groundwater remains close to the surface. The high water table is likely a result of both shallow impermeable geologic layers common to the Owens Valley and man-made water supplements from the periodic diversion and storage of water by the LADWP. Specifically from the 1970's until the 1990's the Department would use the site as an auxiliary floodplain to store water when there was too much to be carried by the aqueduct. The flooding process likely created a decline in the basin big sagebrush and a vector for the introduction of non-native plants. It has been speculated that during these diversions smallflower tamarisk (*Tamarix parviflora*) and saltcedar (*Tamarix ramosissima*) may have been introduced to the site (Figure 7). Specifically the diverted water may have carried tamarisk and saltcedar seeds that were able to establish when the water receded (personal communication, Tom Leatherman, former Superintendent).



Figure 7. Example of smallflower tamarisk and salt cedar stands at MANZ. Source: JOTR and MOJN I&M.

Based on topographic position the current vegetation at MANZ generally trends from west to east and from north the south. The western half of MANZ is mostly undisturbed and contains large homogeneous communities of cattle and shadscale saltbush. Similar stands of saltbush can also be found along the extreme southern and northern boundaries. The central portion of the historic site contains mixed deciduous woodlands and small stands of basin big sagebrush. The eastern half of MANZ is the most altered and contains broad swaths of rubber rabbitbrush and mixed forb vegetation. Riparian vegetation is present along the Bairs Creek drainage where it consists of evergreen and deciduous shrubs and trees in the channel, mostly barren side slopes and thick stands of basin big sagebrush and rubber rabbitbrush on the upper banks (Figure 8).

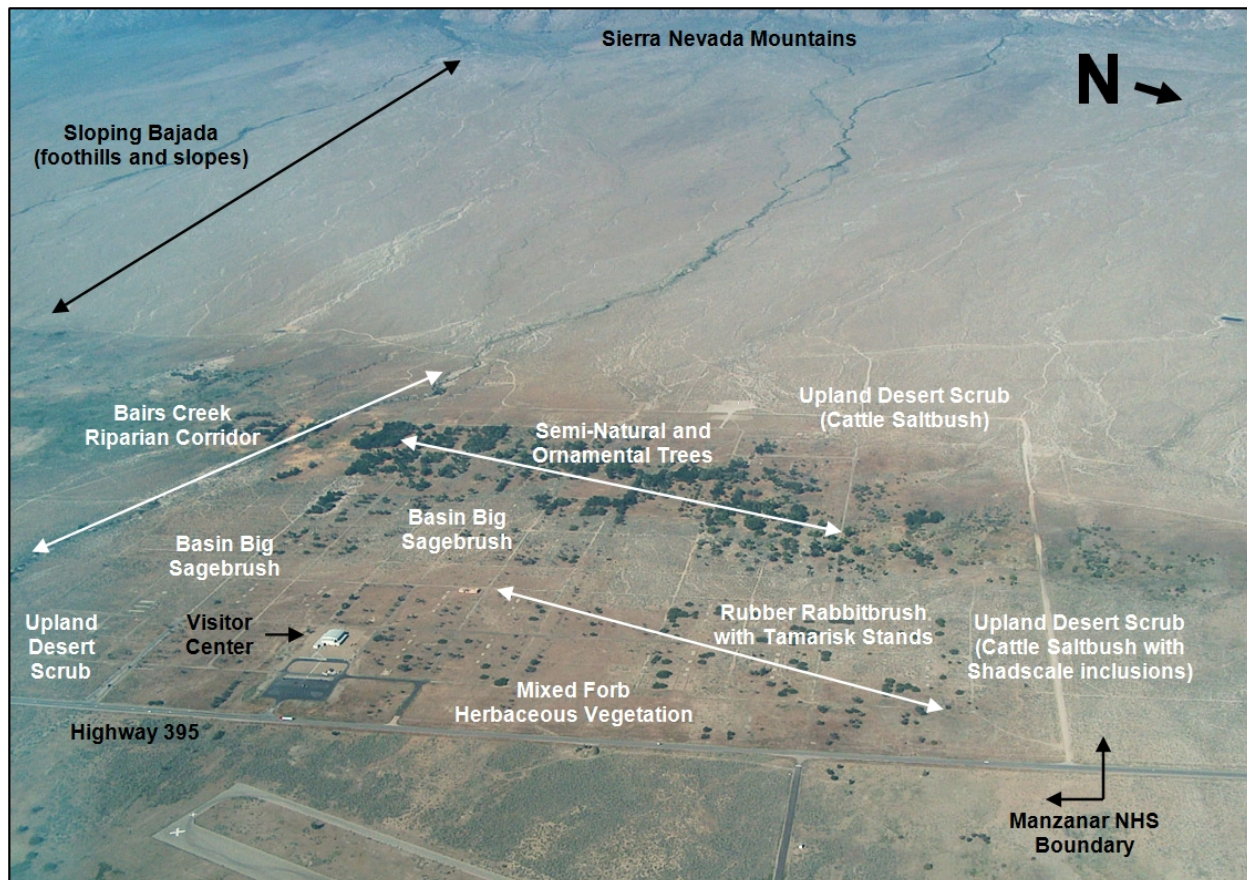


Figure 8. 2005 aerial photograph of MANZ with vegetation patterns. Source: MOJN I&M and CTI.

Vegetation Inventory Project

The specific decision to classify and map the vegetation at MANZ was made in response to guidelines set forth by the NVIP and implemented by the Mojave Desert Network. The MOJN I&M initiated a vegetation inventory for MANZ in 2008 as part of a larger effort to complete vegetation inventory maps for each of the seven parks in the Network. Planning for the inventory projects began with an initial multi-year study plan developed for the MOJN I&M by CTI (2008). The MOJN I&M study plan provided recommendations for completing the plant community classification, digital database, and map products for each of the MOJN I&M parks. The work plan received approval from the Washington Area Service Office (WASO) Inventory Coordinator in 2008.

Since MANZ is a relatively small site, it did not require the extensive planning and scoping as needed for larger NPS projects. Rather, the MANZ project began following two conference calls conducted in March and April of 2008. The first call included the (now former) MANZ park superintendent, Tom Leatherman, Angie Evenden (formally) with the NPS Great Basin Cooperative Ecosystem Studies Unit, and Alice Chung-MacCoubrey the (former) MOJN I&M program manager. During this call, Tom Leatherman provided information on the history and land use practices of the site and the NPS and MOJN I&M representatives provided a review of the NVIP program. Once the project was accepted by MANZ the second call was made to strategize how to set-up and complete the inventory project. Attendees on this call included Tom Leatherman, Karl Brown and Tammy

Cook of the NVIP, Alice Chung-MacCoubrey, Bob Truitt (Data Manager) and Jeanne Taylor, (Biological Technician) of the MOJN I&M.

Each conference call was used to determine whether the MANZ vegetation inventory project could move forward with the existing imagery and staff. To reduce costs and make the project economical the 2005 National Agricultural Imagery Project (NAIP) data was deemed acceptable for delineating the vegetation types. Principal team members were identified and included Bob Waltermire of the U.S. Geological Survey (USGS) in Fort Collins for mapping and GIS support and Jeanne Taylor for coordinating all of the field data collection efforts.

The MANZ vegetation inventory team objectives focused on producing the final data products under the national program's mandates as outlined in their 12 Step Guidance for NPS Vegetation Inventories (NPS 2009). The team addressed the following important NVIP directives:

Vegetation Information

- Vegetation classification will be based on the rUSNVC;
- A dichotomous field key of vegetation associations will be created;
- Formal descriptions of each vegetation association will be included;
- Representative ground photos will be taken of for all vegetation associations;
- All of the field data will be stored in a database format.

Spatial Data

- The map classification will be based on the rUSNVC and will include MANZ-specific requirements;
- Descriptions and a key will be created for each of the map units;
- A spatial database will be created for all of the vegetation data;
- Digital and hardcopy maps of the vegetation will be created;
- Metadata will be included for all spatial databases;
- An accuracy assessment of the vegetation spatial data will be performed.

Scope of Work

As requested by MANZ's superintendent, the vegetation inventory work at MANZ occurred within the historic site boundary. The future BLM addition to MANZ was not included at this time. It was also decided not to sample the semi-natural woodlands that occurred in the center of the historic site as the trees and orchards were considered to be semi-natural types (Figure 9). It was also noted by park staff that the eastern boundary of MANZ would likely be impacted by the future widening of Highway 395 from two to four lanes by the California Department of Transportation and the old highway will become a frontage road, possibly altering the extent of the vegetation mapping. Based on these decisions the final vegetation inventory project boundary covered 330-hectares (814-acres) consisting of the MANZ boundary as it existed in 2005 (Figure 10).



Figure 9. Example of a maintained semi-natural and ornamental orchard at MANZ. Source: NPS 2006.



Vegetation Inventory Project

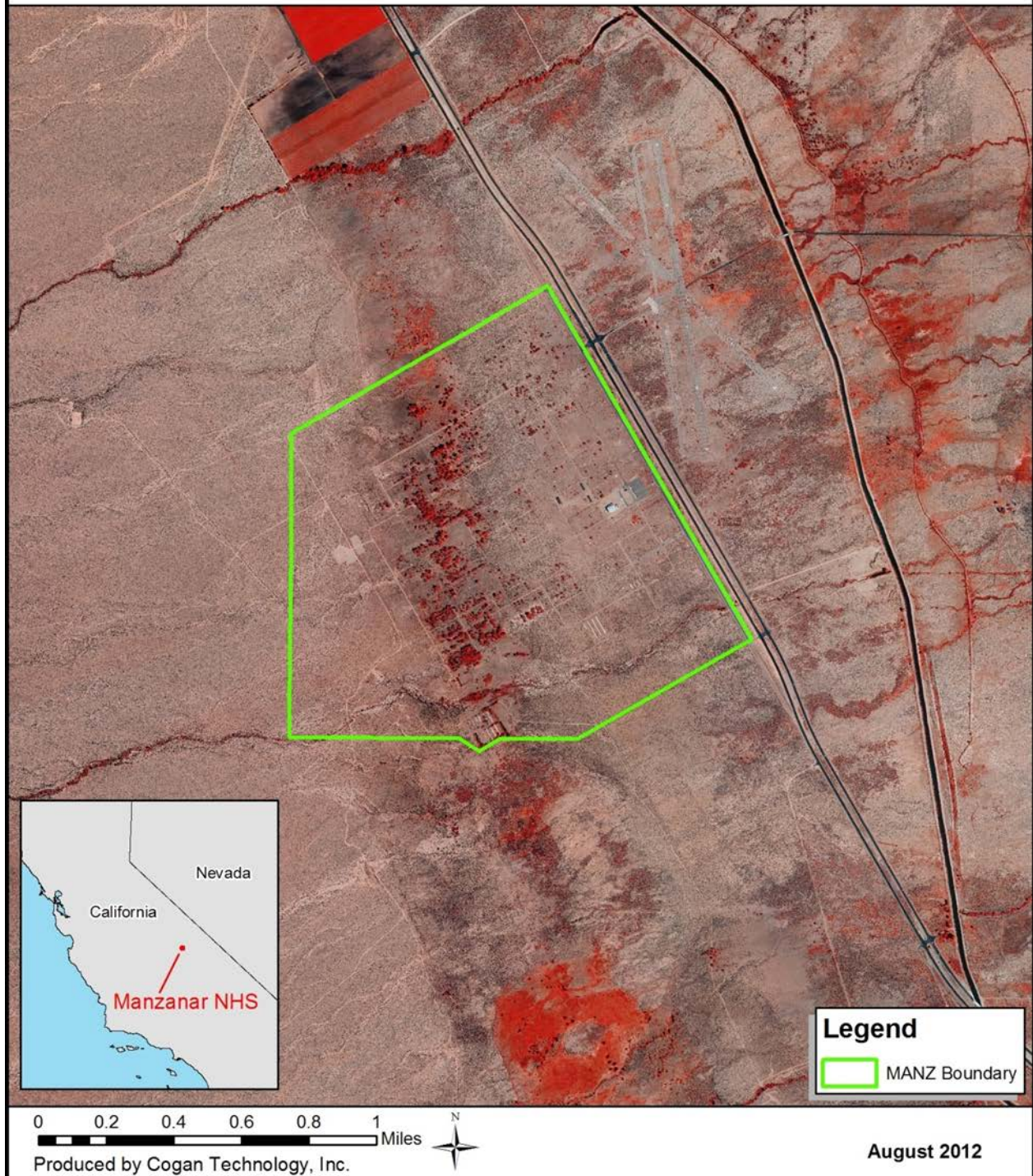


Figure 10. Map of the MANZ Vegetation Project and park boundary. Source: CTI and 2010 NAIP Imagery.

Methods

The vegetation inventory project at MANZ was considered to be in the “medium park” category based on the overall size of the project area (TNC and ESRI 1994b). The field sampling methods for vegetation mapping suggest a gradsect approach to meet the sampling goal of identifying and characterizing all of the vegetation types across the NPS site (TNC and ESRI 1994b). However, since the size of MANZ was close to the cut-off for a small park (i.e. 100 hectares) and the entire site could be easily accessed, the field sampling design and methodology was altered to improve efficiency and accuracy. As a result the main tasks of the project were switched so that a draft map delineating the stands of vegetation using aerial photography would be completed first. Then copies of the map layer would be provided to the MOJN I&M field crews and used for navigation. In this way a park-wide census of all the delineated polygons would be conducted to identify and record the vegetation types. Based on the draft vegetation map, map classes for each vegetation type would be developed, linked to the rUSNVC, and then used to revise and attribute the final vegetation polygons

Other than the sampling and mapping stages, the rest of the remaining vegetation inventory tasks were considered to be standard as outlined in the 12 Step Guidance for NPS Vegetation Inventories (NPS 2009). The five major project categories are summarized below and the following report sections give detailed descriptions for each:

1. Plan, gather data, and coordinate tasks;
2. Survey MANZ to understand and sample the vegetation;
3. Classify the vegetation using the field data to rUSNVC standard associations and alliances and crosswalk these to recognizable map units;
4. Acquire current digital imagery and interpret the vegetation from this using the rUSNVC and a map unit crosswalk;
5. Assess the accuracy of the final map product.

All protocols for this project as outlined in the following sections can be found in the original program documents produced by The Nature Conservancy and Environmental Research Systems Institute (TNC and ESRI 1994a, 1994b, 1994c) and later revisions (Lea 2011, Lea and Curtis 2010) and can be found on the NPS/USGS website: <http://biology.usgs.gov/npsveg>.

Planning, Data Gathering, and Coordination

Following the preliminary conference calls, all appropriate GIS layers necessary to begin the mapping were delivered to the USGS by MOJN I&M and MANZ staff. Relevant layers included the current MANZ boundary (as determined by the park superintendent) and point locations for all of the MANZ orchard trees. The orchard point file was subsequently processed by USGS GIS specialists into 2-meter radius buffers that were used to determine the square or rectangular perimeters for each orchard. In addition to the GIS layers, the USGS also obtained and reviewed all of the existing aerial and ortho imagery available for MANZ. Based on their review it was determined that the 2005 NAIP Manzanar NE Digital Orthophoto Quarter Quadrangle (DOQQ) had sufficient resolution to identify the different vegetation types at MANZ.

After the transfer of existing data, and throughout the entire project, the MANZ vegetation inventory project contributor list changed and evolved as various MOJN I&M and MANZ staff retired, transferred or left the NPS. To maintain workflow and consistency new staff members were briefed on the project and other entities were contracted to help finish the project. The following is a summary list of the principal MANZ vegetation inventory team members and their respective responsibilities:

NPS NVIP Staff

- Provide oversight and project funding;
- Assist with the development of the vegetation classification based on the rUSNVC using quantitative analysis and ecological interpretation of the field data;
- Write a field key to the vegetation types found at MANZ;
- Assist with the AA by generating the stratified random target points, creating field maps and providing GIS support;
- Review draft and final products and provide consultation;
- Accept the final products and finalize the project.

NPS MOJN I&M Staff

- Provide oversight and project funding;
- Provide project management;
- Contract with experienced mapping agencies and companies;
- Conduct all fieldwork and provide ground-based map verification data;
- Coordinate field work with MANZ staff;
- Coordinate the accuracy assessment vegetation data collection;
- Enter all of the field data in the M.S. Access-based PLOTs database;
- Assist with the develop of the vegetation classification based on the rUSNVC using ecological interpretation of the field data;
- Provide the crosswalk of vegetation types to map units;
- Write plant association descriptions;
- Draft preliminary project report that includes the methods and results for the field data collection, vegetation classification, and accuracy assessment portions;
- Review draft and final products;
- Present the final products to MANZ staff.

NPS MANZ Staff

- Provide local expertise and other resources;
- Supply digital boundary files and ancillary data files;
- Assist with fieldwork and provide logistical considerations;
- Review drafts of the vegetation map, classification and report;
- Accept the final products and finalize the project.

USGS Fort Collins Science Center

- Interpret the aerial photographs and delineate the draft vegetation and land use types;
- Develop draft map units that are linked to the rUSNVC;
- Provide field maps and GIS support to the MOJN I&M field crews;
- Transfer and automate interpreted data to a digital spatial database.

Cogan Technology, Inc. (Contractor)

- Help with overall project facilitation and coordination;
- Review AA points, generate contingency tables, and suggest post-AA modifications to the vegetation layer.
- Finalize the vegetation layer using the current 2010 NAIP imagery and create the final geodatabase;
- Provide a visual guide to the photo signatures of each map unit;
- Provide a final report describing the project;
- Document FGDC-compliant metadata for all vegetation data;
- Create a DVD with reports, metadata, guides, vegetation classification, plot data, spatial data, vegetation database (map), graphics, and ground photos;

Field Surveys

The overall objective of the MANZ vegetation inventory project was to produce a very detailed and accurate vegetation map highlighting the location of the native plant communities and documenting the distribution of the non-native species. Due to the small size of the historic site and the lack of existing vegetation data, the MANZ project required intensive ground-based sampling and map verification efforts. Fieldwork consisted of collecting all new vegetation plot data for the classification portion and numerous observation points and reconnaissance verification (waypoint) data to guide the photo-interpretation during the mapping phase.

To help guide the site visit work, USGS produced a very detailed draft vegetation map containing 759 polygons, with 473 of these polygons attributed to a preliminary vegetative map class. Working off the draft map, MOJN I&M staff visited 253 draft polygons and used corresponding verification (waypoint) and observation points to document the dominant vegetation (Figure 11). MOJN I&M staff also established 28 classification plots in representative stands for the following vegetation types: Basin big sagebrush (five plots), cattle saltbush (two plots), shadscale saltbush (five plots), rubber rabbitbrush (six plots), mixed forb herbaceous vegetation (four plots), mixed grass herbaceous vegetation (three plots), and one plot each for the red willow, Woods' rose and narrowleaf willow types. Upon review of the plot data, it was determined that more documentation of the plant communities was needed within the Bairs Creek area. This was addressed by having the AA crews collect additional rapid assessment-type plot data within the channel (see AA section of this report). The rapid assessment plot data was subsequently combined with the original classification plot data (Figure 11).



Plot, Observation Point and Waypoint Map

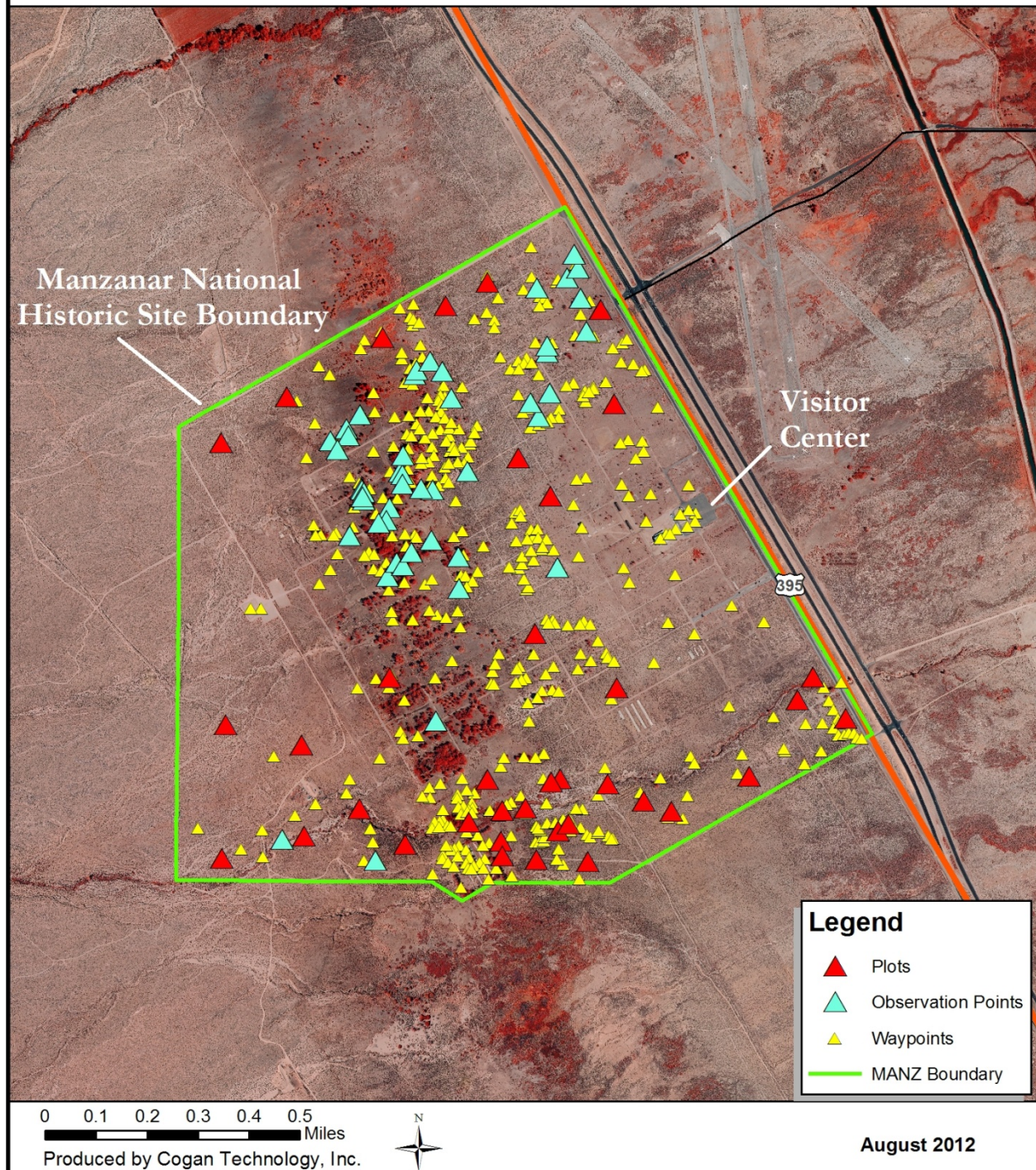


Figure 11. Map of the vegetation plots, observation points, and waypoint (verification point) locations collected at MANZ. Source: CTI and 2010 NAIP.

Initial MANZ field data collection was conducted during two field visits in May and July of 2008 by MOJN I&M staff. The site visits were used to collect initial information on the dominant vegetation communities based on the preliminary vegetation map. During the site visits the objective was to verify or correct the polygon map classes, determine if the delineated polygons needed to be merged, split or redrawn, and to establish at least one classification sample plot in each native stand of vegetation to classify the native vegetation types to the alliance level of the rUSNVC.

The field methods used during the site visits at MANZ followed the methodology outlined by the NVIP standards (TNC and ESRI 1994b and Lea 2011). All classification plot size and shape requirements were consistent with the guidelines (TNC and ESRI 1994b) and were determined by the physiognomy of the plant community being sampled (Table 2). Measuring tapes were used to establish the square or rectangular sampling area and the plot shape was adjusted as needed to sample linear bands of vegetation in drainage bottoms or other confined sites (Figure 12).

Table 2. Plot sizes used for classification sampling at MANZ.

Dominant physiognomy	Plot size	Plot area
Forest: trees have their crowns overlapping, usually forming 60-100% cover, and Woodland: open stands of trees with crowns usually not touching. Canopy tree cover 25-60%, OR exceeds shrub, dwarf-shrub, herb, and nonvascular cover.	Circular	
	11.28 m radius	
	Square	400 m ²
	20 m x 20 m	or 1,000 m ²
Shrubland: shrubs greater than 0.5 m tall are dominant, usually forming more than 25% cover OR exceeding tree, dwarf-shrub, herb, and nonvascular cover, and Dwarf-shrubland (e.g., heath): Shrubs less than 0.5 m tall are dominant, usually forming more than 25% cover OR exceeds tree, shrub, herb, and nonvascular cover.	Rectangle	
	20 m x 50 m	
	Circular	
	11.28 m radius	400 m ²
Herbaceous (e.g., grassland, meadow, marsh): Grasses or forbs dominant, usually forming more than 25% cover OR exceeds tree, shrub, dwarf-shrub, and nonvascular cover.	Square	
	20 m x 20 m	400 m ²
	Circular	or 100 m ²
	11.28 m radius	
Nonvascular (e.g., fen, bog, cliff, scree slopes: nonvascular cover dominant, usually forming more than 25% cover.	Square	
	20 m x 20 m	400 m ²
	Circular	or 100 m ²
	11.28 m radius	
Sparse vegetation (e.g., rock outcrops, talus slopes, and fell-fields): less than 10% total vegetation cover.	Square	
	20 m x 20 m	400 m ²
	Circular	or 100 m ²
	11.28 m radius	

Plots locations were selected after walking through a homogenous stand of vegetation and selecting a site that was representative of the entire stand. Once a representative site was chosen, the point was marked with a rebar and/or wooden stake. For most of the 28 plots, the stake marked the NE corner of the plot and meter tapes were laid in cardinal directions to the west and south to demarcate the sampling area.

Following the establishment of each plot, surveyors recorded plot location, environmental and species composition and cover data. All data were recorded on the plot field forms (Appendix A) and

UTM coordinates were recorded with a GPS unit. Plot location information included plot number, survey date, surveyor, UTM coordinates, directions to plot, plot size and shape, photo numbers and direction. For most plots, photos were taken from the NE corner, or the corner marked by a stake and recorded by with GPS. During the May site visit, three photos of each plot were taken from the NE corner to the W, SW and S. During the July site visit, six photos were taken for each plot from the NE corner to the W, SW, and S; from the NW corner to the SE corner; from the SE corner to the NW corner.

Environmental data collected at each classification plot included: elevation, slope, aspect, topographic position, landform, hydrologic (flooding) regime, animal use evidence and anthropogenic and natural disturbances. A description of the stand sampled and any adjacent stands were recorded in the comments field. The unvegetated surface was estimated and recorded as percent cover of bedrock, litter and duff, wood, bare soil, large rocks (>10 cm), small rocks (0.2 to 10 cm), sand (0.1 to 2 mm), lichens, and mosses. Next, the vegetation was visually divided into strata, with the height and canopy cover of the dominant vegetation (i.e. tree, shrub, herb) estimated for each stratum (Table 3). Within each stratum, all plant taxa within the plot area were identified and the percent foliar (actual) cover of each taxon was estimated.

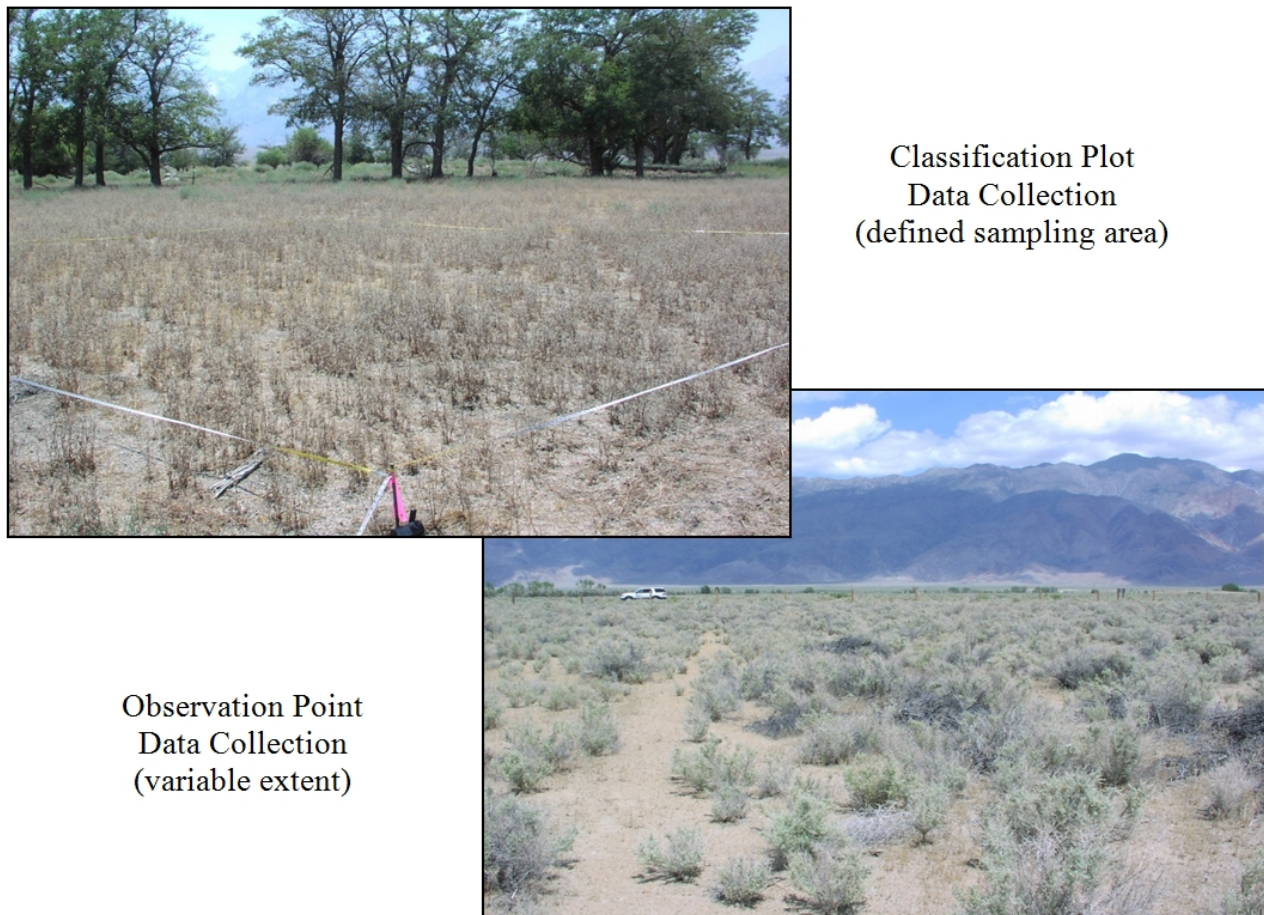


Figure 12. Example ground photos of the MANZ field data collection. Source: MOJN I&M.

Additional species within the vegetation stand that occurred outside of the classification plots were sometimes listed to assist with creation of local descriptions. Species that were not identifiable in the field were collected for later identification and specimens were discarded after being identified. Species were recorded by scientific name following the current nomenclature used by the USDA Plants Database and a provisional vegetation type was assigned to the plot. Appendix B contains all species found within sample plots and common names used throughout the document.

Table 3. Vegetation strata used at MANZ.

Vegetation strata
T1 Emergent Canopy
T2 Main Canopy
T3 Subcanopy
S1 Tall Shrubs
S2 Short Shrubs
S3 Dwarf-shrubs
H1 Herbaceous (Graminoids)
H2 Herbaceous (Forbs)
H3 Herbaceous (Ferns)
H4 Herbaceous (Tree seedlings)
A1 Floating-leaved aquatics
A2 Submerged-leaved aquatics

In addition to the vegetation classification plots, field crews collected observation and waypoint point data. Data recorded at observation points assessed an entire stand of vegetation and unlike the classification plots, the spatial extent around the point varied based on stand size. Data from the observation points were less detailed than that collected from the classification plots and were not used in the classification data analysis. At each observation point, surveyors recorded at a minimum the map polygon number, GPS waypoint number, UTME, UTMN, GPS error, aspect, elevation, photo numbers and photo direction, comments describing the point being sampled, and dominant species present.

Waypoint based data were used to verify the vegetation type of polygons that had been attributed with a preliminary vegetation type. At each waypoint only the polygon I.D., UTME and UTMN coordinates and one to four dominant plant species were recorded. Paper field forms were used for the observation points and waypoints (see Appendix A for observation point field form) and coordinate locations were recorded in the GPS receiver. Overall conditions at each observation/waypoint were documented by one or more digital photographs. All of the observation and waypoint data were collected to help describe the variability and extent of MANZ's plant associations, aid in the writing of the local plant community descriptions, and provide additional feedback on the preliminary mapping.

A third field site visit to MANZ was conducted in May of 2009 by MOJN I&M staff to test the draft vegetation field key prior to the AA. During the site visit, MOJN I&M botanists surveyed the narrow strip of land that lies within the historic site boundary on the east side of Highway 395. Another

vegetation type dominated by saltbush species (*Atriplex lentiformis* ssp. *torreyi* = *Atriplex torreyi*) was added to the list of vegetation communities based on this survey.

Vegetation Classification

In 2009, the MANZ vegetation classification began with entering all of the field data collected by MOJN I&M staff into a copy of the PLOTS database (ver.2.0). The PLOTS database is an Access database designed by the Colorado Natural Heritage Program to store classification, observation and accuracy assessment data produced as part of each mapping project. Data entry was performed by MOJN I&M technicians upon returning from the field. Any unknown plants were identified, data sheets were proofed and all data was entered in an iterative manner. Once the field data was stored in the PLOTS database, 100% of the new digital records were verified against the original field datasheets.

Upon completion of the data entry, the MANZ PLOTS database was sent to Chris Lea, at the NVIP for plant community analysis. All of the data from the 28 classification plots was analyzed using both Bray-Curtis (abundance) and Sorenson (presence/absence) cluster and distance statistical tests (Lea 2011). Additional tabular sorting was done on the preliminary results and the preliminary list of rUSNVC plant associations and alliances were sent to MOJN I&M for review and acceptance.

The final products of the classification task included a field key and local plant association descriptions. The dichotomous field key to the MANZ plant associations was developed to assist users in identifying plant associations in the field, particularly during the accuracy assessment task (Appendix C). The local descriptions were based on the field data and provide MANZ characteristics for each plant association within a modified NatureServe template (Appendix D).

Digital Imagery and Vegetation Mapping

The vegetation mapping was conducted at MANZ in two phases. The first phase conducted by the USGS Fort Collins Science Center created the primary vegetation and associated spatial data layers using the 2005 NAIP Manzanar NE DOQQ imagery (acquired on September 3, 2005 from the Cal-Atlas Geospatial Clearinghouse at <http://atlas.ca.gov/>). Preliminary mapping was conducted by the USGS through a semi-automated process using a combination of the ENVI Feature Extraction Module (ITT Visual Information Systems, 2008) and ArcGIS software (ESRI, 2008).

Preliminary vegetation and land-use/land-cover polygons were created by the USGS to assist with field work and to help with the placement of the classification plots. All preliminary vegetation polygons were created by first converting the 2005 NAIP imagery to The Environment for Visualizing Images (ENVI) format and then using the Feature Extraction Module (FEM) to segment the image. The resulting vectors were then exported, cleaned, and edited. Based on periodic feedback from MOJN I&M, the vegetation database evolved through several iterations of editing, adding, and removing polygons. Early iterations were automatically processed in ENVI and later modifications involved manual on-screen edits based on the field verification and GPS derived data. The USGS produced a draft vegetation layer and a brief accompanying report for MANZ in January 2009 (Figure 13). In addition to the preliminary vegetation map layer the USGS also created digital road and building pad layers.

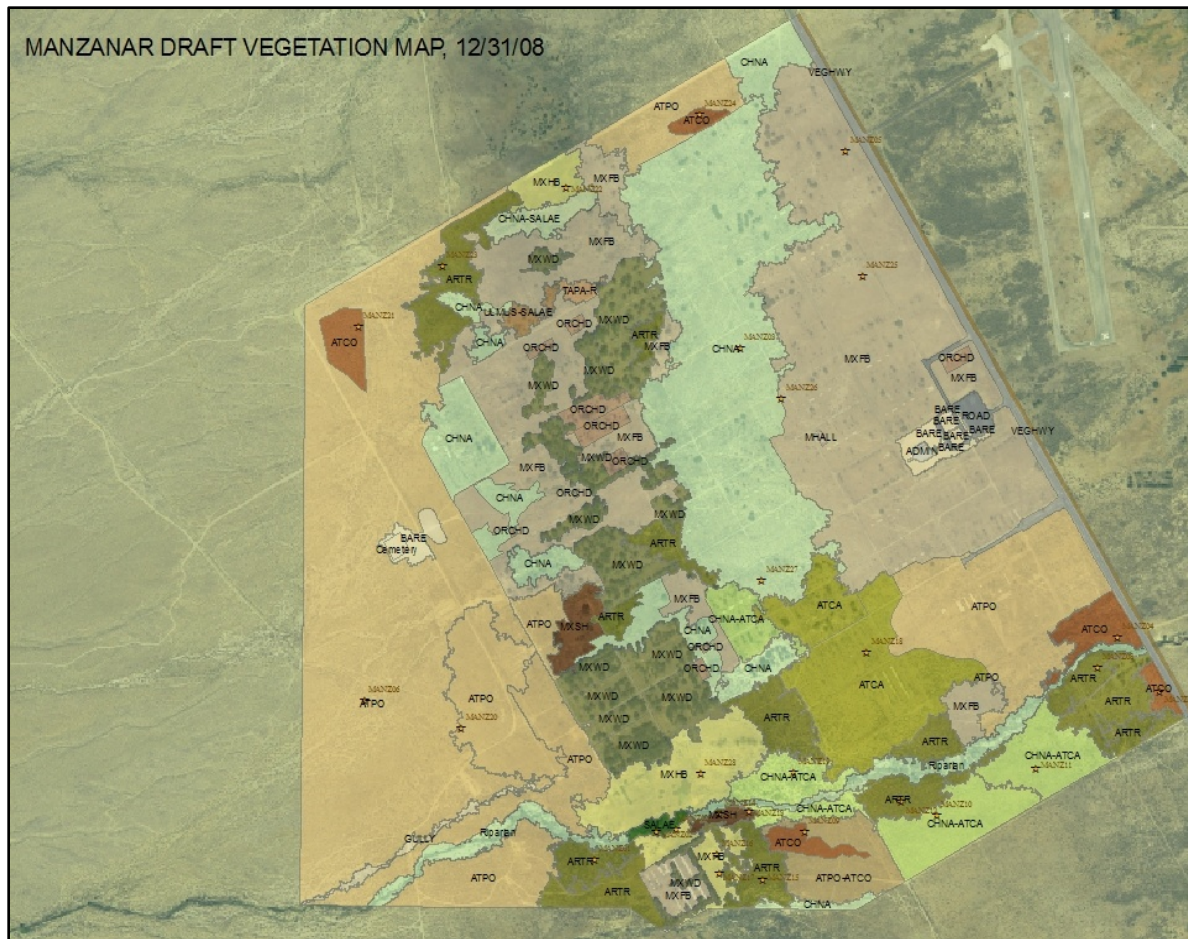


Figure 13. USGS draft MANZ vegetation layer overview map. Source: USGS and NAIP 2005.

Phase two of the vegetation mapping began in the summer of 2012 when Cogan Technology, Inc. (CTI) was contracted by the MOJN I&M to complete the MANZ project. As part of the contract CTI was tasked with reviewing the MANZ vegetation inventory project, improving the accuracy of the preliminary vegetation layer (if possible), and creating all of the standard NVIP final deliverables. To complete the project, CTI obtained all MANZ field, GIS, and supporting datasets from MOJN I&M along with a current digital copy of the 4-band 2010 NAIP DOQQ image for Manzanar NE (Figure 14).

The preliminary vegetation layer, field plots, observations and all other spatial data was overlain on the 2010 NAIP imagery by CTI and all relevant lines and polygons were exported as shapefiles and converted to coverages. The resulting coverages were then run through a series of smoothing routines provided in the ArcGIS software (ESRI, 2008). Following smoothing, the line-work was manually cleaned to remove extraneous lines, small polygons, and polygons that obviously split a homogenous stand of vegetation. The cleaning stage was considered complete when all resulting polygons matched homogenous stands of vegetation apparent on the 2010 NAIP imagery.



Figure 14. Comparison and examples of the 2005 and 2010 NAIP imagery for MANZ.

Review of the preliminary USGS vegetation polygon layer by CTI staff also revealed that many of the mixed grass herbaceous vegetation, riparian shrub, and deciduous tree polygons could be improved using the color infrared band of the 2010 NAIP DOQQ. To improve the accuracy of these map units along with the rest of the vegetation map in general, all polygon lines were manually updated by digitizing them directly off the 2010 NAIP imagery.

The second and final phase of the mapping for MANZ was considered complete with the attribution of the polygons with the final rUSNVC-based map unit names. In most cases, the preliminary map unit names and labels were simply changed to reflect the current rUSNVC association, alliance or higher level name. Any significant departures from the original map unit were recorded as alternative map unit names and codes in the vegetation spatial layer. The resulting map units were then correlated or “cross-walked” to the rUSNVC by noting when plant associations were used as a map unit or when they were grouped. To round-out the mapping scheme, additional map units were created 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, facilities, and bare land. A separate class of map modifiers or “Park Specials” was defined especially for MANZ based on the earlier USGS mapping work to cover bare ground and specific structures.

In addition to the final map unit names and codes other polygon specific information or polygon modifiers were added to the vegetation layer by CTI (Table 4). Polygon modifiers included both physical quantifiers and general comments fields. Physical attributes for each of the vegetation polygons at MANZ included information on the average height of the vegetation, average density of the dominant vegetation stratum, and the general pattern/shape of the vegetation in each polygon. Finally the vegetation layer was converted to a Geodatabase file and all of the common rUSNVC data contained in the final MANZ classification was joined using relationship-classes.

Table 4. Polygon attribute items and descriptions used in the MANZ GIS vegetation layer.

ATTRIBUTE	DESCRIPTION
AREA*	Surface area of the polygon in meters squared
PERIMETER*	Perimeter of the polygon in meters
MANZVEG*	Unique code for each polygon
MANZVEG_ID*	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
ALT_DESC	Map Unit Scientific Alternative Description Name – Project Specific (original name)
ALT_CDESC	Map Unit Scientific Alternative Description Name – Project Specific (original name)
DENS_MOD	Modifier - Percent Cover of the Upper Stratum Layer in the Polygon Percent cover classes: Sparse 10 - 25% , Open 25 - 60% , Discontinuous - Closed > 60%
PTRN_MOD	Modifier - Vegetation Pattern within the Polygon Vegetation pattern classes: Evenly Dispersed = Homogeneous Grouped Stands of Vegetation = Bunched / Clumped , String of Vegetation = Linear
HT_MOD	Modifier - Height Range of the Dominant Vegetation Layer Height classes: < 1, 1-5, 5-15, and 15-30 meters
COMMENTS	Additional Comments about the Individual Polygons
ACRES	Surface area of the polygon in acres
HECTARES	Surface area of the polygon in hectares

*ArcInfo® default items

Accuracy Assessment

After the draft USGS vegetation layer was completed and finalized the accuracy assessment (AA) was conducted at MANZ. In summary, the USGS draft map was checked, AA analyses were computed, and then the new 2010 NAIP imagery was used to refine the edges of the polygons. 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 NVIP however, 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 plus the high resolution and accuracy of the 2010 NAIP imagery allows for the assumption that all products derived from them are well within National Map Accuracy Standards for 1:12,000-scale maps (± 30 feet).

The thematic accuracy of the vegetation map was assessed using the methodology following the standards provided by the NVIP (TNC and ESRI 1994c and Lea and Curtis 2010). The revised protocols included a four step AA process consisting of a sample design, sample site selection, data collection, and 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 5). Using the standard AA sample size parameters and the draft vegetation layer, the NVIP and MOJN I&M picked random target locations that were not already sampled at MANZ. To complete the list of sampling targets, additional points were added to long linear riparian polygons and rare types that were missed. The resulting target locations were restricted to within the boundary of MANZ.

Table 5. Standard sample size allocations for AA points based on map unit area.

MAP CLASS TOTAL AREA*	NUMBER OF OBSERVATIONS PER MAP CLASS
>50 hectares	30**
8.33 to 50 hectares	0.6 per hectare**
<8.33 hectares	5**

* - as measured before buffering for cost surface (access buffer) or for map class boundary buffer.

** - or as many spatially independent (non-overlapping) observation sites as map class area, MMU size and other considerations will allow.

Once the target locations were selected, ecologists from Joshua Tree National Park (JOTR) were provided with draft field maps, overview maps, the field key to the associations (Appendix C), and digital GPS files containing the location of the target AA sites. During the 2009 summer each of the AA targets was visited and the dominant vegetation association as determined by the field key was recorded (Figure 15). At each target the field crews recorded the primary and any secondary plant associations that occurred within roughly 40 meters (131 feet) in radius around the target (Lea and Curtis 2010). Most of the AA points had a circular observation area equivalent to the MMU of 0.5 hectare. For a few AA points, a rectangular observation area was used when assessing linear bands of vegetation (e.g. riparian shrublands). Field crews also recorded AA point location comments, conformance to key (good, fair, poor) dominant species and the stratum and height class of the major species (see AA point form in Appendix A). To better assist the analysis, ground-based photographs were taken at each AA point to photo-document the current state of the vegetation.



Figure 15. Example ground photos of the AA data collection at MANZ. Source: JOTR and MOJN I&M.

In addition to AA point data, the JOTR staff also collected data for 10 Rapid Assessment (RA) points. The RA data was collected at the request of MOJN I&M staff to document in more detail the vegetation types within Bairs Creek, the mixed woodland and the strip of vegetation along the east side of Highway 395. The RA method is a sampling method used to rapidly collect detailed vegetation data to describe plant communities. The method was developed by the California Native Plant Society (CNPS) in conjunction with the California Department of Fish and Game (CDFG) and is employed by both organizations on vegetation classification and mapping projects conducted throughout the state. Though typically an RA is a stand-based assessment, at MANZ, the sampling area was 0.5 hectare. The data collected using the RA method is more detailed than an observation point and less detailed than a classification plot (see Rapid Assessment field form in Appendix A).

Between May and June of 2009, JOTR field staff sampled a total of 119 AA points (Figure 16) located across the entire park. The data recorded on the field forms were subsequently entered into the MOJN I&M PLOTS database and reviewed for data entry errors. Incomplete data on the field sheets were corrected if possible. The results of the AA data collection were imported from the PLOTS database into a GIS layer. The determination of the vegetation associations and corresponding map unit names in the field were then visually compared to the predicted map unit polygon labels during two stages of review. In the first stage the original AA point data was used by the USGS and MOJN I&M to generate a sample contingency table to highlight any errors with the data collection. Points that deviated from the predicted polygon label were further examined by reviewing the field forms in question and their associated ground photographs.



Accuracy Assessment Point Map

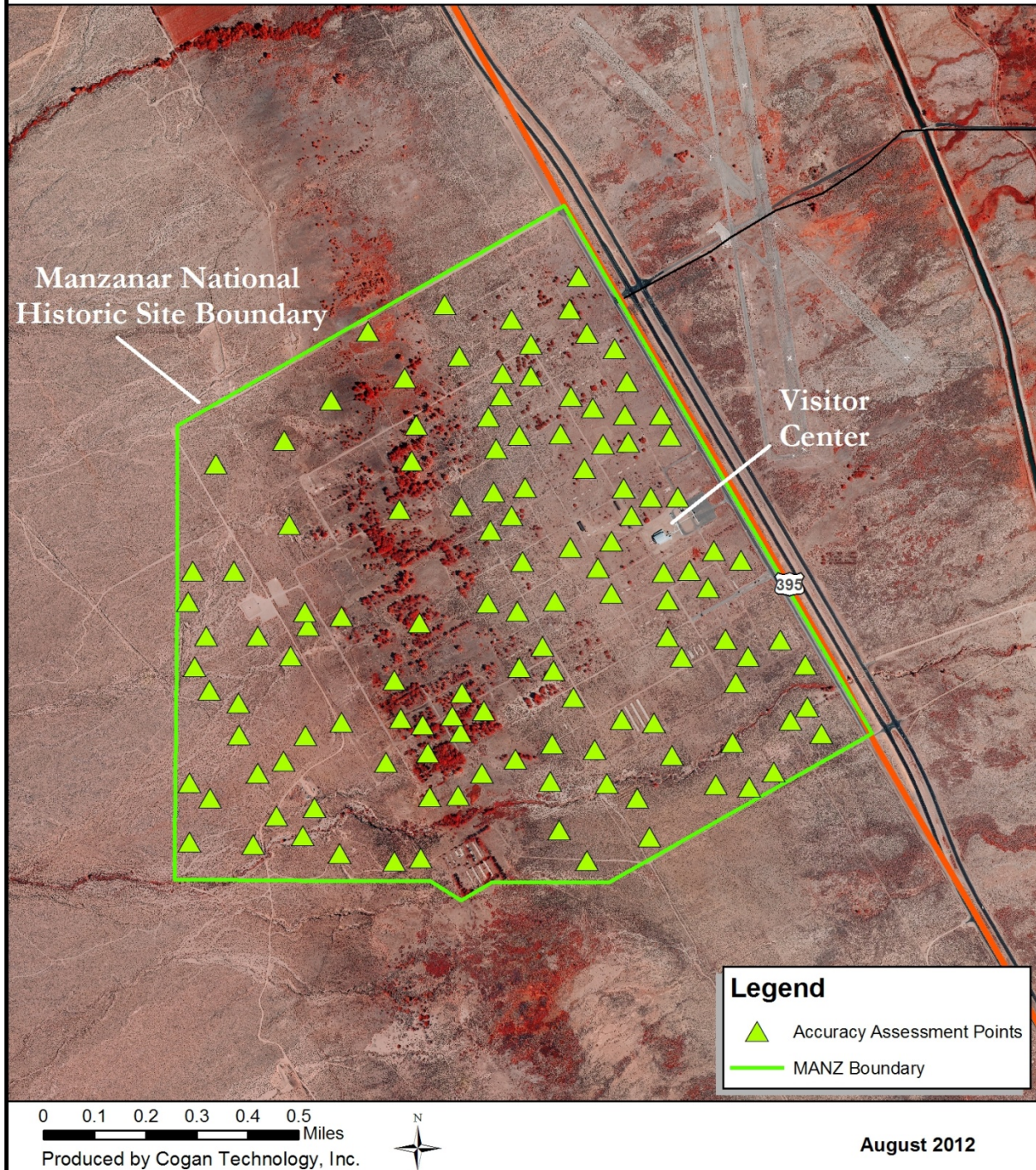


Figure 16. Map of the Accuracy Assessment points collected at MANZ. Source: CTI and 2010 NAIP.

CTI examined all the MANZ AA data in 2012. Common errors found in the AA data included: incorrect UTM coordinates, missing or incomplete field calls, discrepancies in the field key and partial polygons within the USGS draft layer (i.e. unclosed polygons with an incorrect label). Most of the fractional and unlabeled polygons were corrected using the new 2010 NAIP imagery and the final map allowed CTI to resolve most of the other AA issues by having a more recent and accurate view of the vegetation. CTI recorded all changes using a final AA point label and provided a description of the changes in the comments field of the final AA point layer. In most cases, the primary vegetation map unit name assigned by the AA field crews was retained and modified, however some points were assigned a different vegetation map unit based on one of the following reasons: (1) it appeared that the field call was incorrect based on the 2010 NAIP imagery (i.e. mixed woodlands could now be identified to species such as Fremont cottonwood), (2) the data were actually recorded in a stand that was too small (i.e. inclusion below MMU size), or (3) the species and cover data more appropriately matched another map unit (e.g. high grass cover = Mixed Grass Herbaceous Vegetation vs. Mixed Forb Herbaceous Vegetation).

After reviewing all of the MANZ AA data, the final AA analysis was conducted using custom GIS programs and AA templates created by CTI. Through this automated process, the final map units in the AA layer were compared to the map unit designations for their corresponding polygons as described in the program manuals and templates (TNC and ESRI 1994c and Lea and Curtis 2010). Final assessments for each point were recorded using both sample and population error matrices and contingency tables.

Results

Vegetation Classification

The preliminary MANZ classification created by Chris Lea and the NVIP resulted in 10 plant communities (Table 6). Preliminary types included examples of mesic, extremely xeromorphic and microphyllous evergreen shrubland alliances; semi-natural woodlands; riparian woodlands; and herbaceous alliances. Descriptions for all 10 types were produced by NVIP (Appendix D) and were incorporated into the field key (Appendix C) that was used during the accuracy assessment.

Table 6. Summary of preliminary vegetation types for MANZ.

Preliminary Vegetation Type Name
Mixed Woodland
<i>Salix laevigata</i> Seasonally flooded Woodland Alliance
<i>Artemisia tridentata</i> ssp. <i>tridentata</i> Shrubland Alliance
<i>Atriplex polycarpa</i> Shrubland Alliance
<i>Atriplex confertifolia</i> Shrubland Alliance
<i>Atriplex lentiformis</i> Shrubland Alliance
<i>Ericameria nauseosa</i> Shrubland Alliance
<i>Rosa woodsii</i> var. <i>ultramontana</i> Temporarily Flooded Shrubland Alliance
Mixed Forb Alliance
Mixed Herbaceous Alliance
<i>Salix exigua</i>

Although the vegetation was classified by the NVIP, the resulting vegetation types were not in the rUSNVC. To create the final rUSNVC vegetation types, CTI with MOJN I&M assistance, assigned final vegetation association and alliance names (when possible) based on the classification plot data. The current list of rUSNVC types were queried on-line from the NatureServe Explorer website (NatureServe 2012) and existing vegetation associations were then examined for similar species and overlap in distribution. If a preliminary vegetation type was successfully matched to a rUSNVC association or alliance, the official name and code of that type was adopted. In addition to the preliminary vegetation types CTI also thoroughly reviewed the observation point and waypoint data for other undocumented rUSNVC plant associations that occurred at MANZ.

The final MANZ classification resulted in seven existing rUSNVC plant alliances, three alliances currently under review by NatureServe and three alliances that are either provisional (similar concepts used at other NPS sites) or park special alliances that are unique to MANZ. MOJN I&M staff further matched some of the plot data to specific associations as indicated in Table 7. The nomenclature for all of the MANZ plant alliances/associations follows NatureServe and FGDC standards and includes the use of provisional indicators to represent local plant communities that are temporarily included in the rUSNVC based on documentation at other NPS sites. Parentheses in the name indicate the species may or may not be present in a given stand. An “-” indicates the species occurs in the same vegetation stratum and a “/” indicate that species occur in different vegetation strata.

Table 7. Summary of rUSNVC associations, alliances, and park specials for MANZ.

rUSNVC Alliance	rUSNVC Association(s)	Element Code
<u>Woodlands</u>		
<i>Populus fremontii</i> Temporarily Flooded Woodland Alliance		A###
	<i>Populus fremontii</i> - <i>Salix laevigata</i> Woodland	CEGL005308
<i>Robinia pseudoacacia</i> Semi-Natural Stands		Provisional
	(No Association)	(N/A)
<i>Salix laevigata</i> Woodland Alliance		A###
	<i>Salix laevigata</i> Woodland Stand	Park Special
<u>Shrublands</u>		
<i>Artemisia tridentata</i> (ssp. <i>tridentata</i> , ssp. <i>xericensis</i>) Shrubland Alliance		A.830
	<i>Artemisia tridentata</i> Shrubland	CEGL000991
<i>Atriplex confertifolia</i> Alliance		A.870
	<i>Atriplex confertifolia</i> Great Basin Shrubland	CEGL001294
<i>Atriplex</i> (<i>lentiformis</i> , <i>polycarpa</i>) Shrubland Alliance		A.864
	(No Association)	(N/A)
<i>Atriplex polycarpa</i> Shrubland Alliance		A.873
	<i>Atriplex polycarpa</i> Shrubland	CEGL001318
<i>Ericameria nauseosa</i> Shrubland Alliance		A.835
	<i>Ericameria nauseosa</i> - <i>Atriplex canescens</i> Shrubland	Park Special
<i>Rosa woodsii</i> Temporarily Flooded Shrubland Alliance		A.959
	<i>Rosa woodsii</i> Shrubland	CEGL001126
<i>Salix exigua</i> Temporarily Flooded Shrubland Alliance		A.947
	<i>Salix exigua</i> / Mesic Forbs Shrubland	CEGL001202
	<i>Salix exigua</i> – <i>Ericameria nauseosa</i> Riparian Shrubland	Park Special
<u>Herbaceous Vegetation</u>		
<i>Amsinckia</i> (<i>menziesii</i> , <i>tessellata</i>) Alliance		Park Special
	<i>Amsinckia tessellata</i> Herbaceous Vegetation	Park Special
<i>Bromus</i> (<i>diandrus</i> , <i>hordeaceus</i> , <i>madritensis</i>) Herbaceous Alliance		Park Special
	(No Association)	(N/A)
<i>Distichlis spicata</i> Alliance		A###
	<i>Distichlis spicata</i> Herbaceous Vegetation	CEGL001770

-Alliance codes with "###" are under review

The majority of vegetation types classified for MANZ contained some non-native and weedy species and some had overlap among dominant species, especially in types within the same physiognomic group (i.e. woodlands and shrublands). In the dry, upland vegetation types there was little difference in the composition of the herbaceous layer but the herbaceous species did change when compared to the moister, riparian vegetation types. The final classification for MANZ includes mostly park special herbaceous vegetation since the non-native and annual plants occurring at MANZ are not currently recognized by the rUSNVC. The Manual of California Vegetation (MCV) does recognize several annual herbaceous alliances. The Mixed forb and Mixed Herbaceous vegetation types

occurring at MANZ were matched to three herbaceous alliances in the MCV and have been included in the vegetation descriptions under other Classification Systems.

Digital Imagery and Mapping

The final MANZ map classes represent a compromise between the coarseness of the preliminary classification, the needs of the resource management staff, and the resolution of the 2010 NAIP imagery. As a result, the mapping legend does not exactly match the rUSNVC. In most cases the rUSNVC associations or alliances were used as map units, but some of the mapping types represent a one map unit to multiple associations/alliances relationship. When the rUSNVC link was not feasible, descriptive local map units or park specials were created. The concept of a management driven vegetation or land-use type of local interest or concern represents a “park special”. The following types represent the possible map scenarios encountered in the MANZ project:

1. **One-to-one relationship** = When a plant association or vegetation alliance had a unique photo signature and could be readily delineated on the imagery, the map unit adopted the plant association/alliance name or similar synonym.
2. **One-to-many relationship** = When related plant associations shared the same photo signature and could not be distinguished on the imagery, several plant associations were combined into a single map class complex.
3. **Additional Park Special Map Classes** = Created for unique vegetation stands and types of local interest or concern to MANZ management.
4. **Land Use – Land Cover** = Non-vegetated areas and vegetation types not recognized by the rUSNVC received Anderson et al. (1976, updated 2002) map unit designations.

For MANZ, 21 map units (14 vegetated, 1 barren geology, and 6 land-use/land-cover) were developed. The final list of map classes/units was directly cross-walked or matched to corresponding plant associations/alliances, land use classes, or retained as park specials (Table 8). Appendix E contains descriptions and representative photographs for all the vegetation map units used at MANZ.

Table 8. Map classes and relationships to MANZ plant associations or map unit descriptions.

Map Code	Map Class Name	rUSNVC Association/Alliance Assigned to Map Class (or Map Unit Description)	Relationship
Forests and Woodlands			
W_MXWD	Mixed Deciduous Upland Woodland Complex	N/A	Park Special
W_POFR	<i>Populus fremontii</i> - <i>Salix laevigata</i> Woodland	- <i>Populus fremontii</i> - <i>Salix laevigata</i> Woodland	1:1
W_ROPS	<i>Robinia pseudoacacia</i> Woodland Stand	- <i>Robinia pseudoacacia</i> Semi-natural Stands	1:1
W_SALA	<i>Salix laevigata</i> Woodland Stand	N/A	Park Special

Table 8. Map classes and relationships to MANZ plant associations or map unit descriptions (continued).

Map Code	Map Class Name	rUSNVC Association/Alliance Assigned to Map Class (or Map Unit Description)	Relationship
Shrublands			
S_ARTR	<i>Artemisia tridentata</i> ssp. <i>tridentata</i> Shrubland	- <i>Artemisia tridentata</i> (ssp. <i>tridentata</i> , ssp. <i>xericensis</i>) Shrubland Alliance	1:1
S_ATCO	<i>Atriplex confertifolia</i> - <i>Atriplex polycarpa</i> – (<i>Atriplex lentiformis</i>) Shrubland	- <i>Atriplex confertifolia</i> Alliance - <i>Atriplex (lentiformis, polycarpa)</i> Shrubland Alliance	1:Many
S_ATPO	<i>Atriplex polycarpa</i> Shrubland Complex	- <i>Atriplex polycarpa</i> Shrubland	1:1
S_ERNA	<i>Ericameria nauseosa</i> – (<i>Atriplex canescens</i>) Shrubland	- <i>Ericameria nauseosa</i> Shrubland Alliance	1:1
S_MXSB	Mixed Upland Shrubland Stand	N/A	Park Special
S_ROWOW	<i>Rosa woodsii</i> Shrubland	- <i>Rosa woodsii</i> Shrubland	1:1
S_SAEEX	<i>Salix exigua</i> Temporarily Flooded Shrubland	- <i>Salix exigua</i> Temporarily Flooded Shrubland	1:1
S_TAPA	<i>Tamarix parviflora</i> Shrub Stand	N/A	Park Special
Herbaceous Vegetation			
H_MXFB	Mixed Forb Herbaceous Vegetation	<i>Amsinckia (menziesii, tessellata)</i> Alliance	1:1
H_MXGR	Mixed Grass Herbaceous Vegetation	- <i>Bromus (diandrus, hordeaceus, madritensis)</i> Herbaceous Alliance - <i>Distichlis spicata</i> Herbaceous Vegetation	1:Many
Geology and Sparse Vegetation			
G_ROCK	Soil and Rock Outcrop Sparse Vegetation	N/A	Park Special
Land-use / Land-Cover			
L_BARE	Bare Rock / Sand / Other Bare Ground	Unvegetated rock, cleared land, etc.	N/A
L_CEM	Cemetery	Cemetery	N/A
L_FACL	Facilities	Visitor center, mess hall, barracks and other NPS buildings	N/A
L_ORCH	Orchard / Vineyards / Groves	Previously planted woody vegetation used for fruit production, shade, wind-breaks, and landscaping	N/A
L_ROAD	Transportation	Maintained paved and earthen roads	N/A
L_TRAN	Transitional	Concrete foundation and pads of former buildings	N/A

Vegetation Map

The MANZ vegetation map consists of 617 polygons totaling 326 hectares (814 acres) (Appendix F) with an average polygon size of about 0.5 hectares (1.4 acres) (Table 9). The relatively small polygon size was due in part to the detailed mapping of riparian vegetation and the delineating of small stands of other trees and shrubs. The mapping was also finely detailed since the 2010 NAIP imagery was of high resolution and contrast allowing for very small stands of vegetation to be accurately delineated (Figure 17). The 2005 and 2010 were both 1-meter products; however, the contrast, the color infrared band, and the excellent background soils distinction all gave superior interpretive power to the 2010 NAIP dataset. All of the extensive vegetation data created for MANZ in this project prove difficult to convey in a table or on a two-dimensional map but it should be understood that the different attributes can be combined in many ways and at different scales and resolutions to produce additional products better representing the full spectrum of the vegetative diversity. For example, areas of past disturbance or decline in the shrublands could be queried by selecting shrub polygons and then re-selecting polygons with low density (10 – 25% cover).

Upon review of the final vegetation layer, 219 hectares (542 acres) or 67% of MANZ was covered by one of the five upland desert scrub shrubland communities. Riparian wood and shrublands comprised 2% of the total area (6 hectares, 15 acres). Woodlands, both natural and semi-natural, occurred in 106 polygons and covered 27 hectares (67 acres) or 8% of the project area. Across all vegetation polygons, various levels of disturbance were present on 89% of the historic site (290 hectares, 718 acres). Other analysis of the vegetation trends at MANZ include the average height of the tree canopy to be between 5 and 15 meters and the average shrub height was less than one meter.

Table 9. Summary statistics for the MANZ map class polygons.

Map Code	Map Unit Description	MANZ Project Boundary		
		# of Polygons	Acres	Hectares
W_MXWD	Mixed Deciduous Upland Woodland Complex	31	37.2	14.9
W_POFR	<i>Populus fremontii</i> - <i>Salix laevigata</i> Woodland	14	4.0	1.5
W_ROPS	<i>Robinia pseudoacacia</i> Woodland Stand	40	14.8	5.9
W_SALA	<i>Salix laevigata</i> Woodland Stand	12	7.3	2.8
S_ARTR	<i>Artemisia tridentata</i> ssp. <i>tridentata</i> Shrubland	57	91.4	36.9
S_ATCO	<i>Atriplex confertifolia</i> - <i>Atriplex polycarpa</i> - (<i>Atriplex lentiformis</i>) Shrubland Complex	11	17.2	7.1
S_ATPO	<i>Atriplex polycarpa</i> Shrubland	65	244.5	99.1
S_ERNA	<i>Ericameria nauseosa</i> - (<i>Atriplex canescens</i>) Shrubland	101	180.7	72.4
S_MXSB	Mixed Upland Shrubland Stand	11	8.2	3.4
S_ROWOW	<i>Rosa woodsii</i> Shrubland	17	5.0	1.7
S_SAEEX	<i>Salix exigua</i> Temporarily Flooded Shrubland	7	4.1	1.6
S_TAPA	<i>Tamarix parviflora</i> Shrub Stand	36	6.5	1.9
H_MXFB	Mixed Forb Herbaceous Vegetation	70	129.0	52.5
H_MXGR	Mixed Grass Herbaceous Vegetation	16	11.5	4.7
G_ROCK	Soil and Rock Outcrop Sparse Vegetation	21	7.5	2.8
L_BARE	Bare Rock / Sand / Other Bare Ground	15	8.3	3.3
L_CEM	Cemetery	1	0.6	0.2
L_FACL	Facilities	6	1.2	0.4
L_ORCH	Orchard / Vineyards / Groves	9	4.0	1.5
L_ROAD	Transportation	2	27.9	11.3
L_TRAN	Transitional	75	1.6	0.3
Total Vegetation		488	761	306
Total Barren Geology		21	7.5	2.8
Total Land Use / Land Cover		108	44	17
Totals		617	814	326



Example of Vegetation Map Classes

Map Code Map Unit Description

W_MXWD	Mixed Deciduous Upland Woodland Complex
W_POFR	<i>Populus fremontii</i> - <i>Salix laevigata</i> Woodland
W_ROPS	<i>Robinia pseudoacacia</i> Woodland Stand
W_SALA	<i>Salix laevigata</i> Woodland Stand
S_ARTR	<i>Artemisia tridentata</i> ssp. <i>tridentata</i> Shrubland
S_ATCO	<i>Atriplex confertifolia</i> - <i>Atriplex polycarpa</i> - (<i>Atriplex lentiformis</i>) Shrubland Complex
S_ATPO	<i>Atriplex polycarpa</i> Shrubland
S_ERNA	<i>Ericameria nauseosa</i> - (<i>Atriplex canescens</i>) Shrubland
S_MXSB	Mixed Upland Shrubland Stand
S_ROWO	<i>Rosa woodsii</i> Shrubland
S_SAEX	<i>Salix exigua</i> Temporarily Flooded Shrubland
S_TAPA	<i>Tamarix parviflora</i> Shrub Stand
H_MXFB	Mixed Forb Herbaceous Vegetation
H_MXGR	Mixed Grass Herbaceous Vegetation
G_ROCK	Soil and Rock Outcrop Sparse Vegetation
L_BARE	Bare Rock / Sand / Other Bare Ground
L_CEM	Cemetery
L_FACL	Facilities
L_ORCH	Orchard / Vineyards / Groves
L_ROAD	Transportation
L_TRAN	Transitional

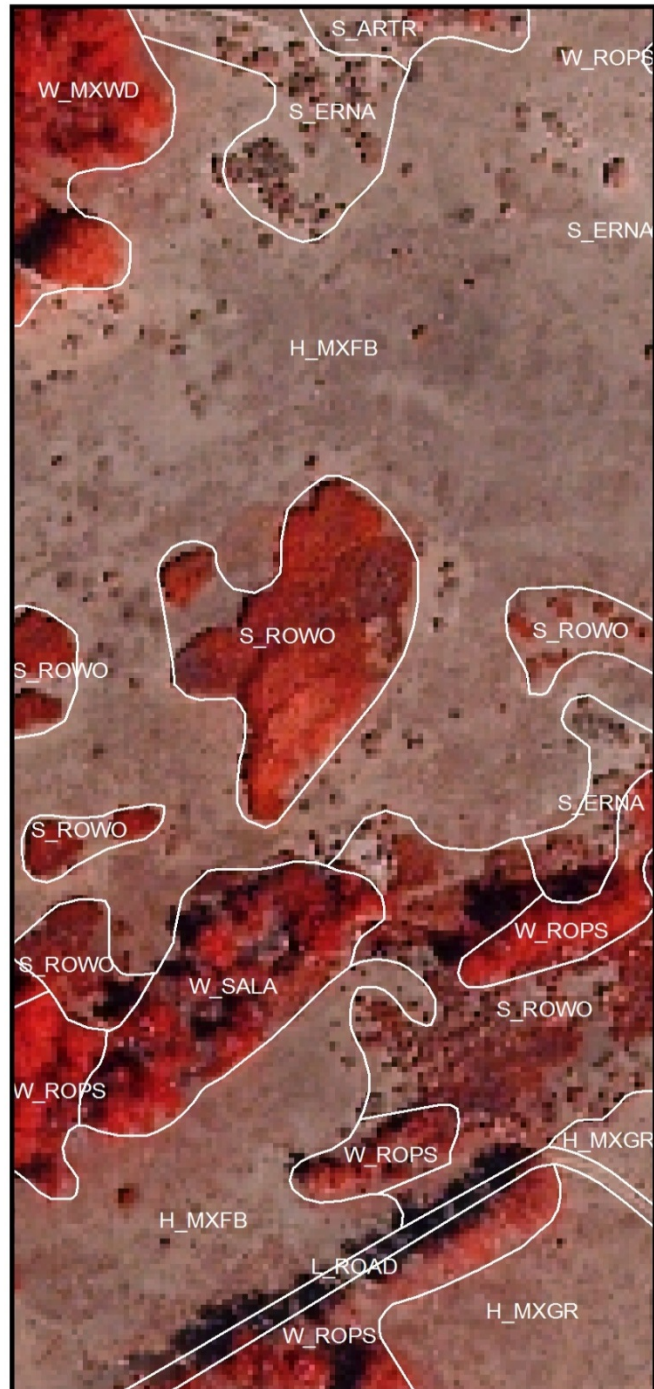
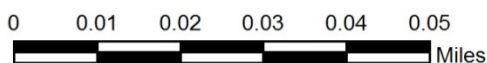
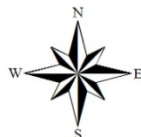


Figure 17. Example of the MANZ vegetation map layer. Source: CTI and 2010 NAIP (Color Infrared Band).

Accuracy Assessment

NPS ecologists from JOTR collected 126 AA points distributed throughout MANZ in the summer of 2009. After the fieldwork, the resulting AA data was entered in the PLOTS database and some of the AA point data was used to update the classification and to revise the local plant community descriptions. Analysis of the AA points involved a point-by-point review in two stages. In stage one, an AA GIS point file was created from the point coordinates recorded in the field. The AA point layer was then digitally overlaid on the preliminary USGS vegetation map and a comparison of the final AA field call versus the vegetation polygon label was made by MOJN I&M staff. Stage one resulted in a preliminary error matrix that was reviewed by CTI and was found to have an overall accuracy of 73% and of the 11 preliminary map units tested, six map units had low accuracy ($\leq 40\%$) and two had marginal accuracy (77-78%) values.

Stage two of the analysis involved an in-depth CTI review of the mapping and AA procedures, making any necessary changes, and re-running the accuracy assessment. Following the up-dates, mapping errors were reported in both a sample contingency table (Table 10) and a population contingency table (Table 11). The sample contingency table includes the observation counts, with the predicted, sample data values (vegetation map classes) as rows and the observed reference data values (vegetation types as identified on the ground) as columns. The value in the cells is the number of accuracy assessment observations mapped in each class (row) that were found to be of a specific class (column) in the field. The values in the shaded cells along the diagonal represent counts for correctly classified observations, where the reference data (column) vegetation type matches the mapped vegetation type (row) value. Conversely, the inaccuracies of each map unit (points off the diagonal) are described as both errors of inclusion (user's or commission errors) and errors of exclusion (producer's or omission errors).

The population contingency table is similar to the sample table; however the values in each cell are the proportion of the target area in the corresponding true and mapped vegetation classes, rather than the raw count of observations. The row sums p_{i+} are the proportions of the total area mapped as type i . The column sums p_{+j} are the proportions of the total area that are truly class J , which is not known, but can be estimated from the reference data values.

By reading across these tables (i.e., rows) one can calculate the percent error of commission, or how many polygons for each map unit were incorrectly labeled when compared to the field data. By reading down the tables (i.e., columns) one can calculate the percent error of omission, or how many polygons for that type were left off the map. Numbers "on the diagonal" tell the user how well the map unit was interpreted and how confident they can be in using it. Numbers "off the diagonal" yield important information about the deficiencies of the map including which types were either: (1) over-mapped - commission errors on the right –more of this type was mapped than occurs at the site, or (2) under-mapped - omission errors on the bottom – some of this type was mapped as other map units

Table 10. Final sample contingency table for MANZ.

Map Code	W_MXWD	W_POFR	W_ROPS	S_ARTR	S_ATCO	S_ATPO	S_ERNA	S_ROWOW	S_TAPA	H_MXFB	Total	User's Accuracy
W_MXWD	12	0	0	0	0	0	0	0	0	0	12	100%
W_POFR	0	3	0	0	0	0	0	0	0	0	3	100%
W_ROPS	0	0	1	0	0	0	0	0	0	0	1	100%
S_ARTR	0	0	0	11	0	0	0	0	0	0	11	100%
S_ATCO	0	0	0	0	4	0	0	0	0	0	4	100%
S_ATPO	0	0	0	0	0	39	0	0	0	0	39	100%
S_ERNA	0	0	0	1	0	3	36	0	0	0	40	90%
S_ROWOW	0	0	0	0	0	0	0	1	0	0	1	100%
S_TAPA	0	0	0	0	0	0	0	0	1	0	1	100%
H_MXFB	0	0	0	0	0	0	1	0	0	13	14	93%
Total	12	3	1	12	4	42	37	1	1	13		
Producer's Accuracy	100%	100%	100%	92%	100%	93%	97%	100%	100%	100%		

Table 12 Note: Columns represent AA observation names (field calls) and rows represent predicted mapping unit names (polygon labels).

Table 11. Final population contingency table for MANZ.

Map Code	W_MXWD	W_POFR	W_ROPS	S_ARTR	S_ATCO	S_ATPO	S_ERNA	S_ROW0	S_TAPA	H_MXFB	Row Total	1	2	3	4
W_MXWD	0.021	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	100%	96%	100%	2%	0.021
W_POFR	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	100%	83%	100%	0%	0.000
W_ROPS	0.000	0.000	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	100%	50%	100%	1%	0.000
S_ARTR	0.000	0.000	0.000	0.131	0.000	0.000	0.000	0.000	0.000	0.000	100%	95%	100%	13%	0.000
S_ATCO	0.000	0.000	0.000	0.000	0.025	0.000	0.000	0.000	0.000	0.000	100%	88%	100%	2%	0.000
S_ATPO	0.000	0.000	0.000	0.000	0.000	0.351	0.000	0.000	0.000	0.000	100%	99%	100%	35%	0.000
S_ERNA	0.000	0.000	0.000	0.006	0.000	0.019	0.233	0.000	0.000	0.000	90%	81%	99%	26%	0.000
S_ROW0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.000	0.000	100%	50%	100%	1%	0.000
S_TAPA	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.009	0.000	100%	50%	100%	1%	0.000
H_MXFB	0.000	0.000	0.000	0.000	0.000	0.000	0.013	0.000	0.000	0.172	93%	78%	100%	19%	0.000
A	100%	100%	100%	95%	100%	95%	95%	100%	100%	100%					
B	100%	100%	100%	95%	100%	94%	93%	100%	100%	98%					
C	100%	100%	100%	95%	100%	95%	96%	100%	100%	100%					
D	14.90	1.50	5.90	95.92	17.20	258.05	171.84	5.00	6.50	119.79					

ROW A = PRODUCERS' ACCURACY ($P_{i=Y|J=Y}$)

ROW B = LOWER LIMIT, 90% CONFIDENCE INTERVAL, PRODUCERS' ACCURACY

ROW C = UPPER LIMIT, 90% CONFIDENCE INTERVAL, PRODUCERS' ACCURACY

ROW D = ESTIMATED TRUE AREA (A_{+j}) (HECTARES)COLUMN 1 = USERS' ACCURACY ($P_{J=X|i=X}$)

COLUMN 2 = LOWER LIMIT, 90% CONFIDENCE INTERVAL, USERS' ACCURACY

COLUMN 3 = UPPER LIMIT, 90% CONFIDENCE INTERVAL, USERS' ACCURACY

COLUMN 4 = π_i

Based on the population table accuracy analysis for MANZ the overall accuracy and Kappa values of the vegetation layer are as follows:

OVERALL ACCURACY (P_o)	=	96.1%
LOWER LIMIT, 90% CONFIDENCE INTERVAL	=	93.2%
UPPER LIMIT, 90% CONFIDENCE INTERVAL	=	99.0%
KAPPA (K):	=	94.9%
LOWER LIMIT, 90% CONFIDENCE INTERVAL, K	=	91.1%
UPPER LIMIT, 90% CONFIDENCE INTERVAL, K	=	98.6%

Analyzing the final AA data shows that the JOTR field crews assessed 10 of the 14 map units at MANZ. The W_SALA, S_MXSB, S_SAEX, and H_MXGR map units were not assessed by the field crews and were not included in the final assessment. All four types were considered in the AA design but were not targeted for AA fieldwork due their very small size and limited distribution. All four types covered less than 5 hectares and occurred in less than 20 polygons. In addition, most of the map unit polygons omitted from the assessment were previously sampled with classification plots, observation points, or waypoints and thus ineligible for further AA sampling.

All of the remaining map units had high user's and producer's accuracy of at least 90% and about half of the map units had low sample sizes of between one and four AA points. Having only one or two points in some of the types was due to the large amount of sampling and verification work that occurred prior to the AA stage. This resulted in only a couple of unsampled polygons for the rare types that could be targeted for AA work. In other words, the census nature of the mapping and review left few, if any remaining polygons to be checked during the AA, resulting in a rather high general confidence in the types shown.

Other sources of error in the map units can likely be explained by the difficulty in resolving the difference in scale and perspective between viewing the vegetation on the imagery and assessing it on the ground. For example, sampling could have occurred in inclusions, or small stands of shrubs (rubber rabbitbrush) below 0.5 hectare observation area size of the AA point that were actually a part of a larger herbaceous vegetation (mixed forb) type. Also the similar appearance of closely related mapping units likely caused some confusion in the mapping signatures leading to incorrect polygon labels (i.e. basin big sagebrush vs. rubber rabbitbrush shrubs).

Discussion

Past disturbances and the recent recovery of the native vegetation at MANZ made for many unique challenges during the vegetation inventory, classification, and mapping stages of this project. Challenges included many classification and mapping considerations due to the presence and high cover of many non-native and ornamental plant species not typically encountered in other NPS sites. The inventory and mapping process described in this report although largely successful revealed opportunities for improvement and new approaches for future efforts that are discussed herein.

Approaches that worked well: The small size of MANZ coupled with unlimited access allowed most of vegetation to be either sampled or verified on the ground. Through multiple, all inclusive field visits over 3-years, the vegetation at MANZ (especially the location of orchard and non-native trees) is likely more thoroughly documented by GPS-located data than similar projects. In addition, updating the vegetation layer using the 2010 NAIP imagery provided a superior mapping product that was more accurate and detailed and produced a map that reflected more recent changes to the landscape in and around MANZ. The color-infrared band of the 2010 imagery also greatly assisted with the delineation of riparian shrubs/trees and the separation of the mixed grassland from the mixed forb herbaceous vegetation type.

Areas for Improvement: Inherent to all vegetation mapping projects is the need to produce both a consistent vegetation classification and a comprehensive set of map units. Since the inception of the rUSNVC, little attention has been paid to non-native and early successional vegetation communities. Instead much of the classification focus has occurred on natural and intact stands of vegetation. For MANZ this lack of national data resulted in the inability to cross-walk most of the mixed tree, shrub and herbaceous vegetation classes. In the future, as the rUSNVC continues to evolve, it may be possible to revisit the mixed types that occur at MANZ and place them into appropriate vegetation associations and alliances.

Users of this product should also remember that the mapping portion of this project is primarily a remotely sensed exercise and the field work was conducted on site, therefore all resulting products are scale dependent. Database users should recognize scale limitations and balance research and modeling projects accordingly. More mapping on the ground at MANZ by experienced ecologists and botanists using GPS receivers may help improve the accuracy and location of the current vegetation communities.

Future Recommendations

This vegetation inventory of MANZ represents the best efforts put forth by NPS, MOJN I&M and others over a relatively short period of time. In order to create the best possible “long-term” vegetation study this project should not be viewed as final, but rather as a baseline for both past and future comparison work. The vegetation map for MANZ was based primarily on the 2010 NAIP imagery. Therefore, all of the resulting mapping products correspond to the summer of 2010 timing of the image acquisition (i.e. snapshot in time). As the data are used, it should be remembered that any changes to the landscape since 2010 are not included in this product. In the future it might be beneficial to update both the map and the classification as new information becomes available.

In summary the products presented herein can assist and direct vegetation and land-use monitoring and management, as follows:

1. The diversity of plant species and dynamic nature of MANZ with respect to periodic flooding, draughts, non-native encroachment, fire, water diversions, climate change, and other vegetation altering influences warrants periodic **field surveys** by experienced ecologists. Working with and sampling more of the plant communities would also be beneficial allowing for the possibility of discovering new associations, updating the descriptions of the current plant associations, and devising better landscape management strategies. Given the high relative AA values, additional fieldwork could also focus on the lower accuracy types to help improve the confidence in these type. All new information could be used to update both the GIS map layer (i.e. better delineation) and the classification (i.e. new associations).
2. Remote sensing does not replace on-the-ground knowledge provided by GPS-linked plots, observations, rapid assessment points, site photographs, and verification/ground-truthing work. Time, topographic features, and funding limitations curtailed the amount of **ground-truthing** performed at MANZ. As research opportunities arise, maps should be examined in the field by experienced crews. Also GPS receiver data and other GIS layers (such as soils and geology) should be used to improve and update the spatial data. Data could be collected on a standard field form, stored, and then used to update the GIS layer on an annual basis. The vegetation map layer should not be viewed as static but should be updated with more current and accurate information.
3. To better understand the limitations of the map, the **accuracy assessment** data presented in the error matrix and final AA report should be thoroughly reviewed by NPS staff. For some applications it may make sense to combine map classes into higher units, such as alliances or groups to improve accuracy for regional and large-area applications.
4. For monitoring purposes, **change over time** could be addressed by similar remote sensing projects and by setting up permanent plots and photo monitoring stations. Past changes to the vegetation at MANZ could be examined by creating similar vegetation maps using old aerial photographs. The vegetation polygons created from the historical record could then be overlaid on the current vegetation map to see if trees were removed, when non-native vegetation became established, and to what extent the various vegetation types have spread or have been cleared. Going forward, similar comparative GIS studies could be conducted as new imagery for MANZ is acquired and new vegetation layers are created or updated. Also the vegetation on the ground could be monitored by establishing or revisiting permanent plots on a regular basis and either collecting new data or simply re-photographing the sites. Each of the 28 classification plots were permanently marked by either a rebar or wooden stake. Plots with wooden stakes may not last, and MANZ should consider replacing them with large nails and washers to allow for metal detector location in future years. The location of the plots could also serve as photo monitoring stations and new photos could be retaken at a predetermined interval (e.g. 3, 5, 10 years) to document change over time. Monitoring of

these plots could also follow-up, and insure the migration of the alliances/associations from provisional to official types in the NVCS.

Research Opportunities

Having an accurate and current vegetation map in a geodatabase also presents many new and exciting opportunities including expanding or linking the GIS layer to derive other information such as fire models, habitat monitoring locations, guides for rare plant surveys, wildlife habitat structural analyses, and inventorying areas that are likely vectors for invasive species. The map could also be enhanced by overlaying other existing GIS layers including geology, hydrology, elevation, and soils. In this manner complex interactions between these layers could be examined and yield important information about growth rates, regeneration after disturbance, biomass distribution, and stream morphology among others. Through innovative analyses the vegetation layer could be used as a baseline for other ecological and climate-related studies including examining how the vegetation is impacted by global warming events and how it interacts with soil chemistry, pollution, paleontological/archeological sites, insect infestations, weather patterns, etc. Specifically the MANZ vegetation map may be useful to researches interested in studying the changes in vegetation based on fluctuations in water availability (as determined by the LADWP).

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Appendix A: MANZ Field Data Forms

Plot Form

MANZANAR NATIONAL HISTORIC SITE PLOT SURVEY FORM 2008 VEGETATION MAPPING PROGRAM

SURVEY AND SITE INFORMATION

Plot Code: MANZ _____		Quad name: _____		BPU Code: _____		Survey Date: _____	
Park Site Name: _____							
Surveyors: _____							
Datum: <u>NAD 83</u>		UTM: <u>ZONE 11N</u>		Plot Center: Northing _____		Easting _____	
Corner: Northing _____		Easting _____		Corner: Northing _____		Easting _____	
Corner: Northing _____		Easting _____		Corner: Northing _____		Easting _____	
GPS Unit: _____				Error +/- _____ m (PDOP: _____)			
GPS Comments: _____							
Directions to Plot: _____							
Sq plot (20 x 20) (10m x 10m)		Rect Plot: len(m) _____ x wid(m) _____		Circ. Plot (100 m ² , 400 m ² , 1000m ²)		Azi _____ deg	
Camera #: _____		Camera Ht: _____ m		Photopoint coords (if not plot center) Northing _____ (deg) Westing _____ (deg)			
Description of Photopoint: _____							
View#	Time	V or H	Bearing	Photographer	View from Photopoint		
1							
2							
3							
4							
a							
Views 1-4 - cardinal directions N,E,S,W; view a - person standing on the photopoint itself to help relocate it in future; additional representative views							
Plot representativeness (discuss plot placement and explain non-representativeness)							

ENVIRONMENTAL DESCRIPTION

Elevation _____ m From: GPS / Map (circle one)		Slope _____ (deg) Aspect _____	
Topographic Position: High level High Slope Mid Slope Low Slope Backslope Step in Slope Toe Slope Low Level Interfluv			
Landform: Alluvial Fan, Colluvium, Rockpile Drainage Channel, Valley Bottom Fill, Side Slope, Interfluv, Intermittent Stream, Ridge, Slick Rock, Terrace, Mesa, Butte, Cliff, Talus, Sand Dune, Plateau Other _____		Geology: Aeolian sands Basalt Conglomerate Limestone Mudstone Obscured by Soil Sandstone Shale Schist Other _____	
Cowardin System ____ Upland ____ Palustrine		Hydrology ____ Unknown ____ Permanently Flooded ____ Seasonally Flooded ____ Temporarily Flooded ____ Semipermanently Flooded ____ Saturated ____ Intermittently Flooded	
Environmental Comments (factors controlling community/plant distribution, seral stage, fire history etc): 			

Plot Form (continued)

MANZANAR NATIONAL HISTORIC SITE PLOT SURVEY FORM 2008 VEGETATION MAPPING PROGRAM

PLOT CODE: **MANZ** _____

DATE: _____

ENVIRONMENTAL DESCRIPTION (Continued)

Ground Cover: (please estimate to the nearest percentage. Sum = 100%)		
<input type="checkbox"/> Bare soil (<0.1 mm)	<input type="checkbox"/> Litter/Duff (dead plant material <3 cm diameter)	<input type="checkbox"/> Lichen (ground)
<input type="checkbox"/> Sand (0.1-2 mm)	<input type="checkbox"/> Coarse woody debris (dead wood 3-10 cm)	<input type="checkbox"/> Moss (ground)
<input type="checkbox"/> Gravel (2 mm - 6.4 cm)	<input type="checkbox"/> Woody debris structure (dead >10 cm deep & wide)	<input type="checkbox"/> Microbiotic soil crust
<input type="checkbox"/> Rock (> 6.4 cm)	<input type="checkbox"/> Live veg (litter / wood)	<input type="checkbox"/> Water
<input type="checkbox"/> Bedrock (solid surface)		<input type="checkbox"/> Other: _____
Soil Texture (see soil key):		Soil Drainage:
<input type="checkbox"/> sand	<input type="checkbox"/> silt loam <input type="checkbox"/> sandy clay <input type="checkbox"/> sandy clay loam	<input type="checkbox"/> Rapidly drained <input type="checkbox"/> Somewhat poorly drained
<input type="checkbox"/> loamy sand	<input type="checkbox"/> silt <input type="checkbox"/> clay <input type="checkbox"/> silty clay loam	<input type="checkbox"/> Well drained <input type="checkbox"/> Poorly drained
<input type="checkbox"/> sandy loam	<input type="checkbox"/> clay loam <input type="checkbox"/> peat	<input type="checkbox"/> Moderately well drained <input type="checkbox"/> Very poorly drained
<input type="checkbox"/> loam	<input type="checkbox"/> silty clay <input type="checkbox"/> muck	
Surface Water w/in 25m? YES/NO Seep Spring Stream Pothole River		Soil Moisture: dry moist saturated standing water
Animal Use Evidence:		
<input type="checkbox"/> Burrows	<input type="checkbox"/> Animal / Game Trails	<input type="checkbox"/> Animal Sighting
<input type="checkbox"/> Scat (Whose? _____)	<input type="checkbox"/> Vegetation Damage (animal)	<input type="checkbox"/> Other: _____
<input type="checkbox"/> Browsing Evidence	<input type="checkbox"/> Bedding Sites	
<input type="checkbox"/> Grazing Evidence	<input type="checkbox"/> Nests (Whose? _____)	
Anthropogenic Disturbances:		Natural disturbances
<input type="checkbox"/> Campsite Evidence	<input type="checkbox"/> Vegetation Damage (human)	<input type="checkbox"/> Drought (tree & shrub die-back)
<input type="checkbox"/> Trails	<input type="checkbox"/> ORV Evidence	<input type="checkbox"/> Fire
<input type="checkbox"/> Rock Cairns	<input type="checkbox"/> Historic Feature	<input type="checkbox"/> Flood
<input type="checkbox"/> Microbiotic Crust Damage	<input type="checkbox"/> Archaeological Feature	<input type="checkbox"/> Mass Wasting
	<input type="checkbox"/> Other: _____	<input type="checkbox"/> Water gullies
		<input type="checkbox"/> Vegetation Damage (natural)
		<input type="checkbox"/> Other: _____
Other Comments. Describe surrounding communities and how they relate to the plot.		

VEGETATION DESCRIPTION (Only check one within each box)

Leaf Phenology (of dominant stratum)	Leaf Type (of dominant stratum)	Physiognomic Class (see cheat sheet)	Habitat Type:
<u>Trees and Shrubs</u>	<input type="checkbox"/> Broad-leaved	<input type="checkbox"/> Forest	<input type="checkbox"/> Subalpine conifer forest
<input type="checkbox"/> Evergreen	<input type="checkbox"/> Needle-leaved	<input type="checkbox"/> Woodland	<input type="checkbox"/> Mixed conifer
<input type="checkbox"/> Cold-deciduous	<input type="checkbox"/> Microphyllous	<input type="checkbox"/> Shrubland	<input type="checkbox"/> Ponderosa pine
<input type="checkbox"/> Mixed evergreen-cold-deciduous	<input type="checkbox"/> Graminoid	<input type="checkbox"/> Wooded Shrubland	<input type="checkbox"/> Great Basin mountain scrub
OR	<input type="checkbox"/> Forb	<input type="checkbox"/> Dwarf Shrubland	<input type="checkbox"/> Great Basin conifer woodland
<u>Herbs</u>	<input type="checkbox"/> Pteridophyte	<input type="checkbox"/> Shrub Herbaceous	<input type="checkbox"/> Great basin desertscrub
<input type="checkbox"/> Annual	<input type="checkbox"/> Non-vascular	<input type="checkbox"/> Wooded Herbaceous	<input type="checkbox"/> Mojave desertscrub
<input type="checkbox"/> Perennial	<input type="checkbox"/> Mixed (describe)	<input type="checkbox"/> Herbaceous	<input type="checkbox"/> Alpine/subalpine grassland
		<input type="checkbox"/> Nonvascular	<input type="checkbox"/> Interior wetlands
		<input type="checkbox"/> Sparsely Vegetated	<input type="checkbox"/> Riparian
			<input type="checkbox"/> Other: _____

Plot Form (continued)

MANZANAR NATIONAL HISTORIC SITE PLOT SURVEY FORM 2008 VEGETATION MAPPING PROGRAM

Plot Code: **MANZ** _____

Date: _____

VEGETATION DESCRIPTION

Provisional Community Name: _____

Supplemental Form (Please Check if Used): ☐

Species/Strata: Starting with the uppermost stratum list all species with full scientific names, cover class and % cover for each species in the stratum. For each tree species estimate seedling, sapling, and total cover in appropriate stratum. Once species level information is completed, then complete height class and cover class for each strata (shaded blocks). Indicate with an asterisk (*) diagnostic species for each stratum and check whether a specimen has been collected. Additional space is available on the back side of this form. List species outside the plot at the end of the table and designate with a 0 in Cover Class Column.

SPECIES/STRATA TABLE / TREES & SHRUBS					SPECIES/STRATA TABLE / HERBACEOUS				
Strata / Species Scientific Name	Cover Class	% Cover	Spec		Strata / Species Scientific Name	Cover Class	% Cover	Spec	
Whole Plot: Height to Lowest Ladder Fuel (m)					Height to Live Crown (m)				
T1 EMERGENT	Strata Height	Strata Cover			Ht HERBACEOUS	Strata Height	Strata Cover		
					Sum of H1, H2, H3, H4				
					H1 GRAMINOIDS	Strata Height	Strata Cover		
T2 CANOPY	Strata Height	Strata Cover							
T3 SUBCANOPY	Strata Height	Strata Cover							
					H2 FORBS	Strata Height	Strata Cover		
S1 TALL SHRUB (> 2m)	Strata Height	Strata Cover							
S2 SHORT SHRUB (< 2m)	Strata Height	Strata Cover							
					H3 FERNS & ALLIES	Strata Height	Strata Cover		
					H4 TREE SEEDLINGS	Strata Height	Strata Cover		
S3 DWARF SHRUB (< 0.5m)	Strata Height	Strata Cover							
					N NON-VASCULAR	Strata Height	Strata Cover		

Cover Scale for Species									
t = few	T = < 1%	1a = 5.01 -> 10%	2 = 15.01 -> 25%	4 = 35.01 -> 45%	6 = 55.01 -> 65%	8 = 75.01 -> 85%	10 = > 95%		
P = 1-5%	1b = 10.01 -> 15%	3 = 25.01 -> 35%	5 = 45.01 -> 55%	7 = 65.01 -> 75%	9 = 85.01 -> 95%				
Height Scale for Strata									
01 = < 0.5 m	03 = 1.01 -> 2 m	05 = 5.01 -> 10 m	07 = 15.01 -> 20 m	09 = 35.01 -> 50 m					
02 = 0.5-1 m	04 = 2.01 -> 5 m	06 = 10.01 -> 15 m	08 = 20.01 -> 35 m	10 = > 50 m					

MANZANAR NATIONAL HISTORIC SITE PLOT SURVEY FORM
2008 VEGETATION MAPPING PROGRAMPlot Code: **MANZ**

Date: _____

SUPPLEMENTAL SPECIES AND TREE INFORMATION.

Use when there is no room on the main data sheet, for recording tree DBH/DRC measurements and for Park Specials: rare plants and exotics.

BE SURE TO INDICATE ON THE OTHER SIDE THAT THERE IS MORE OVER HERE.

[illegible]

Observation Point Form

IDENTIFIERS/LOCATORS

Rapid Point Code: GRBA. _____		Observation Point		Survey Date: ____/____/2009		Surveyors: _____	
Provisional Map Unit Name: _____							
Provisional Association Name: _____							
UTM Zone: 11 UTM X: _____ (m E) UTM Y: _____ (m N) Accuracy _____ m							
Location Comments: _____							
Plot length(m): _____ Plot width(m): _____		Camera #: _____ CF Card #: _____ Other# _____					
Azimuth: _____ ° Radius(m): _____		Photo #: N _____ E _____ S _____ W _____ Rep _____					
Plot representativeness (discuss decisions for placement and/or reasons for non-representativeness)							
a. Representativeness of association (if known):							
b. Representativeness of plot in stand:							

ENVIRONMENTAL DESCRIPTION

Elevation _____ m		Slope _____ °	Aspect _____ °
Topographic Position (see cheat sheet) _____		Landform (see cheat sheet) _____	
Surficial Geology (see cheat sheet) _____			
<u>Cowardin System:</u> <input type="checkbox"/> Upland <input type="checkbox"/> Palustrine <input type="checkbox"/> Riverine <input type="checkbox"/> Lacustrine	<u>Soil Texture:</u> <input type="checkbox"/> sand <input type="checkbox"/> loamy sand <input type="checkbox"/> sandy loam <input type="checkbox"/> silt loam <input type="checkbox"/> sandy clay loam <input type="checkbox"/> clay loam <input type="checkbox"/> silty clay loam <input type="checkbox"/> silt <input type="checkbox"/> sandy clay <input type="checkbox"/> clay <input type="checkbox"/> silty clay <input type="checkbox"/> peat <input type="checkbox"/> muck <input type="checkbox"/> loam	<u>Soil Drainage:</u> <input type="checkbox"/> Rapidly drained <input type="checkbox"/> Well drained <input type="checkbox"/> Moderately well drained <input type="checkbox"/> Somewhat poorly drained <input type="checkbox"/> Poorly drained <input type="checkbox"/> Very poorly drained	<u>% Ground Cover:</u> (<i>Sum = 100%</i>) <input type="checkbox"/> Litter / duff <input type="checkbox"/> Wood (<3 cm) ____ (3<10cm) ____ (>10cm) <input type="checkbox"/> Bare soil <input type="checkbox"/> Sand (0.1-2 mm) <input type="checkbox"/> Small rocks (0.2-10cm) <input type="checkbox"/> Large rocks (10-60cm) ____ Boulder(>60cm) <input type="checkbox"/> Bedrock <input type="checkbox"/> Water <input type="checkbox"/> Moss <input type="checkbox"/> Lichen <input type="checkbox"/> Cryptogam /Biological Crust <input type="checkbox"/> Basal area <input type="checkbox"/> Other: _____
Environmental Comments (dynamic stage, fire history, insect damage, animal use evidence, natural or anthropogenic disturbance, geology, etc.):			
Vegetation and Other Comments: average DBH cm of canopy trees. Even-aged, multi-aged canopy, early or late seral/old growth stand.			

Observation Point Form (continued)

VEGETATION DESCRIPTION Plot Code: GRBA. Survey Date: ____ / ____ / 2009

Leaf phenology (of dominant stratum)	Leaf Type (of dominant stratum)	Physiognomic class	Height Class Scale	Cover Class Scale
<u>Trees and Shrubs</u>	<u>Broad-leaved</u>	<u>Forest</u>	01 <0.5 m	T 0-1%
<u>Evergreen</u>	<u>Needle-leaved</u>	<u>Woodland</u>	02 0.5-1 m	P >1-5%
<u>Cold-deciduous</u>	<u>Microphyllous</u>	<u>Shrubland</u>	03 1-2 m	1- >5-10%
<u>Mixed evergreen-cold-deciduous</u>	<u>Graminoid</u>	<u>Dwarf Shrubland</u>	04 2-5 m	1+ >10-15%
	<u>Forb</u>	<u>Herbaceous</u>	05 5-10 m	2 >15-25%
	<u>Pteridophyte</u>	<u>Nonvascular</u>	06 10-15 m	3 >25-35%
		<u>Sparsely Vegetated</u>	07 15-20 m	4 >35-45%
<u>Herbs</u>			08 20-35 m	5 >45-55%
<u>Annual</u>			09 35 - 50 m	6 >55-65%
<u>Perennial</u>			10 >50 m	7 >65-75%
				8 >75-85%
				9 >85-95%
				10 >95%

	Height Class	Cover Class	Dominant Species (mark Diagnostics with *)
T1 Emergent	_____	_____	_____
T2 Canopy	_____	_____	_____
T3 Sub-canopy	_____	_____	_____
S1 Tall shrub	_____	_____	_____
S2 Short Shrub	_____	_____	_____
S3 Dwarf-shrub	_____	_____	_____
Ht Herbaceous	_____	_____	_____
H1 Graminoids	_____	_____	_____
H2 Forbs	_____	_____	_____
H3 Ferns	_____	_____	_____
H4 Seedlings	_____	_____	_____
N Non-vascular	_____	_____	_____
V Vine/liana	_____	_____	_____
E Epiphyte	_____	_____	_____

SPECIES INFORMATION

[illegible]

Rapid Assessment Point Form

Combined rapid assessment and releve field form

Relevé or Rapid Assessment (Circle One)

(Revised June 17, 2008)

[illegible]

Verification Point (Waypoint) Form

CALIFORNIA NATIVE PLANT SOCIETY - RECON FIELD FORM (May 01, 2002)

Surveyors: _____				Date: _____			
Polygon #: _____		GPS waypoint #: _____ GPS in stand? <u>Y / N</u> If No, distance/bearing: _____ / _____					
Correct <u>Y / N</u>		UTME _____		UTMN _____		Error: +/- _____ GPS name: _____	
Aspect: _____		Elevation: _____ ft/m		Photograph #'s: _____		Size of stand: _____ acre	
Comments: _____				Site quality: _____			
Field-assessed alliance name: _____							
Tree cover/ht/dbh: _____ / _____ / _____		Shrub cover/ht: _____ / _____		Herbaceous cover/ht: _____ / _____		% Density _____	
Strata	Species	% cover	Strata	Species	% cover	Strata	Species

Polygon #: _____		GPS waypoint #: _____ GPS in stand? <u>Y / N</u> If No, distance/bearing: _____ / _____					
Correct <u>Y / N</u>		UTME _____		UTMN _____		Error: +/- _____ GPS name: _____	
Aspect: _____		Elevation: _____ ft/m		Photograph #'s: _____		Size of stand: _____ acre	
Comments: _____				Site quality: _____			
Field-assessed alliance name: _____							
Tree cover/ht/dbh: _____ / _____ / _____		Shrub cover/ht: _____ / _____		Herbaceous cover/ht: _____ / _____		% Density _____	
Strata	Species	% cover	Strata	Species	% cover	Strata	Species

Polygon #: _____		GPS waypoint #: _____ GPS in stand? <u>Y / N</u> If No, distance/bearing: _____ / _____					
Correct <u>Y / N</u>		UTME _____		UTMN _____		Error: +/- _____ GPS name: _____	
Aspect: _____		Elevation: _____ ft/m		Photograph #'s: _____		Size of stand: _____ acre	
Comments: _____				Site quality: _____			
Field-assessed alliance name: _____							
Tree cover/ht/dbh: _____ / _____ / _____		Shrub cover/ht: _____ / _____		Herbaceous cover/ht: _____ / _____		% Density _____	
Strata	Species	% cover	Strata	Species	% cover	Strata	Species

Polygon #: _____		GPS waypoint #: _____ GPS in stand? <u>Y / N</u> If No, distance/bearing: _____ / _____					
Correct <u>Y / N</u>		UTME _____		UTMN _____		Error: +/- _____ GPS name: _____	
Aspect: _____		Elevation: _____ ft/m		Photograph #'s: _____		Size of stand: _____ acre	
Comments: _____				Site quality: _____			
Field-assessed alliance name: _____							
Tree cover/ht/dbh: _____ / _____ / _____		Shrub cover/ht: _____ / _____		Herbaceous cover/ht: _____ / _____		% Density _____	
Strata	Species	% cover	Strata	Species	% cover	Strata	Species

Accuracy Assessment Form

MANZ ACCURACY ASSESSMENT FIELD FORM

Section 1. AA Point\GPS\Photographic Information

Park Code: MANZ Quad Name: Manzanar NE AA Point #: MANZ_AA _____
 Surveyor(s) _____ Survey Date: _____
 GPS Unit: _____ Model _____ Error +/- _____ m 3D Differential _____
 Datum: NAD 83 UTM: ZONE 11N UTMN _____ UTME _____ Waypt #: _____
 GPS comments: _____
 Photo # (s) _____ Photo Azimuth: _____ Declination: 14° E View from Photopoint: _____

Section 2. Observation Area/Shape

☐ Standard Observation Area: 0.5 ha Shape: circular (approximately a 40m radius circle)
☐ Alternate Observation Area: _____ ha Shape: _____

AA point location comments: _____

Section 3. Field Key to Plant Association

☐ Primary Association: _____
☐ Secondary Association: _____

Conformance to Key (☐ Good ☐ Fair ☐ Poor): _____

Classification Comments: _____

Section 4. Dominant Species by strata and height class

Dominant Species Observed (* diagnostic species)	Stratum	Height Class

Stratum Codes: T1-Emergent, T2-canopy, T3-Subcanopy, S1-Tall Shrub (>2m), S2-Short Shrub (<2m), S3-Dwarf Shrub (<0.5m), H1-Herb, H2-Shrub seedlings, H3-Tree seedlings

Height classes: 04 = 2.01 -> 5 m, 05 = 5.01 -> 10 m, 06 = 10.01 -> 15 m, 07 = 15.01 -> 20 m, 08 = 20.01 -> 35 m, 09 = 35.01 -> 50 m, 10 = > 50 m

☐ More than one association?

Appendix B: Plant Species Found During Field Sampling at Manzanar National Historic Site

There were 111 plant taxa were encountered while sampling field plots, observation points, and accuracy assessment points. Subspecies and varieties were listed when provided. Plant names identified only to Family or Genus were included only when there were no Genera recorded in that family or no species recorded in that Genus, respectively. Nomenclature follows that of USDA PLANTS and Kartesz 1999 for flowering plants, ferns and fern-allies. Common names listed were selected primarily from USDA PLANTS.

Family	Genus species	Common Name	NRCS Code
Apocynaceae	<i>Apocynum cannabinum</i>	Indianhemp	APCA
Asclepiadaceae	<i>Asclepias fascicularis</i>	Mexican whorled milkweed	ASFA
Asteraceae	<i>Ambrosia acanthicarpa</i>	flatspine burr ragweed	AMAC2
	<i>Artemisia ludoviciana</i> ssp. <i>incompta</i>	white sagebrush	ARLUI2
	<i>Artemisia ludoviciana</i> x <i>douglasia</i>		
	<i>Artemisia tridentata</i> ssp. <i>tridentata</i>	basin big sagebrush	ARTRT
	<i>Chaenactis fremontii</i>	pincushion flower	CHFR
	<i>Conyza coulteri</i>	= <i>Laennecia coulteri</i>	COCO4
	<i>Encelia virginensis</i>	Virgin River brittlebush	ENVI
	<i>Ericameria nauseosa</i> ssp. <i>consimilis</i>	rubber rabbitbrush	ERNAC2
	<i>Ericameria nauseosa</i> ssp. <i>nauseosa</i> var. <i>hololeuca</i>	rubber rabbitbrush	ERNAH
	<i>Eriophyllum pringlei</i>	Pringle's woolly sunflower	ERPR4
	<i>Hymenoclea salsola</i>	burrobrush	HYSA
	<i>Layia glandulosa</i>	whitedaisy tidytips	LAGL5
	<i>Malacothrix glabrata</i>	smooth desertdandelion	MAGL3
	<i>Stephanomeria pauciflora</i>	brownplume wirelettuce	STPA4
	<i>Xanthium strumarium</i>	rough cocklebur	XAST
Boraginaceae	<i>Amsinckia tessellata</i>	bristly fiddleneck	AMTE3
	<i>Asperugo</i> spp.	German-madwort	ASPER
	<i>Cryptantha circumscissa</i>	cushion cryptantha	CRCI2
	<i>Cryptantha micrantha</i>	redroot cryptantha	CRMI
	<i>Cryptantha pterocarya</i>	wingnut cryptantha	CRPT
	<i>Pectocarya</i>	combseed	PECTO
	<i>Pectocarya peninsularis</i>	peninsular pectocarya	PEPE33
	<i>Penstemon incertus</i>		PEIN3
	<i>Tiquilia nuttallii</i>	Nuttall's crinklemat	TINU2
	<i>Tiquilia plicata</i>	fanleaf crinklemat	TIPL2
	<i>Descurainia pinnata</i> ssp. <i>glabra</i>	western tansymustard	DEPIG
	<i>Descurainia sophia</i>	herb sophia	DESO2
	<i>Lepidium flavum</i> var. <i>flavum</i>	yellow pepperweed	LEFLF2
	<i>Lepidium fremontii</i>	desert pepperweed	LEFR2
	<i>Lepidium lasiocarpum</i>	shaggyfruit pepperweed	LELA
	<i>Sisymbrium altissimum</i>	tall tumblemustard	SIAL2
Brassicaceae	<i>Caulanthus pilosus</i>	hairy wild cabbage	CAPI4
Campanulaceae	<i>Nemacladus glanduliferus</i>	glandular threadplant	NEGL
Capparaceae	<i>Cleomella obtusifolia</i>	Mojave cleomella	CLOB

Family	Genus species	Common Name	NRCS Code
Chenopodiaceae	<i>Atriplex canescens</i>	fourwing saltbush	ATCA2
	<i>Atriplex confertifolia</i>	shadscale saltbush	ATCO
	<i>Atriplex lentiformis</i> ssp. <i>torreyi</i>	= <i>Atriplex torreyi</i>	ATLET2
	<i>Atriplex polycarpa</i>	cattle saltbush	ATPO
	<i>Atriplex serenana</i>	bractscale	ATSE2
	<i>Atriplex torreyi</i>	Torrey's saltbush	ATTO
	<i>Salsola tragus</i>	prickly Russian thistle	SATR12
	<i>Sarcobatus vermiculatus</i>	greasewood	SAVE4
	<i>Suaeda moquinii</i>	Mojave seablite	SUMO
Cuscutaceae	<i>Cuscuta</i>	dodder	CUSCU
	<i>Cuscuta denticulata</i>	desert dodder	CUDE2
	<i>Cuscuta</i> spp.	dodder	
Cyperaceae	<i>Carex</i>	sedge	CAREX
	<i>Carex douglasii</i>		CADO2
Ephedraceae	<i>Ephedra nevadensis</i>	Nevada jointfir	EPNE
Fabaceae	<i>Glycyrrhiza lepidota</i>	American licorice	GLLE3
	<i>Lupinus excubitus</i>	grape soda lupine	LUEX
	<i>Lycium andersonii</i>		LYAN
	<i>Melilotus indicus</i>	annual yellow sweetclover	MEIN2
	<i>Robinia pseudoacacia</i>	black locust	ROPS
Geraniaceae	<i>Erodium cicutarium</i>	redstem stork's bill	ERCIJ
Hydrophyllaceae	<i>Phacelia fremontii</i>	Fremont's phacelia	PHFR2
Juncaceae	<i>Juncus balticus</i>	Baltic rush	JUBA
Loasaceae	<i>Mentzelia albicaulis</i>	whitestem blazingstar	MEAL6
Oleaceae	<i>Forestiera pubescens</i>	stretchberry	FOPU2
Onagraceae	<i>Calystegia longipes</i>	Paiute false bindweed	CALO12
	<i>Camissonia boothii</i> ssp. <i>desertorum</i>	desert suncup	CABOD2
	<i>Camissonia claviformis</i> ssp. <i>claviformis</i>	browneyes	CACLC3
Poaceae	<i>Achnatherum hymenoides</i>	Indian ricegrass	ACHY
	<i>Achnatherum speciosum</i>	desert needlegrass	ACSP12
	<i>Bromus anomalus</i>	nodding brome	BRAN
	<i>Bromus carinatus</i>	California brome	BRCA5
	<i>Bromus catharticus</i>	rescuegrass	BRCA6
	<i>Bromus madritensis</i> ssp. <i>rubens</i>	= <i>Bromus rubens</i>	BRMAR
	<i>Cynodon dactylon</i>	Bermudagrass	CYDA
	<i>Deschampsia cespitosa</i>	= <i>Deschampsia caespitosa</i>	DECE
	<i>Distichlis spicata</i>	inland saltgrass	DISP
	<i>Hordeum murinum</i> ssp. <i>leporinum</i>	hare barley	HOMUL
	<i>Muhlenbergia asperifolia</i>	scratchgrass	MUAS
	<i>Muhlenbergia rigens</i>	deergrass	MURI2
	<i>Phragmites australis</i>	common reed	PHAU7
	<i>Poa secunda</i>	Sandberg bluegrass	POSE
	<i>Schismus</i>	Mediterranean grass	SCHIS
	<i>Schismus barbatus</i>	common Mediterranean grass	SCBA
Polemoniaceae	<i>Eriastrum wilcoxii</i>	Wilcox's woollystar	ERWI
	<i>Gilia</i> spp.	gilia	GILIA
	<i>Gilia brecciarum</i>		GIBR
	<i>Gilia cana</i>	showy gilia	GICA3

Family	Genus species	Common Name	NRCS Code
Polygonaceae	<i>Gilia filiformis</i>	yellow gilia	GIFI2
	<i>Loeseliastrum matthewsii</i>	desert calico	LOMA10
	<i>Loeseliastrum schottii</i>	Schott's calico	LOSC6
	<i>Chorizanthe brevicornu</i>	brittle spineflower	CHBR
	<i>Eriogonum brachyanthum</i>	shortflower buckwheat	ERBR7
	<i>Eriogonum maculatum</i>	spotted buckwheat	ERMA2
	<i>Rumex crispus</i>	curly dock	RUCR
Rosaceae	<i>Rumex salicifolius</i>	willow dock	RUSA
	<i>Malus domestica</i>	= <i>Malus pumila</i>	MADO4
Salicaceae	<i>Rosa woodsii</i> var. <i>ultramontana</i>	Woods' rose	ROWOU
	<i>Populus fremontii</i>	Fremont cottonwood	POFR2
	<i>Salix exigua</i>	narrowleaf willow	SAEX
	<i>Salix laevigata</i>	red willow	SALA3
Scrophulariaceae	<i>Salix lasiolepis</i>	Arroyo willow	SALA6
	<i>Verbascum thapsus</i>	common mullein	VETH
	<i>Veronica americana</i>	American speedwell	VEAM2
Simaroubaceae	<i>Ailanthus altissima</i>	tree of heaven	AIAL
Solanaceae	<i>Datura wrightii</i>	sacred thorn-apple	DAWR2
Tamaricaceae	<i>Tamarix parviflora</i>	smallflower tamarisk	TAPA4
	<i>Tamarix ramosissima</i>	saltcedar	TARA

Appendix C: Field Key to Vegetation of Manzanar National Historic Site, CA

MANZANAR NHS VEGETATION KEY

NOTE: This key is dichotomous, but each side of the couplet (dichotomy) may have multiple conditions to consider. For each couplet with multiple conditions (denoted by multiple paragraphs starting with a hyphen), consider all of the conditions for each side of the couplet and choose the couplet side that fits best. Couplets are hierarchical and denoted by a letter, each side of the couplet (dichotomy) is denoted by a number. Thus, one must read and consider couplet A (and decide between couplet sides A1 or A2) before proceeding to the next lettered couplet following in the key.

Cover means absolute cover.

A1. Tree and shrub cover combined is less than or equal to 7%

A1. Go to couplet B (Herbaceous Vegetation)

B1. -At least 2 of the following species are present: *Gilia* spp. (gilia), *Eriastrum wilcoxii* (Wilcox's woollystar), *Cryptantha circumcissa* (cushion cryptanth), *Malacothrix glabrata* (desert dandelion).

-Combined cover of *Schismus* spp (Mediterranean grass) and *Distichlis spicata* (saltgrass) is less than 5%.

B1. Mixed forb

B2. -No more than 1 of the following species are present: *Gilia* spp. (gilia), *Eriastrum wilcoxii* (Wilcox's woollystar), *Cryptantha circumcissa* (cushion cryptanth), *Malacothrix glabrata* (desert dandelion).

-Combined cover of *Schismus* spp (Mediterranean grass) and *Distichlis spicata* (saltgrass) is greater than or equal to 5%.

B2. Mixed herbaceous

A2. Tree and shrub cover combined is greater than 7%

A2. Go to couplet C

C1. -Cover of trees (woody plants greater than or equal to 5 meters in height, including *Robinia pseudoacacia*, *Populus fremontii*, *Ailanthus altissima*, *Ulmus* spp., and others) is greater than or equal to 15%.

C1. Mixed woodland

C2. –Cover of trees (woody plants greater than or equal to 5 meters in height, including *Robinia pseudoacacia*, *Populus fremontii*, *Ailanthus altissima*, *Ulmus* spp., and others) is less than 15%.

C2. Go to couplet D (Shrublands)

D1. -Combined cover of *Artemisia tridentata* ssp. *tridentata* (big sagebrush), *Ericameria nauseosa* (rubber rabbitbrush), and/or *Atriplex* spp. (saltbushes) is less than 10%

-Combined cover of *Rosa woodsii* var. *ultramontana* (Woods' rose) and/or *Salix* spp. (willows) is greater than 10%

-Combined cover of *Rosa woodsii* var. *ultramontana* (Woods' rose) and/or *Salix* spp. (willows) equals or exceeds the combined cover of *Artemisia tridentata* ssp. *tridentata* (big sagebrush), *Ericameria nauseosa* (rubber rabbitbrush), and/or *Atriplex* spp. (saltbushes).

-At least 2 of the following species present: *Distichlis spicata* (saltgrass), *Glycyrrhiza lepidota* (American licorice), *Apocynum cannabinum* (Indian hemp).

-No more than 1 of the following species present: *Gilia* spp. (*gilia*), *Eriastrum wilcoxii* (Wilcox's woollystar), *Cryptantha circumcissa* (cushion cryptanth), *Cryptantha pterocarya* (wingnut cryptanth), *Eriogonum maculatum* (spotted buckwheat), *Camissonia boothii* ssp. *desertorum* (desert suncup).

D1. Go to couplet E (Riparian Shrublands and Woodlands).

E1. -Cover of *Salix laevigata* (red willow) is equal to or exceeds the combined cover of *Salix exigua* (narrow-leaved willow) and/or *Rosa woodsii* var. *ultramontana* (Woods' rose).

E1. *Salix laevigata*

E2. -Cover of *Salix laevigata* (red willow) is less than the combined cover of *Salix exigua* (narrow-leaved willow) and/or *Rosa woodsii* var. *ultramontana* (Woods' rose).

E2. *Salix exigua* – *Rosa woodsii*

E3. - Cover of *Rosa woodsii* var. *ultramontana* (Woods' rose) is greater than the combined cover of *Salix laevigata* (red willow) and/or *Salix exigua* (narrow-leaved willow).

E3. *Rosa woodsii*

D2. -Combined cover of *Artemisia tridentata* ssp. *tridentata* (big sagebrush), *Ericameria nauseosa* (rubber rabbitbrush), and/or *Atriplex* spp. (saltbushes) is greater than or equal to 10%

-Combined cover of *Rosa woodsii* var. *ultramontana* (Woods' rose) and/or *Salix* spp. (willows) is less than or equal to 10%

-Combined cover of *Rosa woodsii* var. *ultramontana* (Woods' rose) and/or *Salix* spp. (willows) is less than the combined cover of *Artemisia tridentata* ssp. *tridentata* (big sagebrush), *Ericameria nauseosa* (rubber rabbitbrush), and/or *Atriplex* spp. (saltbushes).

-No more than 1 of the following species present: *Distichlis spicata* (saltgrass), *Glycyrrhiza lepidota* (American licorice), *Apocynum cannabinum* (Indian hemp).

-At least 2 of the following species present: *Gilia* spp. (gilia), *Eriastrum wilcoxii* (Wilcox's woollystar), *Cryptantha circumcissa* (cushion cryptanth), *Cryptantha pterocarya* (wingnut cryptanth), *Eriogonum maculatum* (spotted buckwheat), *Camissonia boothii* ssp. *desertorum* (desert suncup).

D2. Go to couplet F (Upland Shrublands).

F1. -Combined cover of *Artemisia tridentata* ssp. *tridentata* (big sagebrush), *Ericameria nauseosa* (rubber rabbitbrush), and/or *Atriplex canescens* ssp. *canescens* (four-wing saltbush) is less than or equal to 8%.

-Combined cover of *Atriplex confertifolia* (shadscale), *Atriplex polycarpa* (allscale) and/or *Atriplex torreyi* ssp. *torreyi* (big saltbush) is greater than or equal to 5%.

-Combined cover of *Atriplex confertifolia* (shadscale), *Atriplex polycarpa* (allscale) and/or *Atriplex torreyi* ssp. *torreyi* (big saltbush) is equal to or exceeds combined cover of *Artemisia tridentata* ssp. *tridentata* (big sagebrush), *Ericameria nauseosa* (rubber rabbitbrush), and/or *Atriplex canescens* ssp. *canescens* (four-wing saltbush).

F1. Go to couplet G (Saltbush Shrublands).

G1. -Combined cover of *Atriplex confertifolia* (shadscale) and/or *Atriplex torreyi* ssp. *torreyi* (big saltbush) is greater than 3%

-Cover of *Atriplex polycarpa* (allscale) is less than or equal to 5%.

-Combined cover of *Atriplex confertifolia* (shadscale) and/or *Atriplex torreyi* ssp. *torreyi* (big saltbush) exceeds cover of *Atriplex polycarpa* (allscale).

G1. Go to couplet H

H1. - Cover of *Atriplex confertifolia* (shadscale) is equal to or exceeds cover of *Atriplex torreyi* ssp. *torreyi* (big saltbush).

H1. *Atriplex confertifolia*

H2. - Cover of *Atriplex torreyi* ssp. *torreyi* (big saltbush) exceeds cover of *Atriplex confertifolia* (shadscale).

H2. *Atriplex torreyi* ssp. *torreyi*

G2. –Combined cover of *Atriplex confertifolia* (shadscale) and/or *Atriplex torreyi* ssp. *torreyi* (big saltbush)) is less than or equal to 3%.

-Cover of *Atriplex polycarpa* (allscale) is greater than 5%.

-Cover of *Atriplex polycarpa* (allscale) exceeds combined cover of *Atriplex confertifolia* (shadscale) and/or *Atriplex torreyi* ssp. *torreyi* (big saltbush)

G2. *Atriplex polycarpa*

F2. -Combined cover of *Artemisia tridentata* ssp. *tridentata* (big sagebrush), *Ericameria nauseosa* (rubber rabbitbrush), and/or *Atriplex canescens* ssp. *canescens* (four-wing saltbush) is greater than 8%.

-Combined cover of *Atriplex confertifolia* (shadscale), *Atriplex polycarpa* (allscale) and/or *Atriplex torreyi* ssp. *torreyi* (big saltbush) is less than 5%

-Combined cover of *Atriplex confertifolia* (shadscale), *Atriplex polycarpa* (allscale) and/or *Atriplex torreyi* ssp. *torreyi* (big saltbush) is less than the combined cover of *Artemisia tridentata* ssp. *tridentata* (big sagebrush), *Ericameria nauseosa* (rubber rabbitbrush), and/or *Atriplex canescens* ssp. *canescens* (four-wing saltbush).

F2. Go to couplet I.

I1. Cover of *Artemisia tridentata* ssp. *tridentata* (big sagebrush) is less than 10%.

I1. (*Ericameria nauseosa* – *Atriplex canescens*)

I2. –Cover of *Artemisia tridentata* ssp. *tridentata* (big sagebrush) is greater than or equal to 10%.

I2. *Artemisia tridentata*

Appendix D: Vegetation Descriptions for Manzanar National Historic Site, CA

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Mixed Deciduous Upland Woodland [Park Special].....	D.7
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<i>Robinia pseudoacacia</i> Semi-Natural Stands [Provisional]	D.7
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2. Shrubland & Grassland Class.....	D.14
Mixed Forb Herbaceous Vegetation [Park Special].....	D.14
<i>Amsinckia tessellata</i> Herbaceous Vegetation.....	D.14
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Glossary of Terms.....	D.57

Introduction

Vegetation types are a collection of stands that have similar species composition and structure and occur across a characteristic range of environmental conditions. This document contains the descriptions of the vegetation types occurring at MANZ. The information in each vegetation description was compiled from classification plot data and rapid assessment data supplemented with data from observation and accuracy assessment points. The descriptions summarize the species composition of each vegetation type by stratum (tree, shrub, and herb), the average and range of environmental conditions in which each type occurs, the distribution of the vegetation type at MANZ and the range of the vegetation type within the Great Basin Desert and the western United States. Stand tables summarizing the species present, average and range of absolute cover and constancy across all samples in each vegetation type are found at the end of each description.

Classification plot, observation point and rapid assessment data identified 3 physiognomic groups, 3 stand types, 9 alliances, 6 associations and 2 park special associations. One alliance (*Atriplex lentiformis* Shrubland Alliance) was sampled outside of the park but not within the park and is therefore not described. Eleven descriptions have been written describing three broad physiognomic group types with component stands, alliances and/or associations identified, one unique woodland stand, five shrub types that match existing NVC association concepts and two shrub types which were considered distinct enough to describe as new park special associations.

Each vegetation type is nested within each level of the National Vegetation Classification (NVC) (Federal Geographic Data Committee, 2008) hierarchy including Class, Subclass, Formation, Division, Macrogroup, Group, Alliance and Association. When a type did not have a matching group or alliance name in the NVC, a group or alliance level name from the Manual of California Vegetation (MCV) was used. The MCV was also consulted to provide information on the occurrence of a vegetation type within California and specifically the Great Basin, Mojave and Colorado Desert regions of the state. Note that the NVC is currently being revised by the Ecological Society of America's Vegetation Panel and thus the hierarchy in which each vegetation type has been placed may be revised at a later date. As of this writing (October 2012), alliances are currently under review with most of the hierarchy levels above alliance finalized.

'Park Special' follows a vegetation type name to designate a group, alliance or association that is unique to Manzanar and had no matching types in the NVC or the MCV. The word 'Provisional' follows a vegetation type name when there was sufficient data to indicate a distinct vegetation type, but not enough data to fully describe the type.

A full hierarchy showing the placement of each of the vegetation types occurring at Manzanar within the NVC precedes the descriptions. Definitions of the information contained in each field of the vegetation descriptions and a glossary of terms used throughout this document can be found at the end of this document

Revised National Vegetation Classification Hierarchy (rUSNVC)

Alliances/Associations in bolded-black font are types occurring at MANZ with a matching element concept in the National Vegetation Classification (NVC); light blue text indicates types not in the NVC but with a matching concept in the Manual of California Vegetation (MCV); royal blue text indicates Group, Alliance, Association, or stand names unique to MANZ.

Class	Subclass	Formation	Division	Macrogroup	Group	Alliance	Association	Rapid Assessments	Plots per type
Class 1. Forest and Woodland									
	Subclass 1.C. Temperate Forest								
		Formation 1.C.3. Temperate Flooded & Swamp Forest							
			Division 013 Southwestern North American Warm Temperate Flooded and Swamp Forest						
				Macrogroup M036. Warm Mediterranean & Desert Riparian, Flooded & Swamp Forest					
					G509 Mediterranean California Lowland Flooded & Swamp Forest Group				
					NPSMANZ001 Mixed Deciduous Upland Woodland [Park Special]				
						A### <i>Populus fremontii</i> Temporarily Flooded Woodland Alliance (under review)			
						MCV61.130.00 <i>Populus fremontii</i> Alliance			
						CEGL005308 <i>Populus fremontii</i> - <i>Salix laevigata</i> Woodland			1
						A### <i>Salix laevigata</i> Woodland Alliance *			--
						MCV61.205.00 <i>Salix laevigata</i> Alliance			
						NPSMANZ003 <i>Salix laevigata</i> Woodland Stand [Park Special]			--
									1
				Macrogroup M298 Western North American Warm Temperate Ruderal Flooded & Swamp Forest					
					G510 Southwest North American Ruderal Riparian Scrub Group				
					NPSMANZ001 Mixed Deciduous Upland Woodland [Park Special]				
						NPSMANZ002 <i>Robinia pseudoacacia</i> Semi-Natural Stands[Provisional]			--
								--	--
Class 2. Shrubland & Grassland									
	Sub-Class 2.B. Mediterranean Scrub and Grassland								
		Formation 2.B.2. Mediterranean Grassland and Forb Meadow							
			Division 2.B.2.a. California Grassland and Meadow						
				Macrogroup MG045. California Annual and Perennial Grassland					
					G496 California Native Bunchgrass Grassland Group				
					MCV California annual forb/grass vegetation Group (No NVC name applicable)				
					NPSMANZ004 Mixed Forb Herbaceous Vegetation [Park Special]				
						MCV42.110.00 <i>Amsinckia (menziesii, tessellata)</i> Alliance			--
						NPSMANZ005 <i>Amsinckia tessellata</i> Herbaceous Vegetation			--
									(3)
					G497 California Ruderal Grassland & Forb Meadow Group				
					MCV Mediterranean California naturalized annual and perennial grassland Group				
					NPSMANZ006 Mixed Grass Herbaceous vegetation [Park Special]				

Revised National Vegetation Classification Hierarchy (rUSNVC)

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Class	Subclass	Formation	Division	Macrogroup	Group	Alliance	Association	Rapid Assessments	Plots per type
Class 2. Shrubland & Grassland (cont.)									
						A###. <i>Bromus (diandrus, hordeaceus, madritensis)</i> Herbaceous Alliance			
						MCV42.024.00 <i>Bromus rubens</i> – <i>Schismus (arabicus, barbatus)</i> Semi-natural Stands			
							NPSMANZ007 <i>Schismus</i> spp. – <i>Atriplex serenana</i> Herbaceous Stands	--	2
	Subclass 2.C. Temperate and Boreal Shrubland and Grassland								
		Formation 2.C.1. Temperate Grassland, Meadow, and Shrubland							
			Division 022 Western North American Grassland & Shrubland						
				Macrogroup M048. Northern Rocky Mountain-Vancouverian Montane & Foothill Grassland & Shrubland					
					Group 275 - Northern Rocky Mountain Montane-Foothill Mesic Deciduous Shrubland Group				
						A.959 <i>Rosa woodsii</i> Temporarily Flooded Shrubland Alliance			
						CEGL001126 <i>Rosa woodsii</i> Shrubland		--	1
		Formation 2.C.5. Temperate and Boreal Freshwater Wet Meadow & Marsh							
			Division 031 Western North American Freshwater Wet Meadow and Marsh						
				Macrogroup M073. Western North American Lowland Freshwater Wet Meadow, Marsh & Shrubland					
					Group 526 - Rocky Mountain & Great Basin Lowland & Foothill Riparian & Seep Shrubland Group				
						A.947 <i>Salix exigua</i> Temporarily Flooded Shrubland (under review)			
						CEGL001202 <i>Salix exigua</i> / Mesic Forbs Shrubland		--	1
						NPSMANZ008 <i>Salix exigua</i> – <i>Ericameria nauseosa</i> Riparian Shrubland [Park Special]		4	--
		Formation 2.C.6 Salt Marsh							
			Division 036 North American Western Interior Brackish Marsh						
				Macrogroup M082 Cool Semi-Desert Alkali-Saline Wetland					
					Group 538 Intermountain Basins Alkaline-Saline Herb Wet Flat Group				
						NPSMANZ006 Mixed Grass Herbaceous vegetation [Park Special]			
						A###. <i>Distichlis spicata</i> Alliance (under review)			
						CEGL001770 <i>Distichlis spicata</i> Herbaceous Vegetation (Provisional)		--	1

Revised National Vegetation Classification Hierarchy (rUSNVC)									
Alliances/Associations in bolded-black font are types occurring at MANZ with a matching element concept in the National Vegetation Classification (NVC); light blue text indicates types not in the NVC but with a matching concept in the Manual of California Vegetation (MCV); royal blue text indicates Group, Alliance, Association, or stand names unique to MANZ.									
Class	Subclass	Formation	Division	Macrogroup	Group	Alliance	Association	Rapid Assessments	Plots per type
Class 3. Xeromorphic Scrub and Herb Vegetation (Semi-Desert)									
	Subclass 3.B. Cool Semi-Desert Scrub and Grassland								
		Formation 3.B.1. Cool Semi-Desert Scrub and Grassland							
			Division 040. Western North American Cool Semi-Desert Scrub and Grassland						
				Macrogroup M093. Great Basin Saltbush Scrub					
					Group 300 - Intermountain Shadscale - Saltbush Scrub Group				
						A.870 <i>Atriplex confertifolia</i> Alliance			
						CEGL001294 <i>Atriplex confertifolia</i> Great Basin Shrubland		1	5
						A.864 <i>Atriplex (lentiformis, polycarpa)</i> Shrubland Alliance		**1	
						A.873 <i>Atriplex polycarpa</i> Shrubland Alliance			
						CEGL001318 <i>Atriplex polycarpa</i> Shrubland		3	2
				Macrogroup M169. Great Basin & Intermountain Tall Sagebrush Shrubland and Steppe					
					Group 303 - Inter-Mountain Dry Tall Sagebrush shrubland Group				
						A.830 <i>Artemisia tridentata</i> (ssp. <i>tridentata</i> , ssp. <i>xericensis</i>) Shrubland Alliance			
						CEGL000991 <i>Artemisia tridentata</i> Shrubland		--	5
				Macrogroup M171. Great Basin & Intermountain Dry Shrubland & Grassland					
					Group 310- Intermountain Semi-Desert Shrubland & Steppe Group				
						A.835 <i>Ericameria nauseosa</i> Shrubland Alliance			
						NPSMANZ009 <i>Ericameria nauseosa</i> - <i>Atriplex canescens</i> Shrubland [Park Special]		1	6
						Totals		11	28
								*New to NVC	
								** sampled outside park	

1. Forest & Woodland Class

Mixed Deciduous Upland Woodland [Park Special]

Identifier: NPSMANZ001

MANZ Component Association(s)

Populus fremontii – Salix laevigata Woodland Association (CEGL005308)

Fremont Cottonwood – Red Willow Woodland Association

MANZ Component Stand Type(s)

Robinia pseudoacacia Semi-Natural Stands [Provisional] (NPSMANZ002)

Black Locust Stands

Classification confidence level: Moderate. Limited data to fully characterize the mixed woodland community and the component associations and stand types.

Classification comments: Only one stand within the mixed woodland was sampled and the environmental data and stand table data presented in this description characterize a *Populus fremontii* – *Salix laevigata* Woodland.

Other Classifications

USFWS Wetland Classification: Upland

MCV: not classified in the MCV.

Map Unit(s): W_MXWD, W_POFR, W_ROPS

Range:

Globally (U.S.): *Populus fremontii* – *Salix laevigata* riparian woodlands are known from northern, central and southern California, from the Sierra Nevada foothills, the central interior Coast Ranges (San Benito County), and San Diego and Riverside counties. ⁽¹⁾ *Robinia pseudoacacia* Provisional Semi-Natural Stands (Black locust groves) have been described from the Great Valley ecoregion of California ⁽⁴⁾

Regionally: none, unique to MANZ

MANZ: The Mixed Woodland community dominates the central portion of the park. Smaller woodland stands occur in the north and eastern portions of the park and on the south side of Bairs Creek.

Environmental description

Elevation (m): 1175

Slope: Gentle

Aspect: Flat

Topographic Position: Low level

Landform: Valley Floor

Geology: Colluvial

Cowardin System: Upland

Hydrology: Mesic

Soil texture: Clay loam

Unvegetated surface cover:

Large Rock: 0%,

Small Rock: 0%

Fines: 90%

Bare Soil: 0.2%

Litter, Duff: 10%

Wood: 0%

Water: 0%

Strata	Characteristic species	Ht. Range (m)	Stratum Absolute Cover (%)
T1 Emergent	none	>10	--
T2 Canopy	<i>Populus fremontii</i> , <i>Robinia pseudoacacia</i> , <i>Salix laevigata</i>	5-10	13.0
T3 Subcanopy	none	2-5	--
S1 Tall shrub	none	2-5	--
S2 Short Shrub	<i>Salix exigua</i> , <i>Rosa woodsii</i> , <i>Ericameria nauseosa</i> ssp. <i>nauseosa</i>	0.5–2	10.2
S3 Dwarf Shrub	none	<0.5	--
H1 Graminoids	<i>Distichlis spicata</i>	<0.5	7.0
H2 Forbs	<i>Atriplex serenana</i> , <i>Salsola tragus</i>	<0.5	25.4

Most abundant species: *Salix laevigata*, *Salix exigua*, *Atriplex serenana*, *Salsola tragus*

Diagnostic species: Any overstory tree species such as *Ailanthus altissima*, *Populus fremontii*, *Robinia pseudoacacia*, *Salix laevigata*, *Tamarix parviflora*.

Membership rules: Tree and shrub cover combined is greater than 7%. Cover of trees (woody plants greater than or equal to 5 meters in height), including *Robinia pseudoacacia* (black locust), *Populus fremontii* (Fremont cottonwood), *Ailanthus altissima* (tree of heaven), *Ulmus* spp. (Elm spp.), and others is greater than or equal to 15%.

Vegetation description: Tree canopies of the mixed woodlands vary from open (>10-33%) to intermittent (>34-66%) to continuous (>66%). The most common overstory tree species are *Ailanthus altissima*, *Robinia pseudoacacia*, *Populus fremontii* and *Salix laevigata* (red willow). In stands where the canopy is continuous, the understory vegetation is very sparse with *Descurainia sophia* (herb Sophia) the most common understory species.

The one mixed woodland stand sampled has an open tree canopy layer (13%) with trees between 5-10m in height; an open shrub layer (10%) between 1-2m in height; and an open herbaceous layer (32.4%) less than 0.5m in height. *Salix laevigata* strongly dominates the tree canopy with 61.5% relative cover. Associate overstory trees include *Populus fremontii* (23.1% relative cover) and *Robinia pseudoacacia* (15.4% relative cover). *Salix exigua* (narrow leaf willow) strongly dominates the shrub layer with 98% relative cover. *Atriplex serenana* (bractscale) and *Salsola tragus* (prickly Russian thistle) co-dominate the herb layer with 46.3% and 30.9% relative cover respectively. *Distichlis spicata* (salt grass) is the third most abundant species in the herb layer at 21.6% relative cover. At 13% overstory tree cover, this stand is at the margin between a *Salix exigua* Shrubland and a *Populus fremontii* – *Salix laevigata* Woodland.

The mixed woodland stands are broad-leaved, cold-deciduous woodlands.

Other noteworthy species: *Ulmus* spp. (Elm spp.), *Morus alba* (white mulberry), *Ficus carica* (ornamental fig), *Glycyrrhiza lepidota* (American licorice), *Asclepias fascicularis* (Mexican whorled milkweed), *Sisymbrium altissimum* (tall tumble mustard)

Conservation rank: Unranked

Comments: Semi-natural vegetation typically encompasses vegetation types where the species composition and/or vegetation growth forms have been altered through anthropogenic disturbances such that no clear natural analogue is known, but they are a largely spontaneous set of plants shaped by ecological processes. Natural and semi-natural vegetation differs from cultural vegetation in that they persist independently of any human activity⁽³⁾

Populus fremontii, *Salix laevigata*, *Salix exigua* are all members of the willow family and most commonly grow in stream channels or on stream banks. Their ability to grow in an upland setting on the valley floor indicates a water table near the surface of the valley floor.

References:

- ⁽¹⁾ NatureServe. Ecological Association Comprehensive Report. *Populus fremontii* – *Salix laevigata* Woodland. CEG005308. Feb. 2012.
- ⁽²⁾ MCV. Sawyer, John O., T. Keeler-Wolf, J.M. Evens. 2009. *A Manual of California Vegetation*. 2nd Edition. California Native Plant Society, Sacramento, CA.
- ⁽³⁾ FGDC. 2008. National Vegetation Classification Standard, Version 2, FGDC-STD-005-2008. Vegetation Subcommittee, Federal Geographic Data Committee, FGDC Secretariat U.S. Geological Survey. Reston, VA, U.S.A.
- ⁽⁴⁾ Buck-Diaz, Jennifer, Batiuk, S., Evens, J.M. 2012. Vegetation Alliances and Associations of the Great Valley Ecoregion, California. California Native Plant Society. Sacramento, CA.

Mixed Deciduous Upland Woodland [Park Special]

***Populus fremontii* – *Salix laevigata* Woodland Association**

Fremont Cottonwood – Red Willow Woodland Association

Stand Table

n=1

Life form	Native	Species Code	Scientific name	CON	AVG	MIN	MAX	Ch	D	Cd	A	Oft
Tree												
	Y	SALA	<i>Salix laevigata</i>	100	8.0	8.0	8.0	X	X			
	Y	POFR	<i>Populus fremontii</i>	100	3.0	3.0	3.0	X				X
	N	ROPS	<i>Robinia pseudoacacia</i>	100	2.0	2.0	2.0	X				X
Shrub												
	Y	SAEX	<i>Salix exigua</i>	100	10.0	10.0	10.0	X				
	Y	ERHNH	<i>Ericameria nauseosa</i> ssp. <i>nauseosa</i> var. <i>hololeuca</i>	100	0.1	0.1	0.1	X				X
	Y	ROWOU	<i>Rosa woodsii</i> var. <i>ultramontana</i>	100	0.1	0.1	0.1	X				X
Forb												
	Y	ATSE	<i>Atriplex serenana</i>	100	15.0	15.0	15.0	X				
	N	SATR	<i>Salsola tragus</i>	100	10.0	10.0	10.0	X				X
	Y	ASFA	<i>Asclepias fascicularis</i>	100	0.1	0.1	0.1	X				X
	Y	GLLE	<i>Glycyrrhiza lepidota</i>	100	0.1	0.1	0.1	X				X
	Y	MEAL	<i>Mentzelia albicaulis</i>	100	0.1	0.1	0.1	X				X
	N	SIAL	<i>Sisymbrium altissimum</i>	100	0.1	0.1	0.1	X				X
Grass/Grass-like												
	Y	DISP	<i>Distichlis spicata</i>	100	7.0	7.0	7.0	X				X

SPECIES RICHNESS: Total: 13 Avg.: 13 Range: 13 - 13

PLOTS: Environmental description and stand table data from Rapid Assessment MANZ.34. Vegetation description information from MANZ.34 supplemented with information from observation and accuracy assessment points collected throughout the mixed woodland.

Salix laevigata* Woodland Stand [Park Special]*Red willow Woodland Stand**Identifier: NPSMANZ003

Classification confidence level: Moderate. Limited data to characterize type. Occurrence limited to one stand within park.

Other Classification Systems**USFWS Wetland Classification:** Wetland**MCV:** Red Willow Series, *Salix laevigata* Woodland Alliance**MANZ Map Unit:** W_SALA**Range:**

Globally (U.S): Though *Salix laevigata* is widespread in the west and southwestern United States, a *Salix laevigata* Alliance has not been described from the Great Basin region in the NVC. In the MCV, this alliance is documented from cismontane California. Stands occur regularly along foothill streams and low gradient riparian settings. ⁽²⁾

Regionally: In transmontane California, stands of the Red Willow alliance occur at springs and streams such as at Darwin Falls and at springs in the Argus Range (Inyo County). ⁽²⁾

MANZ: One stand in Bairs Creek northeast of what was the Chicken Ranch during the camp period.

Environmental description

Elevation (m): 1,190

Slope (°): 1

Aspect: Flat

Topographic Position: Channel Bed

Landform: Valley floor

Geology: Colluvial

Cowardin System: Palustrine- Forested Wetland

Hydrology: Seasonally flooded

Soil texture: Sand

Unvegetated surface cover:

Large Rock: 0%,

Small Rock: 2%

Fines: 12%

Bare Soil: 1%

Litter, Duff: 70%

Wood: 5%

Water: 10%

Strata	Characteristic species	Ht. Range (m)	Stratum Absolute Cover (%)
T1 Emergent	none	>15	--
T2 Canopy	<i>Salix laevigata</i> , <i>Robinia pseudoacacia</i> ,	10-15	40.0
T3 Subcanopy	<i>Salix laevigata</i>	2-5	0.1
S1 Tall shrub	<i>Forestiera pubescens</i>	2-5	1.0
S2 Short Shrub	<i>Rosa woodsii</i> var. <i>ultramontana</i>	0.5–2	0.1
S3 Dwarf Shrub	none	<0.5	--
H1 Graminoids	<i>Bromus rubens</i> , <i>Cynodon dactylon</i> , <i>Distichlis spicata</i>	<0.5	0.6
H2 Forbs	<i>Descurainia sophia</i> , <i>Mentzelia albicaulis</i> , <i>Glycyrrhiza lepidota</i>	<0.5	22.8

Most abundant species: *Salix laevigata*, *Robinia pseudoacacia*, *Descurainia sophia*

Diagnostic species: *Salix laevigata*

Membership rules: *Salix laevigata* >5% absolute cover and >50% relative cover and dominant or co-dominant in the tree canopy ⁽²⁾

Vegetation description: Only one stand of this vegetation type occurs within the historic site. The stand occurs along Bairs creek northeast of what was a chicken ranch during the camp period. The stand extends on both sides of the creek channel and water flows through the stand in the spring and early summer. This stand has an intermittent tree canopy layer (40%) with trees between 10-15m in height; a sparse shrub layer (1%) between 0.5m and 5m in height; and an open herbaceous layer (23.4%) at less than 0.5m in height. *Salix laevigata* (red willow) occurs along the stream channel while *Robinia pseudoacacia* (black locust) occurs on the upper banks. *Salix laevigata* strongly dominates in the tree canopy with 63% relative cover. *Robinia pseudoacacia* is co-dominant with 37% relative cover. *Forestiera pubescens* (stretch berry) occurs in the tall shrub layer near the stream channel under the canopy of the red willow. *Rosa woodsii* var. *ultramontana* (Woods' rose) occurs under the tree canopy on the upper banks of the creek. Non-native species in the herbaceous layer include *Descurainia sophia* (herb Sophia), *Hordeum murinum* ssp. *leporinum* (hare barley), *Bromus rubens* (red brome) and *Cynodon dactylon* (Bermuda grass). Native species in the herbaceous layer include *Artemisia ludoviciana* (white sagebrush), *Carex* spp. (sedge) and *Bromus catharticus* (rescue grass).

Salix laevigata woodlands are broad-leaved, cold-deciduous woodlands.

Other noteworthy species: *Salsola tragus* (prickly Russian thistle)

Conservation rank: G3 S3⁽²⁾

Comments: *Salix laevigata* grows commonly with various willows and other riparian trees but it can dominate sites. Researchers have mostly recognized mixed associations that include *S. laevigata* in the *Alnus rhombifolia*, *Populus fremontii*, *Quercus agrifolia* and *Salix gooddingii* alliances. The associations in this alliance are mainly *Salix laevigata* – *Salix lasiolepis* associations, which might be better classified as *Salix lasiolepis* associations. ⁽²⁾

References:

- ⁽²⁾ MCV. Sawyer, John O., T. Keeler-Wolf, J.M. Evens. 2009. *A Manual of California Vegetation*. 2nd Edition. California Native Plant Society, Sacramento, CA.

***Salix laevigata* Woodland Stand [Park Special]**

Red willow Woodland Stand

Stand Table

n=1

Life Form	Native	Species Code	Scientific Name	CON	AVG.	MIN	MAX	Ch	D	Cd	A	Oft
Tree												
	Y	SALA3	<i>Salix laevigata</i>	100	25.0	25.0	25.0	X	X			
	N	ROPS	<i>Robinia pseudoacacia</i>	100	15.0	15.0	15.0	X		X		
Shrub												
	Y	FOPU2	<i>Forestiera pubescens</i>	100	1.0	1.0	1.0	X				X
	Y	ROWOU	<i>Rosa woodsii</i> var. <i>ultramontana</i>	100	0.1	0.1	0.1	X				X
Forb												
	N	DESO2	<i>Descurainia sophia</i>	100	20.0	20.0	20.0	X	X			
	Y	MEAL6	<i>Mentzelia albicaulis</i>	100	2.0	2.0	2.0	X				X
	Y	AMTE3	<i>Amsinckia tessellata</i>	100	0.1	0.1	0.1	X				X
	Y	ARLUI2	<i>Artemisia ludoviciana</i> ssp. <i>incompta</i>	100	0.1	0.1	0.1	X				X
	Y	CLOB	<i>Cleomella obtusifolia</i>	100	0.1	0.1	0.1	X				X
	N	ERCI6	<i>Erodium cicutarium</i>	100	0.1	0.1	0.1	X				X
	Y	GLLE3	<i>Glycyrrhiza lepidota</i>	100	0.1	0.1	0.1	X				X
	Y	LEFLF2	<i>Lepidium flavum</i> var. <i>flavum</i>	100	0.1	0.1	0.1	X				X
	Y	MAGL3	<i>Malacothrix glabrata</i>	100	0.1	0.1	0.1	X				X
	N	SATR12	<i>Salsola tragus</i>	100	0.1	0.1	0.1	X				X
Grass/Grass-like												
	Y	CAREX	<i>Carex</i> spp.	100	0.1	0.1	0.1	X				X
	N	BRCA6	<i>Bromus catharticus</i>	100	0.1	0.1	0.1	X				X
	N	BRRU2	<i>Bromus rubens</i>	100	0.1	0.1	0.1	X				X
	N	CYDA	<i>Cynodon dactylon</i>	100	0.1	0.1	0.1	X				X
	Y	DISP	<i>Distichlis spicata</i>	100	0.1	0.1	0.1	X				X
	N	HOMUL	<i>Hordeum murinum</i> ssp. <i>leporinum</i>	100	0.1	0.1	0.1	X				X

SPECIES RICHNESS: Total: 20 Avg.: 20 Range: 20-20

Plots: MANZ.2

2. Shrubland & Grassland Class

Mixed Forb Herbaceous Vegetation [Park Special]

Identifier: NPSMANZ004

MANZ Component Alliance(s)

Amsinckia (tessellata, menziesii) Herbaceous Alliance (MCV 42.110.00)

Fiddleneck Fields Herbaceous Alliance

MANZ Component Association(s)

Amsinckia tessellata *Herbaceous Vegetation* (NPSMANZ005)

Bristly Fiddleneck Herbaceous Vegetation

Classification confidence level: High.

Classification Comment: Annual alliances and associations dominated by native forbs have been defined and described in the Manual of California Vegetation (MCV) but not in the National Vegetation Classification (NVC). All four plots sampled were classified as belonging to the Mixed Forb Herbaceous Vegetation group and the *Amsinckia (tessellata, menziesii)* Alliance. Three of the four plots were further classified as *Amsinckia tessellata* Herbaceous Vegetation Association. The fourth plot was unclassified. Stand tables have been included presenting the group, the association and the unclassified data.

Other Classification Systems

USFWS Wetland Classification: Upland

MCV: California annual forb/grass vegetation Group, *Amsinckia (menziesii, tessellata)* Herbaceous Alliance

MANZ Map Unit: H_MXFB

Range:

Globally (U.S.): *Amsinckia tessellata* is a wide-ranging species occurring in the western United States and north into British Columbia. Annual herbaceous alliances dominated by native forbs have not been described outside of California.

Regionally: Not documented in the Great Basin region, but documented in the western Mojave Desert and cismontane California.

MANZ: Large mixed forb stands occur in the northeast, east and central portions of the historic site.

Environmental description

Elevation (m): 1179 (1171 – 1191)

Slope: Flat

Aspect: Flat

Topographic Position: low level (4)

Landform: Valley floor

Geology: Colluvial

Cowardin System: Upland

Hydrology: Dry - mesic

Soil texture: Sand, Sandy loam

Unvegetated surface cover (%):

Large Rock: 0 (0-0)

Small Rock: 83 (50-96)

Fines: 10 (2-30)

Bare Soil: 5 (1-16)

Litter, Duff: 2 (1-4)

Wood: 0 (0-0)

Water: 0 (0-0)

Strata	Characteristic species	Ht. Range (m)	Stratum Absolute Cover (%)
T1 Emergent	none	>10	--
T2 Canopy	none	5-10	--
T3 Subcanopy	none	2-5	--
S1 Tall shrub	none	2-5	--
S2 Short Shrub	<i>Ericameria nauseosa</i> ssp. <i>nauseosa</i> , <i>Atriplex canescens</i> var. <i>canescens</i>	0.5–2	0.1
S3 Dwarf Shrub	<i>Ericameria nauseosa</i> ssp. <i>nauseosa</i> , <i>Atriplex canescens</i> var. <i>canescens</i>	<0.5	0.1
H1 Graminoids	<i>Schismus</i> spp.	<0.5	0.1
H2 Forbs	<i>Amsinckia tessellata</i> , <i>Salsola tragus</i> , <i>Mentzelia albicaulis</i> , <i>Malacothrix glabrata</i>	<0.5	16.4

Most abundant species: *Amsinckia tessellata*, *Salsola tragus*, *Mentzelia albicaulis*, *Malacothrix glabrata*

Diagnostic species: *Amsinckia tessellata*, *Mentzelia albicaulis*, *Malacothrix glabrata*

Membership rules: Tree and shrub cover combined is less than or equal to 7%. Combined cover of *Schismus* spp. (Mediterranean grass) and *Distichlis spicata* (salt grass) is less than 5%. At least two of the following species are present: *Amsinckia tessellata* (bristly fiddleneck), *Mentzelia albicaulis* (whitestem blazing star), *Malacothrix glabrata* (smooth desert dandelion).

Vegetation description: The mixed forb vegetation type is characterized by a predominant herbaceous layer with scattered shrubs and trees. Stands of this vegetation type have a very sparse shrub layer (<1%, 0 – 0.1%) between 0.5-2m in height and an open herbaceous layer (16.4%, 9.7-33.3%) less than 0.5m in height. The composition is primarily native forb species with the exception of *Salsola tragus* (prickly Russian thistle). The dominant forb species vary within mixed forb stands with areas dominated by *Amsinckia tessellata*, *Mentzelia albicaulis* and *Malacothrix glabrata*.

Common associate species which are consistently present but at low cover include *Eriastrum wilcoxii* (Wilcox's woolly star), *Gilia* spp. (*gilia*), *Cryptantha pterocarya* (wingnut cryptantha), *Cryptantha circumscissa* (cushion cryptantha), and *Cryptantha micrantha* (redroot cryptantha). Scattered shrubs include *Ericameria nauseosa* ssp. *nauseosa* (rubber rabbitbrush), *Atriplex torreyi* (Torrey's saltbush), *Atriplex polycarpa* (cattle saltbush), *Atriplex canescens* var. *canescens* (four-wing saltbush) and *Tamarix parviflora* (small-flowered tamarisk).

Other noteworthy species: *Salsola tragus*, *Descurainia sophia* (herb Sophia), *Erodium cicutarium* (red-stem stork's bill).

Conservation rank: G4 S4⁽²⁾

Comments: The mixed forb herbaceous type is distinguished from the mixed grass herbaceous type by an herbaceous layer dominated by native forbs and very sparse (<1%) grass cover. The amount of shrub cover within the mixed forb stands varies. This type is considered an early successional type

which may convert to shrublands over time. *Amsinckia tessellata* (bristly fiddleneck) is well adapted to regular site disturbance and fluctuating Mediterranean climates through its ability to bank seeds and germinate quickly during relatively high rainfall years. ⁽²⁾

References:

- ⁽²⁾ MCV. Sawyer, John O., T. Keeler-Wolf, J.M. Evens. 2009. *A Manual of California Vegetation*. 2nd Edition. California Native Plant Society, Sacramento, CA.

Mixed Forb Herbaceous Vegetation [Park Special]

Stand Table

n=4

Life Form	Native	Species Code	Scientific Name	CON	AVG	MIN	MAX	Ch	D	Cd	A	Oft
Shrub												
	Y	ERNAH	<i>Ericameria nauseosa</i> ssp. <i>nauseosa</i> var. <i>hololeuca</i>	50.0	0.3	0.0	1.0					X
	Y	ATCAC	<i>Atriplex canescens</i> var. <i>canescens</i>	50.0	0.1	0.0	0.1					X
Forb												
	N	SATR12	<i>Salsola tragus</i>	100.0	3.5	0.1	7.0	X				X
	Y	MEAL6	<i>Mentzelia albicaulis</i>	100.0	1.1	0.1	3.0	X				X
	Y	AMTE3	<i>Amsinckia tessellata</i>	75.0	9.5	0.0	28.0	X		X		
	Y	MAGL3	<i>Malacothrix glabrata</i>	75.0	0.8	0.0	3.0	X				X
	Y	GILIA	<i>Gilia</i> sp.	75.0	0.3	0.0	1.0	X				X
	Y	CRC12	<i>Cryptantha circumscissa</i>	50.0	0.1	0.0	0.1					X
	Y	CRPT	<i>Cryptantha pterocarya</i>	50.0	0.1	0.0	0.1					X
	N	DESO2	<i>Descurainia sophia</i>	50.0	0.1	0.0	0.1					X
	Y	ERWI	<i>Eriastrum wilcoxii</i>	50.0	0.1	0.0	0.1					X
	Y	ERMA2	<i>Eriogonum maculatum</i>	50.0	0.1	0.0	0.1					X
	N	ERC16	<i>Erodium cicutarium</i>	50.0	0.1	0.0	0.1					X
	Y	ATSE2	<i>Atriplex serenana</i>	25.0	0.8	0.0	3.0					
	Y	CRMI	<i>Cryptantha micrantha</i>	25.0	0.0	0.0	0.1					
	Y	DEPIG	<i>Descurainia pinnata</i> ssp. <i>glabra</i>	25.0	0.0	0.0	0.1					
	Y	GLLE3	<i>Glycyrrhiza lepidota</i>	25.0	0.0	0.0	0.1					
	Y	LOSC6	<i>Loeseliastrum schottii</i>	25.0	0.0	0.0	0.1					
Grass/Grass-like												
	N	SCHIS	<i>Schismus</i> sp.	50.0	0.1	0.0	0.1					X

SPECIES RICHNESS: Total: 19 Avg. 9.8 Range: 7-12

PLOTS: MANZ.5, MANZ.17, MANZ.25, MANZ.26

Mixed Forb Herbaceous Vegetation [Park Special]

***Amsinckia tessellata* Herbaceous Vegetation**

Bristly Fiddleneck Herbaceous Vegetation

Stand Table

n=3

Life Form	Native	Species Code	Scientific Name	CON	AVG	MIN	MAX	Ch	D	Cd	A	Oft
Shrub												
	Y	ATCAC	<i>Atriplex canescens</i> var. <i>canescens</i>	67	0.1	0.0	0.1					X
	Y	ERNAH	<i>Ericameria nauseosa</i> ssp. <i>nauseosa</i> var. <i>hololeuca</i>	33	0.0	0.0	0.1					
Forb												
	Y	AMTE3	<i>Amsinckia tessellata</i>	100	12.7	0.1	28.0	X	X			
	N	SATR12	<i>Salsola tragus</i>	100	2.4	0.1	5.0	X				X
	Y	MEAL6	<i>Mentzelia albicaulis</i>	100	0.4	0.1	1.0	X				X
	Y	MAGL3	<i>Malacothrix glabrata</i>	67	1.0	0.0	3.0					X
	Y	GILIA	<i>Gilia</i> sp.	67	0.4	0.0	1.0					X
	N	DESO2	<i>Descurainia sophia</i>	67	0.1	0.0	0.1					X
	N	ERCI6	<i>Erodium cicutarium</i>	67	0.1	0.0	0.1					X
	Y	ATSE2	<i>Atriplex serenana</i>	33	1.0	0.0	3.0					
	Y	CRCI2	<i>Cryptantha circumscissa</i>	33	0.0	0.0	0.1					
	Y	CRPT	<i>Cryptantha pterocarya</i>	33	0.0	0.0	0.1					
	Y	DEPIG	<i>Descurainia pinnata</i> ssp. <i>glabra</i>	33	0.0	0.0	0.1					
	Y	ERWI	<i>Eriastrum wilcoxii</i>	33	0.0	0.0	0.1					
	Y	ERMA2	<i>Eriogonum maculatum</i>	33	0.0	0.0	0.1					
	Y	GLLE3	<i>Glycyrrhiza lepidota</i>	33	0.0	0.0	0.1					
Grass/Grass-like												
	N	SCHIS	<i>Schismus</i> sp.	67	0.1	0.0	0.1					X

SPECIES RICHNESS: Total:17 Avg.: 9.3 Range: 7-12

PLOTS: MANZ.5, MANZ.17, MANZ.25

Mixed Forb Herbaceous Vegetation [Park Special]

Unclassified

Stand Table

n=1

Life form	Native	Plant Symbol	Scientific Name	CON	AVG	MIN	MAX	Ch	D	Cd	A	Oft
Shrub												
	Y	ERNAH	<i>Ericameria nauseosa</i> ssp. <i>nauseosa</i> var. <i>hololeuca</i>	100	1.0	1.0	1.0	X				X
Forb												
	N	SATR12	<i>Salsola tragus</i>	100	7.0	7.0	7.0	X	X			
	Y	MEAL6	<i>Mentzelia albicaulis</i>	100	3.0	3.0	3.0	X				X
	Y	CRCI2	<i>Cryptantha circumscissa</i>	100	0.1	0.1	0.1	X				X
	Y	CRMI	<i>Cryptantha micrantha</i>	100	0.1	0.1	0.1	X				X
	Y	CRPT	<i>Cryptantha pterocarya</i>	100	0.1	0.1	0.1	X				X
	Y	ERWI	<i>Eriastrum wilcoxii</i>	100	0.1	0.1	0.1	X				X
	Y	ERMA2	<i>Eriogonum maculatum</i>	100	0.1	0.1	0.1	X				X
	Y	GILIA	<i>Gilia</i> sp.	100	0.1	0.1	0.1	X				X
	Y	LOSC6	<i>Loeseliastrum schottii</i>	100	0.1	0.1	0.1	X				X
	Y	MAGL3	<i>Malacothrix glabrata</i>	100	0.1	0.1	0.1	X				X

SPECIES RICHNESS: Total: 11 Avg.: 11 Range: 11-11

PLOTS: MANZ.26

Mixed Grass Herbaceous Vegetation [Park Special]

Identifier: NPSMANZ006

MANZ Component Stand Type(s)

Schismus spp. – Atriplex serenana Herbaceous Stands (NPSMANZ007)

Mediterranean grass – Bractscale Herbaceous Stands

MANZ Component Association(s)

Distichlis spicata Herbaceous Vegetation [Provisional] (CEGL001770)

Saltgrass Herbaceous Vegetation [Provisional]

Classification confidence level: Moderate. Limited data to fully describe the Mixed Grass Herbaceous community and the component associations.

Other Classification Systems

USFWS Wetland Classification:

1. *Schismus* spp. dominated stands – upland wetland indicator
2. *Distichlis spicata* dominated stands –

MCV:

1. Mediterranean California naturalized annual and perennial grassland Group, *Bromus rubens* – *Schismus* (*arabicus*, *barbatus*) Semi-natural Stands
2. Salt grass series, *Distichlis spicata* Herbaceous Alliance

MANZ Map Unit: H_MXHB

Range:

Globally (U.S.): Both *Schismus arabicus* and *Schismus barbatus* are widespread in the western United States. *S. arabicus* is more common in arid regions while *S. barbatus* is more common in semi-arid shrublands. Semi-natural stands of *Bromus rubens*–*Schismus* (*arabicus*, *barbatus*) have not been described outside of California. *Distichlis spicata* grasslands occur in semi-arid and arid western North America from southern Saskatchewan, Canada to Mexico. Stands are found in lowland habitats such as playas, swales, and terraces along washes that are typically intermittently to seasonally dry.⁽¹⁾

Regionally: Semi-natural stands of *Bromus rubens* – *Schismus* (*arabicus*, *barbatus*) have been documented in California in the Mojave and Colorado Deserts but not the Great Basin region of California. Stands of *Distichlis spicata* occur in alkali meadows of the Owens Valley (Manning 1994) and are associated with alkali basins, playa edges, stream margins, seeps, and springs throughout the Mojave Desert. This type occurs in alkaline depressions and seeps in Deep Springs Valley, Saline Valley and Saratoga Springs in Death Valley National Park (Bradley 1970).⁽²⁾

MANZ: Only two prominent stands with a significant cover of *Schismus* spp. were found within the park. One stand occurs on the south side of Bairs Creek to the east of what was a chicken ranch during the camp period and one stand to the north of Bairs Creek in an area which served as the golf course during the camp period. Small stands of *Distichlis spicata* – *Atriplex serenana* - *Glycyrrhiza lepidota* occur from the north to the south end of the park through the central portion of the historic

site in openings in the woodland canopy. The most prominent stand occurs along the north central boundary of the park.

Environmental description

Elevation (m): 1190 (1188 – 1193)

Slope : Flat to Gentle

Aspect: Flat

Topographic Position: low level (3)

Landform: valley floor

Geology: Colluvial

Cowardin System: Upland

Hydrology: Mesic – Dry-Mesic

Soil texture: Sand, sandy loam

Unvegetated surface cover (%):

Large Rock: 0 (0-0)

Small Rock: 57 (1-93)

Fines: 4 (1-5)

Bare Soil: 4 (1-10)

Litter, Duff: 34 (1-97)

Wood: 1 (0-2)

Water: 0 (0-0)

Strata	Characteristic species	Ht. Range (m)	Stratum Absolute Cover (%)
T1 Emergent	none	>10	--
T2 Canopy	none	5-10	--
T3 Subcanopy	none	2-5	--
S1 Tall shrub	none	2-5	--
S2 Short Shrub	none	0.5–2	--
S3 Dwarf Shrub	none	<0.5	--
H1 Graminoids	<i>Schismus</i> spp., <i>Distichlis spicata</i>	<0.5	16.0
H2 Forbs	<i>Atriplex serenana</i> , <i>Salsola tragus</i> , <i>Mentzelia albicaulis</i>	<0.5	24.1

Most abundant species: *Schismus* spp., *Distichlis spicata*, *Atriplex serenana*, *Glycyrrhiza lepidota*

Diagnostic species: *Schismus* spp., *Distichlis spicata*

Membership rules: Tree and shrub cover combined is less than or equal to 7%. Combined cover of *Schismus* spp. (Mediterranean grass) and *Distichlis spicata* (salt grass) is greater than or equal to 5%.

Vegetation description: The Mixed Grass Herbaceous vegetation type is an herbaceous type with a mix of grass and forb species. Stands in the Mixed Grass Herbaceous vegetation type are characterized by an intermittent herbaceous layer (40.1%, 21.5-46.5%) at less than 0.5m in height. Forb species are strongly dominant with an average of 60% relative cover (46.2-76.7%). Grass species are typically co-dominant with an average of 40% relative cover (23.3-53.8%).

The data from the three plots sampled indicate there are two mixed grass herbaceous vegetation types. One mixed grass herbaceous vegetation type is characterized by sparse (5%) to open (25%) cover of *Schismus* spp. This type was sampled by two plots (MANZ.16, MANZ.28) in two stands where the highest concentration of *Schismus* spp. within the park was observed. The higher cover of *Schismus* spp. in these stands is notable because of the very sparse (<1%) cover of annual grasses in the mixed forb herbaceous stands. A provisional *Distichlis spicata* Herbaceous Vegetation association occurs on moist sites within the central portion of the park. The most prominent stand

occurs in the central portion of the park near the north boundary (MANZ.22). *Atriplex serenana* (bractscale) is the most abundant forb species in both types and is either the dominant or co-dominant species in these stands.

Other noteworthy species: *Salsola tragus* (prickly Russian thistle), *Glycyrrhiza lepidota* (American licorice), *Asclepias fascicularis* (Mexican whorled milkweed)

Conservation rank:

Schismus ssp. – *Atriplex serenana* Herbaceous Stands – Unranked

Distichlis spicata Herbaceous Vegetation – G5⁽¹⁾ S4⁽²⁾

Comments: The mixed grass herbaceous type is distinguished from the mixed forb herbaceous type by grass cover of $\geq 5\%$. *Schismus barbatus* (Mediterranean grass) and *S. arabicus* (Arabian Schismus) are both tufted, cool-season, annual grasses native to southern Europe and Africa. Studies have found that the dominance of non-native, annual grasses is a factor of rainfall totals. *Distichlis spicata* is a rhizomatous, warm-season grass that occurs throughout most of temperate North America. Its physiological adaptations allow it to occupy saline environments. Once established, plants grow in soils that vary greatly in salinity (Uchytel 1990f).⁽²⁾ *Glycyrrhiza lepidota* is an early colonizer of disturbed areas.^(1a)

References

⁽¹⁾ NatureServe Explorer: Ecological Association Comprehensive Report. *Distichlis spicata* Herbaceous Vegetation. CEG001770

^(1a) NatureServe Explorer: Ecological Alliances Comprehensive. *Salix (exigua, interior)* Temporarily Flooded Shrubland Alliance. A.947

⁽²⁾ MCV. Sawyer, John O., T. Keeler-Wolf, J.M. Evens. 2009. *A Manual of California Vegetation*. 2nd Edition. California Native Plant Society, Sacramento, CA.

Mixed Grass Herbaceous Vegetation [Park Special]

Stand Table

n=3

Life Form	Native	Species Code	Scientific Name	CON	AVG	MIN	MAX	Ch	D	Cd	A	Oft
Forb												
	Y	ATSE2	<i>Atriplex serenana</i>	100	15.7	10.0	20.0	X	X			
	N	SATR12	<i>Salsola tragus</i>	100	4.0	0.1	10.0	X				X
	Y	MEAL6	<i>Mentzelia albicaulis</i>	100	0.4	0.1	1.0	X				X
	Y	AMTE3	<i>Amsinckia tessellata</i>	67	1.3	0.0	3.0					X
	Y	CRPT	<i>Cryptantha pterocarya</i>	67	0.1	0.0	0.1					X
	Y	DEPIG	<i>Descurainia pinnata</i> <i>ssp. glabra</i>	67	0.1	0.0	0.1					X
	N	DESO2	<i>Descurainia sophia</i>	67	0.1	0.0	0.1					X
	Y	GLLE3	<i>Glycyrrhiza lepidota</i>	33	2.3	0.0	7.0					
	Y	ASFA	<i>Asclepias fascicularis</i> *	33	0.0	0.0	0.1					
	Y	ERMA2	<i>Eriogonum maculatum</i>	33	0.0	0.0	0.1					
	Y	GILIA	<i>Gilia</i> sp.	33	0.0	0.0	0.1					
	Y	PECTO	<i>Pectocarya</i> sp.	33	0.0	0.0	0.1					
Grass/Grass-like												
	N	SCHIS	<i>Schismus</i> spp.	67	10.0	0.0	25.0					X
	Y	DISP	<i>Distichlis spicata</i>	33	6.0	0.0	18.0					
	N	HOMUL	<i>Hordeum murinum</i> ssp. <i>leporinum</i>	33	0.0	0.0	0.1					

*Outside plot, within stand

SPECIES RICHNESS: Total: 14 Avg. 8.3 Range: 7-10

PLOTS: MANZ.16, MANZ.22, MANZ.28

Mixed Grass Herbaceous Vegetation [Park Special]
***Schismus* spp. – *Atriplex serenana* Herbaceous Stands**
Mediterranean grass – Bractscale Herbaceous Stands
Stand Table
n = 2

Life Form	Native	Species Code	Scientific Name	CON	AVG	MIN	MAX	Ch	D	Cd	A	Oft
Grass	N	SCHIS	<i>Schismus</i> spp.	100	15.0	5.0	25.0	X		X		
Forb	Y	ATSE2	<i>Atriplex serenana</i>	100	15.0	10.0	20.0	X		X		
Forb	Y	AMTE3	<i>Amsinckia tessellata</i>	100	2.0	1.0	3.0	X				X
Forb	N	SATR12	<i>Salsola tragus</i>	100	1.1	0.1	2.0	X				X
Forb	Y	MEAL6	<i>Mentzelia albicaulis</i>	100	0.6	0.1	1.0	X				X
Forb	Y	CRPT	<i>Cryptantha pterocarya</i>	100	0.1	0.1	0.1	X				X
Forb	Y	DEPIG	<i>Descurainia pinnata</i> ssp. <i>glabra</i>	100	0.1	0.1	0.1	X				X
Forb	N	DESO2	<i>Descurainia sophia</i>	50	0.1	0.0	0.1					X
Forb	Y	ERMA2	<i>Eriogonum maculatum</i>	50	0.1	0.0	0.1					X
Forb	Y	GILIA	<i>Gilia</i> sp.	50	0.1	0.0	0.1					X
Forb	Y	PECTO	<i>Pectocarya</i> sp.	50	0.1	0.0	0.1					X

SPECIES RICHNESS: Total: 11 Avg.: 9 Range: 8-10

PLOTS: MANZ.16, MANZ.28

Mixed Grass Herbaceous Vegetation [Park Special]

***Distichlis spicata* Herbaceous Vegetation**

Saltgrass Herbaceous Vegetation

Stand Table

n = 1

Life Form	Native	Species Code	Scientific Name	CON	AVG	MIN	MAX	Ch	D	Cd	A	Oft
Grass	Y	DISP	<i>Distichlis spicata</i>	100	18.0	18.0	18.0	X		X		
Forb	Y	ATSE2	<i>Atriplex serenana</i>	100	17.0	17.0	17.0	X		X		
Forb	N	SATR12	<i>Salsola tragus</i>	100	10.0	10.0	10.0	X				X
Forb	Y	GLLE3	<i>Glycyrrhiza lepidota</i>	100	7.0	7.0	7.0	X				X
Forb	N	DESO2	<i>Descurainia sophia</i>	100	0.1	0.1	0.1	X				X
Forb	N	HOMUL	<i>Hordeum murinum</i> ssp. <i>leporinum</i>	100	0.1	0.1	0.1	X				X
Forb	Y	MEAL6	<i>Mentzelia albicaulis</i>	100	0.1	0.1	0.1	X				X
Forb	Y	ASFA	<i>Asclepias fascicularis</i> *	100	0.1	0.1	0.1	X				X

*Outside plot, within stand

SPECIES RICHNESS: Total: 7 Av: 7 Range: 7-7

PLOTS: MANZ.22

***Rosa woodsii* Shrubland Association**
Woods' Rose Shrubland Association
Identifier: CEGLO01126

Classification confidence level: High

Other Classification Systems

USFWS Wetland Classification: Upland

MCV: Montane Wetland Shrub Habitat, *Rosa woodsii* Provisional Shrubland Alliance

MANZ Map Unit: S_ROW0

Range:

Globally (US): *Rosa woodsii* shrublands occur in the foothills and plains of Montana, Idaho, Nevada and eastern California. ⁽¹⁾

Regionally: Described from the Modoc Plateau, the eastern Sierra Nevada and east to Nevada. Small stands dominated by *R. woodsii* appear to occur in the Mammoth area and the Owens Valley. *Rosa woodsii* is common along most streams draining the east flank of the Sierra Nevada and as a riparian type at higher elevation in the mountains of the Great Basin. ⁽²⁾

MANZ: This association was sampled by one plot on the stream terrace on the south side of Bairs Creek. Small patches (<0.1ha) of *Rosa woodsii* occur on the south and north side of Bairs creek.

Environmental description

Elevation (m): 1191

Slope: Flat

Aspect: Flat

Topographic Position: Low level

Landform: Valley floor

Geology: Colluvial

Cowardin System: Upland

Hydrology: Mesic

Soil texture: Sand

Unvegetated surface cover:

Large Rock: 0%

Small Rock: 5%

Sand: 1%

Bare Soil: 14%

Litter, Duff: 77%

Wood: 3%

Water: 0%

Strata	Characteristic species	Ht. Range (m)	Stratum Absolute Cover (%)
T1 Emergent	none	>10	--
T2 Canopy	none	5-10	--
T3 Subcanopy	none	2-5	--
S1 Tall shrub	none	2-5	--
S2 Short Shrub	<i>Rosa woodsii</i> var. <i>ultramontana</i> , <i>Atriplex canescens</i> var. <i>canescens</i> , <i>Salix exigua</i>	0.5-2	60.1
S3 Dwarf Shrub	none	<0.5	--
H1 Graminoids	none	<0.5	--
H2 Forbs	<i>Atriplex serotena</i> , <i>Apocynum cannabinum</i> , <i>Glycyrrhiza lepidota</i> .	<0.5	2.5

Most abundant species: *Rosa woodsii* var. *ultramontana*

Diagnostic species: *Rosa woodsii* var. *ultramontana*

Membership rules: Tree and shrub cover is greater than 7%. Cover of *Salix laevigata* (red willow) is less than the combined cover of *Salix exigua* (narrow leaf willow) and/or *Rosa woodsii* var. *ultramontana* (Woods' rose). Cover of *Rosa woodsii* at least 10% greater than cover of *Salix exigua*. At least two of the following species are present: *Distichlis spicata* (salt grass), *Glycyrrhiza lepidota* (American licorice), *Apocynum cannabinum* (Indian hemp).

Vegetation description: Only one prominent stand occurs within the historic site. The stand occurs on the south side of Bairs Creek northeast of what was a chicken ranch during the camp period. This stand has an intermittent shrub layer (60.1%) between 0.5m and 2m in height and a sparse (2.5%) herbaceous layer at less than 0.5m in height. The shrub layer is strongly dominated by *Rosa woodsii* var. *ultramontana* with 97% relative cover. The herb layer is characterized by *Atriplex serenana* (bractscale), *Apocynum cannabinum* (Indian hemp) and *Glycyrrhiza lepidota* (American licorice).

Rosa woodsii Shrublands are broad-leaved, cold-deciduous shrublands.

Other noteworthy species: *Descurainia sophia* (Herb sophia), *Salsola tragus* (prickly Russian thistle)

Conservation rank: G5⁽¹⁾ S3⁽²⁾

Comments: *Rosa woodsii* appears to thrive on disturbance. *R. woodsii* is important in stabilizing stream banks and it is an indicator of past heavy grazing where it impedes access of livestock to streams. Bird and mammals primarily disperse the seeds of mature rose hips. ⁽²⁾ *Apocynum cannabinum* and *Glycyrrhiza lepidota* are native, early colonizing forbs on disturbed areas. ⁽¹⁾

References

⁽¹⁾ NatureServe. Ecological Association Comprehensive Report. *Rosa woodsii* Shrubland
CEGL001126, 21Jan2004

⁽²⁾ MCV. Sawyer, John O., T. Keeler-Wolf, J.M. Evens. 2009. *A Manual of California Vegetation*. 2nd
Edition. California Native Plant Society, Sacramento, CA.

***Rosa woodsii* Shrubland Association**
Woods' rose Shrubland Association
Stand Table
n=1

Life Form	Native	Species Code	Scientific Name	CON	AVG	MIN	MAX	Ch	D	Cd	A	Oft
Shrub												
	Y	ROWOU	<i>Rosa woodsii</i> var. <i>ultramontana</i>	100	58.0	58.0	58.0	X	X			
	Y	ATCAC	<i>Atriplex canescens</i> var. <i>canescens</i>	100	2.0	2.0	2.0	X				X
	Y	SAEX	<i>Salix exigua</i>	100	0.1	0.1	0.1	X				X
Forb												
	Y	ATSE2	<i>Atriplex serenana</i>	100	2.0	2.0	2.0	X				
	Y	APCA	<i>Apocynum cannabinum</i>	100	0.1	0.1	0.1	X				X
	Y	DEPIG	<i>Descurainia sophia</i>	100	0.1	0.1	0.1	X				X
	Y	GLLE3	<i>Glycyrrhiza lepidota</i>	100	0.1	0.1	0.1	X				X
	Y	MEAL6	<i>Mentzelia albicaulis</i>	100	0.1	0.1	0.1	X				X
	N	SATR12	<i>Salsola tragus</i>	100	0.1	0.1	0.1	X				X

SPECIES RICHNESS: Total: 9 Avg.: 9 Range: 9-9

PLOTS: MANZ.14

Salix exigua* / Mesic Forbs Shrubland Association*Narrow leaf Willow / Mesic Forbs Shrubland Association**Identifier: CEG001202

Classification confidence level: Moderate. Limited data to characterize this association.

Classification comments: The *Salix (exigua, interior)* Temporarily Flooded Shrubland Alliance is represented at Manzanar by two associations. The data collected from one classification plot matches the species composition and environmental description for the *Salix exigua* / Mesic Forb Association. Data from four rapid assessment points collected in Bairs Creek indicate there is a *Salix exigua* – *Ericameria nauseosa* Riparian Shrubland type, an association not currently described in the NVC; however, a similar type has been described from Pecos Natural Historical Park in a wetland survey conducted by the New Mexico Natural Heritage Program.⁽³⁾

Other Classification Systems

USFWS Wetland Classification: Upland

MCV: Narrowleaf willow series. *Salix exigua* Shrubland Alliance.

MANZ Map Unit: S_SAEX

Range:

Globally (U.S.): *Salix (exigua, interior)* Temporarily Flooded Shrubland Alliance is a widespread alliance in the western United States. These shrublands are found on open sandbars without tree canopy shading on larger, well-developed drainages and along larger sandy rivers, or on coarser-textured substrates. They are associated with annual flooding and inundation and will grow well into the channel, where it is flooded, even in drier years.⁽¹⁾

Salix exigua / Mesic Forbs Shrubland Association typically occurs between 1,464 and 2,562 m elevation in Utah, western Colorado, central Nevada and eastern Idaho, where it occupies streambanks, terraces, and meadows along a wide variety of low to moderate gradient stream types. A low elevation phase of this plant association is found below 1,128 m in south-central and southwestern Idaho on annually flooded banks, islands and terraces of reservoirs and large rivers. In the low elevation phase, flood disturbed stands contain abundant native colonizing forbs such as *Apocynum cannabinum* and *Glycyrrhiza lepidota*.^(1a)

Regionally: Stands of *Salix exigua* are common in transmontane California at springs and in well watered canyons below 1,800m.⁽²⁾

MANZ: One prominent stand on the stream terrace on the south side of Bairs Creek northeast of what was a chicken ranch during the camp period. Scattered stands of *Salix exigua* occur within the creek channel and in the upland central portion of the historic site.

Environmental description

Elevation (m): 1,188

Slope: Flat

Aspect: Flat

Topographic Position: low level

Landform: Valley Floor

Geology: Colluvial

Cowardin System: Upland

Hydrology: Mesic

Soil texture: Sand

Unvegetated surface cover:

Large Rock: 0%

Small Rock: 12%

Fines: 2%

Bare Soil: 1%

Litter, Duff: 81%

Wood: 4%

Water: 0%

Strata	Characteristic species	Ht. Range (m)	Stratum Absolute Cover (%)
T1 Emergent	none	>10	--
T2 Canopy	none	5-10	--
T3 Subcanopy	none	2-5	--
S1 Tall shrub	none	2-5	--
S2 Short Shrub	<i>Salix exigua</i> , <i>Ericameria nauseosa</i> ssp. <i>nauseosa</i> , <i>Atriplex torreyi</i>	0.5–2	58.3
S3 Dwarf Shrub	none	<0.5	--
H1 Graminoids	<i>Distichlis spicata</i>	<0.5	0.1
H2 Forbs	<i>Apocynum cannabinum</i> , <i>Glycyrrhiza lepidota</i> , <i>Distichlis spicata</i> , <i>Salsola tragus</i>	<0.5	4.3

Most abundant species: *Salix exigua***Diagnostic species:** *Salix exigua*

Membership rules: Tree and shrub cover combined is greater than 7%. Cover of trees is less than 15%. Combined cover of *Rosa woodsii* (Wood's rose) and/or *Salix exigua* (narrow leaf willow) is greater than 10%. Cover of *Salix exigua* is at least 10% greater than the cover of *Rosa woodsii*. At least two of the following species present: *Distichlis spicata* (salt grass), *Glycyrrhiza lepidota* (American licorice), *Apocynum cannabinum* (Indian hemp).

Vegetation description: *Salix exigua* / Mesic Forbs Shrubland Association was sampled by one plot in a single stand located on the south side of Bairs Creek north east of the old chicken ranch. This stand has an intermittent shrub layer (58.3%) between 0.5m and 2m in height and a sparse herbaceous layer (4.3%) at less than 0.5m in height. The shrub layer is strongly dominated by *Salix exigua* (84.2%). The herb layer is characterized by *Apocynum cannabinum* and *Glycyrrhiza lepidota*.

Salix exigua shrublands are clonal, broad-leaved, cold-deciduous shrublands. The size of the stand sampled is slightly more than 400m² and could represent a single clonal colony of *Salix exigua*.

Other noteworthy species: *Salsola tragus* (prickly Russian thistle)

Conservation rank: *Salix exigua* Shrubland Alliance - G5 S4.2⁽²⁾; *Salix exigua* / Mesic Forbs Association – G2? ^(1a)

Comments: *Salix exigua* is highly adapted to most forms of disturbance. It is a prolific sprouter and can reestablish on sites dominated by other disturbance associated species such as *Glycyrrhiza lepidota*. ⁽¹⁾ The *Salix exigua* / Mesic Forbs Association is probably successional related to the *Salix exigua* / Bench Community type described by Manning and Padgett (1995) from 8 locations in Nevada. ^(1a)

References

- ⁽¹⁾ NatureServe. Ecological Association Comprehensive Report. *Salix exigua* Temporarily Flooded Shrubland Alliance, A.947.
- ^(1a) NatureServe. Ecological Association Comprehensive Report. *Salix exigua* / Mesic Forbs Shrubland, CEGL001202.
- ⁽²⁾ MCV. Sawyer, John O., T. Keeler-Wolf, J.M. Evens. 2009. *A Manual of California Vegetation*. 2nd Edition. California Native Plant Society, Sacramento, CA.
- ⁽³⁾ Muldavin, Esteban. 1991. Riparian and Wetland Survey Pecos National Historical Park. New Mexico Natural Heritage Program. Albuquerque, New Mexico.

***Salix Exigua* / Mesic Forb Shrubland Association**
Narrow leaf willow / Mesic Forb Shrubland Association
Stand Table

n=1

Life Form	Native	Species Code	Scientific Name	CON	AVG	MIN	MAX	Ch	D	Cd	A	Oft
Shrub												
	Y	SAEX	<i>Salix exigua</i>	100	49.1	49.1	49.1	X	X			
	Y	ERNAH	<i>Ericameria nauseosa</i> ssp. <i>nauseosa</i> var. <i>hololeuca</i>	100	6.0	6.0	6.0	X				X
	Y	ATTO	<i>Atriplex torreyi</i>	100	3.1	3.1	3.1	X				X
	Y	ROWOU	<i>Rosa woodsii</i> var. <i>ultramontana</i>	100	0.1	0.1	0.1	X				X
Herb												
	Y	APCA	<i>Apocynum cannabinum</i>	100	2.0	2.0	2.0	X				
	Y	GLLE3	<i>Glycyrrhiza lepidota</i>	100	1.0	1.0	1.0	X				X
	Y	MEAL6	<i>Mentzelia albicaulis</i>	100	1.0	1.0	1.0	X				X
	Y	AMTE3	<i>Amsinckia tessellata</i>	100	0.1	0.1	0.1	X				X
	N	SATR12	<i>Salsola tragus</i>	100	0.1	0.1	0.1	X				X
Grass/Grass-like												
	Y	DISP	<i>Distichlis spicata</i>	100	0.1	0.1	0.1	X				X

SPECIES RICHNESS: Total: 10 Avg.: 10 Range: 10-10

PLOTS: MANZ.13

***Salix exigua* - *Ericameria nauseosa* Riparian Shrubland Association [Park Special]**
Narrowleaf Willow – Rubber rabbitbrush Riparian Shrubland Association
Identifier: NPSMANZ008

Classification confidence level: High.

Classification comments: The rapid assessment (RA) data was not included in the classification data analysis so the data from these RAs was not formally analyzed. Determination of a unique vegetation type was made by reviewing the data and surveyor comments from the four rapid assessment points collected in Bairs Creek.

Other Classification Systems

USFWS Wetland Classification: Wetland

MCV: Narrowleaf willow series. *Salix exigua* Shrubland Alliance.

MANZ Map Unit: S_SAEX

Range:

Globally (U.S.): *Salix (exigua, interior)* Temporarily Flooded Shrubland Alliance is a widespread alliance in the western United States. These shrublands are found on open sandbars without tree canopy shading on larger, well-developed drainages and along larger sandy rivers, or on coarser-textured substrates. They are associated with annual flooding and inundation and will grow well into the channel, where it is flooded, even in drier years.⁽¹⁾ A *Salix exigua* – *Ericameria nauseosa* Riparian Shrubland Association is not described in the NVC; however, a similar type has been described from Pecos National Historical Park in a wetland survey conducted by the New Mexico Natural Heritage Program.⁽³⁾

Regionally: A *Salix exigua* - *Ericameria nauseosa* Riparian Shrubland type has not been described within the Great Basin region or in California. The species composition within this type resembles that classified as Mojave Riparian Forest (61700) in the Holland vegetation classification. The Mojave Riparian Forest is described as occurring along the larger desert rivers (Owens, Mojave, Colorado) where the vegetation has not been cleared for irrigated agriculture or been dewatered by upstream diversions and generally occurring below about 4,000 feet on flat, fine-grained, subirrigated alluvium.⁽⁴⁾

MANZ: Scattered stands of *Salix exigua* – *Ericameria nauseosa* Riparian Shrubland occur along the length of the Bairs creek channel.

Environmental description

Elevation (m): 1157 (1140–1182)

Slope: Gentle

Aspect: Flat

Topographic Position: Channel bed

Landform: Valley floor

Geology: Colluvial

Cowardin System: Palustrine, Scrub-Shrub Wetland

Hydrology: Seasonally flooded

Soil texture: Sand

Unvegetated surface cover (%):

Large Rock: 0.1 (0-0.2)

Small Rock: 3 (0.2-5)

Fines: 64 (52-83)

Bare Soil: 22 (10-30)

Litter, Duff: 3 (2-4)

Wood: 0 (0-0)

Water: 8 (3-10)

Strata	Characteristic species	Ht. Range (m)	Stratum Absolute Cover (%)
T1 Emergent	none	>10	--
T2 Canopy	<i>Populus fremontii</i> , <i>Robinia pseudoacacia</i> , <i>Salix laevigata</i>	5-10	2.3
T2 Canopy	<i>Populus fremontii</i> , <i>Robinia pseudoacacia</i> , <i>Salix laevigata</i>	2-5	2.3
T3 Subcanopy	<i>Tamarix ramosissima</i>	2-5	<0.1
S1 Tall shrub	<i>Forestiera pubescens</i>	2-5	0.3
S2 Short Shrub	<i>Salix exigua</i> , <i>Ericameria nauseosa</i> ssp. <i>nauseosa</i> , <i>Artemisia tridentata</i> ssp. <i>tridentata</i>	0.5–2	28.6
S3 Dwarf Shrub	<i>Lupinus excubitus</i>	<0.5	3.8
H1 Graminoids	<i>Distichlis spicata</i> , <i>Muhlenbergia asperifolia</i>	<0.5	1.7
H2 Forbs	<i>Artemisia ludoviciana</i> , <i>Melilotus indicus</i> , <i>Veronica americana</i> , <i>Rumex salicifolius</i>	<0.5	5.6

Most abundant species: *Salix exigua*, *Ericameria nauseosa* ssp. *nauseosa*, *Artemisia tridentata* ssp. *tridentata*, *Lupinus excubitus*, *Artemisia ludoviciana*, *Distichlis spicata*

Diagnostic species: *Salix exigua*

Membership rules: Tree and shrub cover combined is greater than 7%. Cover of trees is less than 15%. Cover of *Salix exigua* (narrow leaf willow) is $\geq 5\%$. At least two of the following species present: *Ericameria nauseosa* ssp. *nauseosa* (Rubber rabbitbrush), *Artemisia tridentata* ssp. *tridentata* (Basin big sagebrush), *Artemisia ludoviciana* (white sagebrush), *Distichlis spicata* (salt grass), *Veronica americana* (American speedwell).

Vegetation description: The *Salix exigua* – *Ericameria nauseosa* Riparian Shrubland Association was sampled by four rapid assessments within Bairs Creek. Stands have a sparse tree layer (4.6%, 2.0-7.1%) between 2m and 10m in height; an open shrub layer (32.7%, 20.2-38.1%) between 0.5m and 5m in height; and a sparse herbaceous layer (7.3%, 4.2-12.2%) at less than 0.5m in height. Trees are scattered with *Robinia pseudoacacia* (black locust) (2.3, 0-3%) the most common overstory tree followed by *Salix laevigata* (red willow) (1.3, 0-4%) and *Populus fremontii* (Fremont cottonwood) (1.0%, 0-2%). The shrub layer is co-dominated by *Salix exigua* (28.3% relative cover) and *Ericameria nauseosa* ssp. *nauseosa* (32.1% relative cover). Other common associate shrub species are *Artemisia tridentata* ssp. *tridentata* (23.7% relative cover), *Lupinus excubitus* (grape soda lupine) (6.3% relative cover) and *Atriplex canescens* var. *canescens* (four-wing saltbush) (3.1% relative cover). *Artemisia ludoviciana* dominates the herbaceous layer (51.9% relative cover). Other herbaceous species with significant cover are *Muhlenbergia rigens* (deer grass) (10.7% relative cover) and *Distichlis spicata* (salt grass) (7.6% relative cover). One obligate wetland species, *Veronica americana*, was present on all four sites sampled.

Salix exigua shrublands are clonal, broad-leaved, cold-deciduous shrublands.

Other noteworthy species:

Native species: *Datura wrightii* (sacred-thorn apple), *Rumex salicifolius* (willow dock), *Bromus anomalus* (nodding brome), *Muhlenbergia asperifolia* (scratch grass), *Deschampsia cespitosa* (tufted hair grass), *Poa secunda* (Sandberg bluegrass)

Non-native species: *Tamarix ramosissima* (salt cedar), *Salsola tragus* (prickly Russian thistle), *Verbascum thapsus* (common mullein), *Melilotus indicus* (sweet clover), *Rumex crispus* (curly dock)

Conservation rank:

Salix exigua Shrubland Alliance - G5 S4.2⁽²⁾

Salix exigua – *Ericameria nauseosa* Riparian Shrubland Association [Park Special] – unranked

Comments: The data from these four sample sites provide a good picture of the vegetation within Bairs Creek. These stands have the most diverse forb and grass compositions of all vegetation types sampled at Manzanar and are the only sites where native, perennial bunch grasses were recorded. The species composition in these stands reflects a mixing of upland and wetland communities. Many of the shrub and forb species present in these stands also occur in the upland shrub communities found on the banks to the north and south of Bairs Creek.

At Great Basin National Park, one of the classified riparian vegetation types - *Populus angustifolia* / *Artemisia tridentata* ssp. *tridentata* – *Prunus virginiana* Woodland [Park Special]) – also shows a mix of riparian and upland species. ⁽⁵⁾

References

- ⁽¹⁾ NatureServe. Ecological Association Comprehensive Report. *Salix exigua* Temporarily Flooded Shrubland Alliance, A.947.
- ⁽²⁾ MCV. Sawyer, John O., T. Keeler-Wolf, J.M. Evens. 2009. *A Manual of California Vegetation*. 2nd Edition. California Native Plant Society, Sacramento, CA.
- ⁽³⁾ Muldavin, Esteban. 1991. Riparian and Wetland Survey Pecos National Historical Park. New Mexico Natural Heritage Program. Albuquerque, New Mexico.
- ⁽⁴⁾ Holland, R.F., 1986. Preliminary descriptions of the terrestrial natural communities of California. State of California, The Resources Agency, Nongame Heritage Program, Dept. Fish & Game, Sacramento, Calif. 156 pp. (available at <http://www.biogeog.ucsb.edu/projects/gap/data/cnddb/61700.html>. Last accessed October 7, 2012.)
- ⁽⁵⁾ Cogan, D., K. Schulz, and J.E. Taylor. 2012. Vegetation inventory project: Great Basin National Park NPS/2011/NRR-2012/XXX. National Park Service, Fort Collins, Colorado.

***Salix exigua* – *Ericameria nauseosa* Riparian Shrubland Association [Park Special]**
Narrow leaf willow – Rubber rabbitbrush Riparian Shrubland Association [Park Special]
Stand Table

n=4

Life Form	Native	Species Code	Scientific Name	CON	AVG	MIN	MAX	Ch	D	Cd	A	Oft
Tree												
	N	ROPS	<i>Robinia pseudoacacia</i>	75	2.3	0.0	3.0	X				
	Y	SALA3	<i>Salix laevigata</i>	50	1.3	0.0	4.0					X
	Y	POFR2	<i>Populus fremontii</i>	50	1.0	0.0	2.0					X
	N	TARA	<i>Tamarix ramosissima</i>	25	0.0	0.0	0.1					
Shrub												
	Y	ERNAH	<i>Ericameria nauseosa</i> ssp. <i>nauseosa</i> var. <i>hololeuca</i>	100	10.5	7.0	15.0	X		X		
	Y	SAEX	<i>Salix exigua</i>	100	9.3	5.0	20.0	X		X		X
	Y	ARTRT	<i>Artemisia tridentata</i> ssp. <i>tridentata</i>	100	7.8	5.0	10.0	X				X
	Y	LUEX	<i>Lupinus excubitus</i>	100	2.1	0.1	8.0	X				X
	Y	ATCAC	<i>Atriplex canescens</i> var. <i>canescens</i>	100	1.0	1.0	1.0	X				X
	Y	ATPO	<i>Atriplex polycarpa</i>	50	0.3	0.0	1.0					X
	Y	SALA3	<i>Salix laevigata</i>	25	1.3	0.0	5.0					
	Y	FOPU2	<i>Forestiera pubescens</i>	25	0.3	0.0	1.0					
	Y	SALA6	<i>Salix lasiolepis</i>	25	0.3	0.0	1.0					
	N	TARA	<i>Tamarix ramosissima</i>	25	0.1	0.0	0.1					
	Y	ATTO	<i>Atriplex torreyi</i>	25	0.0	0.0	0.1					
	Y	HYSA	<i>Hymenoclea salsola</i>	25	0.0	0.0	0.1					
Forb												
	Y	ARLUX	<i>Artemisia ludoviciana</i> (x <i>douglasii</i>)	100	3.8	0.1	10.0	X	X			
	N	MEIN2	<i>Melilotus indicus</i>	100	0.1	0.1	0.1	X				X
	Y	VEAM2	<i>Veronica americana</i>	100	0.1	0.1	0.1	X				X
	Y	AMAC2	<i>Ambrosia acanthicarpa</i>	75	0.1	0.0	0.1	X				X
	Y	CRCI2	<i>Cryptantha circumscissa</i>	75	0.1	0.0	0.1	X				X
	Y	CRMI	<i>Cryptantha micrantha</i>	75	0.1	0.0	0.1	X				X
	Y	CRPT	<i>Cryptantha pterocarya</i>	75	0.1	0.0	0.1	X				X
	Y	CUDE2	<i>Cuscuta (denticulata)</i>	75	0.1	0.0	0.1	X				X
	Y	DAWR2	<i>Datura wrightii</i>	75	0.1	0.0	0.1	X				X
	Y	ERWI	<i>Eriastrum wilcoxii</i>	75	0.1	0.0	0.1	X				X
	Y	ERBR7	<i>Eriogonum brachyanthum</i>	75	0.1	0.0	0.1	X				X
	N	ERIC6	<i>Erodium cicutarium</i>	75	0.1	0.0	0.1	X				X
	Y	MEAL6	<i>Mentzelia albicaulis</i>	75	0.1	0.0	0.1	X				X
	Y	RUSA	<i>Rumex salicifolius</i>	75	0.1	0.0	0.1	X				X
	N	SATR12	<i>Salsola tragus</i>	75	0.1	0.0	0.1	X				X
	Y	AMTE3	<i>Amsinckia tessellata</i>	50	0.1	0.0	0.1					X

Life Form	Native	Species Code	Scientific Name	CON	AVG	MIN	MAX	Ch	D	Cd	A	Oft
	Y	GLLE3	<i>Glycyrrhiza lepidota</i>	50	0.1	0.0	0.1					X
	Y	LELA	<i>Lepidium lasiocarpum</i>	50	0.1	0.0	0.1					X
	Y	MAGL3	<i>Malacothrix glabrata</i>	50	0.1	0.0	0.1					X
	Y	STPA4	<i>Stephanomeria pauciflora</i>	50	0.1	0.0	0.1					X
	Y	TINU2	<i>Tiquilia nuttallii</i>	50	0.1	0.0	0.1					X
	N	VETH	<i>Verbascum thapsus</i>	50	0.1	0.0	0.1					X
	Y	ASFA	<i>Asclepias fascicularis</i>	25	0.0	0.0	0.1					
	Y	ASPER	<i>Asperugo</i>	25	0.0	0.0	0.1					
	Y	CACLC3	<i>Camissonia claviformis</i> ssp. <i>claviformis</i>	25	0.0	0.0	0.1					
	Y	CAPI4	<i>Caulanthus pilosus</i>	25	0.0	0.0	0.1					
	Y	COCO4	<i>Conyza coulteri</i>	25	0.0	0.0	0.1					
	Y	DEPIG	<i>Descurainia pinnata</i> ssp. <i>glabra</i>	25	0.0	0.0	0.1					
	Y	ERMA2	<i>Eriogonum maculatum</i>	25	0.0	0.0	0.1					
	Y	GILIA	<i>Gilia</i> sp.	25	0.0	0.0	0.1					
	Y	GIBR	<i>Gilia brecciarum</i>	25	0.0	0.0	0.1					
	Y	GICA3	<i>Gilia cana</i>	25	0.0	0.0	0.1					
	Y	GITR	<i>Gilia transmontana</i>	25	0.0	0.0	0.1					
	Y	LOMA10	<i>Loeseliastrum matthewsii</i>	25	0.0	0.0	0.1					
	Y	PEIN3	<i>Penstemon incertus</i>	25	0.0	0.0	0.1					
	N	RUCR	<i>Rumex crispus</i>	25	0.0	0.0	0.1					
	Y	XAST	<i>Xanthium strumarium</i>	25	0.0	0.0	0.1					
Grass/Grass-like												
	Y	DISP	<i>Distichlis spicata</i>	100	0.6	0.1	1.0	X				
	Y	MUAS	<i>Muhlenbergia asperifolia</i>	75	0.1	0.0	0.1	X				X
	Y	MURI2	<i>Muhlenbergia rigens</i>	50	0.8	0.1	3.0					X
	Y	CADO2	<i>Carex douglasii</i>	50	0.1	0.0	0.1					X
	Y	ACHY	<i>Achnatherum hymenoides</i>	25	0.0	0.0	0.1					
	Y	ACSP12	<i>Achnatherum speciosum</i>	25	0.0	0.0	0.1					
	Y	BRAN	<i>Bromus anomalus</i>	25	0.0	0.0	0.1					
	Y	BRCA5	<i>Bromus carinatus</i>	25	0.0	0.0	0.1					
	N	BRCA6	<i>Bromus catharticus</i>	25	0.0	0.0	0.1					
	Y	DECE	<i>Deschampsia cespitosa</i>	25	0.0	0.0	0.1					
	Y	ELEL5	<i>Elymus elymoides</i>	25	0.0	0.0	0.1					
	Y	JUBA	<i>Juncus balticus</i>	25	0.0	0.0	0.1					
	Y	POSE	<i>Poa secunda</i>	25	0.0	0.0	0.1					

SPECIES RICHNESS: Total: 65 Avg.: 33 Range: 23 - 45

RAPID ASSESSMENTS: MANZ.30, MANZ.31, MANZ.32, MANZ.39

3. Xeromorphic Scrub and Herb Vegetation (Semi-Desert) Class

Atriplex confertifolia Great Basin Shrubland Association

Shadscale Great Basin Shrubland Association

Identifier: CEG001294

Classification confidence level: High

Classification Comments: This broadly defined association describes *Atriplex confertifolia* shrublands that have either a sparse understory or lack any diagnostic species in the understory. ⁽¹⁾

Other Classification Systems

USFWS Wetland Classification: Upland

MCV: Shadscale series. *Atriplex confertifolia* Shrubland Alliance

MANZ Map Unit: S_ATCO

Range:

Globally (US): This *Atriplex confertifolia* Shrubland Association occurs in scattered stands on ridges, flats, alluvial fans, talus slopes and badlands throughout the Colorado Plateau and Great Basin, often in a matrix of other high desert shrublands. Sites tend to occur on level to gentle slopes between 1158m and 2194m in elevation. Soils tend to be alkaline, shallow, well-drained clay loams. Total vegetation cover rarely exceeds 20% and is clearly dominated by *Atriplex confertifolia*. ⁽¹⁾

Regionally: Upland stands are extensive in northern subsections of the Southeastern Great Basin region in California where they mix with stands of *Artemisia tridentata*, *Grayia spinosa*, *Larrea tridentata*-*Ambrosia dumosa* and *Yucca brevifolia* alliances. Upland stands in Saline Valley show a recent decline (Thomas et al. 2004). Stands occupy a broad spectrum of environmental situations. Shrubs exist in low alkali basins, across extensive intermountain flats, and on rocky, upland soils. Plants prefer well-drained, moderately saline soils where groundwater is below the rooting zone. They may be seral and invasive, short-lived, or natural and persistent. ⁽²⁾

MANZ: This vegetation type occurs in small stands along the north, south and east sides of the historic site.

Environmental description

Elevation (m): 1181 (1168–1205)

Slope: Flat

Aspect: Flat

Topographic Position: low level (5)

Landform: Valley floor

Geology: Colluvial

Cowardin System: Upland

Hydrology: Dry – mesic

Soil texture: Sand

Unvegetated surface cover (%):

Large Rock: 0 (0-0)

Small Rock: 69 (51-87)

Fines: 11 (5-20)

Bare Soil: 6 (1-14)

Litter, Duff: 5 (1-11)

Wood: 8 (5-12)

Water: 0 (0-0)

Strata	Characteristic species	Ht. Range (m)	Stratum Absolute Cover (%)
T1 Emergent	none	>10	--
T2 Canopy	none	5-10	--
T3 Subcanopy	none	2-5	--
S1 Tall shrub	none	2-5	--
S2 Short Shrub	<i>Atriplex confertifolia</i> , <i>Atriplex torreyi</i> , <i>Atriplex polycarpa</i> , <i>Ericameria nauseosa</i> ssp. <i>nauseosa</i>	0.5–2	18.1
S3 Dwarf Shrub	<i>Atriplex confertifolia</i>	<0.5	8.1
H1 Graminoids	none	<0.5	--
H2 Forbs	<i>Mentzelia albicaulis</i> , <i>Amsinckia tessellata</i> , <i>Camissonia boothii</i> ssp. <i>desertorum</i> , <i>Eriogonum maculatum</i> , <i>Eriastrum wilcoxii</i>	<0.5	4.2

Most abundant species: *Atriplex confertifolia*

Diagnostic species: *Atriplex confertifolia*

Membership rules: Tree and shrub cover combined is greater than 7%. Tree cover is less than 15%. Cover of *Atriplex confertifolia* (shadscale) and/or *Atriplex torreyi* (Torrey's saltbush) exceeds cover of *Atriplex polycarpa* (cattle saltbush). Cover of *Atriplex confertifolia* is equal to or exceeds cover of *Atriplex torreyi*.

Vegetation description: Stands of *Atriplex confertifolia* (shadscale) have an open shrub layer (26.1%, 12.0-40.1%) between 0.5m and 2m in height and a sparse herbaceous layer (4.2%, 1.2-8.7%) at less than 0.5m in height. These shrub stands are strongly dominated by *Atriplex confertifolia* with 79% relative cover. Associate shrub species are infrequent and include *Ericameria nauseosa* ssp. *nauseosa* (rubber rabbitbrush), *Atriplex torreyi* (Torrey's saltbush) and *Atriplex polycarpa* (cattle saltbush). Shrubs are widely spaced. The herbaceous layer is characterized by native forbs, principally *Mentzelia albicaulis* (whitestem blazingstar), *Amsinckia tessellata* (bristly fiddleneck), *Camissonia boothii* ssp. *desertorum* (desert suncup), *Eriogonum maculatum* (spotted buckwheat) and *Eriastrum wilcoxii* (Wilcox's woolly star).

Atriplex confertifolia shrublands are extremely xeromorphic, evergreen shrublands.

Other noteworthy species: *Salsola tragus* (Russian thistle), *Descurainia Sophia* (herb Sophia), *Lepidium fremontii* (desert pepperweed), *Sarcobatus vermiculatus* (greasewood), *Suaeda moquinii* (Mojave seablite)

Conservation rank: G5^(1a) S4.2⁽²⁾

Comments: These stands occur within larger *Atriplex polycarpa* stands and grade from a mixture of *Atriplex polycarpa* and *Atriplex confertifolia* to stands distinctly dominated by *Atriplex confertifolia*. *Atriplex confertifolia* shrubs often develop large leaves in the spring which increase the rate of photosynthesis. As soil moisture decreases, the leaves are lost, and the plant takes on a dead appearance. During late fall, very small overwintering leaves appear which provide some

photosynthetic capability through the remainder of the year. The species is valued as winter range for native herbivores and livestock. ^(1a)

References

- ⁽¹⁾ NatureServe Explorer. Ecological Association Comprehensive Report. *Atriplex confertifolia* Great Basin Shrubland. CEG001294. 19Feb2011
- ^(1a) NatureServe Explorer. Ecological Alliance Comprehensive Report. *Atriplex confertifolia* Shrubland Alliance. A.870.
- ⁽²⁾ MCV. Sawyer, John O., T. Keeler-Wolf, J.M. Evens. 2009. *A Manual of California Vegetation*. 2nd Edition. California Native Plant Society, Sacramento, CA.

Atriplex confertifolia Great Basin Shrubland

Shadscale Great Basin Shrubland

Stand Table

n=5

Life form	Native	Species Code	Scientific Name	CON	AVG	MIN	MAX	Ch	D	Cd	A	Oft
Shrub												
	Y	ATCO	<i>Atriplex confertifolia</i>	100	20.6	7.0	30.0	X	X			
	Y	ERNAH	<i>Ericameria nauseosa</i> ssp. <i>nauseosa</i> var. <i>hololeuca</i>	60	0.3	0.0	1.0					X
	Y	ATTO	<i>Atriplex torreyi</i>	40	3.0	0.0	10.0					
	Y	ATPO	<i>Atriplex polycarpa</i>	40	0.2	0.0	1.0					
	Y	SAVE4	<i>Sarcobatus vermiculatus</i>	20	1.0	0.0	5.0					
	Y	EPNE	<i>Ephedra nevadensis</i>	20	0.6	0.0	3.0					
	Y	HYSA	<i>Hymenoclea salsola</i>	20	0.2	0.0	1.0					
	Y	LEFR2	<i>Lepidium fremontii</i>	20	0.2	0.0	1.0					
	Y	ARTRT	<i>Artemisia tridentata</i> ssp. <i>tridentata</i>	20	0.0	0.0	0.1					
	Y	SUMO	<i>Suaeda moquinii</i> *	20	0.0	0.0	0.1					
Forb												
	Y	MEAL6	<i>Mentzelia albicaulis</i>	100	2.6	0.1	6.0	X				
	Y	AMTE3	<i>Amsinckia tessellata</i>	100	0.3	0.1	1.0	X				X
	Y	CABOD2	<i>Camissonia boothii</i> ssp. <i>desertorum</i>	100	0.1	0.1	0.1	X				X
	Y	ERMA2	<i>Eriogonum maculatum</i>	100	0.1	0.1	0.1	X				X
	Y	ERWI	<i>Eriastrum wilcoxii</i>	80	0.5	0.0	2.0	X				X
	Y	GILIA	<i>Gilia</i> sp.	80	0.1	0.0	0.1	X				X
	Y	MAGL3	<i>Malacothrix glabrata</i>	80	0.1	0.0	0.1	X				X
	Y	CRCI2	<i>Cryptantha circumscissa</i>	60	0.1	0.0	0.1					X
	Y	CRPT	<i>Cryptantha pterocarya</i>	60	0.1	0.0	0.1					X
	Y	LEFLF2	<i>Lepidium flavum</i> var. <i>flavum</i>	60	0.1	0.0	0.1					X
	N	SATR12	<i>Salsola tragus</i>	60	0.1	0.0	0.1					X
	Y	CRMI	<i>Cryptantha micrantha</i>	40	0.0	0.0	0.1					
	Y	LOSC6	<i>Loeseliastrum schottii</i>	40	0.0	0.0	0.1					
	Y	CLOB	<i>Cleomella obtusifolia</i>	20	0.0	0.0	0.1					
	Y	DEPIG	<i>Descurainia pinnata</i> ssp. <i>glabra</i>	20	0.0	0.0	0.1					
	N	DESO2	<i>Descurainia sophia</i>	20	0.0	0.0	0.1					
	Y	GLLE3	<i>Glycyrrhiza lepidota</i>	20	0.0	0.0	0.1					
	Y	LAGL5	<i>Layia glandulosa</i>	20	0.0	0.0	0.1					
Grass/Grass-like												
	N	SCHIS	<i>Schismus</i> sp. *	20	0.0	0.0	0.1					

*Outside plot, within stand

SPECIES RICHNESS: Total: 27 Avg: 15 Range: 13-19

PLOTS: MANZ.4, MANZ.7, MANZ.9, MANZ.21, MANZ.24

Atriplex polycarpa* Shrubland Association*Cattle saltbush Shrubland**Identifier: CEGLO01318

Classification confidence level: High**Other Classification Systems**

USFWS Wetland Classification: Upland

MCV: Allscale series. *Atriplex polycarpa* Shrubland Alliance

MANZ Map Unit: S_ATPO

Range:

Globally: *Atriplex polycarpa* shrublands occur in desert valleys, basins, playas, bajadas, foothills and plains in southern New Mexico, Nevada and southern California. Climate is arid to semi-arid with hot summers. Sites are generally flat to gently sloping and moderately saline, but the alliance also occurs on rolling to hilly fans and slopes. *Atriplex polycarpa* may occur in nearly pure stands. ⁽¹⁾

Regionally: Stands occur mostly in alkaline basins; they also occur along washes and stream channels in the Eureka, Owens, and Saline valleys (Thomas et al. 2004). ⁽²⁾

MANZ: This shrub type occurs in large stands primarily on the west, south and north ends of the historic site.

Environmental description

Elevation (m): 1216 (1188-1151)

Slope: Flat to Gentle

Aspect: Flat, NE

Topographic Position: low level (5)

Landform: valley floor

Geology: Colluvial

Cowardin System: Upland

Hydrology: Dry-mesic

Soil texture: Sand

Unvegetated surface cover (%):

Large Rock: 0.1 (0-0.2)

Small Rock: 30 (0.2-88)

Fines: 60 (5-89)

Bare Soil: 7 (0-15)

Litter, Duff: 2 (0.2-5)

Wood: 1 (0-2)

Water: 0 (0-0)

Strata	Characteristic species	Ht. Range (m)	Stratum Absolute Cover (%)
T1 Emergent	none	>10	--
T2 Canopy	none	5-10	--
T3 Subcanopy	none	2-5	--
S1 Tall shrub	none	2-5	--
S2 Short Shrub	<i>Atriplex polycarpa</i> , <i>Atriplex canescens</i> var. <i>canescens</i> , <i>Ericameria nauseosa</i> ssp. <i>nauseosa</i> , <i>Hymenoclea salsola</i>	0.5–2	30.7
S3 Dwarf Shrub	<i>Atriplex confertifolia</i>	<0.5	2.1
H1 Graminoids	<i>Achnatherum speciosum</i>	<0.5	<0.1
H2 Forbs	<i>Malacothrix glabrata</i> , <i>Mentzelia albicaulis</i> , <i>Cryptantha circumscissa</i> , <i>Cryptantha pterocarya</i> , <i>Loeseliastrum schottii</i>	<0.5	2.2

Most abundant species: *Atriplex polycarpa*

Diagnostic species: *Atriplex polycarpa*

Membership rules: Tree and shrub cover combined is greater than 7%. Cover of trees is less than 15%. Cover of *Atriplex polycarpa* (cattle saltbush) is greater than 5% absolute cover. Cover of *Atriplex polycarpa* exceeds combined cover of *Atriplex confertifolia* and/or *Atriplex torreyi*.

Vegetation description: *Atriplex polycarpa* shrublands have an open shrub layer (32.8%, 11.0-42.1%) between 0.5m and 2m in height and a sparse herbaceous layer (2.2%, 0.9-6.0%) at less than 0.5m in height. The shrub canopy is strongly dominated by *Atriplex polycarpa* with 70.2% relative cover. Associate shrub species include *Atriplex confertifolia* (shadscale), *Ericameria nauseosa* ssp. *nauseosa* (rubber rabbitbrush), *Atriplex canescens* var. *canescens* (four-wing saltbush) and *Hymenoclea salsola* (burrobrush). Shrubs are widely spaced. The herbaceous layer is characterized by the native forbs *Malacothrix glabrata* (smooth desert dandelion), *Mentzelia albicaulis* (whitestem blazing star), *Cryptantha circumscissa* (cushion cryptantha), *Cryptantha pterocarya* (wing-nut cryptantha) and *Eriastrum wilcoxii* (Wilcox's woolly star).

Atriplex polycarpa shrublands are extremely xeromorphic, evergreen shrublands.

Other noteworthy species: *Lepidium fremontii* (desert pepperweed), *Encelia virginensis* (Virgin River brittlebush), *Lycium andersonii* (water jacket)

Conservation rank: G5⁽¹⁾ S4⁽²⁾

Comments: The *Atriplex polycarpa* stand on the west side of the park is very large and extends beyond the park boundary to the base of the mountains to the west. *Atriplex polycarpa* is a facultative phreatophyte and occurs on moderately saline soils (<2%) just above the water table, or, on xeric, non-saline upland sites (Barbour and Major 1977). It has limited salt tolerance and is very drought-tolerant (Barbour and Major 1977). ⁽¹⁾

References

- ⁽¹⁾ NatureServe. Ecological Alliances Comprehensive. *Atriplex polycarpa* Shrubland Alliance. A.873.
- ⁽²⁾ MCV. Sawyer, John O., T. Keeler-Wolf, J.M. Evens. 2009. *A Manual of California Vegetation*. 2nd Edition. California Native Plant Society, Sacramento, CA.

***Atriplex polycarpa* Shrubland Association**
Cattle saltbush Shrubland Association
Stand Table

n = 5

Life Form	Native	Species Code	Scientific Name	CON	AVG	MIN	MAX	Ch	D	Cd	A	Oft
Shrub												
	Y	ATPO	<i>Atriplex polycarpa</i>	100.0	23.0	11.0	34.0	X	X			
	Y	ATCO	<i>Atriplex confertifolia</i>	60.0	4.0	0.0	10.0					X
	Y	ERNAH	<i>Ericameria nauseosa</i> ssp. <i>nauseosa</i> var. <i>hololeuca</i>	60.0	4.0	0.0	10.0					X
	Y	ATCAC	<i>Atriplex canescens</i> var. <i>canescens</i>	60.0	0.2	0.0	1.0					X
	Y	HYSA	<i>Hymenoclea salsola</i>	40.0	1.0	0.0	4.0					
	Y	EPNE	<i>Ephedra nevadensis</i>	40.0	0.0	0.0	0.1					
	Y	ARTRT	<i>Artemisia tridentata</i> ssp. <i>tridentata</i>	20.0	0.4	0.0	2.0					
	Y	ENVI	<i>Encelia virginensis</i>	20.0	0.0	0.0	0.1					
	Y	LEFR2	<i>Lepidium fremontii</i>	20.0	0.0	0.0	0.1					
	Y	LYAN	<i>Lycium andersonii</i>	20.0	0.0	0.0	0.1					
Forb												
	Y	MAGL3	<i>Malacothrix glabrata</i>	100.0	0.7	0.1	3.0	X				
	Y	MEAL6	<i>Mentzelia albicaulis</i>	100.0	0.5	0.1	2.0	X				
	Y	CRCI2	<i>Cryptantha circumscissa</i>	80.0	0.1	0.0	0.1	X				
	Y	CRPT	<i>Cryptantha pterocarya</i>	80.0	0.1	0.0	0.1	X				
	Y	ERWI	<i>Eriastrum wilcoxii</i>	80.0	0.1	0.0	0.1	X				
	Y	AMTE3	<i>Amsinckia tessellata</i>	60.0	0.1	0.0	0.1					X
	Y	CRMI	<i>Cryptantha micrantha</i>	60.0	0.1	0.0	0.1					X
	Y	ERMA2	<i>Eriogonum maculatum</i>	60.0	0.1	0.0	0.1					X
	Y	CABOD2	<i>Camissonia boothii</i> ssp. <i>desertorum</i>	40.0	0.0	0.0	0.1					
	Y	CACLC3	<i>Camissonia claviformis</i> ssp. <i>claviformis</i>	40.0	0.0	0.0	0.1					
	Y	DEPIG	<i>Descurainia pinnata</i> ssp. <i>glabra</i>	40.0	0.0	0.0	0.1					
	Y	LOMA10	<i>Loeseliastrum matthewsii</i>	40.0	0.0	0.0	0.1					
	Y	LOSC6	<i>Loeseliastrum schottii</i>	40.0	0.0	0.0	0.1					
	Y	PHFR2	<i>Phacelia fremontii</i>	40.0	0.0	0.0	0.1					
	Y	STPA4	<i>Stephanomeria pauciflora</i>	40.0	0.0	0.0	0.1					
	Y	CALO12	<i>Calystegia longipes</i>	20.0	0.0	0.0	0.1					
	Y	CRDU	<i>Cryptantha dumetorum</i>	20.0	0.0	0.0	0.1					
	Y	ERBR7	<i>Eriogonum brachyanthum</i>	20.0	0.0	0.0	0.1					
	Y	ERPR4	<i>Eriophyllum pringlei</i>	20.0	0.0	0.0	0.1					
	N	ERIC6	<i>Erodium cicutarium</i>	20.0	0.0	0.0	0.1					
	Y	GIBR	<i>Gilia brecciarum</i>	20.0	0.0	0.0	0.1					
	Y	GICA3	<i>Gilia cana</i>	20.0	0.0	0.0	0.1					
	Y	GIFI2	<i>Gilia filiformis</i>	20.0	0.0	0.0	0.1					
	Y	NEGL	<i>Nemacladus glanduliferus</i>	20.0	0.0	0.0	0.1					
	Y	PEPE33	<i>Pectocarya peninsularis</i>	20.0	0.0	0.0	0.1					
	N	SATR12	<i>Salsola tragus</i>	20.0	0.0	0.0	0.1					
	Y	TINU2	<i>Tiquilia nuttallii</i>	20.0	0.0	0.0	0.1					
	Y	VEAM2	<i>Veronica americana</i>	20.0	0.0	0.0	0.1					

Life Form	Native	Species Code	Scientific Name	CON	AVG	MIN	MAX	Ch	D	Cd	A	Of
Grass/Grass-like												
	Y	ACSP12	<i>Achnatherum speciosum</i>	20.0	0.0	0.0	0.1					

SPECIES RICHNESS: Total: 40 Avg.: 16 Range: 13 – 22

PLOTS: MANZ.6, MANZ.20 **RAPID ASSESSMENTS:** MANZ.29, MANZ.33, MANZ.37

Artemisia tridentata Shrubland Association**Big Sagebrush Shrubland**Identifier: CEG000991

Classification confidence level: High

Classification comments: Diagnostic at the alliance level is the *Artemisia tridentata* ssp. *tridentata* dominated shrub layer that lacks a significant graminoid layer (<20% cover perennial graminoids) or has over 40% total cover of shrubs. Stands included in this alliance occur in environments (climate or substrates) that limit the growth of perennial graminoids or may be the result of heavy livestock grazing depleting the perennial graminoid layer of stands of *Artemisia tridentata* Shrub Herbaceous Alliance (A.1522).⁽¹⁾ This association is used to describe *Artemisia tridentata* dominated shrublands where the subspecies is not known and the herbaceous layer is generally sparse. Though the sagebrush species at Manzanar has been identified as *Artemisia tridentata* ssp. *tridentata*, these shrublands have been assigned to this association because of the sparse herbaceous layer characteristic of all stands and the fact that other studies conducted in eastern California have been used to describe this association.^(1a)

Other Classification Systems

USFWS Wetland Classification: Upland

MCV: Big Sagebrush Series. *Artemisia tridentata* Shrubland Alliance

MANZ Map Unit: S_ARTR

Range:

Globally (US): This broadly defined sagebrush shrubland is described from eastern California, Nevada, and Utah, but likely occurs throughout much of the western U.S.

Regionally: Stands at Whippoorwill Flat Research Natural Area (Cheng 2004), Inyo County, are similar to those described for western Nevada (Young et al. 1977).⁽²⁾

MANZ: Big sagebrush shrublands occur on the north and south side of Bairs Creek, the central portion of the park, and in the north central portion of the park.

Environmental description

Elevation (m): 1185 (1172-1199)

Slope: Flat

Aspect: Flat

Topographic Position: low level (5)

Landform: Valley floor

Geology: Colluvial

Cowardin System: Upland

Hydrology: Dry-Mesic

Soil texture: Sand

Unvegetated surface cover (%):

Large Rock: 0 (0-0)

Small Rock: 69 (60-79)

Fines: 4 (2-5)

Bare Soil: 5 (1-10)

Litter, Duff: 17 (5-30)

Wood: 6 (2-11)

Water: 0 (0-0)

Strata	Characteristic species	Ht. Range (m)	Stratum Absolute Cover (%)
T1 Emergent	None	>10	--
T2 Canopy	None	5-10	--
T3 Subcanopy	None	2-5	--
S1 Tall shrub	<i>Artemisia tridentata</i> ssp. <i>tridentata</i>	2-5	<0.1
S2 Short Shrub	<i>Artemisia tridentata</i> ssp. <i>tridentata</i> , <i>Ericameria nauseosa</i> ssp. <i>nauseosa</i> , <i>Atriplex canescens</i> var. <i>canescens</i>	0.5–2	36.8
S3 Dwarf Shrub	<i>Artemisia tridentata</i> ssp. <i>tridentata</i> , <i>Ericameria nauseosa</i> ssp. <i>nauseosa</i>	<0.5	0.1
H1 Graminoids	None	<0.5	--
H2 Forbs	<i>Mentzelia albicaulis</i> , <i>Malacothrix glabrata</i> , <i>Amsinckia tessellata</i>	<0.5	4.4

Most abundant species: *Artemisia tridentata* ssp. *tridentata*, *Ericameria nauseosa* ssp. *nauseosa*, *Atriplex canescens* var. *canescens*, *Mentzelia albicaulis*

Diagnostic species: *Artemisia tridentata* ssp. *tridentata*

Membership rules: Tree and shrub cover combined is greater than 7%. Cover of trees is less than 15%. Combined cover of *Artemisia tridentata* ssp. *tridentata* (basin big sagebrush), *Ericameria nauseosa* ssp. *nauseosa* (rubber rabbitbrush) and/or *Atriplex canescens* var. *canescens* (four-wing saltbush) is greater than 8%. Cover of *Artemisia tridentata* ssp. *tridentata* is greater than or equal to 10%.

Vegetation description: *Artemisia tridentata* ssp. *tridentata* shrublands have an intermittent shrub layer (36.8%, 24.2-46.2%) between 0.5m and 5m in height and a sparse herbaceous layer (4.4%, 0.6-10.4%) at less than 0.5m in height. *Artemisia tridentata* ssp. *tridentata* strongly dominates the shrub canopy with an average relative cover of 63.5% (30.4-89.5%). Associate shrub species include *Ericameria nauseosa* ssp. *nauseosa* (22.9%, 7.4-43.3% relative cover) and *Atriplex canescens* var. *canescens* (12.4%, 0-39.2% relative cover). Some stands are strongly dominated by *Artemisia tridentata* ssp. *tridentata* while other stands have an even mix of the three shrub species. The herbaceous layer is characterized by native forbs, principally *Mentzelia albicaulis* (whitestem blazing star), *Eriastrum wilcoxii* (Wilcox's woolly star), *Malacothrix glabrata* (smooth desert dandelion) and *Amsinckia tessellata* (bristly fiddleneck).

Artemisia tridentata shrublands are microphyllous, evergreen shrublands.

Other noteworthy species: *Salsola tragus* (prickly Russian thistle)

Conservation rank: G5^(1a) S5⁽²⁾

Comments: Big sagebrush shrublands may grade into sites with alkaline soils at the edge of internally drained basins. *Artemisia tridentata* is a non-halophyte and requires low salinity for optimum growth. ⁽¹⁾ *Artemisia tridentata* usually does not tolerate saturated soils or alkaline conditions. Soils are deep, lacking well-developed hard pans, gravel, and rock fragments. Shrubs live to 50 years. The stands lacking grass may be the result of livestock overgrazing or increased summer

drought (West 1983b, 1983c). *Artemisia tridentata* once dominated many productive sites that are now farmed. ⁽²⁾

References

- ⁽¹⁾ NatureServe. Ecological Alliances Comprehensive Report. *Artemisia tridentata* (ssp. *tridentata*, ssp. *xericensis*) Shrubland Alliance. A830
- ^(1a) NatureServe. Ecological Association Comprehensive Report. *Artemisia tridentata* Shrubland Association. CEG000991
- ⁽²⁾ MCV. Sawyer, John O., T. Keeler-Wolf, J.M. Evens. 2009. *A Manual of California Vegetation*. 2nd Edition. California Native Plant Society, Sacramento, CA.

Artemisia tridentata Shrubland

Big sagebrush Shrubland

Stand Table

n=5

Life form	Native	Species Code	Scientific Name	CON	AVG	MIN	MAX	Ch	D	Cd	A	Oft
Shrub												
	Y	ARTRT	<i>Artemisia tridentata</i> ssp. <i>tridentata</i>	100.0	23.5	10.1	37.0	X	X			
	Y	ERNAH	<i>Ericameria nauseosa</i> ssp. <i>nauseosa</i> var. <i>hololeuca</i>	100.0	8.5	3.1	20.1	X				X
	Y	ATCAC	<i>Atriplex canescens</i> var. <i>canescens</i>	60.0	4.6	0.0	13.0					X
	Y	ATPO	<i>Atriplex polycarpa</i>	40.0	0.4	0.0	1.0					
Herb												
	Y	MEAL6	<i>Mentzelia albicaulis</i>	100.0	3.4	0.1	8.0	X				
	Y	ERWI	<i>Eriastrum wilcoxii</i>	80.0	0.3	0.0	1.0	X				X
	Y	MAGL3	<i>Malacothrix glabrata</i>	80.0	0.3	0.0	1.0	X				X
	Y	AMTE3	<i>Amsinckia tessellata</i>	80.0	0.1	0.0	0.1	X				X
	Y	GILIA	<i>Gilia</i> sp.	60.0	0.1	0.0	0.1					X
	Y	ERMA2	<i>Eriogonum maculatum</i>	60.0	0.1	0.0	0.1					X
	Y	CRPT	<i>Cryptantha pterocarya</i>	40.0	0.0	0.0	0.1					
	Y	LEFLF2	<i>Lepidium flavum</i> var. <i>flavum</i>	40.0	0.0	0.0	0.1					
	N	SATR12	<i>Salsola tragus</i>	40.0	0.0	0.0	0.1					
	Y	STPA4	<i>Stephanomeria pauciflora</i>	40.0	0.0	0.0	0.1					
	Y	CHFR	<i>Chaenactis fremontii</i>	20.0	0.0	0.0	0.1					
	Y	DEPIG	<i>Descurainia pinnata</i> ssp. <i>glabra</i>	20.0	0.0	0.0	0.1					
	Y	PHFR2	<i>Phacelia fremontii</i>	20.0	0.0	0.0	0.1					

SPECIES RICHNESS: Total: 17 Avg. 11 Range 10 – 12

PLOTS: MANZ.1, MANZ.8, MANZ.12, MANZ.15, MANZ.23

Ericameria nauseosa - Atriplex canescens Shrubland Association [Park Special]**Rubber rabbitbrush – Four-wing saltbush Shrubland Association**Identifier: NPSMANZ009

Classification confidence level: High**Other Classification Systems**

USFWS Wetland Classification: Upland

MCV: Rubber rabbitbrush series, *Ericameria nauseosa* Shrubland Alliance.

MANZ Map Unit: S_ERNA

Range:

Globally (US): *Ericameria nauseosa* is a widespread shrub species occurring across the western United States. *Ericameria nauseosa* shrublands are described from western Colorado, Nevada and Utah. Stands appear to be dependent on disturbance, such as receding lake bed, past prairie dog use, abandoned agriculture or heavy grazing.⁽¹⁾

Regionally: Stands of the *Ericameria nauseosa* alliance occur throughout the semi-arid regions of California though this association has not been described in the Great Basin region. Stands initiated after fire replace stands of the *Artemisia tridentata* Alliance and plants frequently colonize scraped clearings.⁽²⁾ The propensity to colonize cleared areas may explain the large stands of this association that occur in the central and southeastern portions of the park. Much of the historic side was bladed and most vegetation removed prior to any buildings being constructed during the camp period.

MANZ: This vegetation type occurs in large stands throughout the historic site. A very large stand runs NE to SW through the central portion of the site and large stands occur along the southeastern portion of the site. In the stands located on the north and south sides of Bairs Creek in the central portion of the park, the shrubs are very large with rounded crowns and lush foliage, suggesting there is plentiful ground water close to the surface where these stands occur.

Environmental description

Elevation (m): 1881 (1175-1184)

Slope: Flat

Aspect: Flat

Topographic Position: low level (6)

Landform: Valley floor

Geology: Colluvial

Cowardin System: Upland

Hydrology: Dry-mesic

Soil texture: Sand

Unvegetated surface cover (%):

Large Rock: 0 (0-0)

Small Rock: 80 (73-87)

Fines: 4 (2-5)

Bare Soil: 4 (1-10)

Litter, Duff: 6 (1-14)

Wood: 6 (2-10)

Water: 0 (0-0)

Strata	Characteristic species	Ht. Range (m)	Stratum Absolute Cover (%)
T1 Emergent	None	>10	--
T2 Canopy	None	5-10	--
T3 Subcanopy	None	2-5	--
S1 Tall shrub	None	2-5	--
S2 Short Shrub	<i>Ericameria nauseosa</i> ssp. <i>nauseosa</i> , <i>Atriplex canescens</i> var. <i>canescens</i>	0.5–2	19.5
S3 Dwarf Shrub	<i>Ericameria nauseosa</i> ssp. <i>nauseosa</i>	<0.5	0.4
H1 Graminoids	None	<0.5	--
H2 Forbs	<i>Mentzelia albicaulis</i> , <i>Malacothrix glabrata</i> , <i>Eriastrum wilcoxii</i> , <i>Cryptantha circumscissa</i> , <i>Amsinckia tessellata</i> , <i>Eriogonum maculatum</i> , <i>Salsola tragus</i>	<0.5	5.8

Most abundant species: *Ericameria nauseosa* ssp. *nauseosa*, *Atriplex canescens* var. *canescens*, *Mentzelia albicaulis*

Diagnostic species: *Ericameria nauseosa* ssp. *nauseosa*

Membership rules: Tree and shrub cover combined is greater than 7%. Cover of trees is less than 15%. Combined cover of *Artemisia tridentata* ssp. *tridentata* (basin big sagebrush), *Ericameria nauseosa* ssp. *nauseosa* (rubber rabbitbrush), and/or *Atriplex canescens* var. *canescens* (four-wind saltbush) is greater than 8%. Cover of *Artemisia tridentata* is less than 10%.

Vegetation description: *Ericameria nauseosa* – *Atriplex canescens* shrublands have an open (20.0%, 12.3-36.0%) shrub layer between 0.5m and 2m in height and a sparse herbaceous layer (5.8%, 1.4 – 8.6%) at less than 0.5m in height. *Ericameria nauseosa* ssp. *nauseosa* dominates the shrub canopy with an average relative cover of 63.7% (33.3-97.2%). *Atriplex canescens* var. *canescens* co-dominates the shrub canopy with an average relative cover of 36.0% (2.8 – 66.7%). Scattered individuals of *Atriplex polycarpa* (cattle saltbush) and *Artemisia tridentata* ssp. *tridentata* occur within these shrublands on more xeric sites; *Salix exigua* (narrow leaf willow) and *Salix laevigata* (red willow) occur on more mesic sites. The herbaceous layer is characterized by native forbs, principally *Mentzelia albicaulis* (whitestem blazing star), *Malacothrix glabrata* (smooth desert dandelion) and *Eriastrum wilcoxii* (Wilcox’s woolly star).

Ericameria nauseosa shrublands are microphyllous, evergreen shrublands.

Other noteworthy species: *Salsola tragus* (prickly Russian thistle), *Descurainia sophia* (herb Sophia)

Conservation rank: *Ericameria nauseosa* Shrubland Alliance - G5 S5⁽²⁾; *Ericameria nauseosa* – *Atriplex canescens* Shrubland Association [Park Special] – unranked.

Comments: *Ericameria nauseosa* is a fast growing, early seral shrub that establishes after disturbance. It blooms in the late summer and fruits in the fall. The wind-dispersed seeds germinate in the early spring. It has numerous adaptations to arid environments including deep taproots and narrow leaves with trichomes that give it a silver appearance (Tirmenstein 1990c). Plants are often an

important browse for livestock and wildlife. ⁽²⁾ Multitudes of bees, wasps and butterflies visit the flowers, which bloom at a time of year when few other nectar and pollen sources are available. ⁽³⁾

Ericameria nauseosa is considered a shrub of depleted range and disturbed areas (McArthur et al. 1977). It is a fire adapted species that is typically unharmed or enhanced by fire and is often one of the first species to colonize burned areas by resprouting from adventitious buds from its stems and root crown or from off-site seed (FEIS 2006). Stands appear to be dependent on disturbance, such as receding lake bed, past prairie dog use, abandoned agriculture or heavy grazing which favors *Ericameria nauseosa* (USFS 1937). ⁽¹⁾ In a 1944 aerial photo of Manzanar, agricultural fields are visible along the south east boundary of the park where there are now large stands of *Ericameria nauseosa* – *Atriplex canescens*.

References

- ⁽¹⁾ NatureServe. Ecological Association Comprehensive Report. *Ericameria nauseosa* Shrubland. CEGLO02713
- ⁽²⁾ MCV. Sawyer, John O., T. Keeler-Wolf, J.M. Evens. 2009. *A Manual of California Vegetation*. 2nd Edition. California Native Plant Society, Sacramento, CA.
- ⁽³⁾ Bowers, Janice E. *Shrubs & Trees of the Southwest Deserts*. Western National Parks Association. Tucson, AZ. 1993.

Ericameria nauseosa – *Atriplex canescens* Shrubland Association [Park Special]

Rubber rabbitbrush – Four-wing saltbush Shrubland Association

Stand Table

n=6

Life form	Native	Species Code	Scientific Name	CON	AVG	MIN	MAX	Ch	D	Cd	A	Oft
Shrub												
	Y	ERNAH	<i>Ericameria nauseosa</i> ssp. <i>nauseosa</i> var. <i>hololeuca</i>	100.0	12.7	6.0	35.0	X	X			
	Y	ATCAC	<i>Atriplex canescens</i> var. <i>canescens</i>	100.0	7.2	1.0	12.0	X		X		
	Y	ARTRT	<i>Artemisia tridentata</i> ssp. <i>tridentata</i>	33.3	0.1	0.0	0.1					
Forb												
	Y	MEAL6	<i>Mentzelia albicaulis</i>	100.0	3.5	1.0	8.0	X				
	Y	ERWI	<i>Eriastrum wilcoxii</i>	100.0	0.3	0.1	1.0	X				X
	Y	MAGL3	<i>Malacothrix glabrata</i>	83.3	0.9	0.0	4.0	X				X
	Y	CRCI2	<i>Cryptantha circumscissa</i>	83.3	0.2	0.0	1.0	X				X
	Y	AMTE3	<i>Amsinckia tessellata</i>	83.3	0.1	0.0	0.1	X				X
	N	SATR12	<i>Salsola tragus</i>	83.3	0.1	0.0	0.1	X				X
	Y	ERMA2	<i>Eriogonum maculatum</i>	83.3	0.1	0.0	0.1	X				X
	Y	CABOD 2	<i>Camissonia boothii</i> ssp. <i>desertorum</i>	66.7	0.1	0.0	0.1					X
	Y	GILIA	<i>Gilia</i> sp.	66.7	0.1	0.0	0.1					X
	Y	CRPT	<i>Cryptantha pterocarya</i>	66.7	0.1	0.0	0.1					X
	Y	AMAC2	<i>Ambrosia acanthicarpa</i>	50.0	0.1	0.0	0.1					X
	N	DESO2	<i>Descurainia sophia</i>	50.0	0.1	0.0	0.1					X
	Y	LOSC6	<i>Loeseliastrum schottii</i>	33.3	0.2	0.0	1.0					
	Y	CRMI	<i>Cryptantha micrantha</i>	33.3	0.0	0.0	0.1					
	Y	TIPL2	<i>Tiquilia plicata</i>	16.7	0.2	0.0	1.0					
	Y	STPA4	<i>Stephanomeria pauciflora</i>	16.7	0.0	0.0	0.1					
	Y	CHFR	<i>Chaenactis fremontii</i>	16.7	0.0	0.0	0.1					

SPECIES RICHNESS: Total: 20 Avg.: 14 Range 8 – 17

PLOTS: MANZ.3, MANZ.10, MANZ.11, MANZ.18, MANZ.19, MANZ.27

Vegetation Description Field Definitions

Description name and identifier

Name applied to the vegetation type described and the NVC (CEGL####) or NPS (NPSMANZ####) identifying code. NPS codes identify park special types unique to Manzanar.

MANZ Component Stand Type(s) or Association (s)

Stand type or associations identified within group being described.

Classification confidence level

A rating of the confidence in the classification of the vegetation type based on whether there was sufficient data to fully describe the group, alliance or association.

Other Classification Systems

USFWS Wetland Classification: A system developed for the classification of wetlands by the U.S. Fish and Wildlife Service. System refers to a complex of wetlands and deep water habitats that share the influence of similar hydrologic, geomorphic, chemical, or biological factors. As defined in Cowardin et al. (1979), the values are:

Marine - consists of open ocean overlying the continental shelf and its associated high-energy coastline.

Estuarine - consists of deepwater tidal habitats and adjacent tidal wetlands that are usually semi-enclosed by land but have open, partly obstructed, or sporadic access to the open ocean, and in which ocean water is at least occasionally diluted by freshwater runoff from the land.

Riverine - includes all wetlands and deepwater habitats contained within a channel, with two exceptions: (1) wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens, and (2) habitats with water containing ocean-derived salts in excess of 0.5%.

Lacustrine - includes wetlands and deepwater habitats with all of the following characteristics: (1) situated in a topographic depression or a dammed river channel; (2) lacking trees, shrubs, persistent emergents, emergent mosses or lichens with greater than 30% areal coverage; and (3) total area exceeds 8 ha (20 acres).

Palustrine - includes all nontidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean-derived salts is below 0.5%.

MCV: *A Manual of California Vegetation*. 2nd Edition. 2008. Contains the classified communities of California as well as the National Vegetation Classification Hierarchy as applied to California vegetation.

MANZ Map Unit: The corresponding map unit code which denotes the vegetation type described on the vegetation map.

Range:

Globally (U.S.): Distribution within the United States, particularly the western U.S. and the Great Basin Desert. Information obtained from alliance and association descriptions prepared by NatureServe.

Regionally: Distribution within the Owens Valley and Great Basin Desert region of California. Information obtained from *A Manual of California Vegetation*.

MANZ: Distribution within the historic site.

Environmental Description:

All environmental data summarized for the vegetation type described. Includes average and range of values for: elevation, slope, aspect, topographic position, landform, hydrology, Cowardin wetland classification, soil texture and unvegetated surface cover.

Slope categories:

Flat: 0° Gentle: 1-5° Moderate: 6-14° Somewhat steep: 15-26° Steep: 27-45°

Unvegetated Surface Cover categories:

Large rock: >25cm in diameter (includes bedrock, boulders and stones)

Small rock: 2mm – 25 cm in diameter (includes gravel and cobbles)

Fines: 0.074mm – <2mm in diameter (includes sand)

Bare: < 0.074 mm (= mineral soil)

Water: Surface water

Wood: Dead and downed woody debris > 3” in diameter

Litter: Dead and downed leaves and woody debris < 3” in diameter

Strata Table: Characteristic species and average absolute cover values for each stratum for the vegetation type described.

T1 Emergent Tree: A tree taller than the main tree canopy, or, emerging above the tree canopy.

T2 Tree Canopy: The main canopy layer of mature overstory trees of nearly equal height.

T3 Tree Sub canopy: Tree species occurring under the tree canopy.

S1 Tall shrub: Shrub species between 2 -5m in height

S2 Short shrub: Shrub species between 0.5 and 2m in height

S3 Dwarf shrub: Shrub species less than 0.5m in height

H1 Graminoids: Grass and grass-like plants such as sedges (*Carex* spp.) and rushes (*Juncus* spp.)

H2 Forbs: Herbaceous plants other than grasses or grass-like plants

Most abundant species: Those species with high constancy and high average absolute cover.

Diagnostic species: A species that must be present for a stand to be placed within the group, alliance or association described.

Membership rules: Diagnostic species and characteristic cover values that place a vegetation type in the group, alliance, or association described.

Vegetation description: Describes the characteristic species and cover values in each stratum. Stratum cover values are absolute cover values. Dominance cover values are relative cover values.

Vegetation canopy cover descriptors and definitions	
Canopy Cover	Absolute Cover
Very Sparse	<1%
Sparse	1-10%
Open	11-33%
Intermittent	34-66%
Continuous	>66%
Dominance	Relative Cover
Strongly dominant	>60%
Dominant	≥50%
Co-dominant	30 – 60%

Global and State Community Conservation Ranks: NatureServe global and state conservation ranks.

G indicates rarity and threat globally. S indicates rarity and threat in a state.

G1 S1: Fewer than 6 viable occurrences worldwide/statewide, and/or up to 518 hectares

G2 S2: 6-20 viable occurrences worldwide/statewide, and/or between 518-2,590 hectares

G3 S3: 21-100 viable occurrences worldwide/statewide, and/or between 2,590-12,950 hectares

G4 S4: Greater than 100 viable occurrences worldwide/statewide, and/or more than 12,950 hectares

G5 S5: Demonstrably secure because of its worldwide/statewide abundance

Additional Threat Ranks

0.1: Very threatened

0.2: Threatened

0.3: No current threat known

Other noteworthy species: All non-native species documented within the vegetation type being described.

Less common native species documented in the vegetation type being described.

Comments: Supplemental information pertaining to the vegetation type described or the dominant species in the vegetation type such as flowering times, salinity and moisture tolerance, response to disturbance, and suitability as wildlife forage.

References: The references from which information in the description was drawn.

Stand Table Column Heading Definitions

CON = Constancy, or the percentage of plots of a vegetation type in which a species occurs

$$\text{CON}_{\text{sp}} = \frac{\text{\# of samples}_{\text{sp}}}{\text{\# of samples}_{\text{veg type}}} \times 100$$

AVG = Average absolute cover values for each species, as calculated across all samples in a vegetation type

$$\text{AVG} = \frac{\text{Sum absolute cover}_{\text{sp}}}{\text{\# of samples}_{\text{veg type}}} \times 100$$

MIN = Minimum absolute cover value for a species within the vegetation type described

MAX = Maximum absolute cover value for a species within the vegetation type described

Ch = Characteristic: Must be present in at least 75 percent of the samples with no restriction on cover

D = Dominant: Must be in at least 75 percent of the samples, with at least 50 percent relative cover in all samples

Cd = Co-dominant: Must be in at least 75 percent of the samples, with at least 30 percent relative cover in all samples.

A = Abundant: Must be present in at least 50 percent but less than 75 percent of the samples, with at least 30 percent relative cover in all samples

Oft = Often: Must be present in at least 50 percent of the samples, with relative cover less than 30%

NOTE: Dominance and Co-dominance are based on constancy and relative cover values for species in the same stratum.

Glossary of Terms

Abundant: Very likely to be encountered; an abundant species need not be dominant. [Stand Table Definition: Must be present in at least 50 percent but less than 75 percent of samples, with at least 30 percent relative cover in all samples.]

Absolute cover: The percentage of the ground covered by the vertical projection of the plant crowns of a species or defined set of plants (also known as the vertical projection of foliage of plants) as viewed from above. Small openings in the canopy and overlap are excluded (SRM 1989). The absolute cover of herbaceous plants includes any standing plant parts (attached to a living plant and not lying on the ground) whether alive or dead. This definition excludes litter and other separated plant material. Cover may include mosses, lichens, and recognizable cryptogamic crusts (Bartolome et al. 2007a).

Alkaline: Of or relating to or having the properties of an alkali, especially having a pH of more than 7.4. Alkaline soils are characterized by the presence of sodium carbonate (Na_2CO_3) and sodium bicarbonate (NaHCO_3). Alkaline soils form naturally through the weathering of soil parent materials that produce sodium carbonate (Na_2CO_3) and sodium bicarbonate (NaHCO_3).

Alliance: A vegetation classification unit containing one or more associations and defined by a characteristic range of species composition, habitat conditions, physiognomy and diagnostic species, typically at least one of which is found in the uppermost or dominant stratum of the vegetation (Jennings et al. 2006, FGDC 2008). Alliances reflect regional to sub-regional climate, substrates, hydrology, moisture/nutrient factors and disturbance regimes. This term replaces *series* used in the first edition of the MCV.

Annual: Completing the life cycle (germination through death) in one year or growing season. Plants are non-woody. The seed to seed cycle may be completed in as little as a month in some species though most last several months. *See* biennial, perennial.

Association: A vegetation classification unit defined on the basis of a characteristic range of species composition, diagnostic species occurrence, habitat conditions and physiognomy (Jennings et al. 2006, FGDC 2008). Associations reflect topo-edaphic climate, substrates, hydrology, and disturbance regimes.

Biennial: Completing the life cycle (germination through death) in two years or growing seasons (generally only flowering in the second) and non-woody (at least above ground), often with a rosette the first growing season. *See* annual, perennial.

Broad-leaved deciduous: Woody angiosperms (trees or shrubs) with relatively wide, flat leaves that are shed during the cold or dry season; e.g., *Robinia pseudoacacia* (black locust), *Populus fremontii* (Fremont cottonwood), *Salix spp.* (willow species), *Rosa woodsii* (Wood's rose).

Canopy cover: The percentage of ground covered by the combined crowns of all plants that form the outermost perimeter of the spread of foliage. Small openings are included (SRM 1989), USDA-NRCS 1997); applications often include spaces between plant crowns, in part because they are difficult to view or estimate from above.

Characteristic species: A species that is consistently present in a well-defined vegetation type.
[Stand table definition: Must be present in at least 75 percent of the samples with no restriction on cover.]

Cismontane: This side of the mountains. In California, the area west of the Sierra Nevada -Cascade Mountain axis.

Clone (*adjective* = clonal): Genetically identical individuals resulting from asexual reproduction (fragmentation of rhizomes or stolons, budding, etc.). Often used for an apparent population, the members of which are or were connected – e.g. willows, cattails, duckweeds.

Co-dominant species: Two or more abundant species with high cover in relation to other species in the same stratum. Typically co-dominant species are those with near equal cover and between 30% and 60% relative cover. Most often applied to species in the stratum with the highest canopy cover or, the stratum that defines a stand as a forest, woodland, shrubland or herbaceous stand. *See* dominant species, relative cover. [Stand table definition: Must be in at least 75 percent of the samples, with at least 30 percent relative cover in all samples.]

Cold-deciduous woodlands: Woodlands where the dominant tree species lose their leaves during the cold months of the year.

Community: A group of organisms living together and linked together by their effects on one another and their responses to the environment they share (Whittaker 1975). *See* stand.

Constancy: The percentage of samples (e.g. plots) of a given vegetation type in which a species occurs.

Constant species: In this report, species with at least 75% constancy.

Continuous: Having greater than 66% absolute cover. *Compare* very sparse, sparse, open, intermittent.

Cool-season annual: The plants grow and bloom during the cool season when most other plants are dormant or other annuals are in seed form waiting for warmer weather to germinate.

Crosswalk: A comparison of two or more classifications. The relationships may be one-to-one, one-to-many, or many-to-many.

Diagnostic species: A species with high constancy or abundance that differentiates one vegetation type from another (Jennings et al. 2006). A diagnostic species is typically found in the dominant stratum of a vegetation association and lends its name to that association. The species can also be a character, constant, differential, dominant, or indicator species. Some authors restrict the term to include only character, constant or differential species.

Dominance: The extent to which a species or growth form has a strong influence in a stand because of its size, abundance, or cover (Lincoln et al. 1998).

Dominant species: An abundant species with high cover in relation to other species in the layer with highest canopy cover. A dominant species is typically defined as a species with at least 50% relative

cover within a particular stratum. *Compare* co-dominant species. [Stand Table Definition: Must be in at least 75 percent of the samples, with at least 50 percent relative cover in all samples]

Dwarf shrub: A creeping, matt, or cushion-forming shrub that is typically <30 cm tall at maturity because of genetic and/or environmental constraints, and generally small-leaved. The term does not include shrubs that are <30 cm tall only because of young age (Mueller-Dombois and Ellenberg 1974). *See* herb, shrub, subshrub, tree. **Note:** In this report, shrubs placed in the Dwarf Shrub stratum were individuals <50cm in height and were small shrubs of young age. They were *not* dwarf forms of the shrub species that occur within each vegetation type.

Edaphic: Of or relating to the soil. Resulting from or influenced by the soil. (Edaphic qualities may characterize the soil itself, including drainage, texture, or chemical properties such as pH or salinity).

Edaphic climax: An ecological climax resulting from soil factors and commonly persisting through cycles of climatic and physiographic change. *Compare* physiographic climax.

Facultative: As relates to plants, having the capacity to grow in more than one habitat; e.g. a facultative plant, as defined by the USFWS wetland classification system commonly occurs as either a hydrophyte or non-hydrophyte.

Facultative wetland species: Usually a hydrophyte but occasionally found in uplands. *See* obligate wetland species.

Forb: An herbaceous species other than a grass or grass-like plant.

Forest: An area (or vegetation type) in which trees dominate the overstory where their crowns generally overlap (with >60% canopy cover). *Compare* woodland.

Growing season: The frost-free period of the year (see U.S. Department of Interior, National Atlas 1970: 110-111 for generalized regional delineation).

Habitat: The biological and environmental conditions associated with a vegetation type. The conditions reflect topography, substrates, climate, hydrology, and disturbance regimes. Another classic definition is the location where an organism or vegetation type is found and the role a biological “entity” (usually species) plays in an ecosystem.

Halophyte: A plant of salty or alkaline soils.

Herb: A vascular plant lacking above ground woody stems. Herbs may be annual or perennial. The term includes aquatic plants, flowering and spore-bearing broad-leaf plants, grasses, grass-like plants, and vines. *See* dwarf shrub, shrub, subshrub, tree.

Herbaceous: With the characteristics of an herb; a plant with no persistent woody stem above ground.

Hydric soil: Soil that is wet long enough to periodically produce anaerobic conditions, thereby influencing the growth of plants.

Hydrophyte, hydrophytic: Any plant growing in water or on a substrate that is at least periodically deficient in oxygen as a result of excessive water content. (Hydrophytes possess physiological adaptations which allow them to uptake oxygen in a water saturated environment.)

Intermittent: Having 34% to 66% absolute cover. *Compare* very sparse, sparse, open, continuous.

Intermittently Flooded: The substrate is usually exposed, but surface water is present for variable periods without detectable seasonal periodicity. Weeks, months, or even years may intervene between periods of inundation. The dominant plant communities under this regime may change as soil moisture conditions change. Some areas exhibiting this regime do not fall within the Cowardin definition of wetland because they do not have hydric soils or support hydrophytes.

Layer: A structural component of a stand consisting of plants of approximately the same height and growth form. *Compare* stratum.

Mesophyte, mesophytic: Any plant growing where moisture and aeration conditions lie between extremes. (Plants typically found in habitats with average moisture conditions, not unusually dry or wet.)

Microphyllous evergreen: Woody plants with small or narrow leaves that are retained throughout the year; e.g. *Ericameria nauseosa* (rubber rabbitbrush), *Artemisia tridentata* (big sagebrush).

Obligate upland species: Rarely is a hydrophyte, almost always in uplands.

Obligate wetland species: Almost always is a hydrophyte, rarely in uplands.

Open: Having between 11% and 33% absolute cover. *Compare* very sparse, sparse, intermittent, continuous.

Perennial: Living more than two years or growing seasons. Perennial plants can be short-lived (only a few years) (e.g. bush lupine) or long-lived (e.g. bristle cone pine). *See* annual, biennial.

Phreatophyte: A deep-rooted plant that obtains its water from the phreatic zone (i.e. zone of saturation) or the capillary fringe above the phreatic zone. *See* water table

Physiognomy: External aspect. The visible structure or outward appearance of a plant community based on dominant growth form, vegetation cover and vertical structure (e.g. forest, woodland, shrubland, grassland).

Physiographic climax: An ecological climax that develops in association with a particular physiographic situation and persists only while the physiographic factors remain stable. *Compare* edaphic climax.

Physiography: A description of nature or natural phenomena in general. More specifically, a description of the physical geography of a place.

Pioneer plants: Herbaceous annual and seedling perennial plants that colonize bare areas as the first stage in secondary succession.

Plant community: An assemblage of individuals of one to many plant species distinct in structure and composition from other adjacent such groupings. Defined by a specific combination of environmental characteristics such as moisture, temperature, and soil chemistry. *See* stand.

Plot: An area of defined size and shape intended for characterizing a homogenous stand of vegetation (in the context of classifying vegetation).

Relative Cover: A measure of the cover of a species in relation to that of other species within a set area or sample of vegetation. This is usually calculated for species that occur in the same layer (or stratum) of vegetation, and this measure can be calculated across a group of samples (or across a space or time).

$$\text{Relative Cover}_{\text{sp}} = \frac{\text{Sum Absolute Cover}_{\text{sp}}}{\text{Sum Absolute Cover}_{\text{total}}} \times 100$$

Seasonally Flooded: Surface water is present for extended periods especially early in the growing season, but is absent at the end of the season in most years. When surface water is absent, the water table is often near the land surface.

Semi-natural vegetation: Vegetation in which past or present human activities significantly influence composition or structure but do not eliminate or dominate spontaneous ecological processes (Westhoff and Van de Maarel 1973).

Seral: A vegetation type (or component species) that is demonstrably susceptible to replacement by other vegetation types (or component species) based on its ecological characteristics (Daubenmire 1968).

Shrub: A woody plant that generally has two to several stems from the base, giving it a broad crown, and is usually below 5m in height. *See* herb, dwarf shrub, subshrub, tree.

Shrubland: An area (or vegetation type) in which shrubs dominate, including chaparral, coastal scrub, and desert scrub.

Sparse: Having less than or equal to 10% but at least 1% absolute cover (FGDC 2008). *Compare* very sparse, open, intermittent, continuous.

Stand: An area of vegetation that is homogeneous in species composition and structure and in a uniform habitat. *Compare* alliance, plant community.

Stratum (*plural* = strata): A layer within the vertical profile of a vegetation stand stratified by growth form. Each stratum consists of plants of approximately the same height and is named by the typical growth form in that layer (e.g. tree, shrub, or herb stratum). A stratum may be divided further into substrata of the same growth form, such as tall shrub, short (medium) shrub, and low (dwarf) shrub. *See* layer.

Strongly dominant: A species in a stratum that has $\geq 60\%$ relative cover.

Subshrub: A plant with woody lower stems and herbaceous upper stems.

Temporarily Flooded: Surface water is present for brief periods during the growing season, but the water table usually lies well below the soil surface for most of the season. Plants that grow both in uplands and wetlands are characteristic of the temporarily flooded regime.

Transmontane: Across the mountains. In California, the area east of the Sierra Nevada – Cascade Mountains axis.

Tree: A woody plant that generally has one stem (trunk) from the base and is usually over 5m in height. *See* dwarf shrub, shrub, subshrub, herb.

Vegetation type: A classification unit of vegetation at any level in the National Vegetation Classification hierarchy (e.g. class, subclass, formation, division, macrogroup, group, alliance, or association), or a unit used when vegetation has not been classified formally to a specific level. A vegetation type is typically defined on the basis of shared floristic and/or physiognomic characteristics. It is comparable to a taxon in plant classification.

Very sparse: Having less than 1% absolute cover. *Compare* sparse, open, intermittent, continuous.

Warm-season annual: An annual plant that sprouts, flowers and produces seed during the warmer months of the year.

Water table: The upper surface of an area filled with groundwater, separating the **zone of aeration** (the subsurface region of soil and rocks in which the pores are filled with air and usually some water) from the **zone of saturation** (the subsurface region in which the pores are filled only with water). Water tables rise and fall with seasonal moisture, water absorption by vegetation, and the withdrawal of ground water from wells among other factors. The water table is not flat but has peaks and valleys that generally conform to the overlying land surface. *See* phreatic zone, phreatophyte.

Wetland: In general, lands where saturation with water is the dominant factor determining the nature of soil development and the types of plant and animal communities living in the soil and on its surface. Wetlands are transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water.

Woodland: An area (or vegetation type) in which trees occur in open stands where their crowns are open and generally do not overlap (usually with 10% to 60% canopy cover). *Compare* forest.

Woody plant: A seed plant (trees, shrubs and some vines) that develops persistent hard, thickened vascular tissue (xylem) generally in concentric rings.

Xerophyte, xerophytic: Any plant growing in a habitat in which an appreciable portion of the rooting medium dries to the wilting coefficient at frequent intervals. (Plants typically found in very dry habitats.)

Appendix E: Photo-interpretation Key

Manzanar National Historic Site- Map Units

Appendix E describes the map units for the Manzanar National Historic Site (MANZ) Vegetation Inventory Project. Its purpose is to:

- Provide a visual key to the MANZ map units;
- Describe the vegetation of each map unit and its corresponding imagery (i.e. photo) signature;
- Provide a representative ground photograph/image for each map unit;
- Describe the link between each map unit and the revised U.S. National Vegetation Classification (rUSNVC);
- Provide visual examples of each map unit with digital overhead images and delineated overlays.

The map units for MANA were based on a combination of rUSNVC plant associations, local requests (i.e. Park Specials), the limitations of the digital imagery, and land use / land cover classes. The vegetation described in this section reflects the classification designed specifically for this project. Non-vegetated and land-use map units are not described in this key. For more information on the development of the mapping scheme for MANZ please reference the mapping sections of this report and the digital information (i.e. lookup tables, metadata) included on the project DVD.

This key follows the physiognomic grouping of each map unit starting with woodland types. Each map unit is fully described by a variety of characteristics and features. First the rUSNVC crosswalk (if applicable) to associations and the common plant species for each association is presented. Next is a description of the mapping concept and a representative ground photograph. A map of the distribution for each mapping unit across the study area follows along with an example of the 2010 National Agricultural Imagery Program (NAIP) digital basemap ortho-imagery (color infrared bands). The imagery snapshot examples also include representative polygon outlines that highlight the map unit signatures. Many of the map unit descriptions rely heavily on the vegetation field data collected in by Mojave Desert Network Inventory and Monitoring staff (MOJN I&M) during the field sampling and accuracy assessment stages. The sample ground photographs were supplied by MOJN I&M and were taken during either the field sampling (plot data) or the accuracy assessment data collection efforts.

Woodlands

Map Code **Mixed Deciduous Upland Woodland Complex**
W_MXWD

Common Species

Tree of heaven (*Ailanthus altissima*)
Fremont cottonwood (*Populus fremontii*)
Arizona Cypress (*Cupressus arizonica*)
Black Walnut (*Juglans nigra*)
Common Fig (*Ficus carica*)
Garden Plum (*Prunus domestic*)
Mulberry (*Morus alba*)
Southern Catalpa (*Catalpa bignonioides*)
Peach (*Prunus persica*)
Siberian Elm (*Ulmus pumila*)
Silver Maple (*Acer saccharinum*)
Velvet Ash (*Fraxinus velutina*)
Desert Olive (*Forestiera pubescens*)
Herb sophia (*Descurainia sophia*)

Representative Ground Photo



rUSNVC Association

- No Alliance Park Special

Description

Frequency: Mixed stands of deciduous trees are common throughout the central portion of MANZ and may occur as a result of past plantings and high water table levels in the park.

Physiognomy: W_MXWD polygons contain moderate to dense stands of mostly tall deciduous trees. In stands with a continuous canopy, the understory is sparsely vegetated with a mix of native and non-native forbs. *Desurainia sophia* is the most common species in the woodland understory in stands with a continuous canopy. *Ericameria nauseosa* and *Atriplex* spp. occur where there are openings in the canopy.

Condition: Good – Fair. Mixed deciduous trees are widespread at MANZ and appear disease free. Due to the mixed nature of this type it is unclear if some of the rare and/or semi-natural species will or should remain at MANZ. Some of the more common tree species in this type like tree of heaven and mulberry have the potential to spread and may out-compete other native vegetation. Severe wildfires, insect infestations, prolonged drought, or fluctuations in the water table are potential threats to this type.

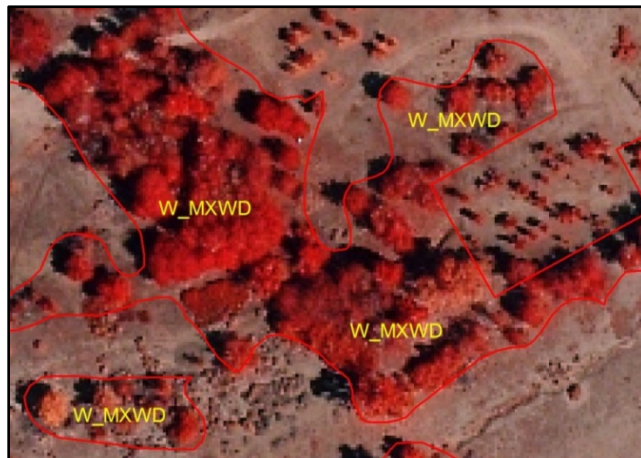
CIR Signature: On the imagery W_MXWD varied by plant species and ranged from dark red to bright orange.

Mapping Notes: The W_MXWD map unit was created to address mixed woodland stands that had no clear dominant species. Former orchard areas were mapped separately using the L_ORCH map unit.

Range and Distribution



Photo Signature Example



Map Code	Fremont Cottonwood - Red Willow Woodland
W_POFR	<i>Populus fremontii</i> - <i>Salix laevigata</i> Woodland

Common Species

Fremont cottonwood (*Populus fremontii*)
Red willow (*Salix laevigata*)
Black locust (*Robinia pseudoacacia*)
Sedge (*Carex* spp.)
Mojave cleomella (*Cleomella obtusifolia*)
Herb sophia (*Descurainia sophia*)
Inland saltgrass (*Distichlis spicata*)
American licorice (*Glycyrrhiza lepidota*)
Whitestem blazingstar (*Mentzelia albicaulis*)
Prickly Russian thistle (*Salsola tragus*)

rUSNVC Association

-*Populus fremontii* - *Salix laevigata* Woodland

Representative Ground Photo



Description

Frequency: Fremont cottonwood with red willow woodlands were found primarily in upland areas associated with the former core settlement area. Other individual cottonwood and red willow trees likely occurred throughout the central portion of MANZ but were mapped as part of the W_MXWD map unit.

Physiognomy: W_POFR polygons contained moderate to dense stands of medium to tall deciduous trees. The understories for this map unit were often diverse and contained mixes of evergreen and deciduous shrubs with pockets of herbaceous vegetation.

Condition: Good – Fair. Fremont cottonwood trees were rare at MANZ and may represent past plantings. Prolonged drought or fluctuations in the water table may cause this community to decline.

CIR Signature: On the imagery, canopies of W_POFR appeared as mottled bright orange circles with white specs representing dead branches.

Mapping Notes: The W_POFR map unit was created to address upland cottonwood stands as opposed to the W_SALA map unit that occurred in more riparian-like settings. Fremont cottonwood trees appeared similar to other large deciduous trees and some confusion may have occurred during the mapping of this type versus the W_MXWD map unit.

Range and Distribution

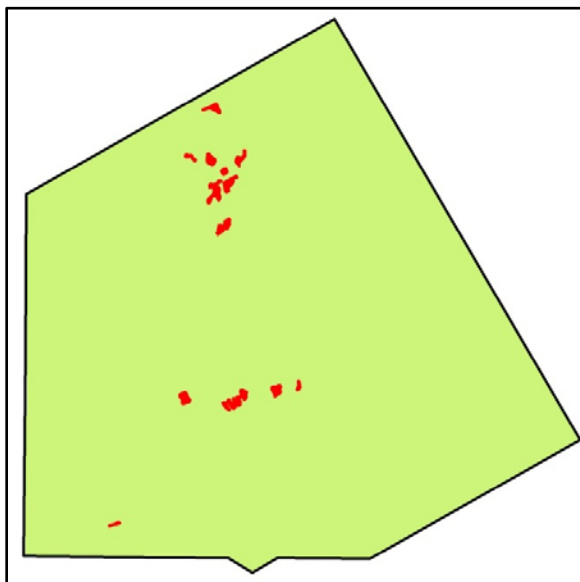
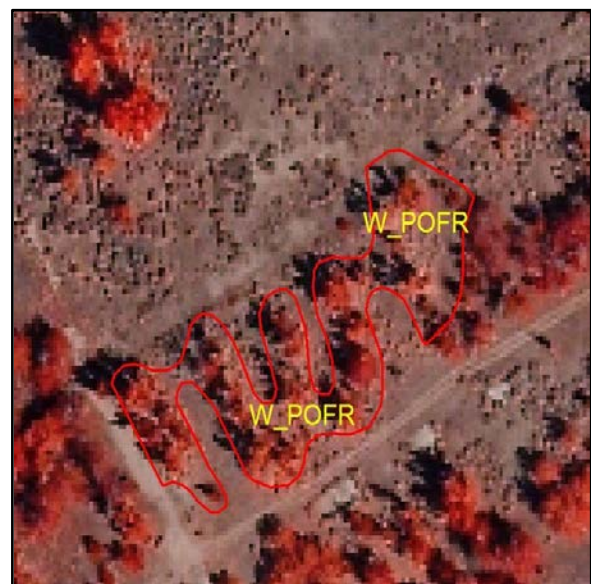


Photo Signature Example



Map Code	Black Locust Semi-natural Woodland Stand
W_ROPS	<i>Robinia pseudoacacia</i> Woodland Stand

Common Species

Black locust (*Robinia pseudoacacia*)
Fremont cottonwood (*Populus fremontii*)
Red willow (*Salix laevigata*)
Sedge (*Carex* spp.)
Herb sophia (*Descurainia sophia*)
Inland saltgrass (*Distichlis spicata*)
Whitestem blazingstar (*Mentzelia albicaulis*)
Prickly Russian thistle (*Salsola tragus*)

rUSNVC Association

- *Robinia pseudoacacia* Semi-natural Forest

Description

Frequency: Black locust trees were common throughout the upland portions of MANZ and are likely the result of past plantings of this species for shade and wind protection.

Physiognomy: W_ROPS polygons contain various sizes and density of black locust trees due to differences in age and growing conditions. On drier sites this map unit had open canopies, shorter trees and understories consisting of evergreen shrubs and native and non-native forbs. On more mesic sites, the black locust trees were taller, denser. The understory is sparsely vegetated with a mix of native and non-native forbs. *Desurainia sophia* is the most common species in the woodland understory particularly under closed canopy stands. *Ericameria nauseosa* and *Atriplex* spp. occur where there are openings in the canopy.

Condition: Good. Black locust trees are widespread at MANZ and appear disease free at this time. Severe wildfires and insect infestations are potential threats to this type.

CIR Signature: On the imagery canopies of W_ROPS appear as dark red spots with either dark gray (evergreen shrubs), solid brown/pink colors (bare soil), or light red (herbaceous vegetation) in the canopy openings.

Mapping Notes: The W_ROPS map unit was created to address continuous upland black locust stands as opposed to individual black locust trees that were included in the W_MXWD map unit. Black locust saplings/seedlings and individual, isolated trees were not mapped.

Representative Ground Photo



Range and Distribution

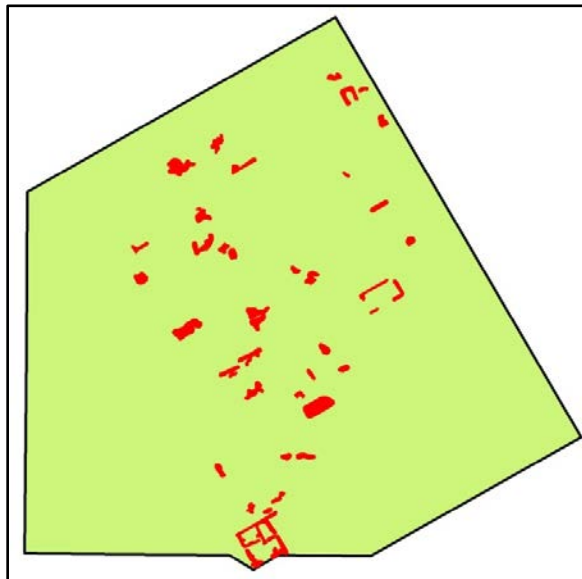


Photo Signature Example



Map Code	Red Willow Woodland Stand
W_SALA	<i>Salix laevigata</i> Woodland Stand

Common Species

Red willow (*Salix laevigata*)
Black locust (*Robinia pseudoacacia*)
Woods' rose (*Rosa woodsii* var. *ultramontana*)
White sagebrush (*Artemisia ludoviciana* ssp. *incompta*)
Sedge (*Carex* spp.)
Mojave cleomella (*Cleomella obtusifolia*)
Bermudagrass (*Cynodon dactylon*)
Herb sophia (*Descurainia sophia*)
Inland saltgrass (*Distichlis spicata*)
Redstem stork's bill (*Erodium cicutarium*)
American licorice (*Glycyrrhiza lepidota*)
Stretchberry (*Forestiera pubescens*)

rUSNVC Association

-No Alliance Park Special

Representative Ground Photo



Description

Frequency: Red willow woodlands were only found along the Bairs Creek drainage in the southern portion of MANZ. Other individual red willow trees likely occurred in the core settlement area but do not represent this plant community.

Physiognomy: W_SALA polygons contain moderate to dense stands of medium to tall deciduous trees (> 5 meters). The understories for this map unit are often diverse and contain a mix of deciduous shrubs with pockets of herbaceous vegetation.

Condition: Good – Fair. Red willow trees are uncommon at MANZ and may represent past plantings. Prolonged drought or fluctuations in the water table may cause this community to decline.

CIR Signature: On the imagery canopies of W_SALA appeared as mottled light red circles with white specs representing dead branches.

Mapping Notes: The W_SALA map unit was created to address riparian red willow stands. Red willow trees appeared similar to the Fremont cottonwood trees and some confusion may have occurred during the mapping of this type and W_POFR map unit.

Range and Distribution

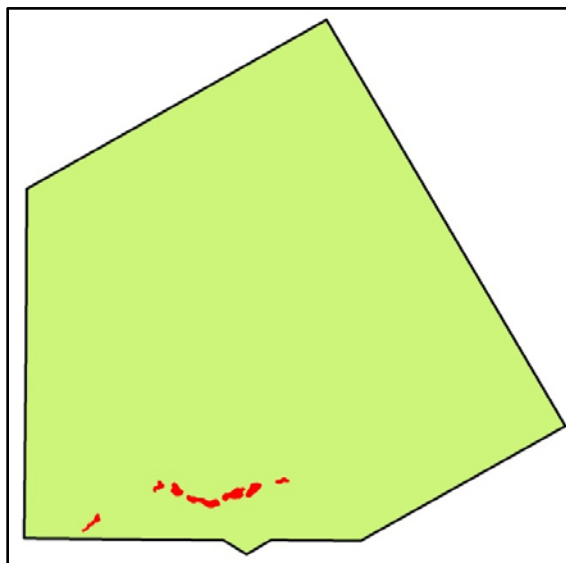
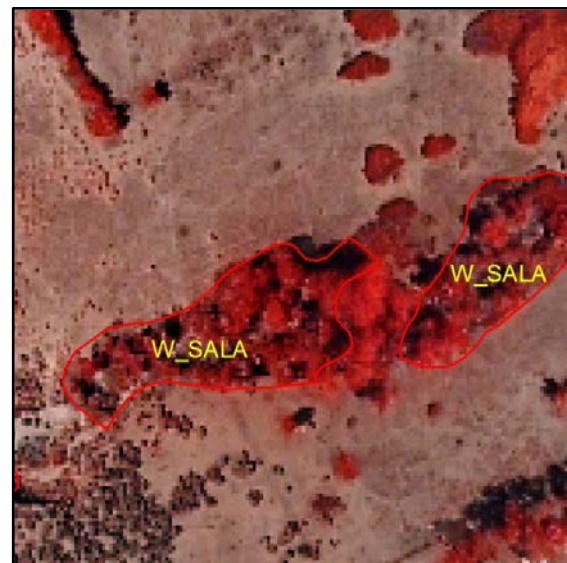


Photo Signature Example



Shrublands

Map Code	Basin Big Sagebrush Shrubland
S_ARTR	<i>Artemisia tridentata</i> ssp. <i>tridentata</i> Shrubland

Representative Ground Photos

Common Species

Basin big sagebrush (*Artemisia tridentata* ssp. *tridentata*)
Rubber rabbitbrush (*Ericameria nauseosa* ssp. *nauseosa* var. *hololeuca*)
Fourwing saltbush (*Atriplex canescens*)
Cattle saltbush (*Atriplex polycarpa*)
Whitestem blazingstar (*Mentzelia albicaulis*)
Eriastrum wilcoxii
Amsinckia tessellata
Prickly Russian thistle (*Salsola tragus*)

rUSNVC Alliance

-*Artemisia tridentata* (ssp. *tridentata*, ssp. *xericensis*)
Shrubland Alliance



Description

Frequency: Basin big sagebrush shrublands are common throughout the central and southern portions of MANZ and can be found along the upper margins of the Bairs Creek drainage.

Physiognomy: S_ARTR polygons are dominated by tall to medium-sized evergreen shrub with understories consisting of forbs, bare soil, and minor short and dwarf-shrubs.

Condition: Good – Fair. Basin big sagebrush is likely a climax community for some of the deeper and more established soils at MANZ. Fluctuations in the water table levels due to water manipulation may cause this community to artificially increase or decline. Some patches may be prone to wildfire events.

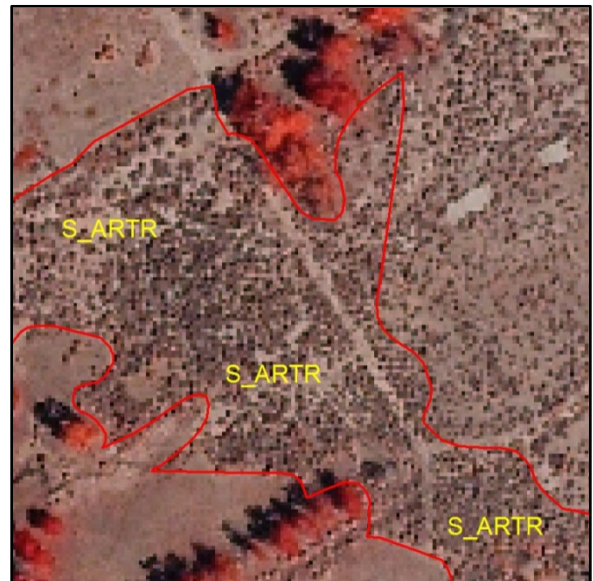
CIR Signature: Polygons of S_ARTR had a textured gray appearance.

Mapping Notes: The S_ARTR type had a similar appearance to the S_ERNA and S_ATPO map units and some overlap and confusion likely occurred in the mapping of these types. More ground-truthing of the S_ARTR map unit may allow for further refinement and increased accuracy.

Range and Distribution



Photo Signature Example



Map Code	Shadscale Saltbush - Cattle Saltbush - (Big Saltbush) Shrubland
S_ATCO	<i>Atriplex confertifolia</i> - <i>Atriplex polycarpa</i> - (<i>Atriplex torreyi</i>) Shrubland

Common Species

Shadscale saltbush (*Atriplex confertifolia*)
 Cattle saltbush (*Atriplex polycarpa*)
 Torrey's saltbush (*Atriplex torreyi*)
 Big sagebrush (*Artemisia tridentata*)
 Nevada jointfir (*Ephedra nevadensis*)
 Burrobrush (*Hymenoclea salsola*)
 Desert pepperweed (*Lepidium fremontii*)
 Greasewood (*Sarcobatus vermiculatus*)
 Whitestem blazingstar (*Mentzelia albicaulis*)
Amsinckia tessellate
Camissonia boothii ssp. *desertorum*
Eriastrum wilcoxii
Malzacothrix glabrata

Representative Ground Photo



rUSNVC Associations/Alliances

-*Atriplex confertifolia* - *Atriplex polycarpa* Shrubland
 -*Atriplex* (*lentiformis*, *polycarpa*) Shrubland Alliance

Description

Frequency: Polygons dominated by various species of saltbush were rare and only successfully mapped along the highway in the eastern portion of the project area. Two additional polygons of S_ATCO were documented by ground-truthing in the southern and northwest corners of the park and were included in the mapping.

Physiognomy: Polygons of S_ATCO were dominated by short evergreen shrubs with understories of barren soil and a forb dominated sparse herbaceous layer.

Condition: Fair –Poor. S_ATCO is not very common at MANZ and it is unknown whether patches of shadscale and/or big saltbush will remain long-term or be replaced by S_ATPO or S_ARTR.

CIR Signature: On the imagery S_ATCO is characterized by a mottled signature with small gray spots (shrubs) against a smooth light brown/pink background (bare soil).

Mapping Notes: The short-statured nature of shadscale saltbush made it appear similar to the S_ATPO map unit and more ground-truthing may help to delineate these closely associated types

Range and Distribution

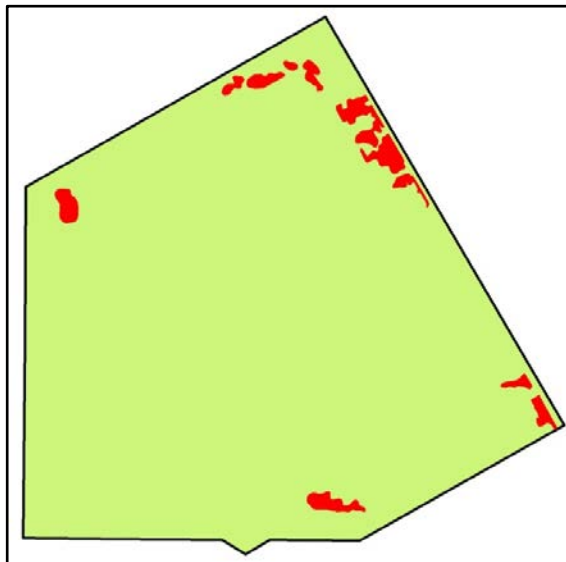


Photo Signature Example



Map Code **Cattle Saltbush Shrubland**
S_ATPO ***Atriplex polycarpa* Shrubland**

Common Species

Cattle saltbush (*Atriplex polycarpa*)
Burrobrush (*Hymenoclea salsola*)
Nevada jointfir (*Ephedra nevadensis*)
Fourwing saltbush (*Atriplex canescens*)
Smooth desertdandelion (*Malacothrix glabrata*)
Whitestem blazingstar (*Mentzelia albicaulis*)

rUSNVC Association

-*Atriplex polycarpa* Shrubland

Representative Ground Photo



Description

Frequency: Polygons dominated by cattle saltbush were very common in the upland areas in the western and southern portions of MANZ.

Physiognomy: Polygons of S_ATPO were dominated by short evergreen shrubs with understories of barren soil and a forb dominated sparse herbaceous layer.

Condition: Good. S_ATPO is one of the climax plant communities for the desert scrub portion of MANZ. This map unit was widespread, appeared drought-resistant, and occurred in mostly remote areas that were not previously disturbed. Some patches may be prone to wildfire events.

CIR Signature: On the imagery S_ATPO is characterized by a mottled signature with brown spots (shrubs) against a smooth light brown/pink background (bare soil).

Mapping Notes: The density of the cattle saltbush plant community varied from sparse stands on thin soils to denser patches on more developed soils. The short-statured nature of cattle saltbush made it appear similar to the S_ATCO map unit and more ground-truthing may help to delineate these closely associated types.

Range and Distribution



Photo Signature Example



Map Code	Rubber Rabbitbrush – (Fourwing Saltbush) Shrubland
S_ERNA	<i>Ericameria nauseosa</i> – (<i>Atriplex canescens</i>) Shrubland

Common Species

Rubber rabbitbrush (*Ericameria nauseosa* ssp. *nauseosa* var. *hololeuca*)
 Fourwing saltbush (*Atriplex canescens*)
 Whitestem blazingstar (*Mentzelia albicaulis*)
 Smooth desertdandelion (*Malacothrix glabrata*)
 Prickly Russian thistle (*Salsola tragus*)
 Flatspine burr ragweed (*Ambrosia acanthicarpa*)
 Cattle saltbush (*Atriplex polycarpa*)
 Schott's calico (*Loeseliastrum schottii*)
 Deergrass (*Muhlenbergia rigens*)
 White sagebrush (*Artemisia ludoviciana*)

rUSNVC Alliance

-*Ericameria nauseosa* Shrubland Alliance

Representative Ground Photo



Description

Frequency: S_ERNA was one of the most common vegetation types found throughout the core settlement area at MANZ. Polygons of this type ranged from short, open stands to tall dense shrublands.

Physiognomy: S_ERNA is dominated by evergreen shrubs with a mixed forb herbaceous layer or barren understory.

Condition: Good –Fair. Rubber rabbitbrush is usually considered an early successional species that quickly colonizes areas after recent disturbance events. It is unclear at MANZ if the rubber rabbitbrush stands represent climax communities or if they will be eventually be replaced by the S_ARTR or S_ATPO types.

CIR Signature: On the imagery the S_ERNA map unit had a characteristic coarse light red to gray signature with whitish and brown areas representing bare soil.

Mapping Notes: This map unit was primarily used to map formally disturbed sites near the roads and in the core settlement area at MANZ. Fourwing saltbush may be locally dominant in some areas. Other common shrub map units like S_ATPO and S_ARTR likely intermix and share similar species.

Range and Distribution

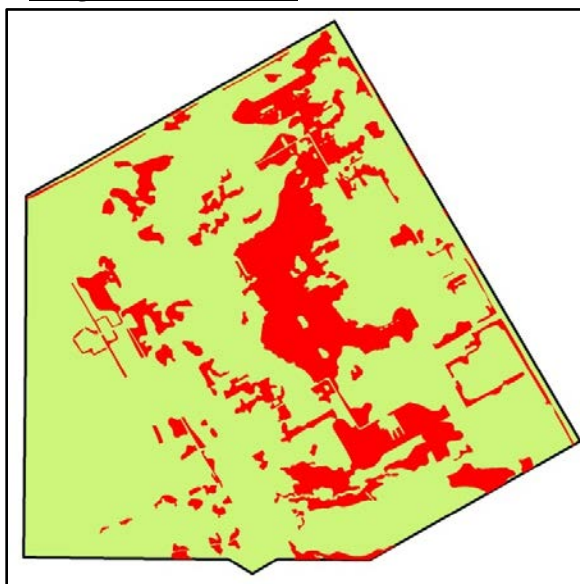
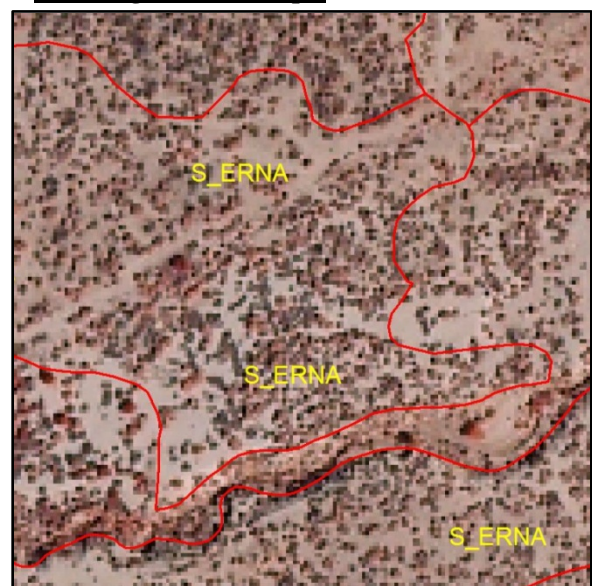


Photo Signature Example



Map Code Mixed Upland Shrubland Stand
S_MXSB

Common Species

Coyote willow (*Salix exigua*)
Wood's rose (*Rosa woodsii*)
Rubber rabbit brush (*Ericameria nauseosa*)
Burrobrush (*Hymenoclea salsola*)
Stretchberry (*Forestiera pubescens*)
Virgin River brittlebush (*Encelia virginensis*)
Nevada jointfir (*Ephedra nevadensis*)
Desert pepperweed (*Lepidium fremontii*)
Greasewood (*Sarcobatus vermiculatus*)
Mojave seablite (*Suaeda moquinii*)
American licorice (*Glycyrrhiza lepidota*)
Box Thorn (*Lycium andersonii*)

rUSNVC Association

-No Alliance Park Special

Representative Ground Photo**Description**

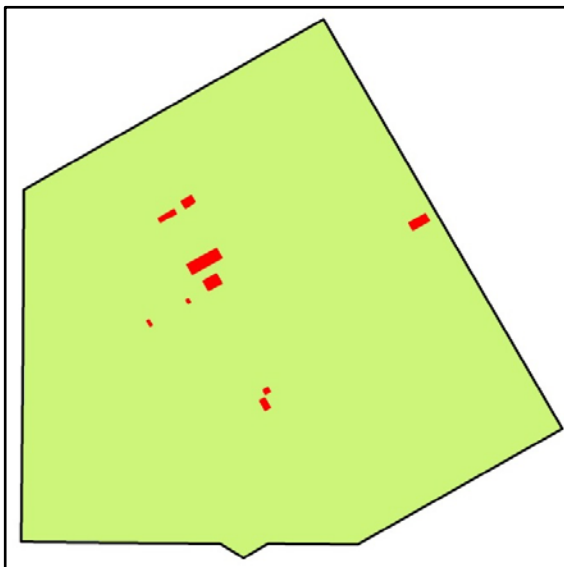
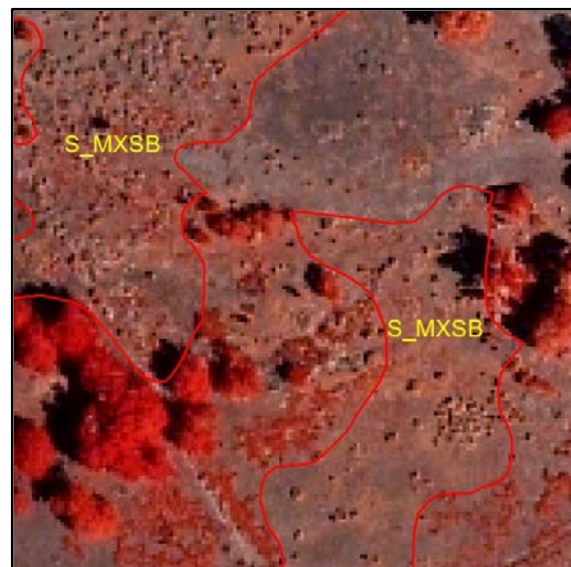
Frequency: Patches of mixed shrubs occurred throughout the core settlement area of MANZ, often associated with mixed woodlands and high water table levels.

Physiognomy: The vegetation in the S_MXSB map units consists of predominately short to medium sized shrubs and herbaceous vegetation.

Condition: Fair. Since this map unit contains various shrub species it is unknown whether they represent climax or early successional plant communities. It is likely that most of the species in the S_MXSB are somewhat dependent on adequate moisture levels and prolonged drought or dramatic fluctuations in water levels could cause them to decline.

CIR Signature: On the imagery the mixed shrublands at MANZ usually contained open shrub stands with orange and red spots (shubs) against a gray (soil) or pink (herbaceous vegetation) background.

Mapping Notes: The mixed shrub map unit was created to account for various patches of shrub or shrub-like vegetation that were either too small or too intermixed to classify in the rUSNVC. Some of the S_MXSB polygons at MANZ likely contain localized dominant species that could be further sampled, monitored, and classified.

Range and Distribution**Photo Signature Example**

Map Code	Woods' Rose Shrubland
S_ROWO	<i>Rosa woodsii</i> Shrubland

Common Species

Woods' rose (*Rosa woodsii*)
Rubber rabbitbrush (*Ericameria nauseosa* ssp. *nauseosa* var. *hololeuca*)
Narrowleaf willow (*Salix exigua*)
Fourwing saltbush (*Atriplex canescens*)
Indianhemp (*Apocynum cannabinum*)
Bractscale (*Atriplex serenana*)
Herb sophia (*Descurainia sophia*)
American licorice (*Glycyrrhiza lepidota*)
Whitestem blazingstar (*Mentzelia albicaulis*)
Common reed (*Phragmites australis*)
Prickly Russian thistle (*Salsola tragus*)

rUSNVC Association

-*Rosa woodsii* Shrubland

Representative Ground Photo



Description

Frequency: Stands of Woods' rose were rare at MANZ. S_ROWO polygons were mainly found along the upper margins of Bairs Creek and scattered among the mixed woodlands of the core settlement area.

Physiognomy: The S_ROWO map unit contains thick stands of medium to tall deciduous shrubs.

Condition: Good –Fair. The S_ROWO type is likely influenced by the presence of high water table levels and prolonged drought or dramatic fluctuations in water levels could cause this map unit to decline.

CIR Signature: On the imagery the S_ROWO map unit had a smooth texture due to the consistent height of the shrubs and exhibited a mostly brick red color. Polygons of this type usually consisted of circular shrubs forming amoeba-like groupings.

Mapping Notes: The S_ROWO map unit was added to the MANZ classification to provide more deciduous shrub detail and to help with management of the important Bairs Creek riparian corridor. Small un-mapped pockets of S_ROWO likely exist at MANZ and other stands of Woods' rose may actually be co-dominated by narrowleaf willow.

Range and Distribution

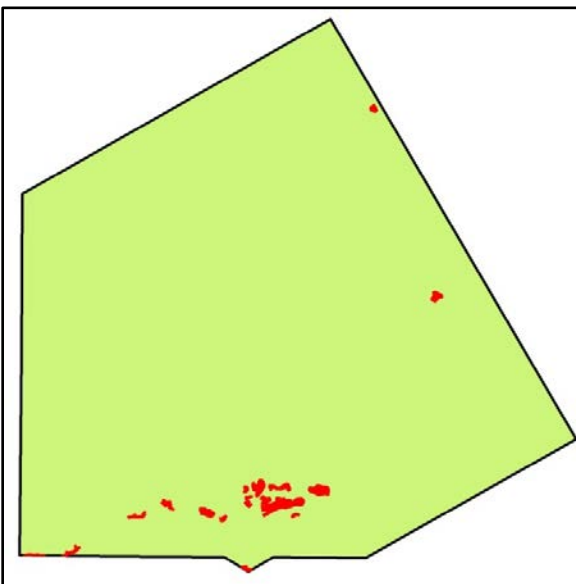
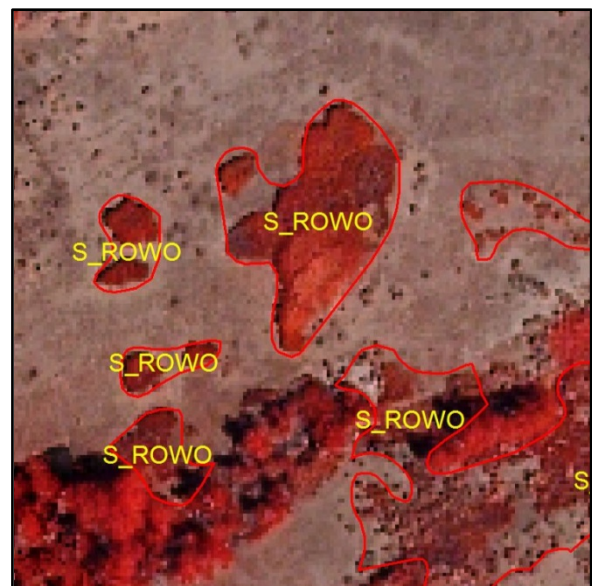


Photo Signature Example



Map Code	Narrowleaf Willow Temporarily Flooded Shrubland
S_SAEX	<i>Salix exigua</i> Temporarily Flooded Shrubland

Common Species

Narrowleaf willow (*Salix exigua*)
Red willow (*Salix laevigata*)
Fremont cottonwood (*Populus fremontii*)
Wood's Rose (*Rosa woodsii*)
Rubber rabbitbrush (*Ericameria nauseosa* ssp. *nauseosa* var. *hololeuca*)

rUSNVC Association

-*Salix exigua* Temporarily Flooded Shrubland

Representative Ground Photo



Description

Frequency: Stands of narrowleaf or coyote willow were common along the riparian areas associated with Bairs Creek in the southern half of MANZ. In addition some other small stands of S_SAEX were found within the upland mixed woodlands (likely a result of high water table levels).

Physiognomy: Polygons of S_SAEX contain medium to tall deciduous shrubs.

Condition: Good –Fair. The S_SAEX riparian shrublands in Bairs Creek appear to be stable although long-term drought or heavy flooding events could impact their frequency and abundance. The upland stands of S_SAEX show some signs of past disturbance. In general, the close proximity of this type to water makes it prone to dramatic water table fluctuations and over-use by native wildlife.

CIR Signature: On the imagery this type has a characteristic light pink to red color. Individual shrubs can be seen and appear shorter and with smaller canopies than similar W_POFR and W_SALA polygons.

Mapping Notes: Due to the intricate mixing of coyote willow and Woods' rose some polygons likely contain both species and more ground-truthing may help better delineate the similar S_SAEX and S_ROW map units.

Range and Distribution

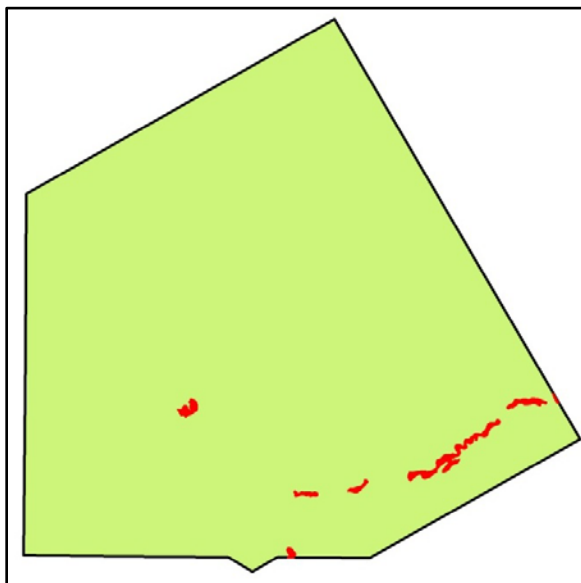
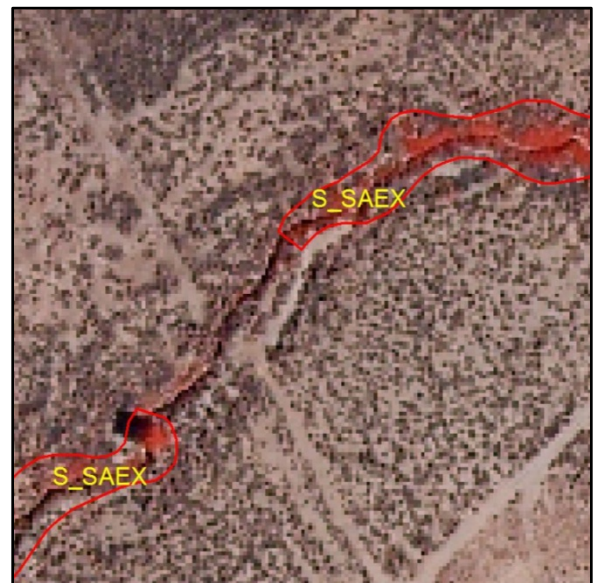


Photo Signature Example



Map Code	Smallflower Tamarisk Shrub Stand
S_TAPA	<i>Tamarix parviflora</i> Shrub Stand

Common Species

Smallflower tamarisk (*Tamarix parviflora*)
Bractscale (*Atriplex serenana*)
Prickly Russian thistle (*Salsola tragus*)
American licorice (*Glycyrrhiza lepidota*)
Smooth desertdandelion (*Malacothrix glabrata*)
Mediterranean grass (*Schismus* spp.)
Whitestem blazingstar (*Mentzelia albicaulis*)
Cushion cryptantha (*Cryptantha* spp.)
Herb sophia (*Descurainia sophia*)
Redstem stork's bill (*Erodium cicutarium*)

rUSNVC Association

-No Alliance Park Special

Description

Frequency: Small groups of tamarisk shrubs and small trees occurred throughout the core settlement area.

Physiognomy: S_TAPA polygons contain small groupings of tall shrubs and small trees.

Condition: Poor. This map unit is dominated by a non-native shrub that may have been introduced either when the camp was active or by more recent water diversion activities in the Owens Valley. Tamarisk is considered a noxious weed throughout the Western United States and is actively controlled at many sites to increase ground moisture levels and to encourage the establishment of native vegetation. The Lake Mead Exotic Plant Management Team has removed some tamarisk from the central portion of the historic site.

CIR Signature: On the imagery the S_TAPA map unit had a characteristic coarse, dark red signature that occurred in large circles.

Mapping Notes: The S_TAPA map unit used to map tamarisk stands that were documented during the ground-truthing and field sampling efforts at MANZ. The S_TAPA map unit was included to provide more information on the shrub and tree distribution at MANZ and to help with management activities. Young tamarisk saplings and individual shrubs/trees were not mapped and some stands of S_TAPA may actually be short black locust trees.

Representative Ground Photo



Range and Distribution

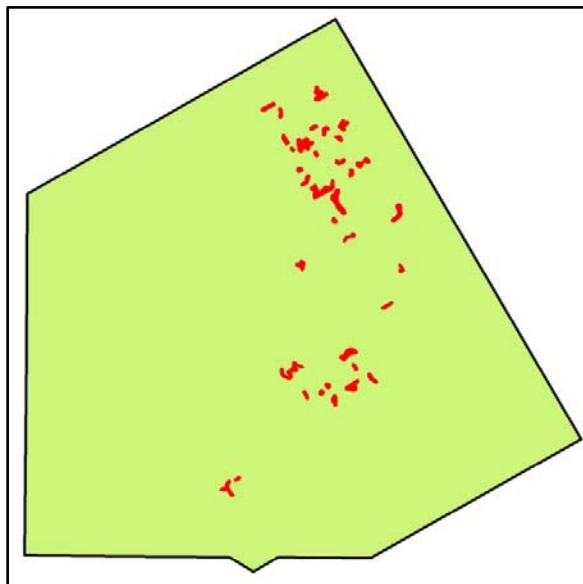
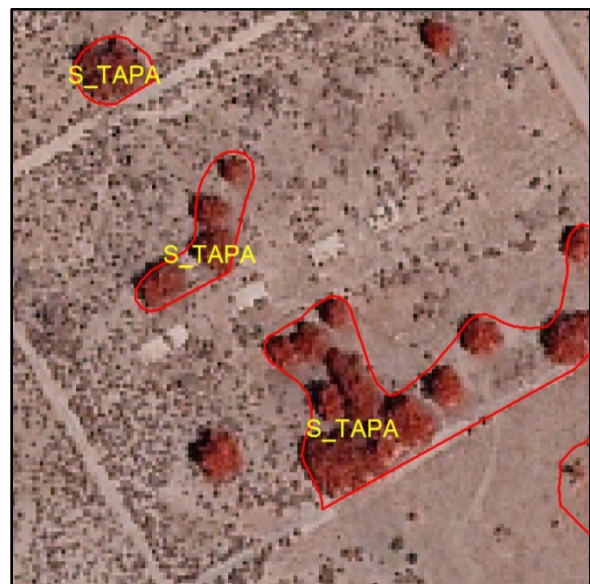


Photo Signature Example



HERBACEOUS VEGETATION

Map Code **Mixed Forb Herbaceous Vegetation**
H_MXFB

Representative Ground Photo

Common Species

Bristly fiddleneck (*Amsinckia tessellata*)
Bractscale (*Atriplex serenana*)
Prickly Russian thistle (*Salsola tragus*)
American licorice (*Glycyrrhiza lepidota*)
Smooth desertdandelion (*Malacothrix glabrata*)
Whitestem blazingstar (*Mentzelia albicaulis*)
Cushion cryptantha (*Cryptantha* spp.)
Herb sophia (*Descurainia sophia*)
Redstem stork's bill (*Erodium cicutarium*)
Spotted buckwheat (*Eriogonum* spp.)
Wilcox's woollystar (*Eriastrum wilcoxii*)
Gilia (*Gilia* spp.)

rUSNVC Association

-No Alliance Park Special



Description

Frequency: Mixed forb sites were common throughout the former core settlement areas at MANZ likely due to past clearing, residential disturbance, and/or former ranching and farming activities.

Physiognomy: H_MXFB polygons contain varying amounts of low-growing, native and non-native forbs with minor inclusions of grasses and desert shrubs.

Condition: Poor. This map unit is an early successional type found on disturbed sites and likely represents a transition from bare land to more natural desert scrub vegetation.

CIR Signature: On the imagery the H_MXFB map unit had a characteristic smooth, gray and pink signature with some mottling depending on if the plants were actively growing (red spots) or dominant (no texture).

Mapping Notes: This map unit was primarily used to map highly disturbed sites near former developments at MANZ. When vegetation was obviously cleared in recent years the L_BARE map unit was used.

Range and Distribution

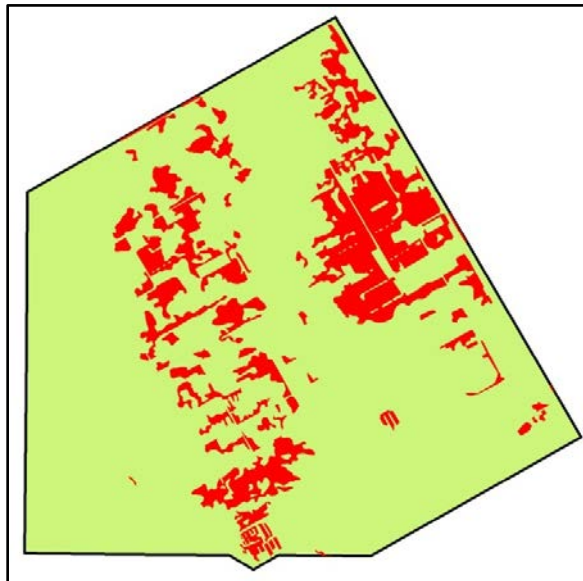
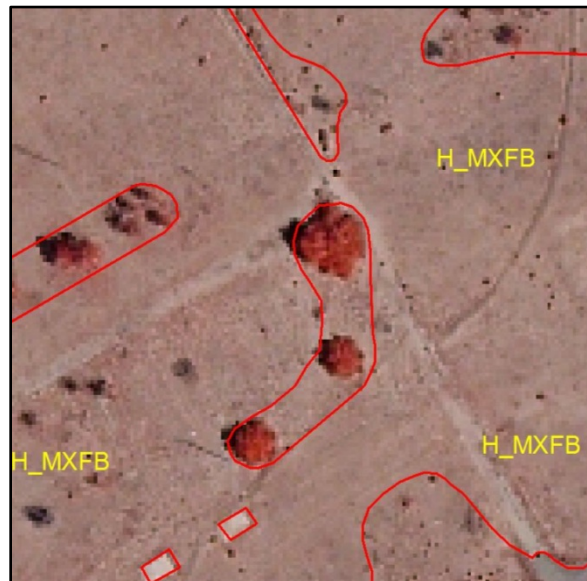


Photo Signature Example



Map Code Mixed Grass Herbaceous Vegetation
H_MXGR

Common Species

Bract Scale (*Atriplex serenana*)
Inland saltgrass (*Distichlis spicata*)
Mediterranean grass (*Schismus barbatus*)
Prickly Russian thistle (*Salsola tragus*)
Whitestem blazingstar (*Mentzelia albicaulis*)
Spotted buckwheat (*Eriogonum maculatum*)
Wilcox's woollystar (*Eriastrum wilcoxii*)
Herb sophia (*Descurainia sophia*)
Redroot cryptantha (*Cryptantha micrantha*)

rUSNVC Association

-No Alliance Park Special

Representative Ground Photo**Description**

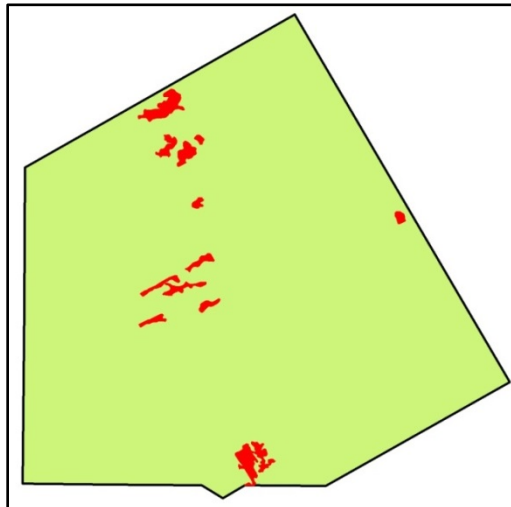
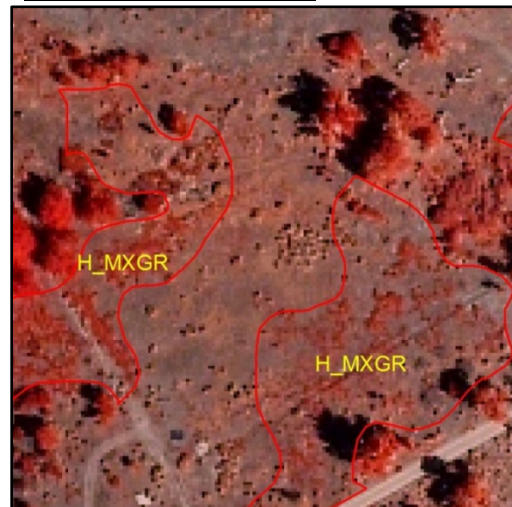
Frequency: Mixed grass herbaceous polygons were rare at MANZ and occurred primarily on historically disturbed areas in the core settlement area. These polygons represented the few areas within the park where there are herbaceous stands with a high grass cover. These stands are of two types: 1) high cover of the non-native annual Mediterranean grass (*Schismus* sp.) and associate native and non-native forbs, and 2) high cover of the native, perennial saltgrass (*Distichlis spicata*) and associate native and non-native forbs.

Physiognomy: H_MXGR polygons contained a mix of annual, native and non-native grasses with high amounts of weedy native and non-native forb species. This type differs from H_MXFB in that there is no significant grass cover in the H_MXFB type.

Condition: Poor. This map unit is an early successional type that contains high levels of weedy and non-native vegetation. With more time and maintenance (i.e. fire, seeding, and exotic removal) polygons of this type may become more natural and sustainable shrublands.

CIR Signature: On the imagery, the H_MXGR map unit had various signatures depending on the dominant mix of vegetation and the height of the grasses. Taller grasses with a high forb cover appeared as a coarse orange to red color and lower grasses with less forbs were smooth and light pink in color.

Mapping Notes: This map unit was primarily used to map disturbed sites near former developments in MANZ where annual grasses had high cover. Other pockets of H_MXGR likely occur at MANZ but were mapped as H_MXFB or were too small to delineate. Further ground-truthing, especially in disturbed areas would help refine and improve this mapping unit. Mapping of H_MXGR polygons was partially based on known locations of existing herbaceous stands with a high grass cover.

Range and Distribution**Photo Signature Example**

GEOLOGY AND SPARSE VEGETATION

Map Code **Soil and Rock Outcrop Sparse Vegetation**
G_ROCK

Common Species

Cattle saltbush (*Atriplex polycarpa*)
Burrobrush (*Hymenoclea salsola*)
Nevada jointfir (*Ephedra nevadensis*)
Fourwing saltbush (*Atriplex canescens*)
Rubber rabbitbrush (*Ericameria nauseosa* ssp. *nauseosa* var. *hololeuca*)

rUSNVC Association

-No Alliance Park Special

Description

Frequency: Small, barren or sparsely vegetated gullies, washes, and arroyos were common in the southern portion of MANZ. The G_ROCK map unit was used to primarily map the riparian gullies and stream banks along Bairs Creek and secondarily to map large, unvegetated dry washes in the upland desert scrub areas.

Physiognomy: G_ROCK polygons consisted of a mix of sparse, low-growing herbaceous vegetation and small patches of desert shrubs that vary in composition based on location.

Condition: Fair. Localized patches are likely prone to land slide and flooding events. Overall this type is potentially threatened by hydrologic changes in the water table and dramatic increases or decreases in water runoff caused by global warming and/or climate change. If long-term water levels and flooding is reduced in Bairs Creek, G_ROCK sites may revert to S_SAEX, S_ATPO or S_ERNA vegetation and conversely if flooding events are increased the G_ROCK type may expand as more vegetation is removed by scouring and erosion events.

CIR Signature: This map unit appears as linear bands of smooth, brown to pink with some isolated patches of shrubs and herbaceous vegetation.

Mapping Notes: The G_ROCK map unit was created to help separate areas with less than 5% vegetation cover from similar flat or rolling upland sites with more established vegetation. Plant species contained in this map unit overlap with the S_ATPO, S_ERNA, and S_ARTR map units.

Representative Ground Photo



Range and Distribution

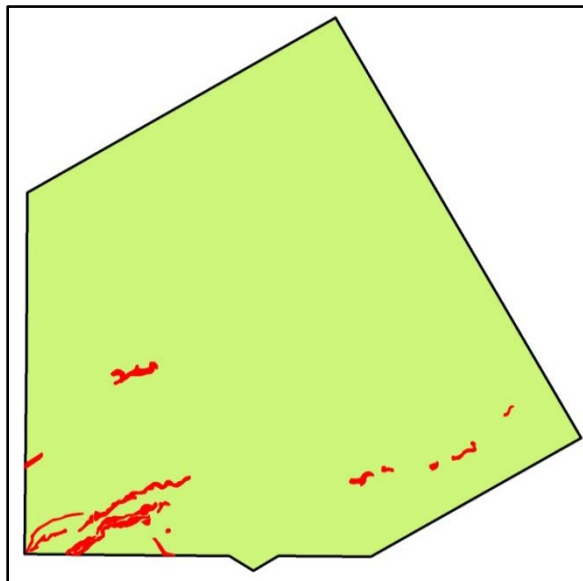
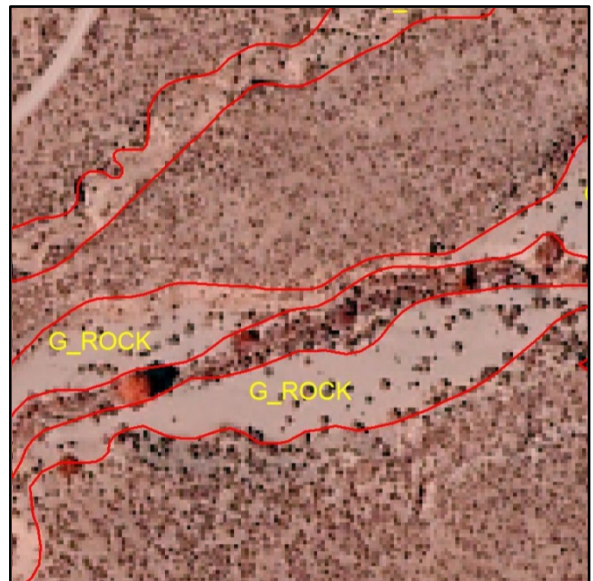
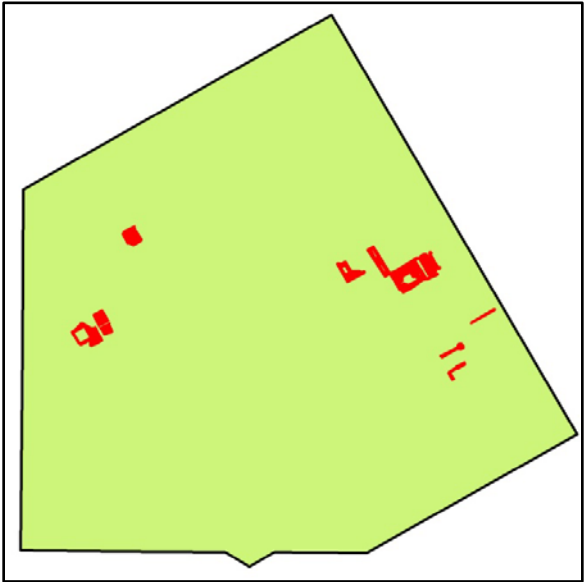


Photo Signature Example

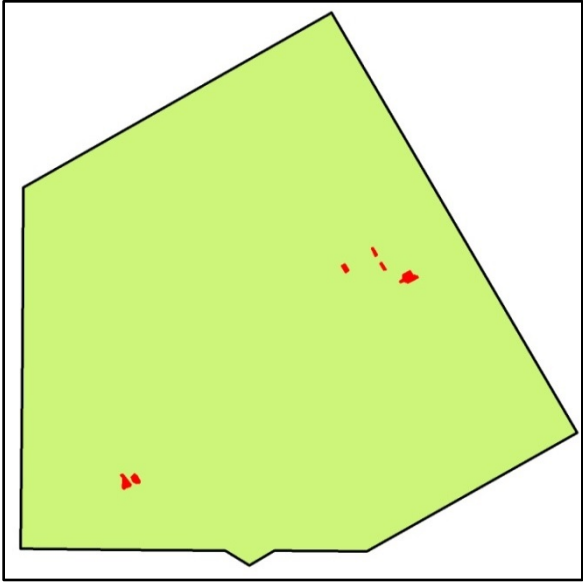


LAND USE – LAND COVER

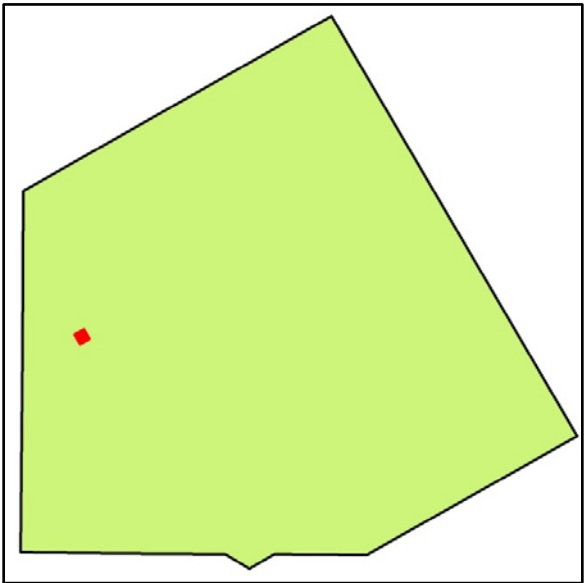
L_BARE Bare Rock / Sand / Other Bare
Ground



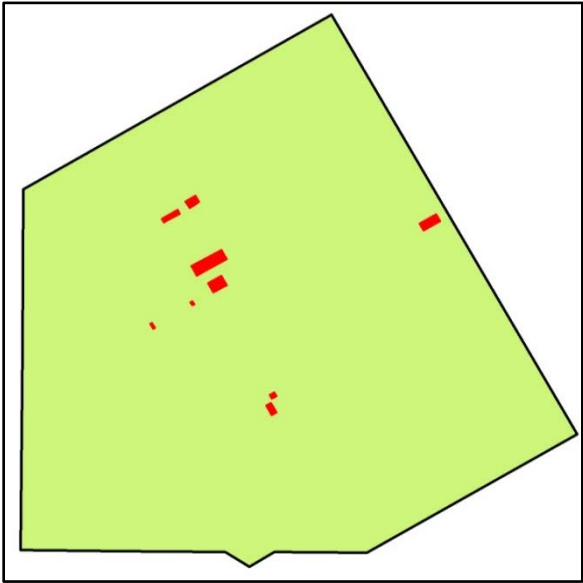
L_FACL Facilities



L_CEM Cemetery



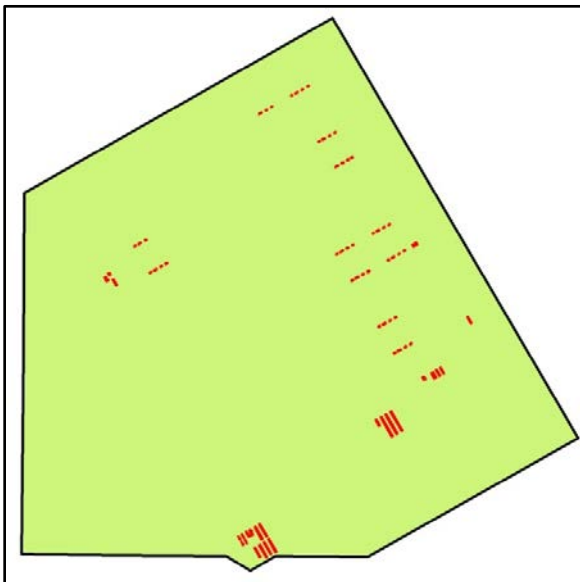
L_ORCH Orchard / Vineyards / Groves



L_ROAD Transportation

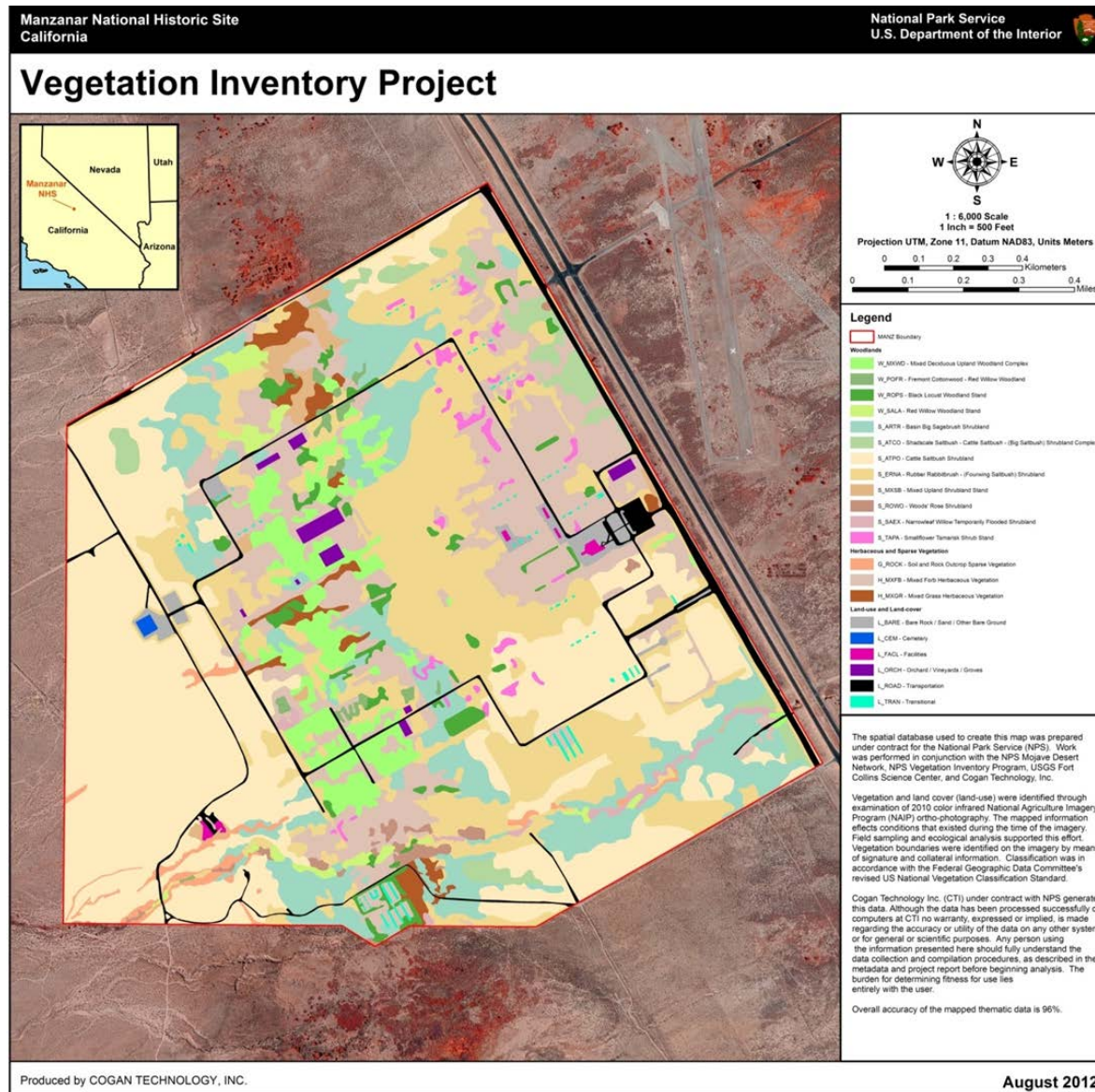


L_TRAN Transitional



Appendix F: MANZ Vegetation Map

APP F.1



The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS 359/124553, May 2014

National Park Service
U.S. Department of the Interior



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