National Park Service
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Natural Resource Stewardship and Science

# A Summary of the Joshua Tree National Park Vegetation Mapping Project

*NPS Vegetation Inventory Program*

Natural Resource Technical Report NPS/JOTR/NRTR—2013/723



**ON THE COVER**

Joshua Tree — California Juniper / Nevada Ephedra (*Yucca brevifolia — Juniperus californica / Ephedra nevadensis)* Woodland Association during a spring bloom in Upper Covington Flats of the Little San Bernardino Mountains (northwestern Joshua Tree National Park). The yellow annual groundcover is *Linanthus aureus* ssp. *aureus*; the photo was taken in May of 2008.

Photograph by: Tasha La Doux

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The National Park Service, Natural Resource Stewardship and Science office in Fort Collins, Colorado, publishes a range of reports that address natural resource topics. These reports are of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

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All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner. This report received informal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data. Data in this report were collected and analyzed using methods based on established, peer-reviewed protocols and were analyzed and interpreted within the guidelines of the protocols.

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This report is available from the Mojave Desert Inventory and Monitoring Network website (http://science.nature.nps.gov/im/units/mojn/rpts_pubs/rpts_pubs_main.cfm) and the Natural Resource Publications Management website (http://www.nature.nps.gov/publications/nrpm/).

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# Contents

Page

Figures ..... v

Tables ..... v

Appendices ..... vii

Executive Summary ..... ix

Acknowledgments ..... xii

List of Abbreviations and Acronyms ..... xiv

List of Relevant Links ..... xiv

1.0 Introduction ..... 1

1.1 Overview of Joshua Tree National Park ..... 1

1.2 NPS Vegetation Inventory Program ..... 4

1.3 Joshua Tree National Park Vegetation Mapping Project ..... 5

2.0 Methods ..... 7

2.1 Timeline ..... 7

2.2 Overview and Purpose of Thematic Accuracy Assessment ..... 8

2.3 Accuracy Assessment Sampling Design (Sample Data Label Methodology) ..... 12

*2.3.1 Determination of Observation Plot Size ..... 12*

*2.3.2 Map Class Sample Sizes ..... 13*

*2.3.3 Inference Area Determination ..... 13*

2.4 Accuracy Assessment Field Protocol (Reference Data Label Methodology) ..... 15

2.5 Accuracy Assessment Analysis ..... 17

*2.5.1 Quality Control for Positioning Relative to Map Class Label ..... 17*

*2.5.2 Thematic Accuracy Calculations ..... 18*

2.6 Rapid Assessments ..... 19

# Contents (continued)

Page

2.7 Vegetation Mapping and Classification ..... 22

3.0 Results ..... 25

3.1 Thematic Accuracy Assessment ..... 25

3.2 Accuracy Assessment Vegetation Data ..... 25

3.3 Rapid Assessments ..... 33

3.4 Vegetation Mapping and Classification ..... 36

4.0 Discussion ..... 43

4.1 Summary ..... 43

4.2 Lessons Learned ..... 44

4.3 Future Work ..... 44

Literature Cited ..... 53

# Figures

Page

**Figure 1**. Location of Joshua Tree National Park in southern California. ..... 1

**Figure 2.** Topographic map of Joshua Tree National Park showing the isolated mountain ranges in the south and east, as well as the Little San Bernardino Mountains to the west ..... 2

**Figure 3.** Precipitation data for Eagle Mountain, CA, WRCC weather station located in the southeastern portion of JOTR. ..... 4

**Figure 4.** Locations of accuracy assessment points collected in 2007-2008. ..... 9

**Figure 5.** Locations of rapid assessment points collected in 2009. ..... 21

**Figure 6.** Overview of Joshua Tree National Park final vegetation map containing 67 map classes. ..... 43

**Figure 7.** Percentage of mapped polygons (per map class) with vegetation data. ..... 48

# Tables

Page

**Table 1.** Standard sample size allocations for thematic accuracy assessment, based on map class area. ..... 13

**Table 2.** Accuracy assessment statistics for JOTR, by National Vegetation Classification class, formation, macrogroup, group, alliance, and association assignments. ..... 26

**Table 3**. Comparison of JOTR's vegetation classification from 2005 to 2012. ..... 36

**Table 4.** Total area mapped and estimated areas within Joshua Tree National Park for all map classes represented on the 2012 version of the map. ..... 38

**Table 5.** Total number of polygons per map class, total number of vegetation plots completed within that map class, the number and percentage of polygons with vegetation data collected ..... 50

# Appendices

Available as separate PDFs through the NPS Data Store (https://irma.nps.gov/) or on CD upon request to the MOJN Data Manager.

**Appendix A**: Vegetation Descriptions for Joshua Tree National Park (2012 version)

**Appendix B**: Vegetation Classification of Joshua Tree National Park (2012 version)

**Appendix C**: Key to Vegetation of Joshua Tree National Park, California

**Appendix D**: Map and Classification Crosswalk, 2005 to 2012

**Appendix E**: Vegetation Classification of Joshua Tree National Park, Riverside and San Bernardino Counties, California (2005 version)

**Appendix F**: Photo-Interpretation Report, USGS-NPS Vegetation and Inventory and Mapping Program, Joshua Tree National Park

**Appendix G**: USGS-NPS Vegetation Mapping Program, Joshua Tree National Park Mapping Classification

**Appendix H**: Sample and Population Contingency Tables

**Appendix I**: Field Forms and Related Materials

# Executive Summary

The U.S. Geological Survey (USGS) and the National Park Service (NPS) Vegetation Characterization Program initiated a project at Joshua Tree National Park (JOTR or Park) in 1996 to classify, describe, and map the vegetation communities of the Park. The project, including the final map, classification, and report, was completed in 2012. Initial mapping, photo-interpretation, and field work was conducted between 1996 and 2005. Final reports for these efforts were generated by 2005, including a map, ecological descriptions, classification, key, and photo-interpretation guide. Following this, a total of 1,313 accuracy assessments were conducted in 2007 and 2008, the results of which spurred additional field relevés and a reworking of the map and classification. An additional 111 relevés were conducted in 2009 targeting problematic associations and alliances; these data were used in conducting additional analyses to produce a revised vegetation map and classification. Photo-interpretation was also redone during this time for a subset of the problematic associations and the classification was updated to match the most recent vegetation classification presented in the Manual of California Vegetation Second Edition (Sawyer et al. 2009). Between 2010 and 2011 data analysis was completed and incorporated into the final map and classification. By February 2012 the ecological descriptions were updated and completed to match (as best as possible) the most recent version of the U.S. National Vegetation Classification and the map was updated to reflect the final nomenclature.

The 2012 version of the vegetation classification for the Park includes 51 Alliances (including Provisional Alliances, Semi-Natural Stands, and Special Stands) and 78 Associations (including Provisional Associations). There are eight map classes that have less than 2% absolute vegetation cover, these include Disturbed/Built-Up, Water, Dunes, Playas, Recent Burns, Rock Outcrops, Desert Pavement, and a generic Non-vegetated Habitat type. The largest amount of land cover is classified under the *Larrea tridentata — Ambrosia dumosa* Shrubland Alliance, which is classified into seven Associations. This Alliance covers a total of 1,130 $km^2$, representing 35% of the total area within JOTR (3,208 $km^2$). On the other hand, there are eight Alliances, mostly associated with riparian habitats, which have less than 1 $km^2$ mapped, these include: *Washingtonia filifera* Woodland Alliance, *Salix gooddingii* Woodland Alliance, *Prosopis glandulosa* Woodland Alliance, *Populus fremontii* Forest Alliance, *Justicia californica* Provisional Shrubland Alliance, *Ericameria nauseosa* Shrubland Alliance, *Cylindropuntia bigelovii* Shrubland Alliance, and *Ambrosia salsola* Shrubland Alliance.

Overall map class accuracies for the JOTR map are 41.0% at the U.S. National Vegetation Classification association level, 61.0% at the alliance level, 82.0% at the group level, 87.3% at the macrogroup level, 92.5% at the formation level, and 92.9% at the class level.

The goals of this report are three-fold: 1) to summarize the events and products that resulted from the 16-year effort; 2) to describe and present the results of the accuracy assessment phase of the project; and 3) to present the final vegetation classification, ecological descriptions, and a geospatial vegetation classification map of the Park.

Final products resulting from the JOTR vegetation mapping project are listed below. Most of these are available online: http://www.usgs.gov/core_science_systems/csas/vip/products.html .

Available as separate PDFs through the NPS Data Store (https://irma.nps.gov/) or on CD upon request to the MOJN Data Manager:

- Appendix A: ***Vegetation Descriptions for Joshua Tree National Park***. *Submitted by J. Evens, D. Roach-McIntosh, and D. Stout of the California Native Plant Society in January 2012.* This is the final report of vegetation descriptions for all vegetation types included in the classification.
- Appendix B: ***Vegetation Classification of Joshua Tree National Park***. *Submitted by J. Evens, D. Roach-McIntosh, and D. Stout of the California Native Plant Society in January 2012.* This is a hierarchical list of the final vegetation classification for JOTR.
- Appendix C: ***Key to Vegetation of Joshua Tree National Park, California***. *Written by T. Keeler-Wolf and T. La Doux.* This is a dichotomous key to be used for field identification of the vegetation types found in JOTR.
- Appendix D: ***Map and Classification Crosswalk, 2005 to 2012***. *Prepared by T. La Doux, E. Babich, and M. Harding in July 2011.* This spreadsheet shows the relationship of the 2005 mapped polygons and classification to the final 2012 mapped polygons and classification.
- Appendix E: ***Vegetation Classification of Joshua Tree National Park, Riverside and San Bernardino Counties, California***. *Submitted by Todd Keeler-Wolf, Sau San, and Diana Hickman of the California Department of Fish and Game (CDFG) in March of 2005*. This report describes the field and classification efforts by CDFG, including the 2005 version of the vegetation classification for JOTR, ecological descriptions for all vegetation types, and a field key.
- Appendix F: ***Photo-Interpretation Report, USGS-NPS Vegetation and Inventory and Mapping Program, Joshua Tree National Park***. *Submitted by Aerial Information Systems, Inc. in December 2004.* This report describes the mapping and photo-interpretation effort (including protocols for data conversion and quality control) conducted by AIS in preparation of the 2005 version of the vegetation map.
- Appendix G: ***USGS-NPS Vegetation Mapping Program, Joshua Tree National Park Mapping Classification***. *Submitted by Aerial Information Systems, Inc. in November 2004.* This report includes photos for many of the Alliances, as well as brief descriptions of the Associations or Mapping Units included in the 2005 version of the vegetation map.
- Appendix H: ***Sample and Population Contingency Tables,*** completed by Chris Lea in July 2012. The twelve tables display producer's and user's accuracies at multiple levels: Association, Alliance, Group, Macrogroup, Formation, and Class.
- **Appendix I**: Field forms and related materials.

Retained elsewhere:

- Geodatabase of vegetation map, titled "JOTR_2012_Veg_Classification.gdb". There are four feature classes included within this geodatabase, their titles are as follows:

JOTR_2012_Veg_Classification_Documentation, JOTR_2012_Veg_Classification, JOTR_2005_Veg_Classification, and JOTR_2012_Veg_Classification_ParkSpecials. Geospatial products are in Universal Transverse Mercator (UTM) projection, Zone 11, using the North American datum of 1983.

- All vegetation plot data collected between 1996-2009, including AA plot data and RA plot data with georeferenced photos. Excel and Access databases of plot data are available on the Park sharedrive.
- Original datasheets and field notebooks from the 2007-2009 field efforts are available in the Park archive.

# Acknowledgments

The authors would like to thank the efforts of all individuals involved in the process of completing this project. Many skilled individuals from a variety of organizations and agencies came together to execute this project over the course of 16 years. In particular, we would like to thank Aerial Information Systems (AIS) and Todd Keeler-Wolf for their persistence in helping us refine and update the map and classification, even after they were no longer being paid. In addition, we thank Julie Evens (and others) at CNPS for completing the final version of the classification.

In an attempt to acknowledge all that are deserving of recognition, listed below are names of individuals and their respective role(s) in the project. Because the authors of this report were not involved in the beginning phases of the project there are likely many individuals who contributed in some way that are not acknowledged here. We apologize for any gaps or unintentional omissions.

**AIS, Inc.**

*Debbie Johnson, General Manager* – Developed work plan and provided overall project management and supervision of the grad sect analysis, vegetation plot sample collection for classification analysis, and map and GIS database development.

*Denise Cline, Technical Project Manager* – Provided project oversight, quality control, photo interpretation, and geo-referencing the final product.

*John Menke, Lead Photo Interpreter* – Provided field ecology and photo interpretation expertise, training, and final quality control of the vegetation map and GIS database.

*Ed Reyes, Senior Photo Interpreter* – Provided photo interpretation expertise, performed final quality control of the vegetation map and GIS database.

*Ben Johnson, Senior GIS Analyst* – Provided GIS modeling and analysis.

*Kumi Rattenbury, Lead Field Ecologist and Photo Interpreter* – Provided field coordination and plot sample collection in support of the vegetation classification development and photo interpretation of vegetation units.

*Rene Vargo, Field Ecologist and Photo Interpreter* – Provided plot sample collection and photo interpretation of vegetation units.

*Marcie Young, Field Ecologist and Photo Interpreter* – Provided plot sample collection and photo interpretation of vegetation units.

*Valerie Cribbs, Photo Interpreter* – Provided photo interpretation of vegetation units.

**National Park Service**

*Chris Lea, Botanist, National Park Service Vegetation Inventory* – Conducted sampling design and analysis of thematic accuracy assessment and trained park staff in reference (field) data collection methods for thematic accuracy assessment.

*Karl Brown, NPS I&M* – Provided oversight and funding for project.

*Mike Story, USGS/NPS* – Project initiation and securing of funds.

*Jesse D'Elia* – Provided GIS modeling and analysis and photo interpretation of vegetation units.

*Gillian Bowser* – Project manager before 2003.

*Kathie Meyer* – Assisted with field data collection.

*Hank McCutchen, Resource Division Chief* – Assisted in procurement of funding to complete the mapping effort.
*Paul DePrey, Resource Division Chief* – Project oversight and administration.
*Andrea Compton, Resource Division Chief* – Project oversight and administration.
*Jane Rodgers, Vegetation Branch Manager* – Project management (1996 - 2003) for initial phases of classification, mapping, and fieldwork.
*Tasha La Doux, Botanist* – Project funding and management (2005 – 2012) through completion of final report, including accuracy assessments, field relevés, training field technicians, data analysis, GIS assistance, and rewriting of the final classification and key.
*Jeanne Taylor, Vegetation Mapping Coordinator, Mojave Desert I&M Network* – Assisted with project management and funding.
*Alice Miller, Vegetation Branch Manager* – Assisted with fieldwork and data entry.
*Josh Hoines, Vegetation Branch Manager* – Project oversight and administration.
*Erin Babich, Botany Tech.* – Lead technician on accuracy assessment and data analysis. Assisted with data collection/management, training of field technicians, and completing the final report.
*Mitzi Harding, Botany Tech.* – Assisted with completing final report.
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*Michael Bell, Biol. Sci. Tech.* – Assisted with fieldwork and data entry.
*Amber Holt Biol. Sci. Tech.* – Assisted with fieldwork and data entry.
*Kathryn Matthews, Biol. Sci. Tech.* – Assisted with fieldwork and data entry.
*Jane Cipra, Biol. Sci. Tech.* – Assisted with fieldwork and data entry.
*Jesse D'Elia, Biol. Sci. Tech.* – Assisted with field work and GIS modeling.
*April Johnson, NPS volunteer* – Assisted with fieldwork.
*Mark Wheeler, NPS volunteer* – Assisted with fieldwork.
*Colleen Ely, NPS volunteer* – Assisted with fieldwork.
*Bill Truesdell, NPS volunteer* – Assisted with fieldwork.
*Kathleen White, NPS volunteer* – Assisted with fieldwork.
*Sean P. Murphy, GIS specialist* – Provided GIS modeling and analysis for the accuracy assessments, as well asassisted with finalizing the map.

**CDFG and CNPS**
*Todd Keeler-Wolf, CDFG Senior Vegetation Ecologist* – Collected and synthesized ecological plot data, produced 2005 version of vegetation classification and field key, and assisted in final analysis and production of final classification and vegetation descriptions.
*Diana Hickson, CDFG Vegetation Ecologist* – Assisted in development of 2005 vegetation classification, developed crosswalks, and quality checked 2005 final report.
*Sau San, CNPS* – Assisted in development of 2005 vegetation descriptions.
*Julie Evens, Vegetation Program Director, CNPS* – Conducted final data analyses and produced final classification and vegetation descriptions.
*Deborah Stout, Assistant Vegetation Ecologist, CNPS* – Assisted with final classification and vegetation descriptions.
*Kendra Sikes, Vegetation Ecologist, CNPS* – Assisted with final classification and vegetation descriptions.
*Danielle Roach-McIntosh, Vegetation Team Leader, CNPS* – Assisted with final classification and vegetation descriptions.

## List of Abbreviations and Acronyms

| | |
|---|---|
| **AA** | Accuracy Assessment |
| **AIS** | Aerial Information Systems, Inc. |
| **CDFG** | California Department of Fish and Game |
| **ESRI** | Environmental Systems Research Institute |
| **FGDC** | Federal Geographic Data Committee |
| **GIS** | Geographic Information System(s) |
| **GPS** | Global Positioning System |
| **JOTR** | Joshua Tree National Park |
| **NPSVIP** | National Park Service Vegetation Inventory Program |
| **MMU** | Minimum Mapping Unit |
| **NAD** | North American Datum |
| **NBS** | National Biological Service |
| **NPS** | U.S. National Park Service |
| **USNVC** | U.S. National Vegetation Classification |
| **USGS** | United States Geological Survey |
| **UTM** | Universal Transverse Mercator |

## List of Relevant Links

| | |
|---|---|
| http://www.usgs.gov/ | United States Geologic Survey |
| http://www.usgs.gov/core_science_systems/csas/vip | USGS-NPS Veg. Mapping Program |
| http://www.nps.gov/jotr | Joshua Tree National Park |
| http://www.aisgis.com/ | Aerial Information Systems, Inc. |
| http://www.dfg.ca.gov/ | Cal. Dept. of Fish and Game |
| http://www.natureserve.org/ | NatureServe |
| http://science.nature.nps.gov/im/ | NPS Inventory & Monitoring Prog. |
| http://www.wrcc.dri.edu/index.html | Western Regional Climate Center |

# 1.0 Introduction

## 1.1 Overview of Joshua Tree National Park

The nearly 800,000 acres known as Joshua Tree National Park (JOTR or Park) is located in southern California, within portions of Riverside and San Bernardino counties (Figure 1). JOTR was declared a U.S. National Park in the California Desert Protection Act of 1994, but had previously been a U.S. National Monument since 1936. Almost three-quarters of the park (593,490 acres) is designated as Federal Wilderness, making much of the park only accessible by foot (Figure 2).




**Figure 1**. Location of Joshua Tree National Park in southern California.

The Park includes portions of two deserts; the Colorado Desert is restricted to regions of the south and east below 3,000 feet, whereas the higher, moister, and slightly cooler Mojave Desert lies in the western and northern regions of the Park. Aquatic or riparian habitats (e.g., springs, oases, and ephemeral stream corridors) represent a very small, but ecologically important, portion of total land cover in JOTR (Chung-MacCoubrey et al. 2008). And while there are several isolated mountain ranges that serve as “sky islands” throughout JOTR, the Little San Bernardino Mountains on the west end of the Park are unique in that they provide a geographic link to the Transverse and Peninsular ranges of the chaparral habitats of southern California (Figure 2). It is the confluence of these three bioregions, mojavean desert, coloradan desert, and cismontane chaparral, which provides for the rich and diverse flora found in JOTR.

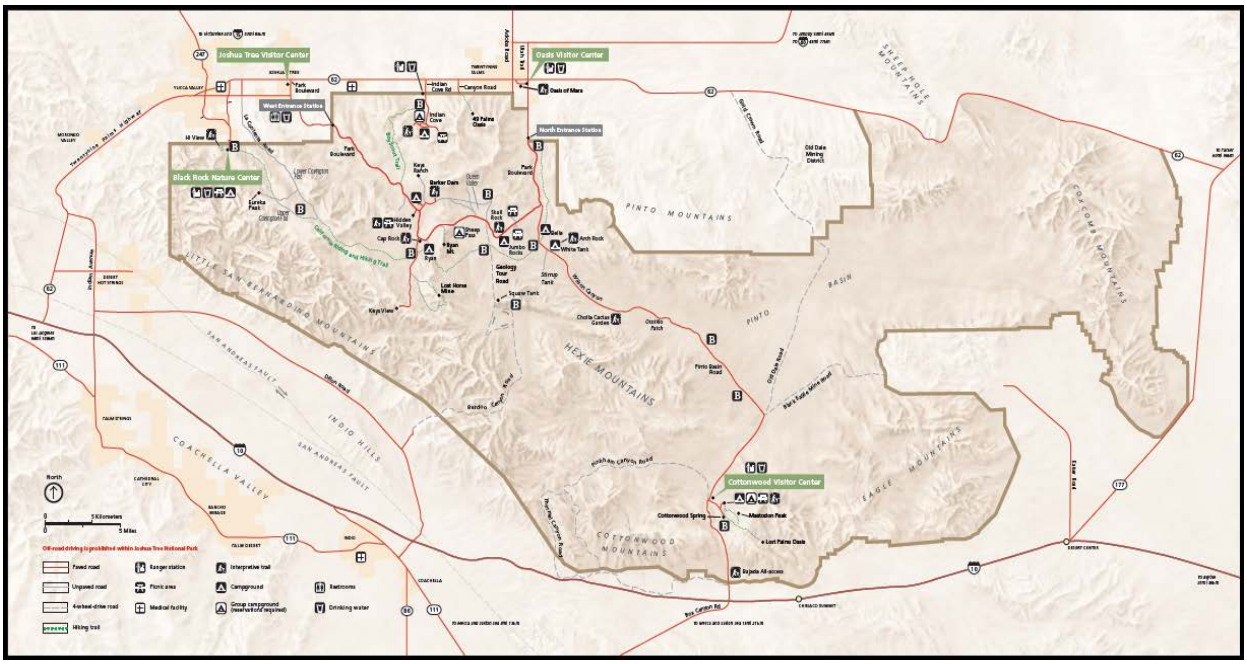



**Figure 2.** Topographic map of Joshua Tree National Park showing the isolated mountain ranges in the south and east, as well as the Little San Bernardino Mountains to the west (obtained from Joshua Tree National Park Website http://www.nps.gov/jotr). Notice the lack of roads throughout much of the Park.

Nearly 730 vascular plant taxa have been documented and vouchered in the park. The floristic richness of this area is greatly enhanced by the high percentage of annual species, which represent approximately 50% of the flora (La Doux in press). Another important aspect contributing to the floristic diversity are the many species that flower during the summer or fall seasons. For example, 5% of the flora consists of obligate summer annuals, species that only respond to summer rains. In addition, JOTR is host to over 40 rare species protected by the park, two of which are federally listed (*Astragalus tricarinatus* and *Erigeron parishii*). One of the rare plant taxa, *Tetracoccus hallii*, is considered a dominant cover in a restricted area of the park, at the northwest end of the Eagle Mountains. Stands of this species generally occur on colluvial slopes with *Yucca schidigera, Simmondsia chinensis*, *Nolina bigelovii*, and *Ephedra nevadensis*. Hall's Tetracoccus (*Tetracoccus hallii*) Provisional Shrubland Alliance is known to occur in San Bernardino, Riverside, and Imperial counties of California, as well as in Arizona and Baja California, Mexico.

As is the case for the entire desert bioregion of California, the Park represents a fairly pristine landscape with only 50 non-native plant species (not including ornamentals isolated to park facilities) representing ~7% of the flora. A number of these are considered invasive species, for example Sahara Mustard (*Brassica tournefortii),* Fountain Grass (*Pennisetum setaceum),* and Russian Thistle (*Salsola tragus*) (Cal-IPC 2006). In some cases the non-native species are so prevalent in the ecosystem they have become the dominant cover and are recognized as distinctive vegetation types in California, two examples include: *Bromus rubens — Schismus* (*arabicus, barbatus*) Semi-Natural Herbaceous Stands and *Tamarix* spp. Semi-natural Shrubland Stands, both of which have been observed in JOTR (Sawyer et al. 2009). All *Tamarix spp*. stands are being monitored and treated by the Invasive Species Program at the Park; current status of these stands can be obtained from park staff.

Though the Park is probably most famous for its namesake, the Joshua Tree (*Yucca brevifolia*), the rock formations found in the Wonderland of Rocks region of the Little San Bernardino Mountains has made JOTR a world-famous rock climbing destination. These unique monzogranitic outcrops, called plutonic intrusions, were formed under the surface of the earth as a result of magma formed during the Mesozoic Era, 245 to 60 million years ago (Schoenherr 1992). Compressional and extensional tectonic activity along fault lines, volcanic activity, and continuous erosional and depositional forces have contributed to the interesting geologic features of the desert region. JOTR is located in the southwestern edge of the Basin and Range Province, which explains the characteristic landscape of uplifted mountain ranges ("sky-islands") consisting primarily of thick Paleozoic Mesozoic rock, separated by broad alluvium filled valleys or basins (Schoenherr 1992, USGS - NPS 2000). Basins consist of piedmont slopes, regions of active erosion and deposition, or basin floors characterized by slow run-off and an accumulation of soluble salts (Chung-MacCoubrey et al. 2008). JOTR ranges in elevation from approximately 500 feet along the southeast boundary of the Coxcomb Mountains, to the summit of Quail Mountain in the Little San Bernardino Mountains at 5,813 feet.

The Park receives precipitation biannually. Both summer and winter precipitation events are highly variable from year to year, but the region exhibits a southeastward gradient of increasing temperature, decreasing average elevation, and decreasing precipitation. Summer rains generally occur from July to September, are often characterized by heavy but isolated thunderstorms, and may contribute upwards of 50% of the average annual rainfall (Figure 3). These monsoonal events are created by sub-tropical moisture originating in the Gulf of Mexico that spreads west and is most noticeable in the southern and eastern portions of the Park where the average annual rainfall is approximately 3.5 inches per year (Eagle Mtn station = 3.65 in. based on records from 1933-2012). While the Little San Bernardino Mountains consistently receive summer rains, the winter rains tend to be more reliable and contribute a greater proportion of the annual rainfall. Winter rains are caused by moist air masses originating in the Pacific Ocean that travel eastward. Although most of the rain is dropped on the west side of the Transverse Mountain ranges, a portion of it reaches the leeward side of the San Bernardino Mountains and provides reliable precipitation in the Little San Bernardino Mountains (Chung-MacCoubrey et al. 2008). Depending on elevation (~3,000 – 5,800 feet), the annual rainfall in these western and northern regions of the park can range from 5 to 12.5 inches, some of which falls as snow during the winter months. These averages are based on annual average precipitation for the following Western Regional Climate Center (WRCC) weather stations: Joshua Tree station = 4.68 inches at 2,760 feet; Lost Horse Valley station = 6.4 inches at 4,200 feet; and Black Rock station = 12.5 inches at 4,080 feet (available at: http://www.wrcc.dri.edu/index.html).

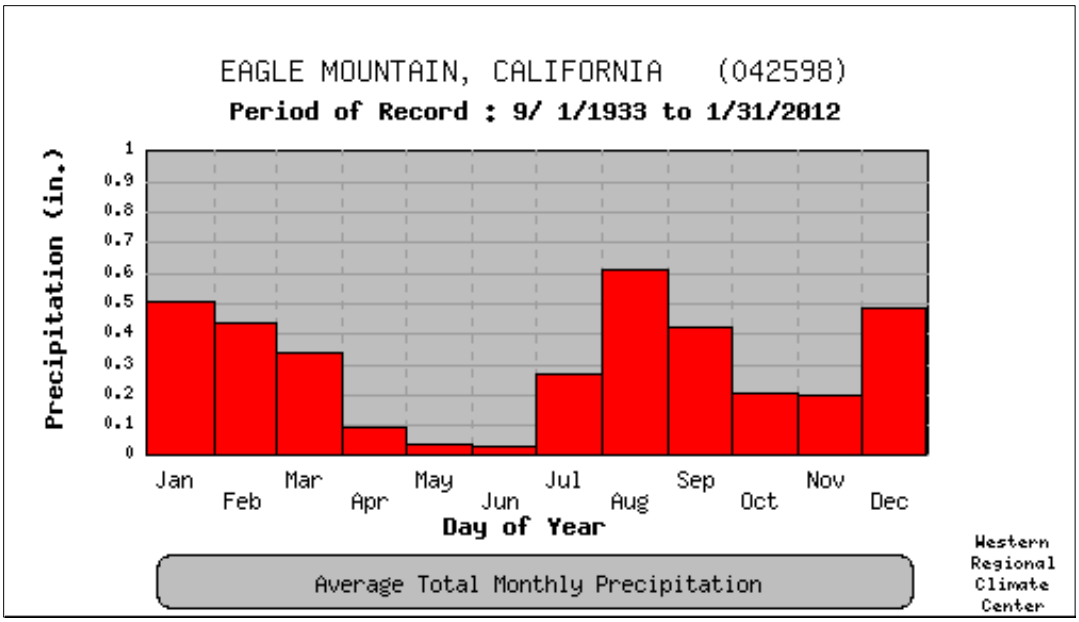



**Figure 3**. Precipitation data for Eagle Mountain, CA, WRCC weather station (elev. 970 feet) located in the southeastern portion of JOTR. Data are for 1933 through 2012 and nicely demonstrate the bimodal precipitation pattern in this region.

### 1.2 NPS Vegetation Inventory Program

In 1994, the National Park Service (NPS) initiated a partnership with the U.S. Geological Survey (USGS) Biological Resources Division to classify, describe, and map vegetation communities in more than 250 National Park units across the United States. This landmark program is both the first to provide national-scale descriptions of vegetation for a federal agency and the first to create national vegetation standards for its data products. Later, the program was split into two separately administered and funded programs, though they remain integral to one another and are still considered a collaborative effort. The two programs are now known as the USGS Vegetation Characterization Program and the NPS Vegetation Inventory Program (NPSVIP). The goals of these programs 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 (Grossman et al. 1998, Federal Geographic Data Committee 2008, Lea 2011). To learn more about these programs, visit the websites: (http://science.nature.nps.gov/im/inventory/veg/index.cfm) or (http://www.usgs.gov/core_science_systems/csas/vip/index.html).

Program scientists and partners have developed data collection procedures for classification, mapping, thematic accuracy assessment, and use of existing data (The Nature Conservancy and Environmental Systems Research Institute 1994, Lea and Curtis 2010, Lea 2011). Program products meet Federal Geographic Data Committee (FGDC) standards for vegetation classification and metadata, and national standards for spatial accuracy and data transfer (FGDC 2008).

Each park developing a vegetation map follows a standardized methodology for sampling field data (The Nature Conservancy and Environmental Systems Research Institute 1994) and vegetation classification (Lea 2011). This information is used by photointerpreters to delineate

polygons of vegetation communities, which are then subjected to a thematic accuracy assessment process (Lea and Curtis 2010). The final products consist of a vegetation map, descriptions of each vegetation type, a key to each type, and all related data and metadata files (original field forms, plot database, accuracy assessment points, etc.).

### 1.3 Joshua Tree National Park Vegetation Mapping Project

The purpose for developing vegetation classifications and maps for the National Park Service units is to provide baseline data for park managers. These products can be used to help managers with many aspects of resource management, for example, to build predictive models for rare plant and animal habitat, to track landscape-level changes in vegetation, and to model the spread of wildfires and invasive species. The JOTR classification and mapping project was initiated in 1996 as one of several pilot studies for the newly formed NPS Vegetation Mapping Program; it was the first desert park to initiate a mapping project. Informative summaries and timelines of the initial phases (1996-2005) are provided in the two final reports submitted to JOTR in 2005 (Appendices E and F). Specifically, the title of these reports are: 1) the "Photo-Interpretation Report, USGS-NPS Vegetation and Inventory and Mapping Program, Joshua Tree National Park" submitted by Aerial Information Systems, Inc. (AIS) in December 2004, and 2) "Vegetation Classification of Joshua Tree National Park, Riverside and San Bernardino Counties, California" submitted by Todd Keeler-Wolf, Sau San, and Diana Hickman of the California Department of Fish and Game (CDFG) in March of 2005. In these reports you can find details of the earlier stages of this project, including information on pre-existing datasets used in the analysis, timelines of events, and protocols used for data collection/analysis. This report will not attempt to summarize what is already available in those reports.

The following products were a result of the initial mapping effort (ending in 2005) and accompany this report as Appendices.

- Appendix E: *Vegetation Classification of Joshua Tree National Park, Riverside and San Bernardino Counties, California. Submitted by Todd Keeler-Wolf, Sau San, and Diana Hickman of the California Department of Fish and Game (CDFG) in March of 2005*. This report describes the field and classification efforts by CDFG, including the 2005 version of the vegetation classification for JOTR, ecological descriptions for all vegetation types, and a field key.
- Appendix F: *Photo-Interpretation Report, USGS-NPS Vegetation and Inventory and Mapping Program, Joshua Tree National Park. Submitted by Aerial Information Systems, Inc. in December 2004.* This report describes the mapping and photo-interpretation effort (including protocols for data conversion and quality control) conducted by AIS in preparation of the 2005 version of the vegetation map.
- Appendix G: *USGS-NPS Vegetation Mapping Program, Joshua Tree National Park Mapping Classification. Submitted by Aerial Information Systems, Inc. in November 2004.* This report includes photos for many of the Alliances, as well as brief descriptions of the Associations or Mapping Units included in the 2005 version of the vegetation map.

Ideally, the mapping, classification, ground truthing, and accuracy assessment can all be completed within a concise time frame by a core set of individuals and, perhaps more importantly, with continuous funding to support the completion of the project. Unfortunately,

this was not the case for the JOTR effort, which suffered from a lack of funding and a high turnover rate of Park staff. The lack of funding contributed to meager field efforts for the collection of vegetation plot data for initial analysis, as well as in ground-truthing the map and classification. In an effort to make-up for this lack of data, the Accuracy Assessment protocol was modified in 2006 to include more vegetation data for each plot. The additional vegetation data were utilized during the final stages of this project to target problematic vegetation types and refine the classification. Preferably, these final stages of fieldwork would have been done in conjunction with the final stages of producing the map and classification, such that feedback from the Park could have been incorporated into the final products submitted in 2005. However, it wasn't until 2006 that funding was secured for the Accuracy Assessment phase of the project, long after all funding had ended to support the vegetation ecologists at CDFG and photo-interpreters at AIS.

The field component of the Accuracy Assessment (AA) phase of the project was completed in 2008 after two seasons of data collection. In addition, one season of targeted Rapid Assessments (see Appendix I for the protocol and field form) were completed in 2009 to assist in refining 14 problematic vegetation types. By July 2009 all fieldwork was completed and incorporated into the data analysis. Based on these results, the map and classification were updated accordingly, including re-working of the map by photo-interpreters at AIS, and then finalization of the classification and descriptions by CDFG and CNPS. The final stages of completing the classification involved incorporating the most recent (or most appropriate) nomenclature published by Sawyer et al. (2009), USNVC (http://usnvc.org/explore-classification/), NatureServe Explorer (http://www.natureserve.org/explorer/servlet/NatureServe?init=Ecol), or in some cases the Vegetation Classification utilized by NatureServe for Grand Canyon National Park (unpublished data, but will be available at http://www.usgs.gov/core_science_systems/csas/vip/products.html).

The following products represent the final Vegetation Classification for JOTR and can be found accompanying this report as Appendices.

- Appendix A: ***Vegetation Descriptions for Joshua Tree National Park***. *Submitted by J. Evens, D. Roach-McIntosh, and D. Stout of the California Native Plant Society in January 2012.* This is the final report of vegetation descriptions for all vegetation types included in the classification.
- Appendix B: ***Vegetation Classification of Joshua Tree National Park***. *Submitted by J. Evens, D. Roach-McIntosh, and D. Stout of the California Native Plant Society in January 2012.* This is a hierarchical list of the final vegetation classification for JOTR.
- Appendix C: ***Key to Vegetation of Joshua Tree National Park, California***. *Written by T. Keeler-Wolf and T. La Doux.* This is a dichotomous key to be used for field identification of the vegetation types found in JOTR.
- Appendix D: ***Map and Classification Crosswalk, 2005 to 2010***. *Prepared by T. La Doux, E. Babich, and M. Harding in July 2011.* This spreadsheet shows the relationship of the 2005 mapped polygons and classification to the final 2012 mapped polygons and classification.

# 2.0 Methods

## 2.1 Timeline

The goals of this report are to present the efforts of the Vegetation Classification project after 2005 as well as provide a summary of the earlier work between 1996-2005. The following timeline depicts major activities for the duration of the project, whereas the remainder of the Methods section will focus on the activities post-2005. Specifically, we will discuss the Accuracy Assessment phase, the additional Rapid Assessment plots completed in 2009, then provide an overview of the reworking of the classification and map that resulted from these efforts.

**1996**—Initial meeting for project planning and park tour. AIS field reconnaissance trip for Malapai Hill area. Vegetation sampling by Joe Watts and U.S. Army Corps of Engineers (108 plots).

**1997**—Mapping of pilot area (Malapai Hill quadrangle). Field data collection by Brent Long and his crew from Joshua Tree National Park using large relevés (74 plots).

**1998**—New color infrared (CIR) aerial photographs acquired (June–November) and vegetation field sampling by Mojave Desert Ecosystem Initiative crews (74 plots).

**1999**—Review and evaluation of park vegetation classification. Preliminary photo-interpretation performed to aid field sampling.

**2000**—AIS conducts vegetation field sampling (300 plots) using gradient directed sample stratification.

**2001**—Vegetation classification for JOTR developed. Aerial photo-interpretation initiated.

**2002**—Vegetation photo-interpretation completed.

**2003**—Data automation and rectification commences.

**2004**—Final vegetation coverage and photo-interpretation report completed by AIS.

**2005—**Final vegetation classification report completed by CDFG.

**2006**—Funding secured for Accuracy Assessment phase of project.

**2007**—Accuracy assessment phase initiated, training of field crew and creation of random sampling points provided. A total of 662 accuracy assessment points completed.

**2008**—Accuracy assessments continue with 651 additional points completed, for a total of 1,313 points. Initial accuracy assessment analysis and contingency table completed by Chris Lea (NPS). Meeting is held at JOTR headquarters in September 2008 (including AIS, CDFG, and NPS staff) to discuss the results and future needs.

**2009**—111 Rapid assessment plots executed in problematic vegetation associations to complement accuracy assessment data. Small amount of funding is secured to hire CDFG to incorporate new data into analysis and make recommendations for updating the classification and map. Meeting is held in August 2009 (including AIS, CDFG, and JOTR staff) to review data and make decisions on updating the classification and map.

**2010**—AIS is contracted to rework the map according to the decisions made at the August 2009 meeting.

**2011**—CNPS is contracted to provide a final Classification and Descriptions report utilizing the most recent nomenclature from USNVC and NatureServe.

**2012**—Accuracy assessment analysis and contingency table are redone using more recent methodologies and corrected AA data. Geodatabase of vegetation map is created and finalized by JOTR staff. Final report and data products are completed and published.

## 2.2 Overview and Purpose of Thematic Accuracy Assessment

Thematic accuracy assessment (AA) for a vegetation map is a test of how well the map represents vegetation on the ground. The AA methodology for JOTR and terminology for this report generally follow Lea and Curtis (2010), which provides more detailed information on sampling design and data analysis within the National Park Service Vegetation Inventory Program. Congalton and Green (2009) and Czaplewski (2003) also provide informative discussions on methodology for calculating various accuracy statistics.

Assessments can be made for each mapped class (individual class accuracy) and/or for the entire map (i.e., all individual classes combined, or overall accuracy). Accuracy is represented by the rate of matches between the map class label and the vegetation type recorded by an observer in the field, using observation plots of a specified size. In practice, a specified number of observation plots are randomly selected within each map class using a Geographic Information System (GIS). Each of these plots is labeled with the geographic location and the corresponding map class, these are referred to as the "sample data label." Field observers are provided with the locations and size of area to observe (the observation plot), but to avoid influencing the field classification, observers do not know the map class label of the observation plot. The observers navigate to each observation plot and decide which vegetation type best fits the assigned observation location, using a field key of all known vegetation types for the project area. The best choice made from the field key is recorded for each plot, referred to as the "reference data label", for that observation. Since vegetation attributes can be more easily and accurately observed on the ground than from a remotely sensed perspective, the reference data labels are assumed to be the most accurately classified label for the location (in practice, the field classifications are rarely 100% accurate), and the sample data label must match the reference data label in order for an observation to be considered correctly mapped. Figure 4 shows the location of accuracy assessment points collected in 2007-2008.

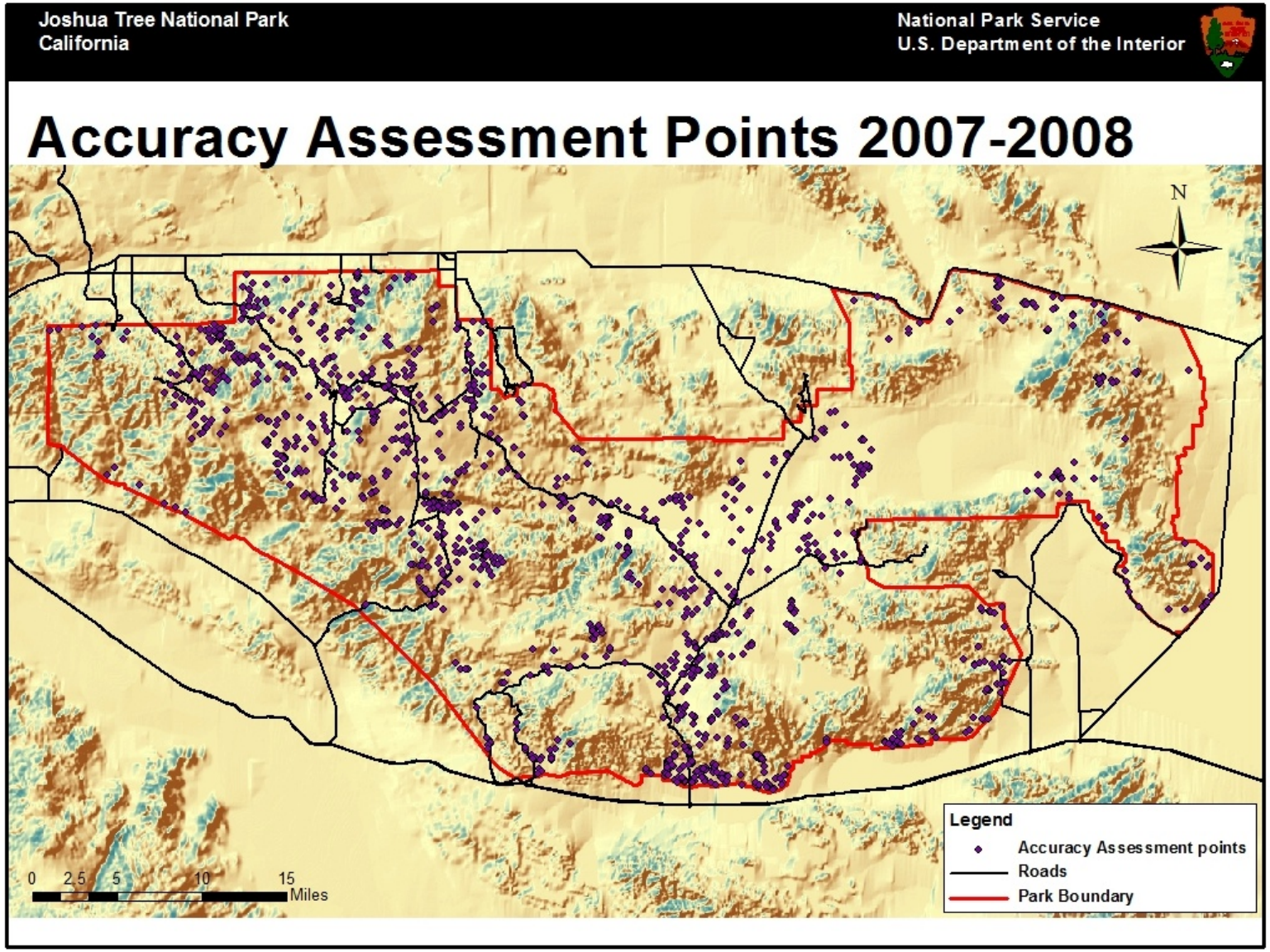



**Figure 4**. Locations of accuracy assessment points collected in 2007-2008.

Ideally, each sample data (map) class corresponds to a single reference data (vegetation) class in a one-to-one relationship, but, because some vegetation types can be identified with relative ease on the ground, but not from a remote sensing perspective, some sample data classes have a one-to-many relationship with vegetation classes. More rarely, sample data classes may have a many-to-one relationship with the reference data classes. In order to assign sample and reference data labels unambiguously, all map class to vegetation class relationships must be conceptually and spatially non-overlapping for a given level of thematic resolution. Sample and reference data both may be relabeled at coarser levels of thematic resolution to assess accuracy at those levels. For example, observations with a sample data label of *Yucca brevifolia – Juniperus californica* / *Ephedra nevadensis* Association are matches with reference data labels of *Yucca brevifolia* / *Coleogyne ramosissima* Association when accuracy is assessed at the Alliance level because both associations are members of the *Yucca brevifolia* Woodland Alliance, but they would not be matches at the Association level.

The rate of matches between the sample data and reference data, *as grouped by each sample data class*, is the "user's accuracy" for that map class. User's accuracy for an individual map class is an estimate of the probability that the map class represents what was found on the ground and is equal to 100% accuracy minus the rate of "errors of commission." The rate of matches between the sample data and reference data, *as grouped by each reference data class*, is the "producer's accuracy" for that vegetation type. Producer's accuracy for an individual vegetation type is an estimate of the probability that the vegetation type has been mapped correctly, wherever it is found in the project area, and is equal to 100% minus the rate of "errors of omission." Note that the terms user's accuracy and producer's accuracy are applied to and have meaning only in reference to a specific map class or vegetation type.

As an example, the *Yucca brevifolia – Juniperus californica* / *Ephedra nevadensis* Association has a user's accuracy of 53.1% and a producer's accuracy of 48.4% (Table 2, Appendix H). The user's accuracy predicts that one can expect to find the *Yucca brevifolia – Juniperus californica* / *Ephedra nevadensis* Association in 53.1% of all areas mapped as this association, and one will find other associations about 46.9% of the time (the population contingency table (Table H3, Appendix H) shows the estimated contributions of the other associations to the incorrectly mapped proportion of 46.9%). The producer's accuracy predicts that, wherever *Yucca brevifolia – Juniperus californica* / *Ephedra nevadensis* Association occurs in JOTR, about 48.4% of this vegetation will be found in areas mapped as this map class, and 51.6% of the vegetation will fall in areas mapped as a different map class (also listed in the population contingency table). These estimates assume an observation area equal to that used by the AA (0.5 hectare or 0.25 hectare), but are likely to be robust enough for both larger and smaller areas.

User's and producer's accuracies may also be assessed at different levels of thematic resolution, including, different levels of the USNVC hierarchy, as is the case for this project (levels presented in the contingency tables are: Association, Alliance, Group, Macrogroup, Formation, and Class). This is useful because map accuracy and thematic resolution are inversely related to each other and different applications of the map may require more of one attribute than of the other. In the case of JOTR, the sample data and reference data are labeled at the finest level of thematic resolution (e.g., USNVC association) but can be regrouped at higher hierarchy levels (e.g., USNVC alliance and above), as needed.

Ideally, a map (sample data) class or vegetation (reference data) class has both high user's and high producer's accuracy. High producer's accuracy combined with low user's accuracy indicates that the map class is over-mapped (i.e., is rarer on the ground than the map indicates). Conversely, low producer's accuracy combined with high user's accuracy indicates that a vegetation type is under-mapped (i.e., is more abundant on the ground than the map indicates). Producer's accuracies, as calculated from population contingency tables, combined with GIS map class area measurements, allow for estimations of map class areas, as corrected for over-mapping or under-mapping error (Lea and Curtis 2010, Czaplewski 2003). For example, the JOTR map database documents 9,359 hectares mapped as the *Larrea tridentata - Ambrosia dumosa - Senna armata* Association, but from the low producer's accuracy (4.8%) and measurements of map classes in which this type was found, the true area of this association in JOTR is estimated to be more than four times as large (41,118 hectares). See Table H1 in Appendix H for mapped and estimated area differences for all classes mapped and assessed.

User's accuracy is important to anyone using the vegetation map because the "user" can assess the reliability of the map for each map class. Given that individual map classes can vary greatly in accuracy and that there may be consequences in relying on a map that is inaccurate at a given location, these values can be important for the decisions made by land managers that are informed by the map. Despite its name, producer's accuracy can also be important to map users because it is an estimate of how abundant each vegetation type is, within the mapped area (accounting for mapping error). Producer's accuracy can be used to derive a more accurate estimate of the area of a given vegetation type than the map alone indicates, because it enables compensation for mapping errors. The nature of the management focus will usually dictate which type of accuracy measure is more germane to the user: User's accuracy is more often applied when one is concerned about management *at a specific location*; producer's accuracy is more often applied when one is concerned about management *of a specific vegetation type*. As an example of the management value of estimating producer's accuracy, the JOTR AA results suggest that the rare plant dominated *Tetracoccus hallii* Provisional Association is likely to be more abundant at JOTR than the map indicates due to a very low producer's accuracy (0.4%). Although there is sampling uncertainty associated with this estimate (because of the small number of observations), estimates of the true area of this type suggest that it could be as much as nine times as abundant as mapping suggests. The contingency tables in Appendix H indicate the other map classes in which this type may occur undetected.

Beyond the basic value of the user's and producer's accuracies for map classes, the AA data can enable a map user to understand which combinations of map classes have been confused with one another by the mapper. Counts of individual observations and proportions of the map for all possible combinations of sample and reference data labels can be displayed in two different types of contingency tables: a sample table and a population table (Tables H1-H12, Appendix H) (see Lea and Curtis 2010 for further explanation). The sample table documents raw counts of observations within each possible combination of sample data labels and reference data labels; the population contingency table adjusts these counts to estimated proportions of the map that fall into each combination and is the correct table to use when estimating the accuracy of combinations of classes aggregated from the thematically finest classes. Reviewing the data in these tables will reveal commonly confused map classes and provide insight for which combinations of classes could be aggregated to produce more accurate units (at a lower level of thematic resolution). The user, of course, must make an informed decision about the best balance

of thematic accuracy and map accuracy that best suits the situation. Combinations of aggregations and assessments of accuracy may be done within a formal hierarchy, as described in this example, or using any *ad hoc* combination of map classes desired.

The entire set of observations may be combined into an estimate of overall accuracy for the map. Overall accuracy is the probability that any location on the ground in the project area is correctly mapped. User's and producer's accuracy do not apply to the overall accuracy estimate, since observations from all classes are combined to derive overall accuracy. Overall accuracy is computed by pooling the individual observations used to assess individual map class accuracy. Since these sets of observations are derived from multiple independent random sampling designs, usually assigned at different sampling densities (because of different map class sizes), the influence of individual observations must be proportionally weighted when pooling the results (Lea and Curtis 2010).

The following sections will describe the three main phases of accuracy assessments completed at JOTR: (1) sampling design, (2) field data collection, and (3) analysis and computation.

## 2.3 Accuracy Assessment Sampling Design (Sample Data Label Methodology)

### *2.3.1 Determination of Observation Plot Size*

The default size for the AA observation plot was 0.5 hectare (5,000 $m^2$); this was used for most JOTR map classes, including the majority of upland map classes. The shape of the AA plot was circular (39.9 meter radius) and centered on the observation point generated in the sampling design phase. Circular plots are logistically convenient because the observer can often estimate the boundaries from the center point. In addition, circular plots are less likely than plots of other shapes to encroach upon polygon boundaries with other map classes, which could cause ambiguity in field observations. A disadvantage of circular plots, compared to elongated plots of the same size, is that individual plant species distributions in individual stands (and, therefore, in the map class) is often clustered, so that isodiametric plots have a greater tendency to either underestimate the contribution of clusters within the stand that happen to be missed by the plot or overestimate the contribution of clusters that happen to be captured by the plot (Daubenmire 1968).

A number of map classes, mostly representing vegetation types associated with riparian washes, were mapped as small or narrow polygons, often less than 80 meters in width (the diameter of a 0.5 hectare circular plot). This condition was problematic because placing a 0.5 hectare circular plot in these map classes would decrease the available inference area, often to below the recommended sample size and, in some cases, eliminate all areas of the class (Lea and Curtis 2010). Therefore, we employed a 0.25 hectare or 2,500 $m^2$ circular (28.2 meter radius) plot in these map classes. A smaller observation area is appropriate in these cases because the ability to map small areas is limited by the narrowest dimension of the polygon. As a general rule, map classes with an overall area (meters$^2$) to edge (meters) ratio of 15:1 or less were assigned the smaller 0.25 hectare observation area (overall area = total map class area; edge = total perimeter of all map class polygons). To decrease possible observer bias, from linking a type to an observation area size in difficult assessments between similar types, we also evaluated all ecologically similar types at a common observation area size, regardless of this ratio for an individual class (e.g., since most wash riparian types had a meters$^2$/meters of edge ratio of less

than 15:1, all wash types were assessed at the observation size). This possible bias from knowing the observation area size remained between riparian and upland types, but we assumed that major differences between riparian and non-riparian types would influence the field assessment strongly enough to override this bias.

### *2.3.2 Map Class Sample Sizes*

Using ArcView ® 3.2, we calculated total areas (in hectares) for all original (2005 version) map classes in the JOTR map in order to determine how many observation plots to assign within each map class. The sample size for each map class was allocated at a density of 0.6 AA plots per hectare of the map class, up to a maximum of 30 samples per map class and a minimum of 5 (where possible) per map class (Table 1).

**Table 1**. Standard sample size allocations for thematic accuracy assessment, based on map class area (from Lea and Curtis 2010).

| 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.

### *2.3.3 Inference Area Determination*

In order to assure that observations can be unambiguously assigned to a map class label, the edge of the circular plot should be far enough away from the polygon edge to eliminate the chance of overlapping the observation plot with a neighboring polygon. The radius of a 0.5 hectare circular plot is approximately 40 meters, whereas the radius of a 0.25 hectare circular plot is approximately 30 meters. To accommodate the placement of the entire observation area of the AA plot within the assigned map class, we used ArcView ® 3.2 to exclude areas within each polygon near boundaries with other map classes as follows:

(1) We created a 40 meter buffer inside the boundary of all polygons in map classes for which 0.5 hectare was designated as the observation area size.

(2) We created a union theme of the original map classes and this buffer theme.

(3) We selected the portions of all polygons that were within the 40 meter buffer and deleted them from this union theme. The result of this geoprocessing step was a polygon theme (sampling population) that was comprised of the interiors of all polygons (all areas more than 40 meters from a boundary with a different map class).

(4) We repeated the above process using a 30 meter buffer for all map classes designated to be evaluated at the 0.25 hectare observation area size. The result of this geoprocessing step was a polygon theme that was comprised of the interiors of all polygons (all areas more than 30 meters from a boundary with a different map class).

Excluding the edge of a polygon may create a bias of reporting more favorable map class accuracies. This would be true if the boundary areas represent more transitional vegetation between two neighboring map classes and may therefore be more difficult to diagnose, both in mapping and in field assessment. If present, this bias would not be expected to distort accuracy reporting overly since the buffered areas were excluded from central plot position selection, but may still be included in the plot. In addition, there are two benefits for excluding the edges: (1) retaining the ability to unambiguously label more individual observation points within a single map class; and (2) a time savings for field crews by reducing the chance of needing to move the center point of the AA plot when near a map class boundary (Lea and Curtis 2010).

Using the appropriate inference area for each map class, we located individual accuracy assessment center plot positions by allocating the specified number of observation points for each map class to the modified union theme derived from the operations above. This was done using the "Select Random Features" function in the National Park Service Alaskapak tools package for ArcView® 3.2 (NPS 2002). This feature achieves the requirement of simple random sampling within each individual inference area.

When two or more randomly selected observation points were near enough to one another to produce overlapping observation areas (i.e., within 80 meters of one another for classes to be observed at the 0.5 hectare scale or within 60 meters of one another for classes to be observed at the 0.25 hectare scale), we randomly selected one of the points (using the random numbers function in Microsoft® Excel 2003), retained it in the sample, and deleted the other positions. These overlapping plots would not be mutually independent observations because observers would likely approach positions in geographical sequence on the same day such that their assessment on the prior observation would tend to influence their assessment of the next observation (Lea and Curtis 2010). A replacement site was generated for each site so deleted, using the "Select Random Features" function (as above). If the replacement site was near enough to a previously located site, so as to produce an overlapping observation area, it was rejected, and the process repeated, until either (1) the full complement of sites for the map class was assigned or (2) it was determined that the map class was saturated (could not accommodate more positions without observation area overlap between one or more plots).

After the observation points were determined and saved to a GIS shapefile, easting and northing coordinates were assigned to the data table using the National Park Service Alaskapak tools package for ArcView® 3.2 (" x, y coordinates" function). In addition, each plot was assigned a six-digit label; the first two digits were either 50 or 25 depending on which size observation plot was to be employed at the point (e.g., 25-0034 or 50-1223).

While we originally were optimistic that the entire map (all of JOTR) could be used as an inference area, field crews had not reached observation positions more than 4 kilometers from a road or trail after the first year of field work, and it became apparent that they would not obtain an adequate sample size if they would need to traverse long distances to some sites originally selected. Therefore we reduced the inference area to all areas represented by the JOTR vegetation map within 4 kilometers of a road or trail. We eliminated all locations farther than 4 kilometers and replaced them, using the methods described above, with new random positions. The selection order of pre-determined observation positions was done opportunistically by the crew, so that the observations made were not an unbiased sample from the revised inference area

for the 2008 field campaign (the portion of the JOTR map representing all areas of JOTR within 4 kilometers of a road or trail) or the original sample selected for the 2007 field campaign (the entire JOTR map). However, since there is no reason to believe that areas more distant than 4 kilometers from a road or trail would be substantially different from those within 4 kilometers of these features and, since the crew observed a large proportion of the 2008 campaign revised sample, we treat the sample as a random selection from the 2008 campaign revised inference area.

Table 2 lists the original (fine level) map classes assessed, with the observation area size assigned to the class, the number of observations assigned to the class, the number of observations actually made within the class, the number of hectares mapped in the class, the numbers of hectares mapped within the 2008 campaign revised inference area, and the proportion of the entire map class contained within the 2009 campaign revised inference area. For 63 of the 74 original map classes considered for sampling, the revised 2009 campaign inference area (representing areas within 4 kilometers of a road or trail) for the map class represented at least 50% of the entire area mapped for the class (representing all of JOTR).

### 2.4 Accuracy Assessment Field Protocol (Reference Data Label Methodology)

After three days of training in January of 2007, data collection for Accuracy Assessment plots started and continued through June 2008. The field observers were trained for the following: 1) how to use a Global Positioning System (GPS) receiver for navigation to an AA point; 2) how to use the JOTR field key; 3) how to estimate absolute and relative canopy cover; 4) how to determine the boundary of the AA plot; 5) species identification for common perennial species; and 6) how to record and enter data collected in the field. All data were collected in Universal Transverse Mercator (UTM) projection, Zone 11, using the North American datum of 1983.

There was not a preconceived order in which the field observers went about visiting points, however consideration was given to completing as many of the low elevation points in the cooler months as possible, then move up in elevation as temperatures increased into the warmer seasons. Slight bias may have resulted from the selection process of points on a daily basis. First, in order to visit as many points as possible in a day, the field observer would choose points close to one another geographically. This would increase the chance of the observer visiting several points within a given polygon or map class due to geographic proximity. As discussed above, this could potentially cause the observer to make similar calls that are not entirely independent of one another. Second, because the plot label contains the size of the plot to be used, the observer may have increased accuracy for those vegetation types that required the 0.25-hectare plots because they were often associated with a limited subset of vegetation types. This bias was deemed to be insignificant, particularly, at the thematically finest levels because many map classes were represented in each observation size. To reduce any bias in making correct field calls for the AA plots, the field observers were not aware of the vegetation type the AA point was representing, nor were they given a map depicting the shape of the polygon the point was located within.

When field observers were ready to navigate to the AA point, the center point coordinates were entered into GPS receivers and the observer then attempted to find the most parsimonious path to the AA plot. Once at the predetermined point, the observer would collect information within a 40 meter or 30 meter radius, depending on the size of the AA plot (0.5- or 0.25-hectare,

respectively). Data collected included date, observer(s) name, AA plot label, GPS coordinates, accuracy of position, type of GPS unit, elevation, absolute percent cover of all perennial species in the plot, and any other relevant notes about the point. The observers always collected a GPS position in the field and these coordinates were considered more accurate than the randomly created coordinates assigned by ArcGIS.

Once the observer was familiar with the observational area inside the AA plot, they consulted the JOTR field key and recorded their first call for the vegetation type that most closely represented their observations. If necessary, a second call was recorded when more than one vegetation type represented what they observed. The field key presents a succession of mutually exclusive vegetation conditions, for example, abundance of certain plant species or species combinations, the presence or absence of diagnostic plant species, minimum percent cover for diagnostic species, etc., for the observer to choose from.

During the 2007 field season, the field observers used the key found in the 2005 vegetation classification report produced by Todd Keeler-Wolf et al. of the California Department of Fish and Game in 2005 (Appendix E, p28-48). At the end of the 2007 field season the original key was modified (see Appendix I) with three significant changes. First, the unmapped vegetation types that were represented in the key were moved to the last page of the key. By moving the unmapped vegetation types to a list at the end of the key it allowed the field observer to consider these types as options but yet choose a mapped type for their AA call. This favors the User's accuracy rate, which supports the management goal of testing the map for on-the-ground accuracy. If the goal of the accuracy assessment is to test the map, then the key should present only map classes that are actually mapped. Secondly, there were a number of map classes that were not listed in the key that were represented on the map, so these were added to the key. The key was written by CDFG and did not account for the differences between the AIS mapping classification and the CDFG ecological classification. Unfortunately, due to the lack of continuity and funding for this project, these differences were not obvious to park staff when the AA process began in 2006. Finally, the field observers substituted a 3-digit code to represent each vegetation type rather than the 5-digit mapping code assigned by the photo-interpreters at AIS (PI code). This was done to reduce the likelihood of transposition errors during data entry, particularly into the GPS receivers. The 3-digit code was transcribed back to the original 5-digit PI code after data were entered.

While a datasheet (see Appendix I) was created to record the field observations, field observers found that pocketsize Rite-in-the-Rain notebooks were more practical due to the long, arduous hikes of up to 8 miles over rough terrain. Carrying a light backpack allowed them to move more quickly and safely. These notebooks are available in the park archive. All data were entered into an excel spreadsheet once the field observer was back in the office.

In cases where two or more distinctly different vegetation types occupied the plot area, observers were given latitude to move the center point a minimum distance in a direction perpendicular to the perceived boundary until the observation area appeared to be within one vegetation type. Observers were instructed to consider significantly steep environmental gradients such as a combination of a wash channel and an upland slope or an abrupt change in stand physiognomy (e.g., regularly spaced trees to no trees) as justification for moving the center position. Because vegetation keys are designed to work in relatively homogeneous vegetation, excessive

heterogeneity can be a justification for rejecting or adjusting an observation area; on the other hand, atypical (but homogeneous) vegetation constitutes a valid observation and should always be assessed as it is encountered (Lea and Curtis 2010). The field observers did not choose to move any of the AA plots using this methodology. This could be due to desert vegetation often being relatively patchy with several ostensibly co-dominant species, therefore the method of moving the center point would not necessarily remedy the seeming lack of homogeneity within the plot.

## 2.5 Accuracy Assessment Analysis

### *2.5.1 Quality Control for Positioning Relative to Map Class Label*

An analysis of the recorded field positions was made in order to determine whether ambiguity in the map class label might exist for any observations, as a result of GPS error, movement of the plot to avoid excessive heterogeneity in assigning the reference data value (as described in Section 2.4), or other reasons:

First, the position (as collected by GPS in the field) of each observation was buffered by a distance according to the following equation (Lea and Curtis 2010):

$$\text{Buffer Distance} = \sqrt{R^2 + F^2 + M^2}$$

where R is the radius distance of the observation area (either 30 meters or 40 meters, for individual JOTR observations), F is the expected (e.g., $90^{th}$ percentile field positioning) GPS error distance (assumed to be 10 meters for all observations at JOTR), and M is the expected maximum positional error distance in the map (12 meters for all observations, as the map was assumed to meet National Map Accuracy Standard (NMAS) requirements for positional accuracy of 1:24,000 scale products). Observations were buffered by 43 meters for all 0.5 hectare observations or by 34 meters for all 0.25 hectare observations.

Using ArcGIS 8.3, the buffer function was used to create polygons of the appropriate radius around each observation. These individual polygons effectively represented the maximum possible extent of any position within the corresponding field plot. Using the spatial join function, these buffered polygons were joined to the JOTR map polygons in order to assign a map class to the buffered observation area. Buffered polygons that received more than one label were removed temporarily from the sample of all observations as having suspected positional ambiguity (due to GPS positioning error).

The position of these buffered polygons, relative to the JOTR map class polygons, showed that 1286 of 1311 observation plots were contained unambiguously within a single map class, in other words the buffered polygon map class was the same as the unbuffered AA observation point. All buffered polygons were labeled with the predominant map class and raw (sample) accuracy was calculated. Of the 25 buffered observation polygons that overlapped more than a single map class, 10 of 25 (40%) had reference labels that matched the sample labels, which exceeds the accuracy of the “unambiguous” positions by almost 10%; only 414 of 1286 (40%) reference labels matched the sample label. Therefore, the 25 suspected “ambiguous” plots were labeled with the predominant map class and retained in the analysis as unambiguous.

During this analysis we found that in two instances the buffered observation area overlapped with two other buffered observation areas, in both cases with more than 75% overlap. We assume that one of the overlapping observations in each case can be considered redundant and removed from the analysis. For one pair, the overlapping observations were labeled with the same unique identifier and therefore considered to have been made in error; one observation was randomly selected and discarded. For the other pair, one observation was randomly selected to be retained in the analysis, and the other overlapping observation was discarded.

### *2.5.2 Thematic Accuracy Calculations*

Following collection and analysis of the accuracy of the original (2005) map, the classification for JOTR was revised (Evens et al. 2012, Appendix A) and the map modified to coincide with the revised classification. These modifications affected the AA in several ways. First, some original associations were deemed too narrowly defined and were merged with other associations (after the map classes representing the original associations had been sampled individually). Second, some original map classes had been mapped as units that had overlapping relationships with other map classes or were ambiguous as to level of thematic resolution (e.g., unique stands of plant species not labeled as to USNVC membership and multiple alliance mapping units). These were assigned a USNVC label. Third, the revised classification defined associations and alliances within the revised USNVC hierarchy (Federal Geographic Data Committee 2008, Evens et al. 2012), enabling aggregations to be done to higher levels of the newer version of the USNVC. Finally, some individual polygons with AA plots were relabeled to match the reference data in the AA plot (i.e., some parts of the map classes were corrected using the AA data).

The first three *post hoc* modifications to the classification and map required that a population contingency table be created for the original map classes prior to merging the cell proportions to derive representative accuracy rates for the user's accuracies of a number of associations using a stratified design (Lea and Curtis 2012). Some associations recognized by Evens et al. (2012) had been sampled in the original field efforts for the project, but were not recognized in the 2005 version of the classification, perhaps due to lack of resolution or too few data points. In addressing the fourth *post hoc* modification to the map (relabeling polygons to match reference data collected within them), we could not apply the new sample data labels (map classes) because of the obvious circular reasoning that would be involved (sample data labels matched reference data labels because they were changed to fit reference data labels). However, the sample error rates derived from the original labels can be expected to be largely representative of population error rates that still exist throughout the uncorrected parts of the map and map classes, and for most map classes these represent most of the map. The reason for this is that entire polygons were relabeled on the basis of a relatively small area observed (0.5 or 0.25 hectare) and a polygon cannot be assumed to be internally homogeneous (as mapped) unless observed in its entirety. This assumption would be less true for smaller map classes, for which larger proportions of the class were corrected, than for extensive map classes. A further consideration is that some polygon relabeling may have reduced map class accuracy because rarely has an entire polygon been ground-truthed. We consider the reported sample accuracy rates to be somewhat conservative, but relatively accurate representations of the current JOTR map (population) accuracy rates.

We attributed the reference (field observation calls) labels to the AA observation point as recorded in the field by GPS. Using a spatial join of this point theme with the JOTR vegetation

map polygon theme, we applied the JOTR map class label to yield a table of all observations with three values (columns): a unique identifier, a map class label, and a reference data label. We applied the Microsoft Excel ® 2007 pivot table function to yield a map class value by reference data value table, with each cell representing a unique combination of map class X reference data value. Each cell contains the number of observations with that combination of values. This pivot table was the raw sample contingency table for the original map and vegetation classes (Lea and Curtis 2010).

From the sample contingency table and map class area calculations, we created a population (proportional) contingency table for all original map classes, as specified by Lea and Curtis (2010), using Microsoft Excel ® 2007.

To report USNVC association level user's, producer's, and overall accuracies in terms of the revised classification (Evens et al. 2012) and map (see Table 2), we relabeled the applicable proportions for rows and columns of individual map classes that underwent global recodes (i.e. either renaming a vegetation type or merging together two or more vegetation types). Observations that were assigned either sample data labels, reference data labels, or both, at a higher level of the USNVC hierarchy (i.e., at a coarser thematic resolution) were not included in the association level analysis. We summed population table rows and columns to derive individual user's and producer's accuracy rates, respectively, and diagonal cell proportions in the population contingency table were summed to derive overall accuracy (Lea and Curtis 2010). We used vegetation type producer's accuracies and the area mapped within each map class to derive estimated areas of all associations (see Table 4), as corrected for overmapping or undermapping (Czaplewski 2003, Lea and Curtis 2010).

To report USNVC alliance level user's, producer's, and overall accuracies in terms of the revised classification and map, we relabeled association level classes with their appropriate alliance membership, and combinations of rows and columns were made, accordingly. Observations that were assigned either sample data labels, reference data labels, or both, at a higher level of the USNVC hierarchy (i.e., at a coarser thematic resolution) were not included in the alliance level analysis.

We repeated this process to report user's, producer's, and overall accuracies at the higher USNVC levels of group, macrogroup, formation, and class, as assigned by Evens et al. (2012). We did not calculate USNVC division and subclass level accuracies because division units are 1:1 with formation units within JOTR and subclass units are nearly 1:1 with class units, and in both cases the respective overall accuracies are identical.

### 2.6 Rapid Assessments

In September 2008, a meeting was held to discuss and analyze the results of the accuracy assessment. Attendees included JOTR staff members and field observers, AIS representatives, Todd Keeler-Wolf representing CDFG, and Chris Lea representing the NPS vegetation mapping program. As a result of this meeting it was decided to collect additional vegetation data to help define the ecological signature of 14 problematic vegetation types or polygons. The goal was to complete a minimum of 10 Rapid Assessments (RA) within the map classes lacking good ecological information (i.e. problematic vegetation types), with a focus on visiting polygons that were not sampled during the AA process, whereas for each of the problematic polygons only one

RA was needed. The 10 vegetation types that were targeted for better ecological definition include (2005 PI code in parentheses): 1) *Yucca brevifolia* Wooded Shrubland Alliance (13010); 2) *(Ephedra nevadensis – Pleurocoronis pluriseta – Encelia farinosa - Trixis californica – Bebbia juncea – Eriogonum fasciculatum – Lycium andersonii – Acacia greggii)* Low-Elevation Rocky Mountain Type (24001); 3) *Salazaria mexicana – Krameria* spp. *– Encelia farinosa – Hyptis emoryi – Eriogonum fasciculatum – Hymenoclea salsola – Acacia greggii – Tetracoccus hallii* Dense Rivulet/Desert Pavement Type (27001); 4) *Larrea tridentata – (Ambrosia dumosa – Viguiera parishii)* Higher-Elevation Type (27046); 5) *Coleogyne ramosissima* — (mixed shrub) Super Association (28023); 6) *Viguiera parishii – (Ephedra nevadensis – Eriogonum fasciculatum – Nolina bigelovii)* High-Elevation Rocky Mountain Type (28133); 7) *Ambrosia dumosa – Senna armata – (Psorothamnus schottii)* Eastern Pediment Type (43013); 8) *Ambrosia dumosa – (Eriogonum fasciculatum – Lycium andersonii/Pleuraphis rigida)* Western Mountain Type (43014); 9) *Bromus tectorum* fire plot (60001); and 10) Desert Pavement (90100). The four vegetation types represented by problematic polygons were: 1) *Prosopis glandulosa* Woodland Shrubland Alliance (16040); 2) *Larrea tridentata* Clones (27022)*;* 3) *Larrea tridentata — Encelia farinosa — Fouquieria splendens* Shrubland Association (27056)*;* and 4) *Acacia greggii* — (*Viquieria parishii — Eriogonum fasciculatum*) Upland Slope Type (36017). A total of 111 relevé plots were completed in 2009 (Figure 5). There are other vegetation types and polygons that will benefit from additional information; however, it was not feasible to include all of them in the 2009 field effort. See the discussion under "Future Work" for suggestions on which vegetation types could benefit most from additional plot data.

The RA protocol developed by CNPS (http://cnps.org/cnps/vegetation/sampling.php) was chosen for data collection because it provides more detailed ecological information than the AA protocol. In particular, the RA plots are meant to sample the entire stand, or polygon, and the observer chooses a representative spot within the polygon to record their observations. Field observers were instructed to walk around in the polygon before choosing a representative location to record data. This is in contrast to the AA protocol, which requires that the point is fixed (randomly assigned to a location inside the polygon) and the observer does not know where the borders of the polygon lie or have the opportunity to move the point to a more representative location. The following guidelines from the CNPS protocol (see Appendix I) were to be considered in choosing an area to represent the stand:

1) It has compositional integrity. Throughout the site, the combination of species is similar. The stand is differentiated from adjacent stands by a discernible boundary that may be abrupt or indistinct.
2) It has structural integrity. It has a similar history or environmental setting that affords relatively similar horizontal and vertical spacing of plant species. For example, a hillside forest originally dominated by the same species that burned on the upper part of the slopes, but not the lower, would be divided into two stands. Likewise, sparse woodland occupying a slope with very shallow rocky soils would be considered a different stand from an adjacent slope with deeper, moister soil and a denser woodland or forest of the same species.

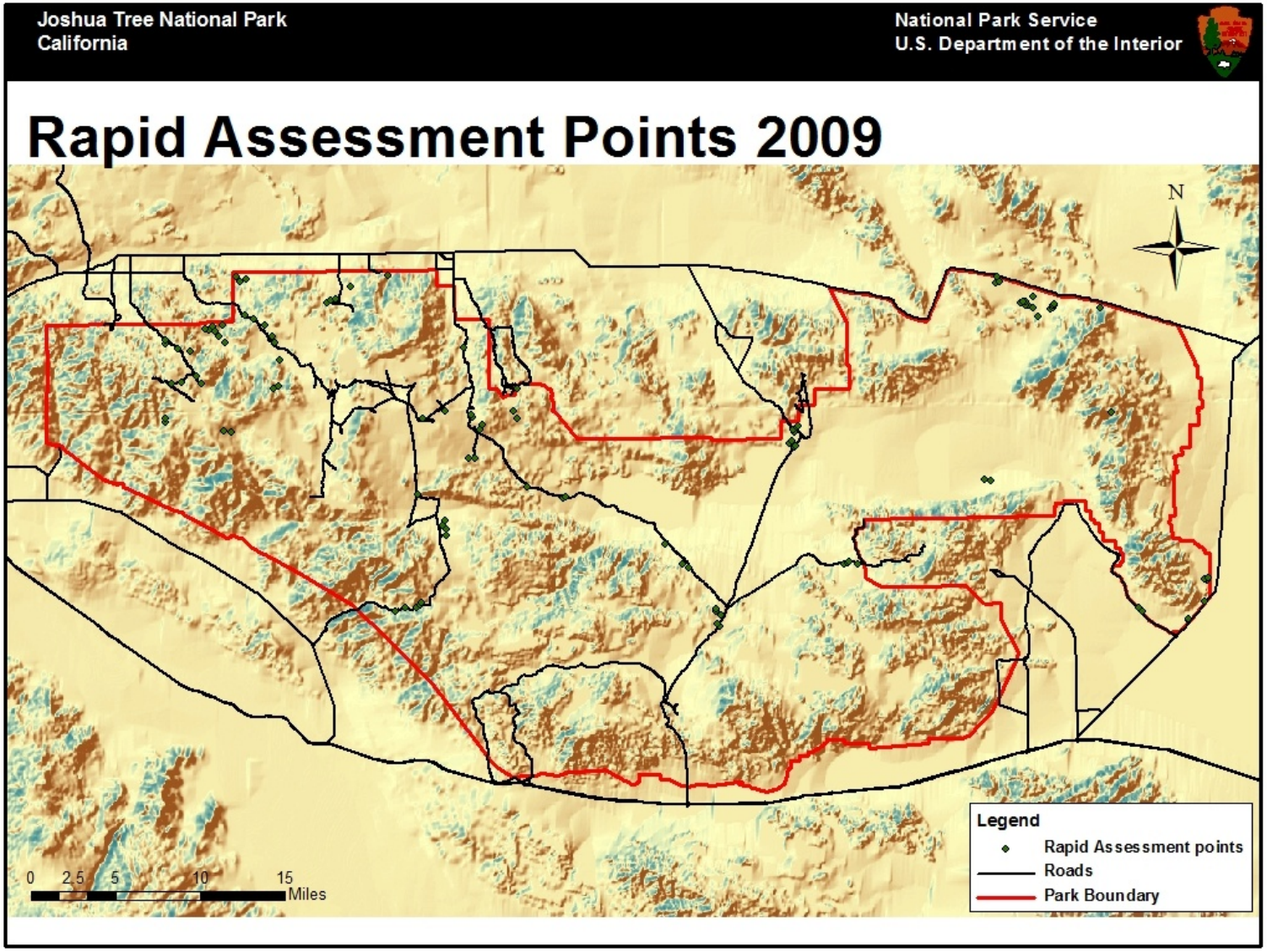



**Figure 5**. Locations of rapid assessment points collected in 2009.

The CNPS Combined Rapid Assessment and Relevé Field Form (Appendix I) was used for data collection in the field (datasheets are available in the Park archive). Upon returning to the office, data were entered into an Access database provided by CNPS (Access database is available on the JOTR sharedrive, "JOTR_2009_PLOTDATA.mdb"). At each RA plot, photographs were taken in each of the cardinal directions; a file geodatabase containing the embedded photos was created in ArcGIS Desktop 9.3.1 and is available on the Park sharedrive (RA_Photos.gdb).

## 2.7 Vegetation Mapping and Classification

The vegetation mapping portion of the project was contracted to Aerial Information Systems, Inc. (AIS) out of Redlands, CA. The mapping effort began in 1996 and by 2004 they had produced a vegetation map (referred to as the 2005 version of the map), along with two reports (see Appendix F and G) titled, *Photo-Interpretation Report, USGS-NPS Vegetation and Inventory and Mapping Program, Joshua Tree National Park* and *USGS-NPS Vegetation Mapping Program, Joshua Tree National Park Mapping Classification.* AIS was hired again in 2009-2010 to assist in updating the map; they hosted the meeting in August 2009, then proceeded to make changes to the map as discussed at the meeting. For the most part, this involved revisiting aerial photos and reevaluating the map class assigned to each problematic polygon, as well as correcting any global recodes and minor edits to the nomenclature. Aerial imagery used for the project was from 1998, including the revisits in 2009, and the minimum mapping unit was defined as 0.50 hectares. For more detail on methods used by AIS to produce the map and a summary of the project pre-2005, refer to the reports mentioned above. All changes made to the map after 2010 were done by JOTR staff, specifically Tasha La Doux and Sean Murphy.

The 2005 version of the vegetation classification was completed by the California Department of Fish and Game (CDFG) in March of 2005. This report, titled "*Vegetation Classification of Joshua Tree National Park, Riverside and San Bernardino Counties, California"*, included ecological descriptions, a key, and an overview of the project (see Appendix E). The lead author, Todd Keeler-Wolf, continued to work with Park staff once the Accuracy Assessment phase started in 2007. He attended both the 2008 and 2009 meetings in which results from the 2007-2009 field seasons were discussed and incorporated into the 2012 version of the classification, largely based on his analyses. In 2011, Julie Evens of the California Native Plant Society (CNPS) was hired to produce a report containing ecological descriptions for the final classification; this report is titled "*Vegetation Descriptions for Joshua Tree National Park"* (see Appendix A). Leading up to this, Todd Keeler-Wolf, Julie Evens, and Tasha La Doux worked together to update the classification to reflect the most recent nomenclature supported by NVC and Sawyer et al. (2009). In addition, newly acquired datasets from nearby areas (e.g., northern and eastern Colorado Desert) were utilized to help clarify some of the vegetation types that had previously been difficult to describe due to lack of data. All statistical analyses were performed by Todd Keeler-Wolf (CDFG) and the methods are described in Appendix E. For more detailed information on these analyses, contact Todd Keeler-Wolf (CDFG) directly. Finally, using a draft version of an ecological key produced by Todd Keeler-Wolf, the final vegetation key was completed by Tasha La Doux (see Appendix C). This key is meant to be an ecological key, such that observations should be based on the stand and not limited to any given plot size. Any plot data obtained by using the key should consider placing the plot in a location that is representative of the surrounding stand (within the mapped polygon).

The final classification was based on vegetation data from a total of 689 plots derived from six different projects. Four of these projects were not directly related to this effort; however, they contributed 278 vegetation plots to the analysis. The majority of the plots (411) were sampled for the purpose of this project, including 300 plots completed by AIS in 2000 and 111 plots sampled by JOTR staff in 2009. All of these plots used the CNPS Relevé protocol (CNPS 2004). The other four data sets with useful vegetation data for this analysis are referred to as Watts, MDEI, NECO, and Long. More specifically, 108 plots collected by Joe Watts of the Army Corps of Engineers in 1996; 76 plots sampled for the Mojave Desert Ecosystem Initiative Program (MDEI) in 1997; 20 plots were utilized from a much larger project referred to as the Northeast Colorado Desert vegetation survey completed by CNPS and CDFG; and 74 plots sampled for the purpose of monitoring restoration effects on desert tortoise habitat in 1997 by Brent Long, an ecologist at Joshua Tree National Park. In addition to these data sets, two reports were utilized in developing the preliminary classification at the beginning of the project, these were 1) "The Ecology of the Joshua Tree in Joshua Tree National Monument," which was a master's thesis by James Hogan of the University of Nevada, Las Vegas, and 2) "Investigation of the Vegetational Communities of Joshua Tree National Monument", a National Park Service technical report by Patrick Leary in 1977. A more complete summary of these data sets (with the exception of the JOTR relevé plots from 2009) is available in Keeler-Wolf et al. (2005), which is attached to this report as Appendix E. In addition, the 1,313 Accuracy Assessment plots were helpful during the discussions in 2008 and 2009 to assess presence/absence of species within vegetation types and were useful in corroborating the presence or absence of certain vegetation types within the Park. All data are available on the Park sharedrive.

# 3.0 Results

## 3.1 Thematic Accuracy Assessment

Overall map class accuracies for the JOTR map are 41.0% at the USNVC association level (41 map classes, number of observations = 1070), 61.0% at the alliance level (32 map classes, n= 1278), 82.0% at the group level (13 map classes, n= 1281), 87.3% at the macrogroup level (10 map classes, n= 1281), 92.5% at the division and formation levels (8 map classes at each level, n= 1285), and 92.9% at the subclass and class level (4 map classes at class level and 5 map classes at subclass level, n= 1290).

Table 2 reports map class user's and producer's accuracies. Because of the complex variance calculations with the large number of aggregations, confidence intervals are not reported; instead, numbers of observations with sample and reference data labels for each class are listed. GIS-calculated areas and estimated areas for each class, as adjusted for mapping error, are listed. Table 4 reports areas for each association and alliance level class as mapped and the estimated areas for each of these classes as adjusted for mapping error (Czaplewski 2003, Lea and Curtis 2010).

Tables H1 through H12 (Appendix H) are sample and population contingency tables for multiple levels of the USNVC hierarchy, as assessed for the JOTR vegetation map. The proportions in the population contingency tables allow patterns of map class confusion not summarized by aggregation within the USNVC hierarchy (Table 2) to be assessed. The numbers in the cells within the sample contingency tables are sums of observations originally assigned to the different map classes, cell counts are from a stratified random design. They are presented to show general patterns of error frequency, but cannot be used for precise estimation of individual class or overall accuracy rates.

## 3.2 Accuracy Assessment Vegetation Data

In August 2009, a meeting was held in Redlands, CA, to review and discuss all the new vegetation data collected during the 2007 – 2009 field seasons. Present at the meeting were Todd Keeler-Wolf (CDFG), Debbie Johnson (AIS), Ed Reyes (AIS), John Menke (AIS), Erin Babich (JOTR), Tasha La Doux (JOTR), and Sean Murphy (JOTR). Prior to the meeting Park staff prioritized the vegetation types to be discussed and made suggestions for how each of these might be affected after reviewing the new data. Todd Keeler-Wolf had also done additional cluster analyses incorporating the new data, which he presented during the meeting. Specifically, the following aspects of each vegetation type were considered and changed if necessary: 1) nomenclature should follow Manual of California Vegetation Second Edition (Sawyer et al. 2009) and/or NVC standards; 2) assignment of a proper PI code; 3) if possible, polygons mapped at the Alliance level were assigned an Association; and 4) any problematic vegetation types (or polygons) were assessed and either left unchanged or reclassified. Major changes made to the map and classification are discussed below, however, the 14 types targeted by the RA effort in 2009 are discussed in the following Section (3.3). To view all changes made to the 2005 version of the map, see the excel document titled "Map and Classification Crosswalk, 2005 to 2012" (Appendix D), as well as the attribute table of the geodatabase feature class titled "JOTR_2012_Veg_Classification_Documentation".

**Table 2**. Accuracy assessment statistics for JOTR, by National Vegetation Classification class, formation, macrogroup, group, alliance, and association assignments. $N_{i+}$ and $N_{+j}$ denote the numbers of sample data observations and reference data observations for each map class, respectively. Overall map accuracies are: at USNVC Class (and USNVC Subclass): 92.9%; at USNVC Formation (and USNVC Division): 92.5%; at USNVC Macrogroup: 87.3%; at USNVC Group 82.0%; at USNVC Alliance: 61.0%; at USNVC Association: 41.0%.

| MAP CLASS NAME AND NUMBER | USERS ACCURACY | $N_{i+}$ | PRODUCERS ACCURACY | $N_{+j}$ |
|---|---|---|---|---|
| **Forest & Woodland Class** | **72.0%** | **38** | **73.6%** | **41** |
| ***Cool Temperate Forest Formation*** | ***72.1%*** | ***26*** | ***73.6%*** | ***31*** |
| **Intermountain Singleleaf Pinyon-Western Juniper Woodland Macrogroup** | **72.1%** | **26** | **73.6%** | **31** |
| **Great Basin Pinyon-Juniper Woodland Group** | **72.1%** | **26** | **73.6%** | **31** |
| ***Pinus monophylla* Woodland Alliance (10160)** | **72.1%** | **26** | **74.4%** | **30** |
| *Pinus monophylla / Quercus cornelius-mulleri* Association (10161) | 72.1% | 26 | 75.8% | 28 |
| ***Temperate Flooded & Swamp Forest Formation*** | ***0.0%*** | ***12*** | ***0.0%*** | ***10*** |
| **Warm Mediterranean & Desert Riparian, Flooded & Swamp Forest MG** | **0.0%** | **12** | **0.0%** | **10** |
| **Southwestern North American Warm Desert Riparian Group** | **0.0%** | **12** | **0.0%** | **10** |
| ***Populus fremontii* Forest Alliance (15040)** | **0.0%** | **3** | **0.0%** | **0** |
| ***Salix gooddingii* Woodland Alliance (15030)** | **100.0%** | **4** | **37.7%** | **6** |
| ***Washingtonia filifera* Woodland Alliance (15110)** | **80.0%** | **5** | **100.0%** | **4** |
| **Shrubland & Grassland Class** | **44.4%** | **39** | **52.6%** | **44** |
| ***Mediterranean Scrub Formation*** | ***41.2%*** | ***17*** | ***31.0%*** | ***38*** |
| **California Chaparral Macrogroup** | **41.2%** | **17** | **31.0%** | **38** |
| **California Mesic North-Slope Chaparral Group** | **41.2%** | **17** | **31.0%** | **38** |
| ***Quercus cornelius-mulleri* Shrubland Alliance (21230)** | **41.2%** | **17** | **31.0%** | **38** |
| *Quercus cornelius-mulleri - Eriogonum fasciculatum - Ericameria linearifolia* Association (21234) | 41.2% | 17 | 39.9% | 17 |
| ***Mediterranean Grassland & Forb Meadow Formation*** | ***0.0%*** | ***18*** | ***0.0%*** | ***0*** |
| **California Annual & Perennial Grassland Macrogroup** | **0.0%** | **18** | **0.0%** | **0** |
| **Mediterranean California Naturalized Annual & Perennial Grassland Group** | **0.0%** | **18** | **0.0%** | **0** |
| ***Bromus rubens - Schismus* (*arabicus, barbatus*) Semi-Natural Herbaceous Stands (60010)** | **0.0%** | **16** | **0.0%** | **0** |
| ***Salt Marsh Formation*** | ***75.0%*** | ***4*** | ***19.6%*** | ***6*** |
| **Warm Semi-Desert & Mediterranean Alkaline-Saline Wetland MG** | **75.0%** | **4** | **19.6%** | **6** |
| **North American Warm Desert Alkaline Scrub & Herb Playa & Wet Flat Group (90400)** | **75.0%** | **4** | **19.6%** | **6** |

**Table 2**. Accuracy assessment statistics for JOTR, by National Vegetation Classification class, formation, macrogroup, group, alliance, and association assignments. $N_{i+}$ and $N_{+j}$ denote the numbers of sample data observations and reference data observations for each map class, respectively. Overall map accuracies are: at USNVC Class (and USNVC Subclass): 92.9%; at USNVC Formation (and USNVC Division): 92.5%; at USNVC Macrogroup: 87.3%; at USNVC Group 82.0%; at USNVC Alliance: 61.0%; at USNVC Association: 41.0% (continued).

| MAP CLASS NAME AND NUMBER | USERS ACCURACY | $N_{i+}$ | PRODUCERS ACCURACY | $N_{+j}$ |
|---|---|---|---|---|
| **Xeromorphic Scrub & Herb Vegetation (Semi-Desert) Class** | **96.1%** | **1179** | **97.7%** | **1183** |
| ***Warm Desert Scrub & Grassland Formation*** | ***96.0%*** | ***1172*** | ***97.7%*** | ***1151*** |
| **Mojave-Sonoran Semi-Desert Scrub Macrogroup** | **90.6%** | **868** | **97.9%** | **876** |
| **Mojave Mid-Elevation Mixed Desert Scrub Group** | **77.8%** | **492** | **88.3%** | **430** |
| ***Coleogyne ramosissima* Shrubland Alliance (28020)** | **28.6%** | **28** | **9.5%** | **23** |
| *Coleogyne ramosissima - Ephedra nevadensis* Association (28023) | 28.6% | 28 | 10.1% | 22 |
| ***Eriogonum fasciculatum - Viguiera parishii* Shrubland Alliance (28130)** | **33.3%** | **35** | **63.7%** | **42** |
| *Viguiera parishii - Ambrosia dumosa - Simmondsia chinensis* Association (28134) | 22.2% | 18 | 47.4% | 28 |
| *Viguiera parishii - Eriogonum fasciculatum - Simmondsia chinensis* Association (28133) | 23.5% | 17 | 41.6% | 12 |
| ***Juniperus californica* Woodland Alliance (10020)** | **72.1%** | **175** | **66.1%** | **140** |
| *Juniperus californica / Yucca schidigera / Pleuraphis rigida* Association (10031) | 24.9% | 27 | 20.4% | 24 |
| *Juniperus californica / Coleogyne ramosissima* Association (10025) | 69.4% | 106 | 61.9% | 103 |
| *Juniperus californica / Quercus cornelius-mulleri – Coleogyne ramosissima* Association (10032) | 25.0% | 24 | 38.3% | 12 |
| ***Pleuraphis rigida* Herbaceous Alliance (59010)** | **53.3%** | **30** | **17.4%** | **20** |
| ***Salazaria mexicana* Shrubland Alliance (28140)** | **0.0%** | **0** | **0.0%** | **5** |
| ***Tetracoccus hallii* Provisional Shrubland Alliance (28180)** | **20.0%** | **5** | **0.4%** | **10** |
| *Tetracoccus hallii* Provisional Association (28181) | 100.0% | 1 | 0.4% | 10 |
| ***Yucca brevifolia* Woodland Alliance (13010)** | **83.4%** | **139** | **78.5%** | **145** |
| *Yucca brevifolia - Juniperus californica / Ephedra nevadensis* Association (13015) | 53.1% | 32 | 48.4% | 40 |
| *Yucca brevifolia / Coleogyne ramosissima* Association (13012) | 37.0% | 27 | 7.4% | 22 |
| *Yucca brevifolia / Larrea tridentata - Yucca schidigera / Pleuraphis rigida* Association (13016) | 71.4% | 28 | 70.4% | 40 |
| *Yucca brevifolia / Pleuraphis rigida* Association (13021) | 66.7% | 24 | 71.4% | 34 |
| ***Yucca schidigera* Shrubland Alliance (29030)** | **34.9%** | **79** | **58.3%** | **43** |
| *Yucca schidigera - Coleogyne ramosissima* Association (29032) | 5.6% | 18 | 10.5% | 10 |
| *Yucca schidigera - Larrea tridentata - Ambrosia dumosa* Association (29033) | 16.1% | 35 | 28.3% | 23 |
| *Yucca schidigera / Pleuraphis rigida* Association (29034) | 8.0% | 25 | 3.9% | 5 |

**Table 2**. Accuracy assessment statistics for JOTR, by National Vegetation Classification class, formation, macrogroup, group, alliance, and association assignments. $N_{i+}$ and $N_{+j}$ denote the numbers of sample data observations and reference data observations for each map class, respectively. Overall map accuracies are: at USNVC Class (and USNVC Subclass): 92.9%; at USNVC Formation (and USNVC Division): 92.5%; at USNVC Macrogroup: 87.3%; at USNVC Group 82.0%; at USNVC Alliance: 61.0%; at USNVC Association: 41.0% (continued).

| MAP CLASS NAME AND NUMBER | USERS ACCURACY | $N_{i+}$ | PRODUCERS ACCURACY | $N_{+j}$ |
|---|---|---|---|---|
| **Xeromorphic Scrub & Herb Vegetation (Semi-Desert) Class (cont.)** | | | | |
| ***Warm Desert Scrub & Grassland Formation (cont.)*** | | | | |
| **Mojave-Sonoran Semi-Desert Scrub Macrogroup (cont.)** | | | | |
| **Sonoran – Mojave Creosotebush – White Bursage Desert Scrub Group** | **86.9%** | **376** | **92.6%** | **446** |
| ***Ambrosia salsola* Shrubland Alliance (28110)** | **0.0%** | **0** | **0.0%** | **13** |
| ***Cylindropuntia bigelovi*i Shrubland Alliance (29050)** | **84.0%** | **25** | **41.1%** | **23** |
| *Cylindropuntia bigelovi*i Association (29051) | 100.0% | 25 | 41.1% | 23 |
| ***Encelia farinosa* Shrubland Alliance (28030)** | **33.3%** | **9** | **7.0%** | **13** |
| *Encelia farinosa - Ambrosia dumosa* Association (28033) | 33.3% | 9 | 7.0% | 13 |
| ***Larrea tridentata - Ambrosia dumosa* Shrubland Alliance (27030)** | **72.3%** | **223** | **81.7%** | **253** |
| *Larrea tridentata - Ambrosia dumosa - Psorothamnus arborescens* Association (27044) | 0.0% | 10 | 0.0% | 0 |
| *Larrea tridentata - Ambrosia dumosa - Krameria grayi* Association (27034) | 0.0% | 26 | 0.0% | 0 |
| *Larrea tridentata - Ambrosia dumosa - Senna armata* Association (27047) | 49.1% | 51 | 4.8% | 99 |
| *Larrea tridentata - Ambrosia dumosa - Simmondsia chinensis* Association (27046) | 25.0% | 20 | 19.9% | 19 |
| *Larrea tridentata - Ambrosia dumosa - Yucca schidigera* Association (27045) | 75.6% | 48 | 59.3% | 57 |
| *Larrea tridentata - Ambrosia dumosa* Association (27031) | 23.8% | 47 | 74.5% | 54 |
| ***Larrea tridentata - Encelia farinosa* Shrubland Alliance (27050)** | **52.8%** | **55** | **75.7%** | **82** |
| *Larrea tridentata - Encelia farinosa - Ambrosia dumosa* Association (27057) | 50.0% | 12 | 70.1% | 51 |
| *Larrea tridentata - Encelia farinosa - Fouquieria splendens* Association (27056) | 27.6% | 29 | 4.1% | 15 |
| *Larrea tridentata - Encelia farinosa - Pleurocoronis pluriseta* Association (27059) | 0.0% | 13 | 0.0% | 10 |
| ***Larrea tridentata* Shrubland Alliance (27010)** | **49.9%** | **59** | **23.7%** | **62** |
| *Larrea tridentata - Atriplex hymenelytra* Association (27023) | 0.0% | 4 | 0.0% | 0 |
| *Larrea tridentata / Pleuraphis rigida* Association (27021) | 46.2% | 26 | 39.2% | 31 |
| *Larrea tridentata Association* (27019) | 35.7% | 28 | 5.5% | 25 |

**Table 2**. Accuracy assessment statistics for JOTR, by National Vegetation Classification class, formation, macrogroup, group, alliance, and association assignments. $N_{i+}$ and $N_{+j}$ denote the numbers of sample data observations and reference data observations for each map class, respectively. Overall map accuracies are: at USNVC Class (and USNVC Subclass): 92.9%; at USNVC Formation (and USNVC Division): 92.5%; at USNVC Macrogroup: 87.3%; at USNVC Group 82.0%; at USNVC Alliance: 61.0%; at USNVC Association: 41.0% (continued).

| MAP CLASS NAME AND NUMBER | USERS ACCURACY | $N_{i+}$ | PRODUCERS ACCURACY | $N_{+j}$ |
|---|---|---|---|---|
| **Xeromorphic Scrub & Herb Vegetation (Semi-Desert) Class (cont.)** | | | | |
| ***Warm Desert Scrub & Grassland Formation (cont.)*** | | | | |
| **North American Warm-Desert Xero-Riparian Macrogroup** | **79.9%** | **304** | **16.5%** | **275** |
| **Sonoran-Coloradan Semi-Desert Wash Woodland / Scrub Group** | **77.7%** | **254** | **18.4%** | **213** |
| ***Chilopsis linearis* Woodland Alliance (15010)** | **54.2%** | **24** | **93.6%** | **15** |
| *Chilopsis linearis* Association (15013) | 56.5% | 23 | 93.6% | 15 |
| ***Hyptis emoryi* Shrubland Alliance (28200)** | **52.9%** | **17** | **0.0%** | **24** |
| *Hyptis emoryi* Association (28203) | 60.0% | 15 | 0.0% | 24 |
| ***Justicia californica* Provisional Shrubland Alliance (28171)** | **0.0%** | **30** | **0.0%** | **0** |
| ***Parkinsonia florida - Olneya tesota* Woodland Alliance (16010)** | **84.1%** | **139** | **28.8%** | **162** |
| *Parkinsonia florida – Olneya tesota / Cylindropuntia* sp. Association (16024) | 50.0% | 28 | 8.0% | 32 |
| *Parkinsonia florida - Olneya tesota / Hyptis emoryi* Association (16025) | 69.0% | 29 | 52.2% | 33 |
| P*arkinsonia florida / Hyptis emoryi* Association (16015) | 53.1% | 51 | 61.5% | 41 |
| *Parkinsonia florida / Larrea tridentata - Peucephyllum schottii* Association (16013) | 37.1% | 28 | 31.9% | 24 |
| ***Prosopis glandulosa* Woodland Alliance (16040)** | **100.0%** | **5** | **100.0%** | **5** |
| ***Psorothamnus spinosus* Woodland Alliance (16030)** | **17.8%** | **49** | **51.3%** | **17** |
| *Psorothamnus spinosus / Hyptis emoryi - Acacia greggii* Association (16035) | 19.1% | 45 | 51.3% | 17 |
| **Warm Semi-Desert Shrub & Herb Wash-Arroyo Group** | **19.5%** | **50** | **0.8%** | **62** |
| **Acacia greggii Shrubland Alliance (36010)** | **19.5%** | **50** | **0.9%** | **53** |
| *Acacia greggii* - (*Bebbia juncea - Hyptis emoryi*) Association (36015) | 5.9% | 17 | 0.2% | 21 |
| *Acacia greggii - Prunus fasciculata* Association (36016) | 40.7% | 27 | 2.9% | 21 |
| ***Prunus fasciculata* Shrubland Alliance (32010)** | **0.0%** | **0** | **0.0%** | **9** |
| *Prunus fasciculata* Association (32013) | 0.0% | 0 | 0.0% | 3 |
| ***Cool Semi-Desert Scrub & Grassland Formation*** | ***100.0%*** | ***7*** | ***6.2%*** | ***23*** |
| **Great Basin & Intermountain Semi-Desert Shrubland & Steppe MG** | **100.0%** | **1** | **100.0%** | **1** |
| **Intermountain Semi-Desert Shrubland & Steppe Group** | **100.0%** | **1** | **100.0%** | **1** |
| ***Ericameria nauseosa* Shrubland Alliance (28210)** | **100.0%** | **1** | **100.0%** | **1** |

**Table 2**. Accuracy assessment statistics for JOTR, by National Vegetation Classification class, formation, macrogroup, group, alliance, and association assignments. $N_{i+}$ and $N_{+j}$ denote the numbers of sample data observations and reference data observations for each map class, respectively. Overall map accuracies are: at USNVC Class (and USNVC Subclass): 92.9%; at USNVC Formation (and USNVC Division): 92.5%; at USNVC Macrogroup: 87.3%; at USNVC Group 82.0%; at USNVC Alliance: 61.0%; at USNVC Association: 41.0% (continued).

| MAP CLASS NAME AND NUMBER | USERS ACCURACY | $N_{i+}$ | PRODUCERS ACCURACY | $N_{+j}$ |
|---|---|---|---|---|
| **Xeromorphic Scrub & Herb Vegetation (Semi-Desert) Class (cont.)** | | | | |
| ***Cool Semi-Desert Scrub & Grassland Formation (cont.)*** | | | | |
| **Great Basin Saltbrush Scrub Macrogroup** | **100.0%** | **6** | **1.8%** | **22** |
| **Intermountain Shadscale-Saltbush Scrub Group** | **100.0%** | **6** | **1.8%** | **22** |
| ***Atriplex canescens* Shrubland Alliance (28080)** | **100.0%** | **6** | **1.9%** | **21** |
| *Atriplex canescens* Association (28083) | 100.0% | 6 | 3.7% | 12 |
| **Nonvascular & Sparse Vascular Rock Vegetation Class** | **32.7%** | **25** | **15.7%** | **22** |
| ***Warm Semi-Desert Cliff, Scree, & Rock Vegetation Formation*** | ***32.7%*** | ***25*** | ***15.7%*** | ***22*** |
| **North American Warm Semi-Desert Cliff, Scree & Rock Vegetation Macrogroup** | **32.7%** | **25** | **15.7%** | **22** |
| **North American Warm Desert Dunes & Sand Flats Group** | **0.0%** | **0** | **0.0%** | **0** |
| ***Dicoria canescens - Abronia villosa* Sparsely Vegetated Alliance (60020)** | **0.0%** | **0** | **0.0%** | **0** |
| **North American Warm Semi-Desert Cliff, Scree & Pavement Group** | **32.7%** | **25** | **15.7%** | **22** |
| ***Geraea canescens - Chorizanthe rigida* Desert Pavement Annual Herbaceous Alliance (90100)** | **33.3%** | **24** | **16.2%** | **19** |
| **Rock Outcrops (90200)** | **0.0%** | **1** | **0.0%** | **3** |
| **Unvegetated - Disturbed/Built-Up (90600)** | **35.7%** | **14** | **100.0%** | **5** |
| **Unvegetated – Water (90900)** | **100.0%** | **3** | **100.0%** | **3** |

In the 2005 version of the map, there were seven Associations (including "mapping units") under the Juniper Alliance (10020), whereas in the final version there are only three. The diversity that was represented in the original classification was not supported by the vegetation data collected during the AA process. While the diversity of species represented in the original classification was present, it didn't support individual Associations based on the presence or absence of these species. It seemed that the Alliance was better described by splitting it into two major groups based on presence/absence of *Coleogyne ramosissima*. The final three Associations include: *Juniperus californica / Coleogyne ramosissima* Association (2012 PI code: 10025), *Juniperus californica / Quercus cornelius-mulleri — Coleogyne ramosissima* Woodland Association (2012 PI code: 10032), and *Juniperus californica / Yucca schidigera / Pleuraphis rigida* Woodland Association (2012 PI code: 10031).

Both the *Pinus monophylla* Alliance and *Quercus cornelius-mulleri* Alliance were changed to include one Association rather than two. *Pinus monophylla* (PIMO) is never very dense in JOTR, unlike other higher elevation areas in the Mojave Desert, and therefore does not have a strong expression as a dominant cover. It generally co-occurs with *Quercus cornelius-mulleri* (QUCO) and sometimes *Juniperus californica* (JUNCAL), and can even be at lower cover than these species. Despite the low cover, these PIMO stands are to be considered part of the PIMO Alliance unless QUCO or JUNCAL cover is >2 times that of PIMO and PIMO has <3% absolute cover. The *Pinus monophylla — (Juniperus californica) / Achnatherum speciosum* Woodland Association (2005 PI code: 10162) was eliminated from the classification and all polygons were changed to *Pinus monophylla / Quercus cornelius-mulleri* Woodland Association (PI code: 10161). The difference between these two Associations was based on a perceived geomorphic difference (north-facing rockier sites with QUCO versus south-facing drier sites with JUNCAL), however, based on the AA data, the presence of *Pinus monophylla — (Juniperus californica) / Achnatherum speciosum* Woodland Association was not corroborated for JOTR. In addition, the final version of the classification has only one association in the *Quercus cornelius-mulleri* Alliance, which is *Quercus cornelius-mulleri — Eriogonum fasciculatum — Ericameria linearifolia* Association (2012 PI code: 21234). The other association, *Quercus cornelius-mulleri — (Juniperus californica / Coleogyne ramosissima* Association (2005 PI code: 21233) was moved to the *Juniperus californica* Alliance under *Juniperus californica / Quercus cornelius-mulleri — Coleogyne ramosissima* Woodland Association (2012 PI code: 10032). Data from other desert regions, as well as from JOTR, supported this Association being a JUNCAL dominated type rather than QUCO dominated.

A reworking of the vegetation types dominated by *Parkinsonia florida* (PAFL) and *Olneya tesota* (OLTE) was done in part to bring them into accordance with the more recent nomenclature used in Sawyer et al. (2009). Rather than two distinct Alliances, these two types have been combined into one Alliance, *Parkinsonia florida — Olneya tesota* Woodland Alliance. This Alliance includes Associations that have only one of the characteristic species, in addition to having Associations with both species present. In the 2005 version of the map, there were two vegetation types mapped under the *Cercidium floridum* Alliance, *Cercidium floridum / Larrea tridentata* (PI code: 16013) and *Cercidium floridum / Hyptis emoryi* (PI code: 16015). After reviewing the vegetation plot data in the context of the most recent descriptions, these two types were renamed as *Parkinsonia florida / Larrea tridentata — Peucephyllum schottii* Association and *Parkinsonia florida / Hyptis emoryi* Association, respectively. Furthermore, based on AA

data one polygon has been relabeled as 16013 (previously labeled to the Alliance level in the 2005 version of the map), as well as one polygon previously labeled as 16015 has been changed to the new *Olneya tesota* Association (2012 PI code: 16016). In addition, in the 2005 version there were two vegetation types mapped under the *Olneya tesota* Alliance: *Olneya tesota / (Larrea tridentata - Encelia farinosa* Fan Type (2005 PI code: 16024) and *Olneya tesota - (Cercidium floridum / Hyptis emoryi*) Wash Type (2005 PI code: 16025). The latter was renamed *Parkinsonia florida — Olneya tesota / Hyptis emoryi* Association (2012 PI code: 16025), whereas the first one was renamed *Parkinsonia florida — Olneya tesota / Cylindropuntia* sp. Association (2012 PI code: 16024). The expression of this Alliance in JOTR is largely determined by geomorphology. The active wash channels, particularly within the south-facing canyons along the southern boundary of the park, are usually dominated by the *Parkinsonia florida / Hyptis emoryi* Association (16015), however as the wash channel widens and fans out onto the bajada, *Olneya tesota* becomes more prominent and 16025 becomes the dominant Association within the wash channels. Further upland, above the active wash channels, *Parkinsonia florida / Larrea tridentata — Peucephyllum schottii* Association (16013) generally dominates on the sandy benches within the canyons and on dissected alluvial fans and flats. Similarly, *Parkinsonia florida — Olneya tesota / Cylindropuntia* sp. Association (16024) occurs slightly above 16025 on the open alluvial fans and flats. Finally, the *Olneya tesota* Association (16016) can be found in isolated stands above the wash channels on flat alluvial bajadas.

Additional riparian vegetation types that required refinement after the AA data were assessed in 2008 were *Chilopsis linearis - Psorothamnus spinosus - (Cercidium floridum / Acacia greggii)* Mapping Unit (2005 PI code: 15012) and *Chilopsis linearis / (Prunus fasciculata- Acacia gregii)* Super Association (PI code: 15013). The AA data and field observations by park staff did not support a vegetation type co-dominated by the three species, *Chilopsis linearis* (CHLI), *Psorothamnus spinosus* (PSSP), and *Cercidium floridum* (CEFL). In JOTR, the riparian corridors with PSSP rarely, if ever, included these other two species. In addition, while CHLI could be found with CEFL in low densities in the lower elevation Sonoran zones, it is more often found as the dominant tree layer in the higher elevation riparian zones. Based on this discussion, it was decided that the expression of CHLI in the Park is best represented by the CHLI Association described by Sawyer et al. (2009) and that many of the polygons previously labeled as 15012 should be reassessed. Therefore, 15013 was given a global name change to *Chilopsis linearis* Association whereas all 49 polygons labeled as 15012 in the 2005 version of the map were revisited and recalled by AIS in 2009. This vegetation type, for the most part, was split into one of three Alliances: *Chilopsis linearis* Woodland Alliance, *Psorothamnus spinosus* Woodland Alliance, or *Parkinsonia florida — Olneya tesota* Woodland Alliance.

All 92 polygons represented by *Larrea tridentata* Undifferentiated Playa and Sandy Dune Top Type (2005 PI code: 27019) in the 2005 version of the map were revisited by the photo-interpreters at AIS in 2009. This map class was being used to lump two different habitats with distinctive plant communities, namely the *Larrea tridentata* dominated playas versus sparsely vegetated sand dunes and flats. The latter is a fairly prominent habitat at lower elevations and is distinguished from Sand Dunes (2012 PI code: 90300) by having >2% vegetative cover. The majority (63%) of the polygons that were labeled as 27019 were relabeled as *Dicoria canescens — Abronia villosa* Sparsely Vegetated Alliance (Desert Dunes & Sand Flats) (2012 PI code: 60020). Twenty of the polygons remained as 27019, and the remainder were assigned new

Associations within the *Larrea tridentata* Shrubland Alliance or *Larrea tridentata — Ambrosia dumosa* Shrubland Alliance.

Another map class that was revisited by AIS in 2009 was Annual Grassland (2005 PI code: 60000), this map class was used by AIS in the 2005 version of the map for areas with smooth pediment surfaces or playas without a shrub layer. At the meeting in Redlands in 2009, it was decided to remove this map class because it was capturing a variety of habitats that are better represented by other map classes available in the classification. AIS reviewed all 155 polygons and relabeled 59 with a more specific map class. Of those polygons that were changed, 49 were relabeled as one of the non-vegetated types with <2% cover (25 were relabeled as Playa (PI code: 90400), 19 were relabeled as Dune (PI code: 90300), and five became *Geraea canescens — Chorizanthe rigida* Desert Pavement Annual Herbaceous Alliance (2012 PI code: 90100)), whereas ten were moved into completely different Alliances (2012 PI codes: 28134, 28083, 27031, and 27019). In some cases it was not possible to ascertain a more accurate map class for the polygons labeled 60000, in which case the polygon was relabeled with 90000 (2012 PI code) Non-vegetated habitat (<2% absolute cover) until more data are available.

In some cases the vegetation type was relabeled with a new PI mapping code and/or new name; this action is referred to as a "global recode". There were three Associations in the 2005 version of the map that received global recodes but were also assigned the "Park Special" status: 1) *Larrea tridentata - (Ambrosia dumosa) - Tetracoccus hallii - (Yucca schidigera)* (2005 PI code: 27043) was changed to *Larrea tridentata — Ambrosia dumosa — Yucca schidigera* Association (2012 PI code: 27045); 2) *Yucca schidigera - Tetracoccus hallii* (2005 PI code: 29035) was relabeled as *Yucca schidigera — Larrea tridentata — Ambrosia dumosa* Association (2012 PI code: 29033); and 3) *Larrea tridentata* Clones, which will be discussed in the next section (3.3 Rapid Assessments). The first two Associations were created because the rare plant *Tetracoccus hallii* (CNPS List 4.3) was present in the stand. However, maintaining these Associations based on this distinction was not supported by the vegetation data, not because it was not present but because it did not stand out as a characteristic species. Therefore, it was decided that retaining the locality information for the species might prove useful for the JOTR rare plant program or for future research on the species; for this reason these polygons were retained in the Park Specials map layer. A separate shapefile labeled "JOTR_2012_Veg_Classification_ParkSpecials" was created to display these three map classes, in which the 2005 PI code is retained under the "Park Specials" field.

### 3.3 Rapid Assessments

Results of the RA plot data were discussed during the August 2009 meeting. A total of 111 RA plots were completed, the results of which are discussed below (Figure 5). A record of all changes made to the 2005 version of the map can be found by looking at the excel document titled "Map and Classification Crosswalk, 2005 to 2012" (Appendix D), as well as in the attribute table of the geodatabase layer titled "JOTR_2012_Veg_Classification_Documentation". In addition, the classification was updated to match the newest nomenclature available in the Manual of California Vegetation Second Edition (Sawyer et al. 2009) and/or NVC standards.

In the 2005 version of the map, eight polygons were labeled as *Prosopis glandulosa* Woodland Shrubland Alliance (2005 PI code: 16040) and no Associations were defined for the Park due to lack of data. In order to clarify which Associations are present in the Park, an assessment of any

previous plot data and prior knowledge of vegetation near or at the site was considered. It was determined that six of the eight polygons could be relabeled as the *Prosopis glandulosa* Association (2012 PI code: 16041) and the other two were relabeled as *Prosopis glandulosa / Atriplex spp. — Suaeda moquinii* Association (2012 PI code: 16043). These latter two polygons are located along the southeastern edge of the park boundary and clearly represent the western edge of a large stand of this vegetation type, which surrounds Palen Dry Lake east of JOTR. One RA plot was done to confirm that the stand contains the characteristic species for this Association.

The *Acacia greggii —* (*Viguiera parishii — Eriogonum fasiculatum*) Upland Slope Type (2005 PI code: 36017) was only represented by one polygon in the 2005 version of the map, and this polygon had not been visited during any stage of the project. One RA plot was completed within this polygon, the results of which supported changing the vegetation type to *Larrea tridentata — Encelia farinosa — Pleurocoronis pluriseta* Association (2012 PI code: 27059). The original *Acacia greggii —* (*Viguiera parishii — Eriogonum fasiculatum*) Upland Slope Type (2005 PI code: 36017) is no longer included in the classification, however a similar Association (*Acacia greggii – Eriogonum fasciculatum* Association*)* was added to the classification based on previous plot data (see page 196 of Appendix A).

The Park has an isolated stand of *Cylindropuntia bigelovii* within the Pinto Basin (referred to as the "Cholla Garden") that was represented by two polygons on the 2005 version of the map. One of these polygons was mislabeled as *Larrea tridentata — Encelia farinosa — Fouquieria splendens* Shrubland Association (2005 PI code: 27056) and no AA points were completed during the 2007-2008 field season within this polygon. The other polygon was labeled correctly, as *Opuntia bigelovii* Shrubland Association (2005 PI code: 29050) and a total of six AA points were completed within this polygon. Two RA plots were completed within the mislabeled polygon during the 2009 field season corroborating that the entire stand does in fact belong to the *Cylindropuntia bigelovii* Shrubland Association (2012 PI code: 29051).

During the initial photo-interpretation effort the photo-interpreters were able to delineate 11 polygons where *Larrea tridentata* Clones (2005 PI code: 27022) are located. However, it was decided later that this feature should be considered separately from the type of vegetation represented in the stand, in other words *Larrea tridentata* Clones are not considered a vegetation type but rather a special feature that is ecologically interesting. These polygons have retained the 2005 PI code under the "Park Specials" attribute but have been relabeled as *Dicoria canescens — Abronia villosa* Sparsely Vegetated Alliance (Desert Dunes & Sand Flats) (2012 PI code: 60020) in the 2012 version of the map (see the geodatabase layer titled "JOTR_2012_Veg_Classification_Documentation" to find the Park Specials attribute). Of note, however, is that only two of the eleven polygons have ever been visited due to their remoteness. The two that were visited each have an RA plot confirming that the Desert Dunes & Sand Flats map label is best suited for those stands; however the other nine polygons should eventually be visited to confirm their status.

There were 14 polygons in the 2005 version of the map labeled as *Yucca brevifolia* Wooded Shrubland Alliance (2005 PI code: 13010), whereas in the 2012 version only 4 of these remain at the Alliance level. Each of the 14 polygons was assessed to determine if the data could support a new call to the Association level. There were 10 RA plots completed in 9 of the polygons plus 28

AA points within 7 of the polygons; this information combined with proximity to other polygons and familiarity with the site allowed 10 of the 14 polygons to be relabeled to an appropriate Association. The polygons that were renamed within the Alliance became either *Yucca brevifolia / Prunus fasciculata* Association (2012 PI code: 13014) or *Yucca brevifolia / Coleogyne ramosissima* Woodland Association (2012 PI code: 13012). Seven of these polygons were changed to an Association within a completely different Alliance; this was, in part, due to fires occurring in this area between 1998 (the year the aerial photos used by the PI's were taken) and 2009 when the RA plots were completed. These seven polygons were relabeled as *Acacia greggii — Eriogonum fasciculatum* Association (2012 PI code: 36018), *Prunus fasciculata* Association (2012 PI code: 32013) or *Quercus cornelius-mulleri — Eriogonum fasciculatum — Ericameria linearifolia* Association (2012 PI code: 21234).

There were 114 polygons of the *Coleogyne ramosissima* — (mixed shrub) Super Association (2005 PI code: 28023) in the 2005 version of the map that either retained the same map code (but a new name) or were changed to one of seven different associations in the final version of the map. Apparently the dense stands of *Coleogyne ramosissima* at higher elevations were easier to map than the lower elevation stands, which often had co-dominant species in the stand making correct field calls difficult for the AA plots. A total of ten RA plots were completed in 2009 within ten different polygons to complement the 35 AA plots that were completed in 16 different polygons. Each of the 114 polygons was reviewed a second time by photo-interpreters at AIS in 2009 and a mapping decision was made based on the newest classification and new vegetation data. The majority (51) of the changes were to *Viguiera parishii — Ambrosia dumosa — Simmondsia chinensis* Association (2012 PI code: 28134), whereas 35 were retained as 28023 but given the new name *Coleogyne ramosissima — Ephedra nevadensis* Association. In addition, 16 polygons were renamed as *Viguiera parishii — Eriogonum fasciculatum — Simmondsia chinensis* Association (2012 PI code: 28133) and six polygons were changed to *Yucca brevifolia / Larrea tridentata — Yucca schidigera / Pleuraphis rigida* Woodland Association (13016). Finally, two polygons were changed to *Juniperus californica / Coleogyne ramosissima* Association (10025) and one polygon was changed to each of the following: *Yucca brevifolia / Coleogyne ramosissima* Woodland Association (2012 PI code: 13012), *Larrea tridentata — Ambrosia dumosa — Simmondsia chinensis* Association (2012 PI code: 27046), *Larrea tridentata — Encelia farinosa — Ambrosia dumosa* Shrubland Association (2012 PI code: 27057), and *Yucca schidigera — Larrea tridentata — Ambrosia dumosa* Association (2012 PI code: 29033).

In the original 2005 version of the map, there were 513 polygons of *Ambrosia dumosa – (Eriogonum fasciculatum – Lycium andersonii/Pleuraphis rigida)* Western Mountain Type (43014), which was not identified in the CDFG 2005 Classification (Appendix E), but was added to the classification by AIS during their mapping efforts. Due to the lack of an ecological description and supporting information, this vegetation type was difficult to identify in the field. Therefore, in addition to the 18 AA plots completed within 15 polygons, ten RA plots within 10 different polygons were completed in 2009. The mapping code 43014 does not occur in the 2012 version of the map, all polygons were changed to one of the following: *Viguiera parishii — Eriogonum fasciculatum — Simmondsia chinensis* Association (2012 PI code: 28133) or *Viguiera parishii — Ambrosia dumosa — Simmondsia chinensis* Association (2012 PI code: 28134).

In seven cases all polygons of the problematic vegetation type received a global recode. These were done based on an assessment of data from previous plot data, including AA plots, as well as the new RA plots completed in 2009. There were four that required both name and code changes, these include: 1) 21 polygons of *Ambrosia dumosa – Senna armata – (Psorothamnus schottii)* Eastern Pediment Type (2005 PI code: 43013) are now called *Larrea tridentata — Ambrosia dumosa — Psorothamnus arborescens* Association (2012 PI code: 27044); 2) 643 polygons of *(Ephedra nevadensis – Pleurocoronis pluriseta – Encelia farinosa - Trixis californica – Bebbia juncea – Eriogonum fasciculatum – Lycium andersonii – Acacia greggii)* Low-Elevation Rocky Mountain Type (2005 PI code: 24001) were changed to *Larrea tridentata — Encelia farinosa — Pleurocoronis pluriseta* Association (2012 PI code: 27059); 3) 618 polygons of *Salazaria mexicana – Krameria* spp. *– Encelia farinosa – Hyptis emoryi – Eriogonum fasciculatum – Hymenoclea salsola – Acacia greggii – Tetracoccus hallii* Dense Rivulet/Desert Pavement Type (2005 PI code: 27001) were changed to *Larrea tridentata — Ambrosia dumosa — Krameria grayii* Association (2012 PI code: 27034); and 4) 57 polygons of *Bromus tectorum* fire plot (2005 PI code: 60001) were globally recoded to *Bromus rubens — Schismus (arabicus, barbatus)* Semi-Natural Herbaceous Stands (2012 PI code: 60010). The other three problematic types received global name changes only, these include: 1) 1,301 polygons of Desert Pavement (PI code: 90100) were renamed to *Geraea canescens — Chorizanthe rigida* Desert Pavement Annual Herbaceous Alliance; 2) 142 polygons of *Larrea tridentata – (Ambrosia dumosa – Viguiera parishii)* Higher-Elevation Type (PI code: 27046) were renamed to *Larrea tridentata — Ambrosia dumosa — Simmondsia chinensis* Association; and 3) 305 polygons of *Viguiera parishii – (Ephedra nevadensis – Eriogonum fasciculatum – Nolina bigelovii)* High-Elevation Rocky Mountain Type (PI code: 28133) were changed to *Viguiera parishii — Eriogonum fasciculatum — Simmondsia chinensis* Association. In each of these problematic vegetation types ten RA plots were completed, with the exception of the *Ambrosia dumosa – Senna armata – (Psorothamnus schottii)* Eastern Pediment Type (2005 PI code: 43013), in which 14 were completed.

## 3.4 Vegetation Mapping and Classification

The 2012 version of the vegetation map for the Park includes a total of 130 map classes, consisting of 51 Alliances (including Provisional Alliances, Semi-Natural Stands, and Special Stands), 78 Associations (including Provisional Associations), and eight non-vegetated map classes (Table 3). Forty-three vegetation types were not mapped due to lack of data. These unmapped vegetation types were documented or observed during vegetation sampling but the plot data lacked enough information to fully describe the vegetation type and in many cases occur in small enough stands (<MMU) that the PI could not pick them up in the aerial photos.

**Table 3**. Comparison of JOTR's vegetation classification from 2005 to 2012.

| Year | Number of vegetation alliances | Number of vegetation associations | Number of non-vegetated classes |
|---|---|---|---|
| 2005 | 47 | 52 | 7 |
| 2012 | 51 | 78 | 8 |

The largest amount of land cover in JOTR is classified under the *Larrea tridentata — Ambrosia dumosa* Shrubland Alliance, which is classified into seven Associations (see Table 4). This Alliance covers a total of 1,130 $km^2$ (279,229 acres), representing 35% of the total area (3,208

$km^2$ or 792,714 acres) within JOTR. The second largest Alliance in terms of land cover is the *Larrea tridentata — Encelia farinosa* Shrubland Alliance; it covers a total of 708 $km^2$ (174,951 acres), or 22% of the total area and is classified into three Associations. On the other end of the spectrum, there are eight Alliances, mostly associated with riparian habitats, that have less than 1 $km^2$ (<247 acres) mapped, these include: *Washingtonia filifera* Woodland Alliance, *Salix gooddingii* Woodland Alliance, *Prosopis glandulosa* Woodland Alliance, *Populus fremontii* Forest Alliance, *Justicia californica* Provisional Shrubland Alliance, *Ericameria nauseosa* Shrubland Alliance, *Cylindropuntia bigelovii* Shrubland Alliance, and *Ambrosia salsola* Shrubland Alliance.

There are 16,499 total polygons on the map, containing 67 map classes. The three most frequent map classes are as follows: 1) *Larrea tridentata — Ambrosia dumosa* Association (PI code: 27031) with 1,718 polygons covering 693 $km^2$ (171,244 acres); 2) *Larrea tridentata — Encelia farinosa — Ambrosia dumosa* Association (PI code: 27057) which covers 599 $km^2$ (148,016 acres) within 1,706 polygons; and 3) *Geraea canescens — Chorizanthe rigida* Desert Pavement Annual Herbaceous Alliance (PI code: 90100) for which there are 1,306 polygons covering 116 $km^2$ (28,664 acres). The first two are also the most abundant Associations in terms of cover. The third largest Association in cover is the *Larrea tridentata — Ambrosia dumosa — Yucca schidigera* Association, with an area of 276 $km^2$ (68,201 acres). See Table 4 for a complete list of map classes and their respective covers.

There are eight map classes that have less than 2% absolute vegetation cover, these include Disturbed/Built-Up, Water, Dunes, Playas, Rock Outcrops, Recent Burns, Desert Pavement, and a generic Non-vegetated Habitat type (which was only used in cases where a lack of data did not allow a better assignment). With the exception of the first one, all of these are ecologically important for the Park. In particular, the Dune habitat found within JOTR is highly restricted (0.5 $km^2$ or 124 acres) but supports a unique assemblage of plant species found only on fine sand habitats. For example, *Astragalus aridus, Eriastrum harwoodii*, and *Cryptantha costata* are only found on the sand ramps along the southeastern Eagle Mountains. In addition, Rock Outcrops, which consist of monzogranitic plutons and boulder outcrops, are part of the signature habitat found in the Wonderland of Rocks and one of the reasons JOTR is world famous for rock climbing. This map class covers 6.6 $km^2$ (1,631 acres) and hosts a number of rock-dwelling species such as *Ericameria cuneata, Phacelia rotundifolia*, and *Ivesia saxosa*. In addition, Desert Pavement, though by definition has less than 2% perennial cover, is listed as a distinct Alliance (*Geraea canescens — Chorizanthe rigida* Desert Pavement Annual Herbaceous Alliance) rather than a generic type (as is the case for the other non-vegetated types) and can be found on 116 $km^2$ (28,664 acres) in the lower elevations of the southern and eastern areas of the Park. Species such as *Phacelia neglecta, Erodium texanum*, and *Gilia latifolia* are often found on these surfaces.

**Table 4**. Total area mapped and estimated areas (accounting for mapping error from accuracy assessment data) (Czaplewski 2003; Lea and Curtis 2010) within Joshua Tree National Park for all map classes represented on the 2012 version of the map. Total area mapped under each Alliance, including all Associations under that Alliance, are shown in the first row in bold. Only in cases where there is at least one polygon labeled at the Alliance level will there be an additional row showing total area mapped with that particular map code.

| ALLIANCE | ASSOCIATION | PI MAPPING CODE | MAPPED AREA (km2) | ESTIMATED AREA (km2) |
|---|---|---|---|---|
| ***Acacia greggii* Shrubland Alliance** | | | **78.93** | **27.69** |
| | *Acacia greggii — (Bebbia juncea — Hyptis emoryi)* Association | 36015 | 51.98 | 19.93 |
| | *Acacia greggii — Eriogonum fasciculatum* Association | 36018 | 2.60 | 0.00 |
| | *Acacia greggii — Prunus fasciculata* Association | 36016 | 24.35 | 7.76 |
| ***Ambrosia salsola* Shrubland Alliance** | | **28110** | **0.03** | **1.30** |
| ***Atriplex canescens* Shrubland Alliance** | | | **0.67** | **0.75** |
| | *Atriplex canescens* Association | 28083 | 0.67 | 0.75 |
| ***Bromus rubens — Schismus (arabicus, barbatus)* Semi-Natural Herbaceous Stands** | | **60010** | **23.64** | **0.00** |
| ***Chilopsis linearis* Woodland Alliance** | | | **6.57** | **1.67** |
| | *Chilopsis linearis* Association | 15013 | 6.57 | 1.67 |
| ***Coleogyne ramosissima* Shrubland Alliance** | | | **2.52** | **29.30** |
| | *Coleogyne ramosissima — Ephedra nevadensis* Association | 28023 | 2.52 | 29.30 |
| ***Cylindropuntia bigelovii* Shrubland Alliance** | | | **0.62** | **0.89** |
| | *Cylindropuntia bigelovii* Association | 29051 | 0.62 | 0.89 |
| ***Dicoria canescens — Abronia villosa* Sparsely Vegetated Alliance (Desert Dunes)** | | **60020** | **15.44** | **15.44** |
| ***Encelia farinosa* Shrubland Alliance** | | | **30.81** | **132.17** |
| | *Encelia farinosa — Ambrosia dumosa* Association | 28033 | 30.81 | 132.17 |
| ***Ericameria nauseosa* Shrubland Alliance** | | **28210** | **0.02** | **0.03** |
| ***Eriogonum fasciculatum — Viguiera parishii* Shrubland Alliance** | | | **182.68** | **94.43** |
| | *Viguiera parishii — Ambrosia dumosa — Simmondsia chinensis* Association | 28134 | 123.50 | 63.84 |
| | *Viguiera parishii — Eriogonum fasciculatum — Simmondsia chinensis* Association | 28133 | 59.18 | 30.59 |
| ***Geraea canescens — Chorizanthe rigida* Desert Pavement Annual Herbaceous Alliance** | | **90100** | **115.81** | **114.48** |
| ***Hyptis emoryi* Shrubland Alliance** | | | **19.25** | **76.27** |
| | *Hyptis emoryi* Association | 28203 | 19.25 | 76.27 |

**Table 4**. Total area mapped and estimated areas (accounting for mapping error from accuracy assessment data) (Czaplewski 2003; Lea and Curtis 2010) within Joshua Tree National Park for all map classes represented on the 2012 version of the map. Total area mapped under each Alliance, including all Associations under that Alliance, are shown in the first row in bold. Only in cases where there is at least one polygon labeled at the Alliance level will there be an additional row showing total area mapped with that particular map code (continued).

| | | | | |
|---|---|---|---|---|
| ***Juniperus californica* Woodland Alliance** | | | **198.36** | **174.63** |
| | *Juniperus californica* Woodland Alliance | **10020** | 0.09 | 0.00 |
| | *Juniperus californica / Yucca schidigera / Pleuraphis rigida* Association | 10031 | 21.19 | 55.25 |
| | *Juniperus californica / Coleogyne ramosissima* Association | 10025 | 158.45 | 110.67 |
| | *Juniperus californica / Quercus cornelius-mulleri — Coleogyne ramosissima* Association | 10032 | 18.63 | 8.71 |
| ***Justicia californica* Provisional Shrubland Alliance** | | **28171** | **0.57** | **0.00** |
| ***Larrea tridentata — Ambrosia dumosa* Shrubland Alliance** | | | **1129.64** | **1142.55** |
| | *Larrea tridentata — Ambrosia dumosa — Psorothamnus arborescens* Association | 27044 | 1.46 | 0.00 |
| | *Larrea tridentata — Ambrosia dumosa — Fouquieria splendens* Association | 27049 | 0.67 | 0.67 |
| | *Larrea tridentata — Ambrosia dumosa — Krameria grayi* Association | 27034 | 13.72 | 0.00 |
| | *Larrea tridentata — Ambrosia dumosa — Senna armata* Association | 27047 | 94.47 | 411.88 |
| | *Larrea tridentata — Ambrosia dumosa — Simmondsia chinensis* Association | 27046 | 50.43 | 69.91 |
| | *Larrea tridentata — Ambrosia dumosa — Yucca schidigera* Association | 27045 | 276.25 | 389.85 |
| | *Larrea tridentata — Ambrosia dumosa* Association | 27031 | 692.65 | 270.24 |
| ***Larrea tridentata — Encelia farinosa* Shrubland Alliance** | | | **707.63** | **572.67** |
| | *Larrea tridentata — Encelia farinosa — Ambrosia dumosa* Association | 27057 | 599.36 | 474.76 |
| | *Larrea tridentata — Encelia farinosa — Fouquieria splendens* Association | 27056 | 8.60 | 66.52 |
| | *Larrea tridentata — Encelia farinosa — Pleurocoronis pluriseta* Association | 27059 | 99.67 | 31.39 |
| ***Larrea tridentata* Shrubland Alliance** | | | **94.10** | **288.38** |
| | *Larrea tridentata — Atriplex hymenelytra* Shrubland Association | 27023 | 0.11 | 0.00 |
| | *Larrea tridentata / Pleuraphis rigida* Association | 27021 | 91.99 | 139.12 |
| | *Larrea tridentata* Association | 27019 | 1.99 | 149.26 |
| ***Parkinsonia florida — Olneya tesota* Woodland Alliance** | | | **54.96** | **98.15** |
| | *Olneya tesota* Association | 16016 | 0.02 | 0.02 |
| | *Parkinsonia florida — Olneya tesota / Cylindropuntia sp.* Association | 16024 | 9.08 | 66.89 |
| | *Parkinsonia florida — Olneya tesota / Hyptis emoryi* Association | 16025 | 7.52 | 7.85 |
| | *Parkinsonia florida / Hyptis emoryi* Association | 16015 | 25.87 | 7.52 |
| | *Parkinsonia florida / Larrea tridentata — Peucephyllum schottii* Association | 16013 | 12.48 | 15.89 |

**Table 4**. Total area mapped and estimated areas (accounting for mapping error from accuracy assessment data) (Czaplewski 2003; Lea and Curtis 2010) within Joshua Tree National Park for all map classes represented on the 2012 version of the map. Total area mapped under each Alliance, including all Associations under that Alliance, are shown in the first row in bold. Only in cases where there is at least one polygon labeled at the Alliance level will there be an additional row showing total area mapped with that particular map code (continued).

| | | | | |
|---|---|---|---|---|
| ***Pinus monophylla* Woodland Alliance** | | | **130.48** | **107.68** |
| | *Pinus monophylla* Woodland Alliance | **10160** | 0.15 | 19.04 |
| | *Pinus monophylla / Quercus cornelius-mulleri* Association | 10161 | 130.33 | 88.64 |
| ***Pleuraphis rigida* Herbaceous Alliance** | | | **1.20** | **3.63** |
| | *Pleuraphis rigida / Ambrosia dumosa* Association | 59011 | 0.16 | 0.49 |
| | *Pleuraphis rigida / Atriplex canescens* Association | 59012 | 1.03 | 3.14 |
| ***Populus fremontii* Forest Alliance** | | **15040** | **0.06** | **0.00** |
| ***Prosopis glandulosa* Woodland Alliance** | | | **0.05** | **0.05** |
| | *Prosopis glandulosa / Atriplex spp.* Association | 16043 | 0.02 | 0.02 |
| | *Prosopis glandulosa* Association | 16041 | 0.03 | 0.03 |
| ***Prunus fasciculata* Shrubland Alliance** | | | **1.65** | **4.64** |
| | *Prunus fasciculata* Association | 32013 | 1.65 | 4.64 |
| ***Psorothamnus spinosus* Woodland Alliance** | | | **27.47** | **2.50** |
| | *Psorothamnus spinosus / Hyptis emoryi — Acacia greggii* Association | 16035 | 27.47 | 2.50 |
| ***Quercus cornelius-mulleri* Shrubland Alliance** | | | **58.90** | **63.74** |
| | *Quercus cornelius-mulleri - Eriogonum fasciculatum - Ericameria linearifolia* Association | 21234 | 58.90 | 63.74 |
| ***Salazaria mexicana* Shrubland Alliance** | | **28140** | **0.00** | **3.46** |
| ***Salix gooddingii* Woodland Alliance** | | **15030** | **0.03** | **0.12** |
| ***Tetracoccus hallii* Provisional Shrubland Alliance** | | | **0.10** | **8.83** |
| | *Tetracoccus hallii* Provisional Association | 28181 | 0.10 | 8.83 |
| ***Washingtonia filifera* Woodland Alliance** | | **15110** | **0.10** | **>0.01** |
| ***Yucca brevifolia* Woodland Alliance** | | | **166.50** | **188.04** |
| | *Yucca brevifolia* Woodland Alliance | **13010** | 0.10 | 0.00 |
| | *Yucca brevifolia — Juniperus californica / Ephedra nevadensis* Association | 13015 | 49.77 | 54.94 |
| | *Yucca brevifolia / Coleogyne ramosissima* Association | 13012 | 6.65 | 22.93 |
| | *Yucca brevifolia / Larrea tridentata — Yucca schidigera / Pleuraphis rigida* Association | 13016 | 56.77 | 54.80 |
| | *Yucca brevifolia / Pleuraphis rigida* Association | 13021 | 53.04 | 55.20 |
| | *Yucca brevifolia / Prunus fasciculata* Association | 13014 | 0.17 | 0.17 |

**Table 4**. Total area mapped and estimated areas (accounting for mapping error from accuracy assessment data) (Czaplewski 2003; Lea and Curtis 2010) within Joshua Tree National Park for all map classes represented on the 2012 version of the map. Total area mapped under each Alliance, including all Associations under that Alliance, are shown in the first row in bold. Only in cases where there is at least one polygon labeled at the Alliance level will there be an additional row showing total area mapped with that particular map code (continued).

| | | | | |
|---|---|---|---|---|
| ***Yucca schidigera* Shrubland Alliance** | | | **148.92** | **76.68** |
| | *Yucca schidigera — Coleogyne ramosissima* Association | 29032 | 57.55 | 22.94 |
| | *Yucca schidigera — Larrea tridentata — Ambrosia dumosa* Association | 29033 | 87.40 | 46.41 |
| | *Yucca schidigera / Pleuraphis rigida* Association | 29034 | 3.96 | 7.33 |
| **Sparse Vegetation & Non-Vegetated Habitat (less than 2% absolute cover** | | | **10.17** | **5.49** |
| | | **90000** | 2.00 | 2.00 |
| | North American Warm Semi-Desert Cliff, Scree & Pavement Group ("Rock Outcrops") | 90200 | 6.63 | 3.22 |
| | North American Warm Desert Dunes & Sand Flats Group ("Dunes") | 90300 | 0.53 | 0.00 |
| | North American Warm Desert Alkaline Scrub & Herb Playa & Wet Flat Group ("Playa") | 90400 | 0.50 | 0.22 |
| | Disturbed / Built-up | 90600 | 0.50 | 0.02 |
| | Water | 90900 | 0.01 | 0.03 |
| **Grand Total** | | | **3207.87** | |

Several vegetation types are uncommon within JOTR for ecological reasons such as elevation or habitat limitations. For example, *Parkinsonia florida* and *Olneya tesota* are geographically restricted to the very southern and eastern boundary of the Park, but are more common to the east and south of JOTR in the Sonoran portions of the California desert, for this reason, the *Parkinsonia florida — Olneya tesota* Woodland Alliance is uncommon in the Park. On the other hand, *Pinus monophylla* is limited ecologically to the highest elevations in the Park; therefore the *Pinus monophylla* Woodland Alliance is mainly restricted to elevations above 4,300 feet in the Little San Bernardino Mountains in the western portion of the Park. So, while these vegetation types are uncommon in JOTR, they are not uncommon throughout their geographic range.

However, twenty-six Associations are considered rare within California, and a number of these are unique to JOTR. For example, *Achnatherum speciosum — Sphaeralcea ambigua* Association, *Washingtonia filifera / Salix exigua / Muhlenbergia rigens* Provisional Association, and *Lycium andersonii — Simmondsia chinensis / Pleuraphis rigida* Association have only been documented in JOTR, however, it is possible that with more inventory throughout the desert bioregion (currently underway by NPS and CDFG) these vegetation types will be found to be more common. On the other hand, some of these rare vegetation types, such as *Juniperus californica — Coleogyne ramosissima* Association and *Yucca brevifolia — Coleogyne ramosissima* Woodland Association, are considered rare and threatened throughout their range as a result of environmental degradation due to factors such as increased fire frequency (Evens et al. 2012).

# 4.0 Discussion

## 4.1 Summary

In 1996 AIS and CDFG were contracted to work with NPS staff on completing a vegetation map of the Park. Unfortunately, this project was not completed until 2012 due to lack of funding and inconsistent staffing. During the first phase of the project, 1996-2005, a classification and map were produced (referred to as the 2005 version) based on 556 vegetation plots. Details of these efforts can be found in the final reports produced by AIS and CDFG (Appendices E, F, and G), and the 2005 version of the map can be found in the geodatabase ("JOTR_2005_Veg_Classification.gdb") available online at: http://www.usgs.gov/core_science_systems/csas/vip/parks.html.

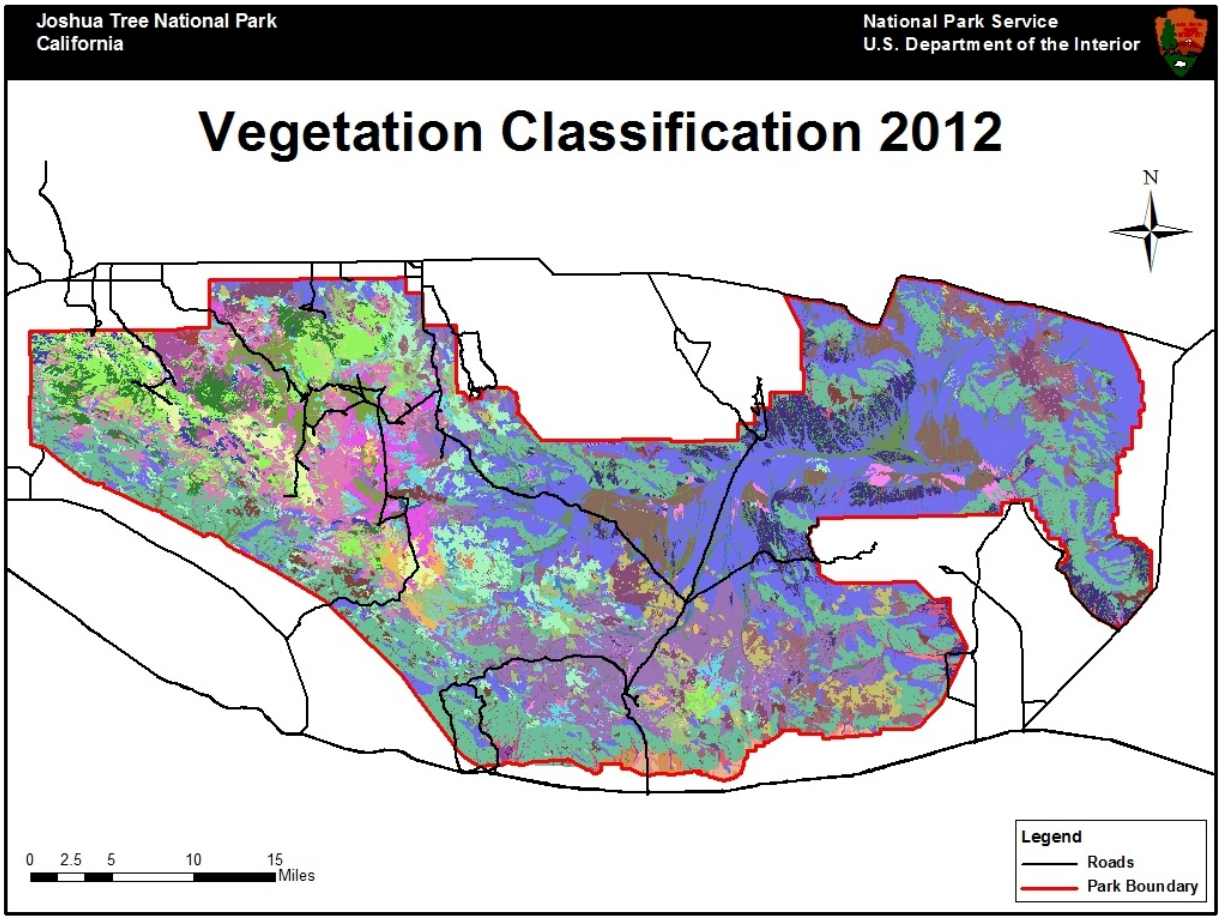



**Figure 6.** Overview of Joshua Tree National Park final vegetation map containing 67 map classes (map classes not included in the legend for lack of space).

In 2006, funding was secured to begin the accuracy assessment phase of the project. A total of 1,313 accuracy assessment points were completed between 2007-2008, followed by 111 rapid assessment plots in 2009. The data collected during these field efforts were then used to refine the 2005 version of the map and classification. In total, 792,700 acres were mapped within the boundary of Joshua Tree National Park (see Figure 6). There are 130 map classes in the final classification for the park, consisting of 51 Alliances, 78 Associations, and 8 non-vegetated map

classes. The final version of the map (referred to as the 2012 version) was completed by AIS and Park staff between 2009-2012. The final classification, which was completed by CDFG, CNPS, and Park staff between 2008-2012, is based on vegetation data from 689 vegetation plots. A geodatabase, titled "JOTR_2012_Veg_Classification.gdb," which includes four feature classes (JOTR_2012_Veg_Classification_Documentation, JOTR_2012_Veg_Classification, JOTR_2005_Veg_Classification, and JOTR_2012_Veg_Classification_ParkSpecials) and all associated vegetation plot data can be found at: http://www.usgs.gov/core_science_systems/csas/vip/parks.html. In addition to this summary report, ecological descriptions of each map class are available in a separate report (Appendix A), a classification list (Appendix B), an ecological key (Appendix C), and a crosswalk showing the relationship between the 2005 and 2012 map classes (Appendix D).

### 4.2 Lessons Learned

There were several challenges that presented themselves during the 16-year effort to produce the vegetation classification for this Park; some were unforeseen and others could have been avoided with better planning. As is customary, we would like to learn from our mistakes and hope that future projects will benefit from the lessons learned at JOTR. Because the authors of this report were not a part of earlier planning and operational stages (i.e. pre-2005), we recognize that our insights may not reflect the full spectrum of issues.

The most obvious and critical issue affecting this project was the lack of continuous funding and the resulting turnover in Park staff over the duration of the project. This project was part of the prototype phase of the precursor of the NPSVIP, the USGS Vegetation Characterization Program—NPS Vegetation Mapping Program. In this phase, many aspects of the program were being tested, including photo-interpretation, field sampling, and accuracy assessment procedures. It is possible that a clear understanding of the cost and necessary oversight for the project to be successful in JOTR was underestimated from the beginning. We note that experience with the JOTR project was a major influence on improving the operations of the NPSVIP (NPS 2010, Lea and Curtis 2010, Lea 2011).

Another negative outcome of the discontinuity in funding and staffing was that the ecologists from CDFG and the photo-interpreters from AIS were not able to coordinate their findings as effectively as they would have liked (and is now considered a normal expectation of current NPSVIP projects). Because of this, any ground-truthing that might have resolved conceptual differences between remotely sensed classes (by AIS) and field-derived classes (by CDFG) did not occur. Reasonably intensive testing of the field key prior to collecting reference data might have revealed these differences earlier. This was one of the reasons it was decided to collect vegetation data while sampling the accuracy assessment plots in 2007-2008. The AA data were useful in resolving some of these issues for the 2012 version of the map and classification.

### 4.3 Future Work

As with any project of this nature there are always unresolved issues that need to be reconciled and new questions that arise as a result. This is certainly true for this project. Listed below (not in any particular order) are a number of recommendations that the Park will consider when time and funding become available.

1) The final field key should be tested and refined. The key provided with this report has not been used in the field, and as with any document of this nature, it should be considered a working document. The final key provided here is based on the new classification and aimed to resolve some of the issues encountered by field staff using the 2005 key during the AA process.

2) There are three polygons of *Prosopis glandulosa* Association (PI code: 16041) that do not have any plot data. Vegetation plots should be done in each polygon to verify they are labeled correctly, and if not, relabeled accordingly. In addition, there are a number of *Prosopis glandulosa* stands that are smaller than the minimum mapping unit and have been encountered in the process of doing fieldwork. These stands are of high priority to the Park, as are any stands with obligate riparian species, so an effort to map these stands should be considered. In particular, the following four plots, which were part of the AIS field effort in 2000 (indicated by the prefix JOTRA), should be visited again with the intention of mapping the *Prosopis glandulosa* stand: JOTRA116, 196, 092, 027.

3) Only two of the eleven polygons that are labeled as *Larrea tridentata* Clones (Park Special code: 27022) under the Park Specials field have ever been visited due to their remoteness. The two that were visited each have an RA plot, these data support those polygons being labeled as *Dicoria canescens — Abronia villosa* Sparsely Vegetated Alliance (Desert Dunes) (2012 PI code: 60020), but for lack of any data to accurately label the other nine polygons, all eleven were assigned the same map class. The other nine polygons should be visited to collect vegetation data, then an appropriate map class can be assigned or confirmed if no change is required.

4) Additional vegetation data would be beneficial for the *Dicoria canescens — Abronia villosa Sparsely Vegetated Alliance (*Desert Dunes & Sand Flats*)* (PI code: 60020), in JOTR and throughout the desert region. Currently, this Alliance lacks enough data to describe the variation found across its range and according to Sawyer et al. (2009) the Alliance is best described by the sandy substrate than by the presence of any particular species. With additional data, compositional patterns may begin to emerge and reveal Association level differentiation. Any sampling that is done should be conducted during a good rainfall season such that the ephemeral components of the vegetation can be captured by the data. Also, for sparsely vegetated habitats, such as this, altering the sampling protocol to a belt transect instead of circular plots might decrease the chance of overestimating total cover and improve estimates for relative contributions of the characteristic species to cover.

5) All *Non-vegetated habitats (less than 2% absolute cover)* (PI code: 90000) polygons should be visited and vegetation plots should be done to determine which map class is most appropriate. Again, for sparsely vegetated habitats, altering the sampling protocol to a belt transect instead of circular plots might decrease the chance of overestimating total cover and improve estimates for relative contributions of the characteristic species to cover. In the 2005 version of the map, these polygons were all labeled as *Annual Grassland* (PI code: 60000). It should not be assumed that all 96 polygons are of the same vegetation type because the 90000 map class was only used for lack of any data within the polygon and lack of resolution on the aerial imagery. There were seven

different map classes that 60000 was changed to (see discussion in Results section), not including 90000, so it is possible that the remaining polygons could also be represented by a variety of vegetation types.

6) There are five polygons labeled as *Pinus monophylla* Woodland Alliance (PI code: 10160) in the highest elevations of the Coxcomb Mountains. Ideally, vegetation plots should be completed in each of these polygons, then relabeled to the Association level. Based on the aerial imagery this area did not seem to fit the one Association described for the Park (*Pinus monophylla / Quercus cornelius-mulleri* Woodland Association), if this is true we may be able to add another Association to the classification. Other possibilities might include: *Pinus monophylla / Prunus fasciculata — Rhus trilobata* Association or if Juniper is present, *Pinus monophylla — Juniperus californica / Achnatherum speciosum* Association.

7) In the 2005 version of the map, there were 50 polygons labeled as *Larrea tridentata* Alliance (PI code: 27010), all of which were recoded to *Larrea tridentata — Ambrosia dumosa* Association (PI code: 27031). This global recode was based on vegetation data from 13 AA plots within 11 polygons. Ideally, additional data could be collected with a focus on visiting polygons that have not been field checked. Specifically those that were labeled 27010 in the 2005 version of the map could be targeted, but overall the 27031 map class could benefit from additional plot data because <5% of all polygons have been field checked.

8) An effort to refine the polygons in which *Washingtonia filifera* occur could be beneficial because the polygons drawn around these stands encompass portions of the riparian corridor lacking the species all together. Stands of *Washingtonia filifera* tend to be in small isolated patches that are smaller than the minimum mapping unit (0.5 hectares), making it difficult to map without ground-truthing each site. Also, additional vegetation plots should be conducted within these polygons in an effort to define the stands at the association level. Based on vegetation data collected in 2000 by AIS (JOTRA points) there is support for these stands to be called *Washingtonia filifera / Salix exigua / Muhlenbergia rigens* Provisional Association and the AA data seems to corroborate the presence of this association. After field checking the 10 polygons labeled as *Washingtonia filifera* Woodland Alliance (PI code: 15510), they could potentially be relabeled at the Association level.

9) More thorough surveys of any riparian corridors with stands of *Salix spp*. and/or *Populus fremontii* are of high priority for the Park. Additional data from these areas may help refine the map, as well as provide insight for the Classification. Currently, two of these map classes (PI codes: 15030 and 15040) are mapped to the Alliance level, and in the case of *Populus fremontii*, an Association has not been identified for the Park. We included the *Salix exigua* Alliance and Association (PI code: 15020 and 15021) in the Classification because this seemed to be supported by the vegetation data collected during the AA process. However, these data weren't incorporated into the statistical analyses for the Classification and therefore we have not identified specific plots that might represent this map class. For example, it is possible that the areas surrounding the *Washingtonia filifera* stands (PI code: 15112), upon closer look, could be best

represented by the *Salix exigua* Association (see discussion point #7 above). In addition, anecdotal observations by the field technicians and botanist for the Park seem to support the presence of this vegetation type. Regardless, additional vegetation data and a more detailed approach to mapping these riparian corridors, will undoubtedly reveal the variation in these stands and aid in reclassifying the polygons.

10) Although the *Baccharis sergiloides / Muhlenbergia rigens* Association (PI code: 22031) is not mapped, it is included in the classification due to vegetation data from one plot (JOTRA151). This stand should be revisited, verified, and a polygon could be drawn around the stand. In addition, it is likely that other stands of this Association occur in the riparian corridors throughout the Park, a detailed survey of the riparian corridors would allow these stands to be identified and mapped.

11) Currently, the *Larrea tridentata — Ambrosia dumosa — Fouquieria splendens* Association (PI code: 27049) is only documented by one polygon in JOTR. This area is referred to as the "Ocotillo Patch" by the Park and represents a northern edge of the distribution of *Fouquieria splendens* within California. This stand is unique because it lacks *Encelia farinosa*, which is a characteristic shrub in the more commonly encountered (in JOTR) Associations including *Fouquieria splendens.* No vegetation plots have been completed within this polygon. In addition, there are other isolated stands of this species in the park that may well be repesented by this association.

12) There were three polygons labeled as *Pleuraphis rigida* Herbaceous Alliance (PI code: 59010) in the 2005 version, all three have been renamed at the Association level. Two of these were renamed *Pleuraphis rigida / Ambrosia dumosa* Association (PI code: 59011); one of these is located on the Sand Hill in Pinto Basin and the other is on the eastern flanks of the Coxcomb Mountains. The recall was based on vegetation data collected from the Sand Hill polygon only, so ideally the polygon in the Coxcombs (AIS_ID_2012 = 10043) should be field checked.

13) More plot data for *Chorizanthe rigida — Geraea canescens* Desert Pavement Annual Herbaceous Alliance (PI code: 90100) is needed to better describe the Alliance and potentially define any compositional variation at the Association level. Specifically, in JOTR there are 44 vegetation plots that have been completed within 38 polygons, only 3% of the total number of polygons.

14) Additional plot data for *Viguiera parishii — Eriogonum fasciculatum — Simmondsia chinensis* Association (2012 PI code: 28133) and *Viguiera parishii — Ambrosia dumosa — Simmondsia chinensis* Association (2012 PI code: 28134) should be collected (see the discussion under the Results section). Both of these Associations are only known from JOTR, they were described as a result of this project. With more plot data, from outside the Park as well, these vegetation types may become better defined, in particular, their relationship to closely allied Associations such as, *Viguiera parishii – Eriogonum fasciculatum* Association found in Lake Mead Recreation Area and in the Newberry Mountains of Nevada, may be clarified.

15) Finally, there are a number of polygons labeled as *Bromus rubens — Schismus (arabicus, barbatus*) Semi-Natural Herbaceous Stands (PI code: 60010) that were labeled as *Bromus tectorum* fire plots (2005 PI code: 60001) in the 2005 version of the map. Most of these polygons were burned during the 1995 or 1999 fires in the Covington Flats region of the Park, and many of them had burned at least once in the previous 10 years as well. The PI work that was completed for the 2005 version of the map used images from 1998 and mapping was still in progress during the 1999 fire, therefore many of these polygons were completely burned at the time the area was being mapped for this project. However, by the time we were conducting the AA fieldwork, many of these areas had developed a post-fire vegetation community and would be more accurately defined by a different vegetation type. We did not try to update any of the polygons after our 2007-2009 field efforts for two reasons. First, in this case it is important for the history of the vegetation change to be recorded in the map, and secondly, in order to reclassify all of these polygons accurately, an effort to collect data should take into consideration the boundaries of the various fires. More plot data in these polygons would be of great value to the Park, not only for the purpose of the vegetation map, but because it would help Resource Management understand the progression of post-fire vegetation development.

There are many polygons that have never been field checked, and while this is certainly an unrealistic goal for a Park as large as JOTR, it would be a worthy effort to conduct vegetation plots in as many as possible. Only 3.5% of all polygons have had any type of vegetation plot conducted within it and of the 67 map classes currently on the map, only 28 have vegetation data from >20% of polygons (see Table 5 and Figure 7).

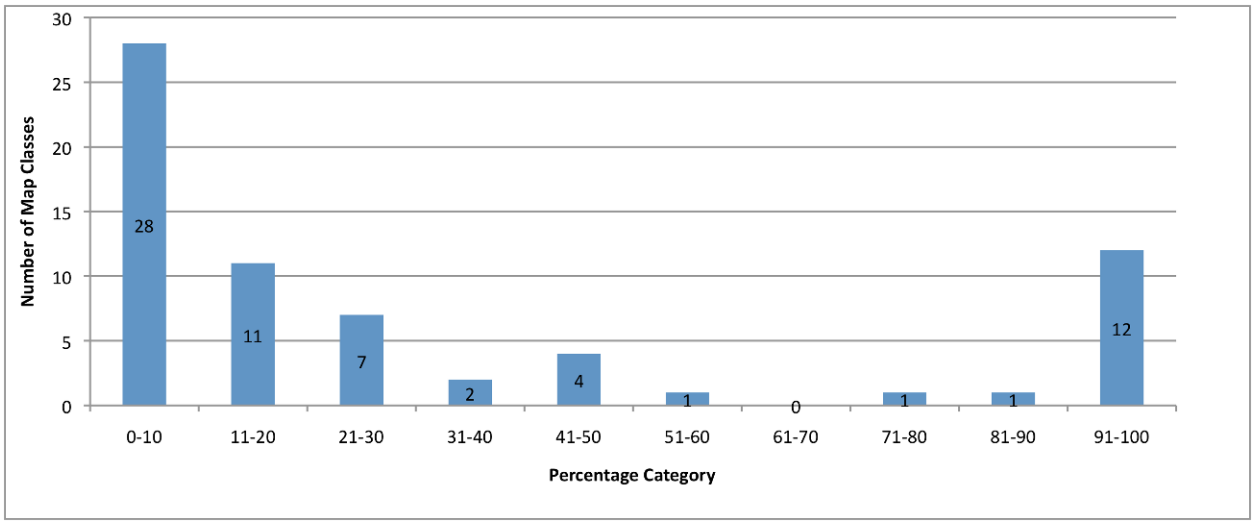



**Figure 7**. Percentage of mapped polygons (per map class) with vegetation data. Only 15 map classes have vegetation data from over half of the mapped polygons.

Particular attention should be given to any map classes where none of the polygons have been visited, these include PI codes: 10160, 13010, 16016, 27049, 90000, and 90300. An attempt to bring more than half of the map classes above the 50th percentile, in terms of number of polygons with vegetation plots, would be an enormous step in the right direction. Any additional plots that are completed in an effort to advance the vegetation classification should follow the

CNPS combined rapid assessment and relevé protocol (Appendix I). These plots should be placed in a location that is subjectively assessed to be representative of the stand (within the polygon) rather than randomly placing the plot as was done for the AA analysis. More importantly, this new relevé data should be included in any future statistical analyses. And although they are not floristically complete, the data from the AA observations from this project could provide supplementary data that could be used to better circumscribe the vegetation types and could therefore be included, to whatever extent possible, in future classification analyses.

**Table 5.** Total number of polygons per map class (2012 PI Code), total number of vegetation plots completed within that map class, the number and percentage of polygons with vegetation data collected within it.

| 2012 PI Code | # Polygons | # Veg Plots | # Polygons w/ Plot | % Polygons w/ Plot |
|---|---|---|---|---|
| 10160 | 5 | 0 | 0 | 0.0% |
| 13010 | 4 | 0 | 0 | 0.0% |
| 16016 | 1 | 0 | 0 | 0.0% |
| 27049 | 1 | 0 | 0 | 0.0% |
| 90000 | 96 | 0 | 0 | 0.0% |
| 90300 | 19 | 0 | 0 | 0.0% |
| 28203 | 612 | 19 | 7 | 1.1% |
| 90200 | 389 | 6 | 5 | 1.3% |
| 27057 | 1706 | 60 | 44 | 2.6% |
| 36015 | 867 | 32 | 25 | 2.9% |
| 90100 | 1306 | 44 | 38 | 2.9% |
| 27034 | 618 | 23 | 20 | 3.2% |
| 27059 | 644 | 33 | 25 | 3.9% |
| 10161 | 916 | 56 | 38 | 4.1% |
| 36016 | 537 | 41 | 24 | 4.5% |
| 27045 | 973 | 106 | 45 | 4.6% |
| 27031 | 1718 | 128 | 80 | 4.7% |
| 28033 | 133 | 14 | 7 | 5.3% |
| 29032 | 427 | 36 | 24 | 5.6% |
| 27047 | 778 | 75 | 48 | 6.2% |
| 28134 | 565 | 71 | 39 | 6.9% |
| 21234 | 324 | 39 | 24 | 7.4% |
| 13016 | 319 | 65 | 24 | 7.5% |
| 29033 | 417 | 59 | 32 | 7.7% |
| 60020 | 70 | 13 | 6 | 8.6% |
| 10025 | 785 | 142 | 73 | 9.3% |
| 28133 | 298 | 42 | 28 | 9.4% |
| 27019 | 21 | 11 | 2 | 9.5% |
| 27021 | 201 | 44 | 22 | 10.9% |
| 90400 | 27 | 5 | 3 | 11.1% |
| 13015 | 215 | 67 | 24 | 11.2% |
| 16015 | 140 | 48 | 16 | 11.4% |
| 13021 | 138 | 39 | 16 | 11.6% |
| 10032 | 152 | 31 | 19 | 12.5% |
| 16013 | 190 | 33 | 24 | 12.6% |
| 27046 | 143 | 37 | 22 | 15.4% |
| 10031 | 99 | 32 | 17 | 17.2% |
| 90600 | 63 | 14 | 11 | 17.5% |
| 15013 | 87 | 33 | 17 | 19.5% |
| 16035 | 96 | 57 | 20 | 20.8% |

**Table 5**. Total number of polygons per map class (2012 PI Code), total number of vegetation plots completed within that map class, the number and percentage of polygons with vegetation data collected within it (continued).

| 2012 PI Code | # Polygons | # Veg Plots | # Polygons w/ Plot | % Polygons w/ Plot |
|---|---|---|---|---|
| 60010 | 57 | 31 | 13 | 22.8% |
| 28023 | 35 | 11 | 8 | 22.9% |
| 13012 | 71 | 32 | 18 | 25.4% |
| 16025 | 40 | 39 | 11 | 27.5% |
| 27056 | 39 | 30 | 11 | 28.2% |
| 29034 | 27 | 27 | 8 | 29.6% |
| 16024 | 36 | 31 | 11 | 30.6% |
| 28181 | 11 | 5 | 4 | 36.4% |
| 15110 | 10 | 5 | 5 | 50.0% |
| 16041 | 6 | 3 | 3 | 50.0% |
| 28171 | 6 | 30 | 3 | 50.0% |
| 59011 | 2 | 2 | 1 | 50.0% |
| 27023 | 7 | 5 | 4 | 57.1% |
| 15030 | 5 | 4 | 4 | 80.0% |
| 29051 | 6 | 27 | 5 | 83.3% |
| 27044 | 21 | 42 | 20 | 95.2% |
| 10020 | 1 | 4 | 1 | 100.0% |
| 13014 | 1 | 1 | 1 | 100.0% |
| 15040 | 3 | 3 | 3 | 100.0% |
| 16043 | 2 | 3 | 2 | 100.0% |
| 28083 | 1 | 18 | 1 | 100.0% |
| 28110 | 1 | 2 | 1 | 100.0% |
| 28210 | 1 | 2 | 1 | 100.0% |
| 32013 | 3 | 10 | 3 | 100.0% |
| 36018 | 3 | 23 | 3 | 100.0% |
| 59012 | 1 | 35 | 1 | 100.0% |
| 90900 | 3 | 3 | 3 | 100.0% |
| **All Polygons** | **10972** | **598** | **382** | **3.5%** |

In conclusion, the authors recommend that the Park continue to work on the vegetation classification by supporting staff within the Resource Division dedicated to this purpose. Management of Park resources can only benefit by having an active vegetation program, as there are many facets of land management that rely heavily on having an accurate vegetation map. For this reason, it is important that both the map and classification remain current by continuing to build upon the existing data.

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# Vegetation Descriptions for Joshua Tree National Park

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# Contents

Page

**Introduction** ..... **1**
**1. Forest & Woodland Class** ..... **3**
**1.C.2. Cool Temperate Forest Formation** ..... **3**
1.C.2.c. Western North American Cool Temperate Woodland & Scrub Division ..... 3
M026. Intermountain Singleleaf Pinyon-Western Juniper Woodland Macrogroup ..... 3
Great Basin Pinyon-Juniper Woodland Group ..... 3
Pinus monophylla Woodland Alliance ..... 3
*Pinus monophylla / Quercus cornelius-mulleri Woodland Association* ..... *4*
**1.C.3. Temperate Flooded & Swamp Forest Formation** ..... **7**
1.C.3.d. Western North American Warm Temperate Flooded & Swamp Forest Division ..... 7
M036. Warm Mediterranean & Desert Riparian, Flooded & Swamp Forest Macrogroup ..... 7
Southwestern North American Warm Desert Riparian Group ..... 7
Populus fremontii Forest Alliance ..... 7
Salix gooddingii Woodland Alliance ..... 9
Washingtonia filifera Woodland Alliance ..... 11
*Washingtonia filifera / Salix exigua / Muhlenbergia rigens Provisional Association* ..... *12*
M298. Western North American Warm Temperate Ruderal Flooded & Swamp Forest Macrogroup ..... 14
Southwestern North American Ruderal Riparian Scrub Group ..... 14
Tamarix spp. Semi-Natural Shrubland Stands ..... 14
**2. Shrubland & Grassland Class** ..... **15**
**2.B.1. Mediterranean Scrub Formation** ..... **15**
2.B.1.a. California Scrub Division ..... 15
M043. California Chaparral Macrogroup ..... 15
California Mesic North-Slope Chaparral Group ..... 15
Quercus cornelius-mulleri Shrubland Alliance ..... 15
*Quercus cornelius-mulleri – Eriogonum fasciculatum – Ericameria linearifolia Association* ..... *16*
California Xeric Chaparral Group ..... 19
Arctostaphylos glauca Shrubland Alliance ..... 19
**2.B.2. Mediterranean Grassland & Forb Meadow Formation** ..... **21**
2.B.2.a. California Grassland & Meadow Division ..... 21
M045. California Annual & Perennial Grassland Macrogroup ..... 21
California Annual Forb / Grass Vegetation Group ..... 21
Amsinckia (menziesii, tessellata) Herbaceous Alliance ..... 21
Mediterranean California Naturalized Annual & Perennial Grassland Group ..... 22
Bromus rubens – Schismus (arabicus, barbatus) Semi-Natural Herbaceous Stands ..... 22
**2.C.1. Temperate Grassland, Meadow, & Shrubland Formation** ..... **24**
2.C.1.a. Vancouverian & Rocky Mountain Grassland & Shrubland Division ..... 24
M048. Western North American Temperate Grassland & Meadow Macrogroup ..... 24

Vancouverian & Rocky Mountain Naturalized Annual Grassland Group ..... 24
Bromus tectorum Semi-Natural Herbaceous Stands ..... 24
**2.C.5. Temperate & Boreal Freshwater Wet Meadow & Marsh Formation ..... 26**
2.C.5.c. Western North American Warm Desert Freshwater Marsh Division ..... 26
M076. Warm Desert Freshwater Shrubland, Marsh & Meadow Macrogroup ..... 26
North American Warm Desert Riparian Low Bosque & Shrubland Group ..... 26
Baccharis sergiloides Shrubland Alliance ..... 26
**3. Xeromorphic Scrub & Herb Vegetation (Semi-Desert) Class ..... 28**
**3.A.1. Warm Desert Scrub & Grassland Formation ..... 28**
3.A.2.a. North American Warm Desert Scrub & Grassland Division ..... 28
M088. Mojave-Sonoran Semi-Desert Scrub Macrogroup ..... 28
Mojave Mid-Elevation Mixed Desert Scrub Group ..... 28
Coleogyne ramosissima Shrubland Alliance ..... 28
*Coleogyne ramosissima – Ephedra nevadensis Association ..... 30*
Ephedra nevadensis Shrubland Alliance ..... 33
Eriogonum fasciculatum – Viguiera parishii Shrubland Alliance ..... 35
Eriogonum fasciculatum Rock Outcrop Shrubland Association ..... 37
*Viguiera parishii – Ambrosia dumosa – Simmondsia chinensis Association ..... 39*
*Viguiera parishii – Eriogonum fasciculatum – Simmondsia chinensis Association ..... 42*
*Juniperus californica* Woodland Alliance ..... 45
*Juniperus californica / Coleogyne ramosissima Association ..... 46*
*Juniperus californica / Quercus cornelius-mulleri – Coleogyne ramosissima Woodland Association ..... 49*
*Juniperus californica / Yucca schidigera / Pleuraphis rigida Woodland Association ..... 52*
Lycium andersonii Shrubland Alliance ..... 55
Lycium andersonii – Simmondsia chinensis / Pleuraphis rigida Association ..... 56
Pleuraphis rigida Herbaceous Alliance ..... 58
*Pleuraphis rigida / Ambrosia dumosa Association ..... 60*
*Pleuraphis rigida / Atriplex canescens Grassland Association ..... 62*
Salazaria mexicana Shrubland Alliance ..... 64
Tetracoccus hallii Provisional Shrubland Alliance ..... 66
Yucca brevifolia Woodland Alliance ..... 68
*Yucca brevifolia – Juniperus californica / Ephedra nevadensis Woodland Association ..... 73*
*Yucca brevifolia / Larrea tridentata – Yucca schidigera / Pleuraphis rigida Woodland Association ..... 76*
*Yucca brevifolia / Pleuraphis rigida Woodland Association ..... 79*
*Yucca brevifolia / Prunus fasciculata Association ..... 82*
Yucca schidigera Shrubland Alliance ..... 85
*Yucca schidigera – Coleogyne ramosissima Association ..... 87*
*Yucca schidigera – Larrea tridentata – Ambrosia dumosa Association ..... 90*
*Yucca schidigera / Pleuraphis rigida Association ..... 93*
Sonoran – Mojave Creosotebush – White Bursage Desert Scrub Group ..... 96
Ambrosia dumosa Shrubland Alliance ..... 96
*Ambrosia dumosa Shrubland Association ..... 98*
Ambrosia salsola (= Hymenoclea salsola) Shrubland Alliance ..... 101
*Ambrosia salsola (= Hymenoclea salsola) Shrubland Association ..... 102*
*Ambrosia salsola – Senna armata Shrubland Association ..... 104*

Cylindropuntia bigelovii Shrubland Alliance ..... 106
*Cylindropuntia bigelovii Shrubland Association* ..... *107*
Encelia farinosa Shrubland Alliance ..... 110
*Encelia farinosa – Ambrosia dumosa Association* ..... *112*
Larrea tridentata Shrubland Alliance ..... 115
*Larrea tridentata Association* ..... *117*
*Larrea tridentata – Ambrosia salsola Shrubland Association* ..... *119*
*Larrea tridentata – Atriplex hymenyletra Shrubland Association* ..... *122*
*Larrea tridentata / Pleuraphis rigida Association* ..... *124*
Larrea tridentata – Ambrosia dumosa Shrubland Alliance ..... 126
*Larrea tridentata – Ambrosia dumosa Association* ..... *129*
*Larrea tridentata – Ambrosia dumosa – Krameria grayi Association* ..... *132*
*Larrea tridentata – Ambrosia dumosa – Psorothamnus arborescens Association* ..... *134*
*Larrea tridentata – Ambrosia dumosa – Senna armata Association* ..... *137*
*Larrea tridentata – Ambrosia dumosa – Yucca schidigera Association* ..... *140*
Larrea tridentata – Encelia farinosa Shrubland Alliance ..... 143
*Larrea tridentata – Encelia farinosa Shrubland Association* ..... *145*
*Larrea tridentata – Encelia farinosa – Ambrosia dumosa Shrubland Association* ..... *148*
*Larrea tridentata – Encelia farinosa – Fouquieria splendens Association* ..... *151*
*Larrea tridentata –Encelia farinosa – Pleurocornis pluriseta Association* ..... *154*
M092. North American Warm-Desert Xero-Riparian Macrogroup ..... 156
Sonoran-Coloradan Semi-Desert Wash Woodland / Scrub Group ..... 156
Chilopsis linearis Woodland Alliance ..... 156
*Chilopsis linearis Association* ..... *157*
Hyptis emoryi Shrubland Alliance ..... 159
*Hyptis emoryi Association* ..... *160*
Justicia californica Provisional Shrubland Alliance ..... 163
Parkinsonia florida – Olneya tesota Woodland Alliance ..... 165
*Parkinsonia florida / Hyptis emoryi Association* ..... *169*
*Parkinsonia florida / Larrea tridentata – Peucephyllum schottii Association* ..... *172*
*Parkinsonia florida – Olneya tesota / Cylindropuntia sp. Association* ..... *174*
Prosopis glandulosa Woodland Alliance ..... 177
*Prosopis glandulosa Association* ..... *178*
*Prosopis glandulosa / Atriplex spp. – Suaeda moquinii Association* ..... *180*
Psorothamnus spinosus Woodland Alliance ..... 182
*Psorothamnus spinosus / Ephedra californica – Ambrosia salsola Association* ..... *183*
*Psorothamnus spinosus / Hyptis emoryi – Acacia greggii Association* ..... *186*
Ziziphus obtusifolia Shrubland Special Stands ..... 189
Warm Semi-Desert Shrub & Herb Wash-Arroyo Group ..... 191
Acacia greggii Shrubland Alliance ..... 191
*Acacia greggii – (Bebbia juncea – Hyptis emoryi) Association* ..... *193*
*Acacia greggii – Eriogonum fasciculatum Association* ..... *196*
*Acacia greggii – Prunus fasciculata Association* ..... *199*
Ephedra californica Shrubland Alliance ..... 202
Ephedra californica – Ambrosia salsola Association ..... 203
Ericameria paniculata (= Chrysothamnus paniculatus) Shrubland Alliance ..... 206
Encelia virginensis Shrubland Alliance ..... 208

*Encelia virginensis ssp. actoni Shrubland Association* ..... *209*
Prunus fasciculata Shrubland Alliance ..... 212
*Prunus fasciculata Association* ..... *213*
**3.B.1. Cool Semi-Desert Scrub & Grassland Formation ..... 216**
3.B.1.a. Western North American Cool Semi-Desert Scrub & Grassland Division ... 216
M071. Great Basin & Intermountain Semi-Desert Shrubland & Steppe Macrogroup 216
Intermountain Semi-Desert Shrubland & Steppe Group ..... 216
Ericameria nauseosa Shrubland Alliance ..... 216
Ericameria teretifolia Shrubland Alliance ..... 218
M169. Great Basin & Intermountain Tall Sagebrush Shrubland & Steppe Macrogroup ..... 220
Intermountain Mesic Tall Sagebrush Shrubland & Steppe Group ..... 220
Purshia tridentata Shrubland Alliance ..... 220
Intermountain Semi-Desert Grassland Group ..... 223
Achnatherum speciosum Herbaceous Alliance ..... 223
*Achnatherum speciosum – Sphaeralcea ambigua Association* ..... *224*
M093. Great Basin Saltbrush Scrub Macrogroup ..... 226
Intermountain Shadscale-Saltbush Scrub Group ..... 226
Atriplex canescens Shrubland Alliance ..... 226
*Atriplex canescens Association* ..... *228*
Grayia spinosa Shrubland Alliance ..... 230
**6. Nonvascular & Sparse Vascular Rock Vegetation Class ..... 232**
**6.C.1. Warm Semi-Desert Cliff, Scree, & Rock Vegetation Formation ..... 232**
6.C.1.a. North American Warm Semi-Desert Cliff, Scree & Rock Vegetation Division ..... 232
M117. North American Warm Semi-Desert Cliff, Scree & Rock Vegetation Macrogroup ..... 232
North American Warm Semi-Desert Cliff, Scree & Pavement Group ..... 232
Atriplex hymenelytra Shrubland Alliance ..... 232
Chorizanthe rigida – Geraea canescens Desert Pavement Annual Herbaceous Alliance ..... 234
Peucephyllum schottii Provisional Shrubland Alliance ..... 236
North American Warm Desert Dunes & Sand Flats Group ..... 238
Dicoria canescens – Abronia villosa Sparsely Vegetated Alliance (Desert Dunes & Sand Flats) ..... 238
**Glossary of Terms ..... 240**
**References ..... 24046**

## Introduction

This document is the compilation vegetation alliances and associations described from Joshua Tree National Park (JOTR). Many of the vegetation types represent well documented concepts. For the alliances, narrative descriptions were prepared with updates from *A Manual of California Vegetation* (Sawyer et al. 2009) and other recent projects. For the association descriptions, full global vegetation and environmental sections as well as local sections were written. Some associations in this document represent new concepts which are not currently documented in the US National Vegetation Classification (NVC). These new concepts were prepared upon extensive classification analysis and literature review. Based on this process and the number of existing samples, the association's status was determined as standard or provisional, and concept confidence was also determined. These alliance and association descriptions were authored and/or edited by staff of the CNPS Vegetation Program, based on the original JOTR classification report (Keeler-Wolf et al. 2005) by the California Department of Fish and Game and the CNPS.

For associations which are new standard or provisional, global summaries were drafted from local descriptions but lack full global vegetation and environmental descriptions (until more information is available). Provisional associations typically are represented by 3–9 samples, while standard associations are represented by 10 or greater samples (within and outside of the JOTR study area). Typically, association descriptions were written when the sample size was 3 or more. If an association or non-standard sample description has not been prepared, lists have been provided at the end of the corresponding alliance descriptions with their plot/sample numbers.

The US Department of Agriculture Natural Resources Conservation Service (USDA-NRCS) Plants Database was used as the standard for all species names included in the vegetation descriptions (USDA-NRCS 2011).

The presentation of the following descriptions follows the nested hierarchy of the NVC (Federal Geographic Data Committee 2008), including the Class, Formation, Division, Macrogroup and Group. However, the new hierarchy of the NVC is currently being evaluated for revision by the Ecological Society of America's Vegetation Panel in 2012. Thus, the hierarchy in this document and related JOTR classification documents may need future updates once the Panel's revisions are completed.

# 1. Forest & Woodland Class

## 1.C.2. Cool Temperate Forest Formation

## 1.C.2.c. Western North American Cool Temperate Woodland & Scrub Division

## M026. Intermountain Singleleaf Pinyon-Western Juniper Woodland Macrogroup

## Great Basin Pinyon-Juniper Woodland Group

### *Pinus monophylla* Woodland Alliance

**Singleleaf Pinyon Woodland Alliance (Mapping code 10160)**

The *Pinus monophylla* woodland alliance occurs in the southeastern Great Basin, Mono, Mojave Desert, Sierra Nevada, and Southern California Mountains and Valleys sections in California (Sawyer et al. 2009), and west to Nevada, Utah, Arizona, Wyoming, and Idaho (NatureServe 2011). Conservation rank: G5, S4.

Prescribed fire has commonly been used by range managers to open up *Pinus monophylla* stands and promote grass and other forage species. However, it is no longer an effective management option on most *Pinus monophylla* sites. Fuels on such sites are often insufficient to carry fire. In addition, understory plants in closed stands do not respond as well to fire as those in more open stands. When fires do occur in closed stands, they are usually of such high severity that soil seed reserves are depleted. Without successful postfire seeding, highly flammable annual grass communities often establish. Losses due to fire in some areas of its range are likely a combination of fire suppression as well as invasion by non-native grass and high cover of *Bromus tectorum* (Zouhar 2003).

In California's deserts stands at upper elevations, in desert transitions on the eastern side of the Sierra Nevada, and in the southern California mountains, appear as relicts from past climates. Fossil packrat middens suggest that as recently as 7500 years ago, much of the Mojave Desert contained pinyon pine and pinyon-juniper woodlands. Recent aridity has restricted the alliance's range (Wells and Berger 1967, Van Devender and Spaulding 1979, Thorne et al. 2007).

This alliance is represented in Joshua Tree National Park by one association, known from the desert margins of the transverse and Peninsular Ranges of southern California and adjacent Baja California. Two associations were initially described in the Keeler-Wolf et al. (2005) report: *Pinus monophylla / Quercus cornelius-mulleri* Woodland Association and *Pinus monophylla* / *Juniperus californica / Achnatherum speciosum* Woodland Association. The latter has been subsumed into the *Pinus monophylla / Quercus cornelius-mulleri* Woodland Association.

In addition to the association described below, five unclassified alliance-level samples were taken that may suggest further variation.

*Pinus monophylla* (Watts: n=5)

## *Pinus monophylla / Quercus cornelius-mulleri* Woodland Association

**Singleleaf Pinyon Pine / Muller's Oak Woodland Association (Mapping code 10161)**

### Range

Globally: Although the *Pinus monophylla* Woodland Alliance occurs broadly from California, Nevada, Utah, Arizona, and Idaho (NatureServe 2011), this association is only known from Joshua Tree National Park. This type may also occur in other portions of the desert slopes of the transverse and Peninsular Ranges of Southern California.

JOTR: Stands of the *Pinus monophylla / Quercus cornelius-mulleri* Woodland Association are found in the western part of the park. Plots were located within the Cottonwood Spring, East Deception Canyon Indian Cove, Joshua Tree South, Malapai Hill, Queen Mountain and Yucca Valley South 7.5-minute topographic quadrangles.

### Environmental Description

Globally: N/A

JOTR: Stands of *Pinus monophylla / Quercus cornelius-mulleri* Woodland Association are found at mid to high elevations (4,300–5,400 ft.; 1,300–1,600 m) of erosional highlands, arroyos, and alluvial fans with variable aspects though regularly found on north-facing slopes. This association is found on often convex, but also linear, concave, undulating surfaces of gentle to steep (5–40 degrees) slopes. Soil textures range from coarse sand to loams derived from granitic parent materials. These sites can be rocky with 0–37 percent bedrock cover, 0–28 percent boulder cover, 0–20 percent stone cover, <1–10 percent cobble cover, 0–79 percent gravel cover, and <1–87 percent fines cover. Litter ranges from <1–30 percent cover. These sites generally experience low to high levels of competition from exotics, low to moderate levels of disturbance from trampling, and low levels of disturbance from erosional rills.

### Vegetation Description

Globally: N/A

JOTR: Stands of the *Pinus monophylla / Quercus cornelius-mulleri* Woodland Association form an open to intermittent woodland with 0–31 percent cover for the tree/tall stratum, 2–29 percent cover for the shrub/medium stratum, and 0–27 percent cover for the herb/low stratum. Total vegetative cover ranges from 11–43 percent.

Stands of this association are dominated by *Pinus monophylla* and *Quercus cornelius-mulleri* in the tree and shrub layer, respectively. Characteristic species include *Achnatherum speciosum, Eriogonum fasciculatum, Opuntia basilaris,* and *Yucca brevifolia*. The exotic *Bromus rubens* is often abundant, as are crustose lichens on rocks. Often present are *Gutierrezia microcephala* and *Nolina parryi.*

**Other Noteworthy Species**
N/A

**Conservation Rank:** N/A

**Rank Justification**
This association is likely to be localized in the transverse and Peninsular Ranges of California and adjacent Baja California, Mexico.

**Comments**
Globally: Similar vegetation exists in Anza-Borrego Desert State Park but lacks sufficient sampling to substantiate if it is the same association.

JOTR : Fires in the Covington Flat area have removed much of the *Pinus monophylla* from former stands of this association in the past decade. *Quercus cornelius-mulleri* typically is resprouting following these fires.

A few plots lacking *Quercus cornelius-mulleri* but having *Juniperus californica* and other shrubs (including JOTRA: 18-27-6, 34A-03-1) suggest a distinctive phase of *Pinus monophylla* / *Juniperus californica / Achnatherum speciosum* in this more broadly defined association.

Plots used for this description: N=17; JOTRA: 06A-03-1, 06A-03-5, 06A-08-2, 16-24-3, 17-27-1, 18-27-5, 18-27-6, 18-28-2, 34A-03-1; Long: VMAL97-22, VMAL97-46, VMAL97-47; MDEI: 120-1-1, 120-1-6, 120-1-7, 120-4-4, 120-4-6, Watts: n=1.

Map Accuracy Assessment plots: N=26; 50-1049, 50-1053, 50-1057, 50-1066, 50-1069, 50-1074, 50-1079, 50-1080, 50-1081, 50-1082, 50-1086, 50-1087, 50-1089, 50-1090, 50-1092, 50-1093, 50-1094, 50-1095, 50-1096, 50-1097, 50-1100, 50-1101, 50-1102, 50-1104, 50-1106, 50-1780

## Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Tree** | | | | | | | | | |
| | ***Pinus monophylla*** | **100** | **6.8** | **1.0** | **19.0** | **X** | **X** | **X** | **X** |
| | *Yucca brevifolia* | 76 | 0.5 | 0.2 | 1.5 | | X | | X |
| | *Juniperus californica* | 47 | 1.7 | 1.0 | 8.0 | | | | |
| **Shrub** | | | | | | | | | |
| | ***Quercus cornelius-mulleri*** | **88** | **9.5** | **2.2** | **25.0** | **X** | **X** | **X** | **X** |
| | *Opuntia basilaris* | 88 | 0.2 | 0.2 | 0.5 | | X | | X |
| | *Eriogonum fasciculatum* | 82 | 1.4 | 0.2 | 6.0 | | X | | X |
| | *Ericameria linearifolia* | 71 | 1.1 | 0.2 | 7.2 | | | | X |
| | *Gutierrezia microcephala* | 53 | 0.2 | 0.2 | 1.2 | | | | X |
| | *Nolina parryi* | 53 | 1.4 | 0.4 | 9.2 | | | | X |
| | *Cylindropuntia echinocarpa* | 47 | 0.1 | 0.2 | 0.5 | | | | |
| | *Coleogyne ramosissima* | 35 | 0.4 | 0.2 | 2.0 | | | | |
| | *Ericameria teretifolia* | 35 | 0.2 | 0.2 | 3.2 | | | | |
| | *Yucca schidigera* | 35 | 0.2 | 0.2 | 2.0 | | | | |
| **Herb** | | | | | | | | | |
| | *Achnatherum speciosum* | 94 | 1.1 | 0.2 | 4.2 | | X | | X |
| | *Bromus rubens* | 71 | 5.3 | 0.2 | 21.0 | | | X | X |
| | *Mirabilis laevis* var. *villosa* | 35 | 0.1 | 0.2 | 1.0 | | | | |
| | *Achnatherum coronatum* | 35 | 0.1 | 0.2 | 0.4 | | | | |
| **Nonvascular** | | | | | | | | | |
| | Unknown Lichen | 59 | 0.2 | 0.2 | 1.0 | | | X | X |
| | Unknown Moss | 35 | 0.1 | 0.2 | 0.2 | | | | |

## 1.C.3. Temperate Flooded & Swamp Forest Formation

## 1.C.3.d. Western North American Warm Temperate Flooded & Swamp Forest Division

## M036. Warm Mediterranean & Desert Riparian, Flooded & Swamp Forest Macrogroup

## Southwestern North American Warm Desert Riparian Group

### *Populus fremontii* Forest Alliance

**Fremont Cottonwood Forest Alliance (Mapping code 15040)**

The *Populus fremontii* forest alliance occurs in the central California coast, southern California coast, Klamath Mountains, California coast ranges, Sierra Nevada foothills, Great Valley, southern California mountains and valleys, Mojave Desert, Sonoran Desert, and Colorado Desert regions of California and in the western United States (Sawyer et al. 2009, NatureServe 2011). In Joshua Tree National Park, this alliance is known from one large stand in the park in Smith Water Canyon; it otherwise occurs in small stands or singly in wet canyons. Conservation rank: G4, S3.

Trees are fast growing, short lived, and are intolerant of shade. Copious, wind-dispersed seed is produced in the spring and is viable for up to five days. Seeds germinate on moist alluvium and other recently disturbed sites. Seedlings establish in areas where subsurface water is available during the growing season. *P. fremontii* vegetatively regenerates by root suckers, but seed is the primary mode of reproduction. Trees damaged by cutting and fire resprout if the trees are not aged (Taylor 2000).

*Populus fremontii* may dominate or mix with other trees in wetland settings. Most stands have been eliminated, reduced in size and extent, and altered greatly in California, especially in areas supporting agriculture. Structure and composition of the remaining stands are changed as a result of hydrologic alternations, introduction of exotic species, grazing clearing, cutting for fence posts, fuel and wood projects, and other human impacts. *P. fremontii* is browse for livestock and wildlife and supplies cooler habitat in the summer.

The fire interval was probably long in original stands. Those invaded by *Tamarix* species have a shorter fire interval of 10 to 20 years in Arizona (Ohmart et al. 1977), and California (Brooks and Minnich 2006). Many stands in southern California and the Central Valley have been invaded by *Arundo donax*, which has a similar effect in increasing fuel load and fire intensity and in reducing fire interval, often resulting in high mortality of native cottonwoods and willows and increased post-fire dominance by *Arundo* (Coffman 2007).

This alliance has not yet been sampled with classification plot in Joshua Tree National Park, and three map accuracy assessment samples provide limited data for this alliance:

*Populus fremontii* (MapAA: 25-1655, 25-1656, 25-1657).

## *Salix gooddingii* Woodland Alliance

**Black Willow Woodland Alliance (Mapping code 15030)**

The *Salix gooddingii* woodland alliance is found in California, the Trans-Pecos of western Texas, southern New Mexico, southern Arizona, and the Colorado Plateau in Utah; in Mexico it occurs in the states of Chihuahua, Coahuila and possibly Sonora (NatureServe 20011). Within California, this alliance is present throughout the Central Valley, southern portions of the state, and on the east side of the Sierra Nevada (Sawyer et al. 2009). In Joshua Tree National Park, this alliance was sampled within the Indian Cove 7.5-minute quadrangle. Conservation rank: G4, S3.

*Salix gooddingii* is a common riparian tree or shrub in the west, occurring on terraces along large rivers; in canyons; and along rocky floodplains of small, intermittent streams, seeps, and springs at low elevations (0–500 m). Germination is best on fine-grained, moist, bare soil. Seedling establishment is high if seasonal and moisture requirements are met. Disturbances during winter and spring floods modify and create riparian stands; timing of seed dispersal and spring flood patterns determine seedling success.

Fire return intervals and character are associated with neighboring upland alliances, though the intervals are typically longer in the riparian habitats of this species. Plants are top-killed by low and moderate intensity fire, and they sprout vigorously. Fluvial processes are the primary disturbance to stands.

The *Salix gooddingii* woodland alliance is represented by one sampled plot classified as the following association (and see stand table on next page). Also, four map accuracy assessment samples provide limited data for alliance:

*Salix gooddingii – Salix laevigata* Association (JOTRA 15-25-1)
*Salix gooddingii* Alliance (MapAA: 25-1321, 25-1659, 25-1660, 25-1661).

## Stand table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Tree** | | | | | | | | | |
| | ***Salix gooddingii*** | **100** | **14.0** | **14.0** | **14.0** | **X** | **X** | **X** | **X** |
| | *Salix laevigata* | 100 | 6.0 | 6.0 | 6.0 | X | X | X | X |
| **Shrub** | | | | | | | | | |
| | *Baccharis* | 100 | 0.2 | 0.2 | 0.2 | X | X | X | X |
| | *Baccharis sergiloides* | 100 | 0.2 | 0.2 | 0.2 | X | X | X | X |
| | *Solanum xanti* | 100 | 0.2 | 0.2 | 0.2 | X | X | X | X |
| **Herb** | | | | | | | | | |
| | *Datura wrightii* | 100 | 3.4 | 3.4 | 3.4 | | X | | X |
| | *Bromus* | 100 | 3.0 | 3.0 | 3.0 | | X | | X |
| | *Xanthium strumarium* | 100 | 3.0 | 3.0 | 3.0 | | X | | X |
| | *Artemisia dracunculus* | 100 | 1.0 | 1.0 | 1.0 | | X | | X |
| | *Phacelia* | 100 | 0.6 | 0.6 | 0.6 | | X | | X |
| | *Artemisia ludoviciana* | 100 | 0.4 | 0.4 | 0.4 | | X | | X |
| | *Unknown Forb (herbaceous,* | 100 | 0.4 | 0.4 | 0.4 | | X | | X |
| | *Amaranthus* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Bromus rubens* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Cryptantha* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Erodium cicutarium* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |

## *Washingtonia filifera* Woodland Alliance

### California Fan Palm Woodland Alliance (Mapping code 15110)

The *Washingtonia filifera* Woodland Alliance occurs in the Mojave, Colorado, and Sonoran Desert regions of California; in Arizona; and in Baja California Norte, Mexico (Sawyer et al. 2009, NatureServe 2011). It is restricted to elevations below 900 m having springs, fault lines, and seasonally flooded canyon waterways where water is available continuously. Conservation rank: G3, S3.

*Washingtonia filifera* is a palm with a robust trunk that grows to a height of 15 m. The fan-shaped leaves accumulate around the trunk as a skirt of thatch. Birds and coyotes eat the black drupes and disperse the seeds, which remain dormant on the ground until leached of germination inhibitors.

The fan palm oases of the Colorado and adjacent Sonoran Deserts are well known and have been a resource for humans since arrival in the desert over 10,000 years ago. Natural disturbance patterns to oases involved both flood and fire, and because fan palm bark is extremely fire resistant. Fire was used effectively by California Indians to manage these resources. *W. filifera* does not reproduce vegetatively, and seedlings require sunny, moist openings for germination. Historically, openings were created by periodic flash floods, occasional lightning fires, and active burning. The subsequent decrease in vegetation also increased water availability, resulting in increased germination and growth of the *W.filifera* seeds and seedlings (Howard 1992).

Many *Washingtonia filifera* oases have been destroyed by agricultural and urban development, and through disruption or elimination of water sources. *W. filifera* requires a continuous source of water, making it sensitive to any change in water level; either a lowering of water tables or the inundation of root systems may kill plants. Other phreatophytes competing for limited water resources can also greatly affect how much water will be available to palms. Shrubs such as *Tamarix* spp., with its extremely high evapotranspiration rate, can reduce or eliminate oases seeps and springs and is displacing *W. filifera* in some areas. Another threat to water resources is the San Andreas Fault, where fault shifts can relocate or eliminate springs and seeps. Because *W. filifera* oases are popular destinations for hikers and off-highway vehicle enthusiasts, vegetation disturbance and vandalism are of continuing management concern.

This alliance is represented in Joshua Tree National Park by the *Washingtonia filifera / Salix exigua / Muhlenbergia rigens* Provisional Association.

### *Washingtonia filifera / Salix exigua / Muhlenbergia rigens* Provisional Association

**California Fan Palm / Narrowleaved Willow / Deer Grass Provisional Association (Mapping code 15112, not mapped)**

**Range**

Globally: This provisional association is known only from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: This association was sampled at Fortynine Palms Oasis on the Queen Mountain and Lost Palms Oasis on the Cottonwood Springs 7.5-minute quadrangles. It was also mapped at Cottonwood Springs.

**Environmental Description**

Globally: This provisional association is known only from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of *Washingtonia filifera / Salix exigua / Muhlenbergia rigens* are found at mid- to high elevations (2,800–3,200 ft.; 900 – 1,000 m) on undulating, sandy substrates. The substrate surface consists of 5–7 percent bedrock, 10–<13 percent boulder, 5–10 percent stone, 5 percent cobble, 3–5 percent gravel, and 8–10 percent fines cover. Litter consists of 5–15 percent cover.

**Vegetation Description**

Globally*:* This provisional association is known only from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: *Washingtonia filifera* is the sole or dominant tree in the canopy; understory dominants include the shrub *Salix exigua,* the herb *Muhlenbergia rigens,* and nonvascular moss. Other characteristic species include *Baccharis sergiloides*, *Typha angustifolia,* and *Epilobium canum.* Often occurring species include *Populus fremontii, Prosopis glandulosa, Brandegea bigelovii, Andropogon glomeratus, Cryptantha* spp., *Epipactis gigantean, Equisetum laevigatum, Juncus acutus, Juncus orthophyllus, Juncus xiphiodes, Mirabilis laevis* var. *villosa,* and *Schismus barbatus.*

**Other Noteworthy Species**

N/A

**Conservation Rank:** Rare

**Rank Justification**

*Washingtonia filifera* is restricted to seeps and springs in the Colorado, Mojave, and Sonoran deserts. These habitats are largely threatened by human-induced destruction of water sources, and their restricted range makes these stands highly susceptible to stochastic events (i.e. fault shifts, droughts) that may alter water sources.

**Comments**

JOTR: The stands at Cottonwood Spring may have been introduced.

Plots used for this description: N=2; JOTRA: 34-06-3,18B-04-1.

Map Accuracy Assessment plots: N=5; 25-1650, 25-1651, 25-1652, 25-1653, 25-1654.

**Stand table**

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Tree** | | | | | | | | | |
| | ***Washingtonia filifera*** | **100** | **27.2** | **21.2** | **33.2** | **X** | **X** | **X** | **X** |
| | *Prosopis glandulosa* | 50 | 0.5 | 1.0 | 1.0 | | | | X |
| | *Salix laevigata* | 50 | 0.5 | 1.0 | 1.0 | | | | X |
| | *Populus fremontii* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| **Shrub** | | | | | | | | | |
| | ***Salix exigua*** | **100** | **15.6** | **4.0** | **27.2** | **X** | **X** | **X** | **X** |
| | *Baccharis sergiloides* | 100 | 3.5 | 1.0 | 6.0 | | X | | X |
| | *Brandegea bigelovii* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| **Herb** | | | | | | | | | |
| | ***Muhlenbergia rigens*** | **100** | **5.5** | **1.0** | **10.0** | **X** | **X** | **X** | **X** |
| | *Typha angustifolia* | 100 | 2.0 | 1.0 | 3.0 | | X | | X |
| | *Epilobium canum* | 100 | 1.2 | 0.2 | 2.2 | | X | | X |
| | *Cryptantha* | 50 | 0.2 | 0.4 | 0.4 | | | | X |
| | *Andropogon glomeratus* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Schismus barbatus* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Phacelia campanularia* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Unknown Fern* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Mirabilis laevis* var. *villosa* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Juncus xiphioides* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Juncus acutus* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Epipactis gigantea* | 50 | 0.5 | 1.0 | 1.0 | | | | X |
| | *Equisetum laevigatum* | 50 | 0.6 | 1.2 | 1.2 | | | | X |
| | *Juncus orthophyllus* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| **Nonvascular** | | | | | | | | | |
| | Unknown Moss | 100 | 0.2 | 0.2 | 0.2 | X | X | X | X |

## M298. Western North American Warm Temperate Ruderal Flooded & Swamp Forest Macrogroup

## Southwestern North American Ruderal Riparian Scrub Group

### *Tamarix* spp. Semi-Natural Shrubland Stands

**Tamarisk Semi-Natural Shrubland Stands (Mapping code 60120, not mapped)**

Five species of *Tamarix* spp. grow throughout much of California: *T. aphylla, T. chinensis, T. gallica, T. parviflora*, and *T. ramosissima* (Sawyer et al. 2009). These species are not widespread within Joshua Tree National Park, but may occur in moist environments near springs and streams with semi-permanent moisture.

*Tamarix* spp. are African and Eurasian species that possess eco-physiological characteristics that make them remarkably formidable as invasive plants. These species are long-lived shrubs or trees with extensive and deep root systems. They consume large quantities of water, possibly more than any other woody species in similar habitats, because they can obtain water at very low water potentials and have very high water-use efficiencies. They are highly tolerant of alkaline and saline habitats and can concentrate salts in their leaves. For these reasons, these species have an advantage over native phreatophytes (e.g., cottonwoods and willows) in areas where salt levels are elevated or water tables depressed (Sawyer et al. 2009).

Tamarisk species have invaded the native vegetation in riparian areas where they develop dense, monospecific stands across floodplains, wetlands, and lake margins throughout the western United States. They impact vegetation alliances such as *Populus fremontii, Prosopis glandulosa, Salix gooddingii*, and *Washingtonia filifera* in this desert region.

## 2. Shrubland & Grassland Class

## 2.B.1. Mediterranean Scrub Formation

## 2.B.1.a. California Scrub Division

## M043. California Chaparral Macrogroup

## California Mesic North-Slope Chaparral Group

### *Quercus cornelius-mulleri* Shrubland Alliance

**Muller Oak Shrubland Alliance (Mapping code 21230)**

The *Quercus cornelius-mulleri* Shrubland Alliance occurs in the Mojave Desert and in the inner Peninsular Ranges of Southern California and adjacent Baja California, Mexico (Keeler-Wolf et al. 1998). Conservation rank: G4, S4.

*Quercus cornelius-mulleri* is a slow-growing, evergreen shrub that grows to 6 m in height. Bicolor leaves are a prominent feature of the species, in which dense whitish stellate hairs are fused together and appressed on the lower leaf surfaces (Nixon 2002). Shrubs produce large acorn crops at irregular intervals. Seeds germinate without stratification. California ground squirrels and jays cache the acorns, which are also eaten by livestock and wildlife. Plants sprout from swollen root crowns and roots sucker after damage to their trunks. Shrubs act as nurse plants, moderating environmental conditions and offering seedlings and saplings protection. Plants are shade tolerant (Nixon and Muller 1997).

This alliance is characteristic of dry slopes and alluvial washes on the western margins of the southwestern Mojave and western Colorado deserts of San Bernardino, Riverside, and San Diego County.

Q*uercus cornelius-mulleri* sprouts vigorously from root crowns after fire. *Q. cornelius-mulleri* chaparral occurs in areas of lower rainfall and sparser vegetation cover, and it typically has less frequent fire and slower recovery rates than typical cismontane chaparral types.

This alliance was thought to be represented in Joshua Tree National Park by two associations from the Keeler-Wolf et al. (2005) report: *Quercus cornelius-mulleri – Eriogonum fasciculatum – Ericameria linearifolia* Shrubland Association and *Quercus cornelius-mulleri – Coleogyne ramosissima* Shrubland Association. However, these have been combined into the more broadly defined *Quercus cornelius-mulleri – Eriogonum fasciculatum – Ericameria linearifolia* Shrubland Association.

In addition to the associations described below, eight unclassified alliance-level samples were taken that may suggest further variation:

*Quercus cornelius-mulleri* (Watts: n=8)

### *Quercus cornelius-mulleri – Eriogonum fasciculatum – Ericameria linearifolia Association*

**Muller Oak – California Buckwheat – Narrowleaf Goldenbush Association (Mapping code 21234)**

#### Range

Globally: This association is known from Joshua Tree National Park and Anza-Borrego Desert State Park. Keeler-Wolf et al. (1998) first defined the association from the Peninsular Ranges in that State Park of San Diego County. Similar stands have been observed in the eastern San Bernardino Mountains, north of Pioneertown, and may occur northwest toward Cajon Pass and south of Hesperia (San Bernardino County).

JOTR: Stands of the *Quercus cornelius-mulleri – Eriogonum fasciculatum – Ericameria linearifolia* Association is found in the western part of the park in the Covington Flats area and in the Little San Bernardino Mountains. Samples were located within the East Deception Canyon, Indian Cove, Joshua Tree South, and Yucca Valley South 7.5-minute topographic quadrangles.

#### Environmental Description

Globally: This association, as described in Anza-Borrego State Park (Keeler-Wolf et al. 1998), occurs on desert slopes in granitic mountains and hills between 3,400 and 5,000 feet (1,000 and 1,500 m) elevation. It is the most common form of "desert transition chaparral" in Anza-Borrego.

JOTR: Stands of *Quercus cornelius-mulleri / Eriogonum fasciculatum – Ericameria linearifolia* Association are found at high elevations (4,000–5,200 ft.; 1,200–1,600 m) on slopes of rocky highlands having variable aspect. Soils are usually sands but are occasionally loams formed from granitic parent material. Ground cover consists of 1–36 percent bedrock, 0–17 percent boulder, 0–13 percent stone, 1–10 percent cobble, 5–28 percent gravel, and 8–47 percent fines. Litter ranges from 2–17 percent cover. These sites generally experience low to high disturbance levels from exotics species, moderate levels of disturbance from foot traffic/trampling, and moderate to high disturbance levels from improper burning regime (2 out of 6 plots sampled were recovering from recent fires).

#### Vegetation Description

Globally: In Anza-Borrego Desert State Park, Muller oak forms a scattered canopy (3–12 percent) over low desert shrubs including *Eriogonum fasciculatum, Ericameria linearifolia, and Opuntia basilaris.* This association may also have other evergreen shrubs, such as *Juniperus californica, Rhus ovata, Cercocarpus betuloides*, and *Ceanothus greggii*, but these other species are usually much less common than the Muller Oak (Keeler-Wolf et al. 1998).

JOTR: Stands of the *Quercus cornelius-mulleri – Eriogonum fasciculatum – Ericameria linearifolia* Association form an open woodland with 0–<1 percent cover for the tree/tall stratum, 3–33 percent cover for the shrub/medium stratum, and 0–6 percent cover for the herb/low stratum. Total vegetative cover ranges from 10–33 percent.

This association is dominated by *Quercus cornelius-mulleri* in the shrub layer and the non-native *Bromus rubens* in the herb layer, and crustose lichens. Characteristic species include *Eriogonum fasciculatum, Opuntia basilaris,* and *Achnatherum speciosum.* Other species that are often present are *Achnatherum coronatum,* the exotic *Bromus tectorum, Encelia virginensis, Ericameria linearifolia, E. teretifolia, Eriophyllum confertiflorum, Galium angustifolium, Nolina parryi,* and *Yucca shidigera.*

**Other Noteworthy Species**
N/A

**Conservation Rank:** N/A

**Rank Justification**
This is a common type on the desert slopes of the Transverse and Peninsular Ranges of California.

**Comments**
Globally: N/A

JOTR: N/A

Plots used for this description: N=6; JOTRA: 03-14-2, 06A-03-2, 06A-03-3, 08B-02-1, 09A-05-2, 16-26-2.

Map Accuracy Assessment plots: N=31; 50-0839, 50-0840, 50-0842, 50-0846, 50-0847, 50-0851, 50-0852, 50-0854, 50-0856, 50-0857, 50-0865, 50-0867, 50-1022, 50-1305, 50-1306, 50-1307, 50-1308, 50-1309, 50-1310, 50-1311, 50-1313, 50-1315, 50-1316, 50-1317, 50-1318, 50-1320, 50-1794, 50-1795, 50-1796, 50-1801, 50-1802.

## Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Tree** | | | | | | | | | |
| | *Pinus monophylla* | 67 | 0.2 | 0.2 | 0.4 | | | | X |
| | *Yucca brevifolia* | 33 | 0.2 | 0.4 | 0.6 | | | | |
| | *Juniperus californica* | 33 | 0.4 | 0.2 | 2.0 | | | | |
| **Shrub** | | | | | | | | | |
| | ***Quercus cornelius-mulleri*** | **100** | **8.5** | **3.0** | **18.0** | **X** | **X** | **X** | **X** |
| | ***Eriogonum fasciculatum*** | **83** | **2.1** | **1.2** | **4.0** | | **X** | | **X** |
| | *Opuntia basilaris* | 83 | 0.2 | 0.2 | 0.2 | | X | | X |
| | ***Ericameria linearifolia*** | **67** | **1.0** | **0.2** | **5.0** | | | | **X** |
| | *Galium angustifolium* | 67 | 0.2 | 0.2 | 0.4 | | | | X |
| | *Ericameria teretifolia* | 67 | 0.3 | 0.2 | 1.2 | | | | X |
| | *Nolina parryi* | 67 | 0.5 | 0.4 | 1.2 | | | | X |
| | *Yucca schidigera* | 50 | 0.2 | 0.2 | 0.4 | | | | X |
| | *Encelia virginensis* | 50 | 0.1 | 0.2 | 0.4 | | | | X |
| | *Eriophyllum confertiflorum* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Echinocereus engelmannii* | 33 | 0.1 | 0.2 | 0.2 | | | | |
| | *Ephedra nevadensis* | 33 | 0.1 | 0.2 | 0.4 | | | | |
| | *Cylindropuntia echinocarpa* | 33 | 0.1 | 0.2 | 0.4 | | | | |
| | *Salazaria mexicana* | 33 | 0.6 | 0.4 | 3.0 | | | | |
| | *Echinocereus* | 33 | 0.1 | 0.2 | 0.2 | | | | |
| | *Arctostaphylos glauca* | 33 | 2.4 | 0.2 | 14.0 | | | | |
| | *Sphaeralcea ambigua* | 33 | 0.1 | 0.2 | 0.2 | | | | |
| | *Bebbia juncea* | 33 | 0.1 | 0.2 | 0.2 | | | | |
| | *Coleogyne ramosissima* | 33 | 0.1 | 0.2 | 0.4 | | | | |
| **Herb** | | | | | | | | | |
| | *Bromus rubens* | 100 | 2.7 | 0.2 | 5.0 | X | X | X | X |
| | *Achnatherum speciosum* | 83 | 0.7 | 0.2 | 2.0 | | X | | X |
| | *Bromus tectorum* | 67 | 2.2 | 0.2 | 8.0 | | | | X |
| | *Achnatherum coronatum* | 67 | 0.3 | 0.2 | 1.0 | | | | X |
| | *Eriogonum* | 33 | 0.1 | 0.2 | 0.6 | | | | |
| | *Lotus rigidus* | 33 | 0.1 | 0.2 | 0.4 | | | | |
| **Nonvascular** | | | | | | | | | |
| | Unknown Lichen | 83 | 0.2 | 0.2 | 0.2 | X | X | X | X |

## California Xeric Chaparral Group

### *Arctostaphylos glauca* Shrubland Alliance

**Bigberry Manzanita Shrubland Alliance (Mapping code 21210, not mapped)**

The *Arctostaphylos glauca* Shrubland Alliance occurs in the central California coast, Southern California coast, and Southern California mountains and valley regions in California and in Baja California, Mexico (Sawyer et al. 2009, NatureServe 2011). This alliance was sampled in Joshua Tree National Park near South Park Peak on the Yucca Valley South 7.5-minute topographic quadrangle. Conservation rank: G4, S4.

*Arctostaphylos glauca* is a long-lived, evergreen, sclerophyllous shrub that grows up to 6 m and may live to 100 years. By age 20, shrubs begin to produce abundant seeds that form a seed bank of hard stones, which are the primary means of regeneration. Prostrate stems can root, although coastal populations rarely do so because of their upright habit. Stands of *A. glauca* occupy mid to upper slopes of moderate to high elevations for chaparral. Stands in southern California occur more often on north-facing slopes on granitic and metamorphic bedrocks. Small stands also occur in central California on south-facing serpentine slopes and on north-facing slopes of sandstone and other sedimentary substrates.

This alliance has been sampled only once in Joshua Tree National Park (JOTRA: 03-14-1), where it is limited to small stands usually adjacent to stands of *Quercus cornelius-mulleri* (see Stand Table on next page). Stands tend to occur in more xeric locations than the oaks (e.g., southerly facing steep slopes).

## Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Tree** | | | | | | | | | |
| | *Pinus monophylla* | 100 | 3.2 | 3.2 | 3.2 | X | X | X | X |
| | *Yucca brevifolia* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Juniperus californica* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| **Shrub** | | | | | | | | | |
| | ***Arctostaphylos glauca*** | **100** | **14.2** | **14.2** | **14.2** | **X** | **X** | **X** | **X** |
| | *Ericameria linearifolia* | 100 | 8.0 | 8.0 | 8.0 | X | X | X | X |
| | *Quercus cornelius-mulleri* | 100 | 4.0 | 4.0 | 4.0 | X | X | X | X |
| | *Coleogyne ramosissima* | 100 | 0.4 | 0.4 | 0.4 | | X | | X |
| | *Echinocereus engelmannii* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Galium angustifolium* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Opuntia basilaris* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Yucca schidigera* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Nolina parryi* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Eriogonum fasciculatum* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Eriophyllum confertiflorum* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| **Herb** | | | | | | | | | |
| | *Bromus rubens* | 100 | 12.0 | 12.0 | 12.0 | X | X | X | X |
| | *Lotus rigidus* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Eriogonum saxatile* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Achnatherum speciosum* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Poa secunda* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Bromus tectorum* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| **Nonvascular** | | | | | | | | | |
| | Unknown Lichen | 100 | 0.2 | 0.2 | 0.2 | X | X | X | X |

## 2.B.2. Mediterranean Grassland & Forb Meadow Formation

## 2.B.2.a. California Grassland & Meadow Division

## M045. California Annual & Perennial Grassland Macrogroup

## California Annual Forb / Grass Vegetation Group

### *Amsinckia (menziesii, tessellata)* Herbaceous Alliance

**Fiddlenecks Herbaceous Alliance (Mapping code 60030, not mapped)**

The *Amsinckia* (*menziesii, tessellata*) herbaceous alliance occurs in the Central and Southern California Coast Ranges, the Central Valley, the Mojave Desert, the interior North Coast Ranges, Sierra Nevada Foothills, and throughout southern California mountains and valleys (Sawyer et al. 2009). Conservation rank: G4, S4.

This alliance has been identified for Joshua Tree National Park, but no classification plot/sampling data exist for this description. Individuals of *Amsinckia tessellata* have been documented in several sampled plots at low cover (JOTRA: n=2; MDEI: n-2).

*A. menziesii* and *A. tessellata* are common native annuals of the California Floristic Province. Plants are well adapted to regular site disturbance and fluctuating Mediterranean climates through their ability to bank seeds and germinate quickly during relatively high rainfall years. *A. tessellata* grows under somewhat drier climate conditions than *A. menziesii*, but both species grow together in some stands in the inner central Coast Ranges.

The alliance fluctuates depending on location in California in correlation with the amount and timing of precipitation. As with other annual vegetation, stand appearance and size also may vary from year to year. We need further sampling and analysis to understand the relationships of this alliance versus the non-native *Bromus* spp. and with other native herb alliances, including the *Plagiobothrys nothofulvus* alliance. Prior to European colonization, patterns of disturbance-related native plants, including *Amsinckia* spp., probably occurred across much of the non-woody landscapes of lowland California. In some El Niño years, *Amsinckia* species cover large areas, displaying seasonal dominance. In other years, non-native species of *Bromus, Erodium,* and *Lactuca* dominate the same areas.

In the hot deserts of California, grazing, fire and other disturbances modify stand dynamics of perennial vegetation types as well as annual herbaceous types. In the inner Central Coast ranges of California, Schiffman (2007) discussed the role of giant kangaroo rat (*Dipodomys ingens*), California ground squirrel (*Spermophillus beacheyi*), and pocket gophers (*Thomomys* spp.) in maintaining a mosaic of herbaceous vegetation types including stands of *Amsinckia* atop regularly spaced, active rodent colonies surrounded by less disturbance adapted annuals.

This alliance has been observed by not sampled in Joshua Tree National Park. Stands contain *Amsinckia tessellata* with a variety of other herbs.

## Mediterranean California Naturalized Annual & Perennial Grassland Group

### *Bromus rubens – Schismus (arabicus, barbatus)* Semi-Natural Herbaceous Stands
**Red Brome – Mediterranean Grass Semi-Natural Herbaceous Stands (Mapping code 60010)**

*Bromus rubens – Schismus* (*arabicus, barbatus*) stands occur throughout the Central Coast Range, the Colorado and Mojave deserts, the Central Valley, and southern California mountains and valleys (Sawyer et al. 2009). This alliance has been identified in Joshua Tree National Park, but no classification plot/sampling data exist for this description. However, individuals of *Bromus rubens* have been documented in approximately 175 sampled plots at covers ranging from <1 to 50 percent; and *Schismus* spp. has been observed in 123 plots at covers ranging from <1 to 15 percent. Conservation rank: N/A.

*Bromus rubens*, red brome, has a California Invasive Pest Council (Cal-IPC) ranking of High. It is a cool-season, non-native, annual grass from Europe with plump, reddish inflorescences and awns. Freezing temperatures kill plants, and seeds germinate throughout the growing season at temperatures between 20–25º C and rainfall greater than 1 cm. Plants are shade intolerant, and at high densities, they produce less biomass and set seed or die. *B. rubens* requires about half as much rain to stimulate seed germination as do native winter annuals (Newman 2001, Simonin 2001). *B. rubens* grows across California at low elevations, but exhibits strongest dominance in warm deserts and semi-deserts of the state.

*Schismus barbatus* and *S. arabicus* have a Cal-IPC rank of Limited. *S. arabacus* is similar to *S. barbatus* ecologically, but it grows in more arid areas within the range of *S. barbatus.* Both species are tufted, cool-season, annual grasses with narrow, greenish-purple inflorescences. The stems are erect or lie on the ground. Plants grow in sandy soils, on sandy flats, arroyos, washes, bases of larger dunes, and as agricultural and urban weeds. As with *B. rubens*, *S. barbatus* and *S. arabicus* have become important components of the winter and early spring annual flora, and they both prevent native ephemerals from sprouting (DiTomaso and Healy 2007).

When *Bromus rubens* and *Schismus* spp. invade, they shorten fire return intervals in warmer and drier portions of the state by producing abundant and continuous cover of long-lasting fine fuels. They also promote fires that are hot and fast, in areas where fires previously were infrequent due to insufficient fuels. Fires may return every 10 years, when previously they were at > 35 to > 100 year cycles, and these short-return fires continue to promote establishment of grasses such as *B. rubens* (Simonin 2001b). Annual herbaceous vegetation in similar areas is less susceptible to these types of fires.

Post-burn stands in Joshua Tree National Park exhibiting this alliance exhibit emergent *Quercus cornelius-mulleri, Yucca schidigera, Eriogonum fasciculatum,* and *Ericameria linearifolia* in the shrub layer, and *Achnatherum speciosum* in the herb layer along with the nonnative exotic *Bromus rubens* and/or *Schismus* spp.

No classification plots were conducted in the Park to define this type. Map accuracy assessment samples provide limited information, and these samples are at the alliance/stand level:

> *Bromus rubens – Schismus* (*arabicus, barbatus*) (MapAA: 50-0082, 50-0084, 50-0085, 50-0087, 50-0088, 50-0089, 50-0090, 50-0094, 50-0095, 50-0097, 50-0099, 50-0100, 50-0101, 50-0104, 50-0106, 50-0107, 50-0109).

## 2.C.1. Temperate Grassland, Meadow, & Shrubland Formation

## 2.C.1.a. Vancouverian & Rocky Mountain Grassland & Shrubland Division

## M048. Western North American Temperate Grassland & Meadow Macrogroup

## Vancouverian & Rocky Mountain Naturalized Annual Grassland Group

### *Bromus tectorum* Semi-Natural Herbaceous Stands

**Cheatgrass Semi-Natural Herbaceous Stands (Mapping code 60120, not mapped)**

This alliance is found throughout much of western North America from the western Great Plains to intermountain and southwestern U.S. (NatureServe 2011). In Joshua Tree National Park it is known only from one plot sampled within the Joshua Tree South 7.5-minute quadrangle, though it has been observed in post-burn sites. Conservation rank: N/A.

*Bromus tectorum* stands occur at elevations ranging from sea level to 2,200 m and establishes after disturbance of a natural shrub- or grass-dominated community, resulting in the replacement of the natural vegetation by non-native, annual grass species. *Bromus tectorum* typically dominates the community with over 80–90% of the total vegetation cover, making it difficult to determine what natural community was formerly present.

*Bromus tectorum* is a non-native, annual grass that is favored by cultivation, frequent fire, and overgrazing. Plants grow as long as soil moisture is present, commonly maturing, fruiting, and drying by late June. Seeds accumulate in the litter from earlier plants, and moist litter provides ideal conditions for seed germination. Seeds germinate in the fall, if water is available, and seedlings grow until temperatures drop; seeds may germinate in the spring and even in summer (Sawyer et al. 2009).

*Bromus tectorum* seriously impacts natural vegetation in northeastern California and invades other middle elevation sites in California, especially post-burn areas adjacent to woodlands. It competes well with other plants for soil moisture and promotes frequent fires. In many areas invaded by *B. tectorum*, the fire cycle is 3–5 years. Not only are fires more frequent, but they are uniform, with fewer patches of unburned plants (Whisenant 1990). This shortened fire cycle considerably reduces the viability of perennials and promotes *B. tectorum* dominance (Carpenter and Murray 2005, Young 2000, Zouhar 2003).

This alliance has been sampled once in Joshua Tree National Park during the classification phase (JOTRA: 08B-02-2; see Stand Table on next page). One other post-burn sample during the Accuracy Assessment phase exhibited high cover and strong dominance of *Bromus tectorum*.

## Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Tree** | | | | | | | | | |
| | *Juniperus californica* | 100 | 0.2 | 0.2 | 0.2 | X | X | X | X |
| | *Yucca brevifolia* | 100 | 0.2 | 0.2 | 0.2 | X | X | X | X |
| **Shrub** | | | | | | | | | |
| | *Ephedra nevadensis* | 100 | 0.4 | 0.4 | 0.4 | | X | | X |
| | *Sphaeralcea ambigua* | 100 | 0.4 | 0.4 | 0.4 | | X | | X |
| | *Coleogyne ramosissima* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Gutierrezia microcephala* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Lycium andersonii* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Salazaria mexicana* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| **Herb** | | | | | | | | | |
| | ***Bromus tectorum*** | **100** | **35.0** | **35.0** | **35.0** | **X** | **X** | **X** | **X** |
| | *Pleuraphis rigida* | 100 | 1.2 | 1.2 | 1.2 | | X | | X |
| | *Achnatherum coronatum* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Amsinckia tessellata* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Bromus rubens* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Eriogonum* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| **Nonvascular** | | | | | | | | | |
| | Cryptogammic crust | 100 | 0.2 | 0.2 | 0.2 | X | X | X | X |

## 2.C.5. Temperate & Boreal Freshwater Wet Meadow & Marsh Formation
## 2.C.5.c. Western North American Warm Desert Freshwater Marsh Division
## M076. Warm Desert Freshwater Shrubland, Marsh & Meadow Macrogroup
## North American Warm Desert Riparian Low Bosque & Shrubland Group

### *Baccharis sergiloides* Shrubland Alliance
**Broom Baccharis Shrubland Alliance (Mapping code 22030, not mapped)**

The *Baccharis sergiloides* Intermittently Flooded Shrubland Alliance occurs in the Mojave Desert and southern California mountains and valley regions of California (Sawyer et al. 2009), and in Nevada, Arizona, and northern Mexico (NatureServe 2011). Within Joshua Tree National Park it is known only from a sample at Rattlesnake Canyon in the western part of the Park. Conservation rank: G4, S3.

*Baccharis sergiloides* is a common shrub of arroyos, moist canyon bottoms, seeps, springs, and washes in the mountains of the Mojave Desert. It occurs in similar habitats in the desert-facing peninsular and transverse ranges of California. Stands are often small and are tied to relatively moist, intermittently flooded stretches of desert mountain canyon bottoms or borders and tails of springs and seeps. Boulders and bedrock may break up the stands, although rooting substrate is typically relatively fine sand (Sawyer et al. 2009). Evens (2000) found this alliance on granitic substrates in the narrower canyons of the eastern Mojave Desert mountains of California. She describes variation in this association based on co-occurring species and microtopography ranging from flat, sandy stretches and bouldery ravines with >10 percent slope, to vertical waterfalls on bedrock. In comparison to other canyon alliances in this region, the *Baccharis sergiloides* alliance has the most ecological overlap with the *Salix exigua* alliance, suggesting that relatively high subsurface moisture is required.

As with other members of the genus, *Baccharis sergiloides* produces abundant seed that is easily dispersed on the wind, with the assistance of substantial pappus bristles. Little specific information exists on the autecology of the species. Its longevity and relationship to fire and mechanical disturbance are not known. However, as with its congeners (*e.g., Baccharis sarothroides, B. pilularis, and B. salicifolia*), it probably does resprout following disturbance and does not attain great age.

This alliance is represented by one sampled plot in the *Baccharis sergiloides / Muhlenbergia rigens* Association (JOTRA: 16-26-4) (see stand table on next page).

## Stand table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Tree** | | | | | | | | | |
| | *Fraxinus velutina* | 100 | 1.0 | 1.0 | 1.0 | X | X | X | X |
| | *Quercus cornelius-mulleri* | 100 | 0.4 | 0.4 | 0.4 | | X | | X |
| **Shrub** | | | | | | | | | |
| | ***Baccharis sergiloides*** | **100** | **4.2** | **4.2** | **4.2** | **X** | **X** | **X** | **X** |
| | *Salix exigua* | 100 | 2.2 | 2.2 | 2.2 | | X | | X |
| | *Acacia greggii* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Phoradendron californicum* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Gutierrezia microcephala* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Prunus fasciculata* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Opuntia phaeacantha* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Galium* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| **Herb** | | | | | | | | | |
| | *Epilobium canum* | 100 | 1.0 | 1.0 | 1.0 | X | X | X | X |
| | *Lotus rigidus* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Artemisia ludoviciana* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Artemisia dracunculus* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Bromus rubens* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Euphorbia eriantha* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Andropogon glomeratus* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Muhlenbergia rigens* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Juncus* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| **Nonvascular** | | | | | | | | | |
| | Unknown Moss | 100 | 0.2 | 0.2 | 0.2 | X | X | X | X |

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

## 3.A.1. Warm Desert Scrub & Grassland Formation

## 3.A.2.a. North American Warm Desert Scrub & Grassland Division

## M088. Mojave-Sonoran Semi-Desert Scrub Macrogroup

## Mojave Mid-Elevation Mixed Desert Scrub Group

### *Coleogyne ramosissima* Shrubland Alliance

**Blackbush Shrubland Alliance (Mapping code 28020)**

*Coleogyne ramosissima* Shrubland Alliance is widespread throughout the west. It is described from Wyoming, the Colorado Plateau of southern Utah and northern Arizona, and the Mojave Desert in Nevada and California. It is most extensive on the Colorado Plateau, where abundant terrain is present at the proper altitude. In the Mojave, it forms an altitudinal belt on peripheral and interior ranges of sufficient elevation (NatureServe 2011). Conservation rank: G5, S4.

*Coleogyne ramosissima* is in a monotypic genus restricted to the arid southwestern United States; Stebbins and Major (1965) consider it a paleoendemic. According to Browns and West (1976), *Coleogyne ramosissima* is a relict species that may be on its way to extinction. This alliance occurs at transitional elevations between the Mojave Desert and the Great Basin Desert. Over the past few years, plot data (Thomas et al. 2004, Keeler-Wolf 2007) have confirmed the intermediate relationship between the two deserts.

Elements of the lower, hotter Mojavean flora may be mixed with *Coleogyne ramosissima* Shrubland including *Larrea tridentata-Ambrosia dumosa, Yucca schidigera*, and *Yucca brevifolia* Shrublands. Upper elevation stands may mix with *Artemisia tridentata, Atriplex confertifolia, Ephedra nevadensis, Juniperus californica, Juniperus osteosperma,* and *Pinus monophylla*-dominated alliances. Blackbush is also found in the Peninsular Ranges as far south as Anza-Borrego Desert State Park (Keeler-Wolf et al. 1998), where it forms intermittent stands between *Yucca schidigera* Shrubland Alliance stands and *Juniperus californica* or *Pinus monophylla* dominated stands.

*Coleogyne ramosissima* is a long-lived shrub, up to 400 years in age (Webb et al. 1988). Individual plants produce relatively few seeds, which are relatively large and less mobile than other shorter-lived species in genera such as *Ericameria, Atriplex*, and *Artemisia*. Browns and West (1976) report that while some *Coleogyne ramosissima* seed germinate on the surface, seedlings often emerge from rodent caches. Seedling survival is poor, with most not surviving beyond cotyledon stage. *Coleogyne* stands are notably depauperate in seedlings and young plants, suggesting that pulse establishment after favorable weather conditions are rare. Growth rates for the species are very slow (Webb et al. 1988). Densities of *Coleogyne* stands vary and individuals in a stand are evenly distributed (Lei 2001a), suggesting strong competition for moisture and other resources.

*Coleogyne* is typically killed outright by fire, and since most stands are relatively dense and monospecific, even low-frequency fire can destroy significant portions of stands for long periods. Recovery from fire is slow. Sinuous, sharp transitions between remnant stands of *Coleogyne ramosissima* and adjacent stands that may have been burned more than 50 years ago are frequently obvious. Lei (2001b) found most seeds in seed bank were killed in a lightning fire. Long-distance dispersal with relatively poorly dispersed seeds from adjacent stands is required for re-establishment. For a fire to carry through a *Coleogyne ramosissima* stand, not only does the stand need to be relatively dense but climatic conditions also need to be favorable (strong winds and dry conditions). Fire frequency is not high in these stands, since they occur in relatively low lightning frequency areas. In much of its range, the *Coleogyne*-dominated alliance may be succeeded postfire by several phases of vegetation including an *Achnatherum speciosum*-dominated phase, an *Eriogonum fasciculatum*–dominated phase, an *Ericameria teretifolia*–dominated phase, or a *Salazaria mexicana*–dominated phase (Brooks and Minnich, 2006, and Keeler-Wolf, personal observation).

Increased fire frequency and nonnative plants in the California deserts have adverse impacts on this alliance. The presence of non-native, annuals, such as *Bromus rubens*, *Bromus tectorum* and *Erodium cicutarium,* can contribute to carrying fire and these plants can increase in post-fire sites within the Mojave Desert, at the detriment of Blackbush stands (Brooks 1999, Brooks and Matchett 2003). Although relatively widespread in California, the alliance is sporadically distributed, particularly toward the south of its range. Some parts of the desert (e.g., Anza-Borrego) have very spotty distributions of this alliance. Extralimital and isolated stands are particularly vulnerable to fire.

The alliance is well-defined with plot sampling of the *Coleogyne ramosissima – Ephedra nevadenis* Association. The following samples from Joshua Tree National Park suggest further variation than what is currently reported in this Alliance:

*Coleogyne ramosissima* Association (Watts n=2)
*Coleogyne ramosissima-Peucephyllum schottii* (Watts n=2)

## *Coleogyne ramosissima – Ephedra nevadensis* Association

**Blackbrush – Nevada Ephedra Association (Mapping code 28023)**

### Range

Globally: Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona (NatureServe 2011), and from Joshua Tree National Park in California.

JOTR: This association has been sampled within the Cottonwood Spring, East Deception Canyon, Indian Cove, Keys View, Malapai Hill, Queen Mtn., and Rockhouse Canyon 7.5-minute topographic quadrangles.

### Environmental Description

Globally: In Arizona, this association occurs primarily on sideslopes but can be seen on a variety of landforms including plateaus, ridges, terraces, and valley bottoms. It generally occurs from approximately 850 to 1575 m in elevation. While predominantly found on flat or low-gradient settings (0–15 degrees), this association occasionally occurs on moderate to steep slopes (30–40 degrees) as well. Soils are predominantly rapidly-drained sandy loams that rarely contain silt and clay.

JOTR: The *Coleogyne ramosissima – Ephedra nevadenis* Association occurs along slope faces at mid to high elevations (3,400–5,000 ft.; 1,100–1,500 m) as variable aspects. Slopes are gentle to steep with flat, concave, convex, or undulating topographies. Soils range from sands to loams derived from granitic parent materials. Ground cover in these stands is comprised of 0–25 percent bedrock, 0–6 percent boulder, 0–13 percent stone, 0–32 percent cobble, 19–80 percent gravel, and 11–51 percent fines. Litter cover ranges from <1–14 percent.

### Vegetation Description

Globally*:* In Arizona, three species of *Ephedra* are common, with *Ephedra fasciculata* and *Ephedra torreyana* occurring most frequently. *Ephedra viridis* also occurs, but its presence is sporadic. Additionally, the short-shrub stratum often includes *Yucca baccata*. A dwarf-shrub layer typically occurs and is dominated by *Opuntia polyacantha*. Occasionally *Agave utahensis* also occurs here. The desert grasses *Dasyochloa pulchella*, *Tridens muticus*, and *Vulpia octoflora* are all common in a fairly sparse graminoid layer, as well as the exotic *Bromus rubens*. A variety of species, including *Sphaeralcea grossulariifolia* and *Erodium cicutarium*, occur in the relatively sparse forb understory.

JOTR: The *Coleogyne ramosissima – Ephedra nevadenis* Association forms open shrublands with 0–1 percent cover in the tree/tall stratum, 5–21 percent cover in the shrub/mid stratum, and 0–4 percent cover in the herb/low stratum. Total vegetation cover ranges from 10–22 percent.

**Other Noteworthy Species**
N/A

**Conservation Rank:** N/A

**Rank Justification**
N/A

**Comments**
Globally*:* N/A

JOTR: N/A

Plots used for this description: N=12; JOTRA: 09A-06-1, 15-09-2, 15-25-3, 16-24-1, 22-26-1, 22-32-2, 23-20-2, 33-07-5; JOTRJOTR49, JOTR50, JOTR52, JOTR53. Watts n=3.

Map Accuracy Assessment plots: N=6; 50-0437, 50-0440, 50-0443, 50-0446, 50-0454, 50-0456.

## Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Tree** | | | | | | | | | |
| | *Yucca brevifolia* | 58 | 0.2 | 0.2 | 1.2 | | | X | X |
| **Shrub** | | | | | | | | | |
| | ***Coleogyne ramosissima*** | **100** | **7.1** | **2.0** | **19.0** | **X** | **X** | **X** | **X** |
| | *Yucca schidigera* | 92 | 1.7 | 0.2 | 6.2 | | X | | X |
| | ***Ephedra nevadensis*** | **83** | **0.5** | **0.2** | **1.4** | | **X** | | **X** |
| | *Eriogonum fasciculatum* | 75 | 0.8 | 0.2 | 2.0 | | X | | X |
| | *Viguiera parishii* | 75 | 0.7 | 0.2 | 3.0 | | X | | X |
| | *Acacia greggii* | 67 | 0.6 | 0.2 | 2.0 | | | | X |
| | *Lycium andersonii* | 58 | 0.3 | 0.2 | 1.2 | | | | X |
| | *Krameria grayi* | 50 | 0.2 | 0.2 | 1.0 | | | | X |
| | *Salazaria mexicana* | 50 | 0.2 | 0.2 | 1.2 | | | | X |
| | *Cylindropuntia ramosissima* | 50 | 0.1 | 0.2 | 0.4 | | | | X |
| | *Cylindropuntia echinocarpa* | 42 | 0.2 | 0.2 | 1.2 | | | | |
| | *Encelia actonii* | 42 | 0.1 | 0.2 | 0.4 | | | | |
| | *Echinocereus engelmannii* | 42 | 0.1 | 0.2 | 0.2 | | | | |
| | *Larrea tridentata* | 33 | 1.0 | 0.2 | 8.2 | | | | |
| | *Ambrosia dumosa* | 33 | 0.4 | 0.2 | 3.0 | | | | |
| | *Senna armata* | 33 | 0.4 | 0.2 | 2.0 | | | | |
| | *Prunus fasciculata* | 33 | 0.3 | 0.2 | 2.0 | | | | |
| | *Ericameria linearifolia* | 33 | 0.2 | 0.2 | 1.0 | | | | |
| | *Ambrosia salsola* | 33 | 0.2 | 0.2 | 1.0 | | | | |
| | *Krameria erecta* | 33 | 0.1 | 0.2 | 1.0 | | | | |
| | *Opuntia basilaris* | 33 | 0.1 | 0.2 | 0.2 | | | | |
| **Herb** | | | | | | | | | |
| | *Bromus rubens* | 50 | 0.7 | 0.2 | 2.0 | | | | X |
| | *Erodium cicutarium* | 50 | 0.2 | 0.2 | 1.0 | | | | X |
| | *Achnatherum speciosum* | 33 | 0.6 | 0.2 | 6.0 | | | | |
| | *Pleuraphis rigida* | 33 | 0.2 | 0.2 | 1.2 | | | | |
| **Nonvascular** | | | | | | | | | |
| | Unknown Lichen | 50 | 0.1 | 0.2 | 0.2 | | | X | X |
| | Cryptogammic crust | 42 | 0.3 | 0.2 | 2.4 | | | | |

## *Ephedra nevadensis* Shrubland Alliance

### Nevada Joint Fir Shrubland Alliance (Mapping code 24010)

*Ephedra nevadensis* Shrubland Alliance occurs in valleys, bajadas, and mountains of the Mojave Desert, Columbia Plateau, Great Basin, Colorado Plateau, and Great Basin in California, Nevada, Utah, and Arizona (NatureServe 2011). Conservation rank: G4, S4.

Stands of *Ephedra nevadensis* alliance are common but generally widely scattered throughout the Mojave and southeastern Great Basin sections of California (Sawyer et al. 2009). They often have a high diversity of perennial species and may include 35 species of shrubs (Reid et al. 1999). *Ephedra nevadensis* is a component of many alliances including the *Atriplex confertifolia, Coleogyne ramosissima, Grayia spinosa, Juniperus osteosperma, Larrea tridentata – Ambrosia dumosa, Lycium andersonii, Menodora spinescens, Pleuraphis jamesii, Yucca brevifolia,* and *Yucca schidigera* alliances. *Ephedra nevadensis* occupies a similar climatic zone to *G. spinosa* but appears to segregate from it primarily based on soil depth; *G. spinosa* tends to prefer deeper alluvial soils than *E. nevadensis*. Typical habitats for this alliance include dry, open slopes, ridges, breaks with southern exposures, canyons, sides of arroyos, and washes.

The *Ephedra nevadensis* Shrubland Alliance is sometimes indicative of disturbed sites within the upper Mojave and the lower Great Basin Deserts. Yoder (1983) suggests it is the result of heavy use by livestock in *Artemisia tridentata* or *Coleogyne ramosissima* stands. *E. nevadensis* is considered to be the most palatable and sought out by livestock of the ephedras. It resprouts readily following browsing and light to moderate fire. Its seed set is variable but can be prolific in wet years. It is a relatively slow growing shrub and may slowly spread and replicate itself clonally. Seed viability is short (generally < 5 years), although seeds do germinate from rodent caches with favorable moisture. Seedlings are very tolerant of drought and generally establish well following fall or winter planting.

*E. nevadensis* generally sprouts from the root or crown after fire. However, under certain circumstances, regenerative structures may be eliminated by hot fires. Periods of above normal precipitation can contribute to increased stand flammability by promoting the growth of annuals such as *Bromus rubens* and *B. tectorum.*

The full extent of this alliance is not well known; however, stands should be monitored and disturbance effects quantified throughout its range. One hypothesis is that it may not have been an extensive vegetation type and may have increased as a result of more frequent and extensive fires and livestock use over the last 100 years or more. Also, the high diversity of shrub species in some stands should be investigated more closely. Is this diversity related to disturbance regime, and if so, what does this say about the appropriateness of disturbance for maintaining floristic diversity in the desert? Another hypothesis is that this shrub co-occurs with a number of other shrub species at a transition between lower and upper elevation ranges, where there is a mixing zone of similarly adapted shrub species. Thus, is the diversity related to

an ecological setting where various shrubs are able to intermix within an ecotone between the lower elevation creosote bush scrub types and the higher elevation *Coleogyne ramosissima* and *Artemisia* spp. alliance types?

The following samples in JOTR are characteristic of the *Ephedra nevadensis* alliance:

*Ephedra nevadensis* (Undifferentiated) (Watts n=1)

**Stand Table**

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Shrub** | | | | | | | | | |
| | *Echinocactus polycephalus* | 100 | 22.7 | 22.7 | 22.7 | X | X | X | X |
| | ***Ephedra nevadensis*** | **100** | **3.3** | **3.3** | **3.3** | | **X** | | **X** |
| | *Ambrosia dumosa* | 100 | 0.6 | 0.6 | 0.6 | | X | | X |
| | *Senna armata* | 100 | 0.3 | 0.3 | 0.3 | | X | | X |
| | *Coleogyne ramosissima* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Cylindropuntia ramosissima* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Lycium andersonii* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Simmondsia chinensis* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| **Herb** | | | | | | | | | |
| | *Eriogonum inflatum* | 100 | 8.2 | 8.2 | 8.2 | X | X | X | X |
| | *Lotus* | 100 | 2.7 | 2.7 | 2.7 | | X | | X |
| | *Stephanomeria exigua* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Xylorhiza tortifolia* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |

## *Eriogonum fasciculatum – Viguiera parishii* Shrubland Alliance

**California buckwheat – Desert Sunflower Shrubland Alliance (Mapping code 28130)**

The *Eriogonum fasciculatum – Viguiera parishi* Shrubland Alliance occurs in the Southern California mountains and valleys, and the Mojave and Colorado Desert regions of California (Sawyer et al. 2009). Conservation rank: G4, S4.

*Eriogonum fasciculatum* is a semi-woody, many-branching shrub with roots that penetrate to a depth of 1.5 m. Plants lose some leaves in the dry season and nearly all during severe drought (Sawyer et al. 2009). Plants flower from early spring through summer, and mature seeds are dispersed by ants, wind, and water (Sawyer et al. 2009). Although *Eriogonum fasciculatum* will sprout following fire, most regeneration results from buried seeds (Keeley 1998).

There is little information available on *Viguiera parishii*. It is a facultatively decidous plant that flowers profusely in rainy years, but remains dormant during dry years (Sawyer et al. 2009). Co-occurring species such as *Bebbia juncea, E. fasciculatum, Gutierrezia microcephala,* and *Salazaria mexicana,* suggest this is a disturbance-related species (Sawyer et al. 2009).

This shrubland alliance occurs on moderate to steep slopes and may contain a high diversity of perennial species. It occurs in the mid-elevations of the Mojave Desert and occupies a transition zone between the lower, hot Sonoran Desert and higher, cooler Mojave Desert or Peninsular Ranges. As a vegetation type in Joshua Tree National Park, it occurs in a transition zone between the lower *Larrea tridentata – Ambrosia dumosa* Shrubland Alliance and the upper *Coleogyne ramosissima*, *Juniperus californica,* and other higher elevation types.

This vegetation covers a large area in the Colorado Desert/Peninsular Range borderland on rocky substrates at mid-elevations; thus, it is important to understand the vegetation dynamics of this type as compared to related types such as *Eriogonum fasciculatum* and *Lycium andersonii* Shrubland Alliances. More monitoring and study are needed.

This alliance is represented in Joshua Tree National Park by four associations: *Eriogonum fasciculatum* Association, *Viguiera parishii* Association, *Viguiera parishii – Eriogonum fasciculatum – Simmondsia chinensis* Association and *Viguiera parishii – Ambrosia dumosa – Simmondsia chinensis* Association. In the Keeler-Wolf et al. (2005) report, *Eriogonum fasciculatum* and *Viguiera parishii* were described as separate, full alliances. After further analysis and classification, they overlap significantly in range and species composition and are described as a combined alliance. This provides for a clearer representation for warm desert stands of *Eriogonum fasciculatum* as compared to stands occurring in the California Coast Ranges.

In addition to these associations, there is an alliance-level sample that may suggest additional variation:

*Viguiera parishii* (Watts: 4-17-96-3B).

## *Eriogonum fasciculatum* Rock Outcrop Shrubland Association

**California Buckwheat Rock Outcrop Shrubland Association (Mapping code 28060, not mapped)**

### Range

Globally: The *Eriogonum fasciculatum* Rock Outcrop Shrubland Association occurs in the Mojave Desert, and in western Colorado Desert regions in California, and in Baja California, Mexico (Sawyer et al. 2009, NatureServe 2011). Stands have been identified recently in Lake Mead National Recreation Area, the Newberry Mountains, and Red Rock Canyon National Conservation Area in Nevada, on west to Joshua Tree National Park in California.

JOTR: This association has been sampled only once within Joshua Tree National Park, but is fairly common in the upper-elevation areas of the park, mostly in the west. This stand was sampled in the Malapai Hill 7.5-minute topographic quadrangle.

### Environmental Description

Globally: This association occurs at mid to upper elevations on rocky slopes to ridgelines. Substrates are typically granitic or volcanic. Slopes vary from moderate to steep. Ground cover typically consists of shallow rocky soils (gravels and cobbles) and some large rocks.

JOTR: The *Eriogonum fasciculatum* Rock Outcrop Association is located at mid elevations. These sites generally experience low disturbance levels from exotics species.

### Vegetation Description

Globally: This association forms sparse to open shrublands. *Eriogonum fasciculatum* is typically dominant in the shrub layer. Co-occurring species include *Ambrosia dumosa, Bebbia juncea, Ephedra nevadensis, Krameria erecta, Larrea tridentata, Viguiera parishii,* and *Yucca schidigera. Juniperus californica* is also sometimes present at sparse cover. It commonly associates with other upper-elevation alliances such as *Juniperus californica, Pinus monophylla, Quercus cornelius-mulleri,* and *Salazaria mexicana*. Total vegetation cover ranges from 2–20%.

JOTR: This alliance has been sampled only once in Joshua Tree National Park adjacent to stands of *Viguiera parishii* and *Juniperus californica* alliances (see Stand Table on next page). In addition, the expression of this alliance in the Colorado, Mojave and Sonoran deserts is closely associated with *Viguiera parishii* and other mid-elevations scrub types.

### Other Noteworthy Species

N/A

**Conservation Rank:** N/A

**Rank Justification**
N/A

**Comments**
Globally: N/A

JOTR: N/A

Plots used for this description: N=1: VMAL97-23

Map Accuracy Assessment plots: N=0

**Stand Table**

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Tree** | | | | | | | | | |
| | *Juniperus californica* | 100 | 0.2 | 0.2 | 0.2 | X | X | X | X |
| **Shrub** | | | | | | | | | |
| | ***Eriogonum fasciculatum*** | **100** | **4.0** | **4.0** | **4.0** | **X** | **X** | **X** | **X** |
| | *Salvia mohavensis* | 100 | 2.2 | 2.2 | 2.2 | | X | | X |
| | *Brickellia arguta* | 100 | 1.2 | 1.2 | 1.2 | | X | | X |
| | *Gutierrezia microcephala* | 100 | 1.2 | 1.2 | 1.2 | | X | | X |
| | *Ericameria linearifolia* | 100 | 1.2 | 1.2 | 1.2 | | X | | X |
| | *Thamnosma montana* | 100 | 1.2 | 1.2 | 1.2 | | X | | X |
| | *Brickellia californica* | 100 | 1.0 | 1.0 | 1.0 | | X | | X |
| | *Simmondsia chinensis* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| **Herb** | | | | | | | | | |
| | *Bromus rubens* | 100 | 5.0 | 5.0 | 5.0 | X | X | X | X |
| | *Achnatherum speciosum* | 100 | 1.0 | 1.0 | 1.0 | | X | | X |

### *Viguiera parishii – Ambrosia dumosa – Simmondsia chinensis* Association

**Desert Sunflower – White Bursage – Jojoba (Mapping code 28134)**

#### Range

Globally: This association is known only from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of the *Viguiera parishii – Ambrosia dumosa – Simmondsia chinensis* Association were sampled within the Coxcomb Mts., Indian Cove, Malapai Hill, Porcupine Wash, Queen Mtn., and Rockhouse Canyon 7.5-minute topographic quadrangles.

#### Environmental Description

Globally: This association is known only from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: The *Viguiera parishii – Ambrosia dumosa – Simmondsia chinensis* Association is located at mid elevations (2,600–3,800 ft., 800–1,100 m), on variable slope exposures. This association is found on gentle to steep (0–>25 degrees) undulating slopes. Soils range from coarse sands to medium silt loams derived from granitic substrates. Ground cover consists of 2–75 percent bedrock, 2–35 percent boulder, 2–45 percent stone, 1–20 percent cobble, 1–70 percent gravel, and <1–32 percent fines. Litter ranges from <1–2 percent cover. These sites generally experience low disturbance levels from exotics species.

#### Vegetation Description

Globally: This association is known only from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of the *Viguiera parishii – Ambrosia dumosa – Simmondsia chinensis* Association form a sparse to open shrublands with 0–<1 percent cover for the tree/tall stratum, 5–21 percent cover for the shrub/medium stratum, and 2 <1–5 percent cover for the herb/low stratum. Total vegetative cover ranges from 5–25 percent.

Species characteristic of this association include *Ambrosia dumosa, Simmondsia chinensis, Sphaeralcea ambigua,* and *Viguiera parishii*. Other species that are often present are *Acacia greggii, Bebbia juncea, Encelia farinosa, Ephedra nevadensis, Eriogonum fasciculatum, Galium stellatum, Krameria grayi, Larrea tridentata, Lycium andersonii, Opuntia basilaris, Eriogonum inflatum, Mirabilis laevis* var. *villosa, Pleuraphis rigida,* and *Pleurocoronis pluriseta.*

**Other Noteworthy Species**
N/A

**Conservation Rank:** N/A

**Rank Justification**
N/A

**Comments**
Globally: N/A

JOTR: In this association, *V. parishii* is an indicator species occurring with a variety of shrubs, and it may be present and sub-dominant to co-dominant with *Acacia greggii, Ambrosia dumosa, Simmondsia chinensis* and/or others. Stands are found on rocky and gravelly mid-elevation sites in Joshua Tree National Park.

Plots used for this description: N=10: JOTRA: 34B-07-1; JOTR: JOTR38, JOTR51, JOTR64, JOTR73, JOTR75, JOTR76, JOTR77, JOTR78; MDEI: 157-1-8

Map Accuracy Assessment plots: N=39; 50-0114, 50-0126, 50-0129, 50-0135, 50-0139, 50-0140, 50-0141, 50-0172, 50-0179, 50-0187, 50-0189, 50-0193, 50-0194, 50-0198, 50-0199, 50-0200a, 50-0201, 50-0432, 50-0433, 50-0435, 50-0436, 50-0439a, 50-0439b, 50-0448, 50-0455, 50-0459, 50-1877, 50-1879, 50-1881, 50-1883, 50-1884, 50-1938, 50-1939, 50-1940, 50-1942, 50-1944, 50-1947, 50-1948, 50-1950.

## Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Shrub** | | | | | | | | | |
| | ***Viguiera parishii*** | **100** | **2.2** | **0.2** | **4.0** | | **X** | | **X** |
| | ***Ambrosia dumosa*** | **100** | **1.6** | **0.2** | **5.0** | | **X** | | **X** |
| | ***Simmondsia chinensis*** | **90** | **1.3** | **0.2** | **3.0** | | **X** | | **X** |
| | *Sphaeralcea ambigua* | 90 | 0.6 | 0.2 | 4.0 | | X | | X |
| | *Ephedra nevadensis* | 70 | 1.0 | 0.2 | 3.0 | | | | X |
| | *Galium stellatum* | 70 | 0.2 | 0.2 | 0.5 | | | | X |
| | *Larrea tridentata* | 60 | 1.0 | 1.0 | 3.0 | | | | X |
| | *Bebbia juncea* | 60 | 0.7 | 0.2 | 3.0 | | | | X |
| | *Acacia greggii* | 50 | 1.3 | 1.0 | 5.0 | | | | X |
| | *Encelia farinosa* | 50 | 0.9 | 0.2 | 4.0 | | | | X |
| | *Lycium andersonii* | 50 | 0.3 | 0.2 | 1.0 | | | | X |
| | *Pleurocoronis pluriseta* | 50 | 0.2 | 0.2 | 1.0 | | | | X |
| | *Eriogonum fasciculatum* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Krameria grayi* | 50 | 0.1 | 0.2 | 0.4 | | | | X |
| | *Opuntia basilaris* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Yucca schidigera* | 40 | 0.2 | 0.2 | 1.0 | | | | |
| | *Salazaria mexicana* | 30 | 0.2 | 0.2 | 1.0 | | | | |
| | *Echinocereus engelmannii* | 30 | 0.1 | 0.2 | 0.5 | | | | |
| | *Ferocactus cylindraceus* | 30 | 0.1 | 0.2 | 0.2 | | | | |
| **Herb** | | | | | | | | | |
| | *Pleuraphis rigida* | 60 | 0.4 | 0.2 | 2.0 | | | | X |
| | *Eriogonum inflatum* | 60 | 0.2 | 0.2 | 0.5 | | | | X |
| | *Mirabilis laevis* var. *villosa* | 60 | 0.1 | 0.2 | 0.4 | | | | X |
| | *Lotus rigidus* | 40 | 0.1 | 0.2 | 0.5 | | | | |
| | *Achnatherum speciosum* | 30 | 0.1 | 0.2 | 0.5 | | | | |
| | *Adenophyllum porophylloides* | 30 | 0.1 | 0.2 | 0.2 | | | | |
| | *Stephanomeria pauciflora* | 30 | 0.1 | 0.2 | 0.2 | | | | |

### *Viguiera parishii – Eriogonum fasciculatum – Simmondsia chinensis* Association
**Desert sunflower – California Buckwheat – Jojoba Association (Mapping code 28133)**

**Range**

Globally: This association is known only from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of the *Viguiera parishii – Eriogonum fasciculatum – Simmondsia chinensis* Association were sampled in the Cadiz Valley SW, Cottonwood Spring, Fried Liver Wash, Indian Cove, Joshua Tree South, Malapai Hill, Porcupine Wash, Queen Mtn., Rockhouse Canyon, Seven Palms Valley, Twentynine Palms Mtn. 7.5-minute topographic quadrangles.

**Environmental Description**

Globally: This association is known only from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of *Viguiera parishii – Eriogonum fasciculatum – Simmondsia chinensis* Association are found at mid to high elevations (2,700–4,400 ft.; 800–1,300 m) on variable slope exposures. This association is found on gentle to steep (3–40 degrees) slopes, including concave, convex, and undulating surfaces. Soils range from coarse sand to moderately fine silty clay loams formed from basaltic, gneissose, or granitic parent material. Ground cover consists of 0–90 percent bedrock, 0–75 percent boulder, <1–40 percent stone, <1–38 percent cobble, <1–47 percent gravel, and <1–70 percent fines. Litter ranges from 0–15 percent cover. These sites generally experience low disturbance levels from exotics species. A few of the plots sampled show evidence of fire.

**Vegetation Description**

Globally: This association is known only from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of the *Viguiera parishii – Eriogonum fasciculatum – Simmondsia chinensis* Association form sparse to open shrublands with 0–<1percent cover for the tree/tall stratum, 0–20 percent cover for the shrub/medium stratum, and <1–21 percent cover for the herb/low stratum. Total vegetative cover is <1–21 percent.

Species characteristic of this association include *Eriogonum fasciculatum, Simmondsia chinensis,* and *Viguiera parishii.* Other species that are often present are *Acacia greggii, Ephedra nevadensis, Yucca schidigera, Achnatherum speciosum,* and *Pleuraphis rigida.*

**Other Noteworthy Species**
N/A

**Conservation Rank:** N/A

**Rank Justification**
N/A

**Comments**
Globally: This association is known only from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

It is similar to other stands sampled in the southern and central Mojave. For example, a *Viguiera parishii – Eriogonum fasciculatum* Association has been recently identified as a mixed shrub type on rocky hillslopes and bases of mountains, including at Lake Mead National Recreation Area and the Newberry Mountains of Nevada.

JOTR: In this association, *V. parishii* occurs as a co-dominant or sub-dominant with *E. fasciculatum, Simmondsia chinensis,* and other shrubs. Several sampled stands show evidence of previous fire.

Plots used for this description: N=36; JOTRA: 16-26-1, 17-03-1, 20-13-3, 22-18-1, 22-32-3, 23-34-1, 32-08-1, 32-17-1, 33-07-1, 34A-03-2, 58B-01-3; JOTR: JOTR10, JOTR100, JOTR12, JOTR14, JOTR36, JOTR54, JOTR55, JOTR56, JOTR57, JOTR58, JOTR59, JOTR61, JOTR62, JOTR79, JOTR98, JOTR99; Long: LIZ-2, VMAL97-11, VMAL97-27, VMAL97-28, VMAL97-32, VMAL97-36, VMAL97-52; MDEI: 141-2-7, 154-3-1; Watts: n=2.

Map Accuracy Assessment plots: N=17; 50-0371, 50-0372, 50-0373, 50-0374, 50-0375, 50-0377, 50-0382, 50-0383, 50-0384, 50-0387, 50-0390, 50-0391, 50-0394, 50-0399, 50-0400, 50-1890, 50-1891.

## Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Shrub** | | | | | | | | | |
| | ***Viguiera parishii*** | **97** | **3.3** | **0.2** | **10.0** | | **X** | | **X** |
| | ***Eriogonum fasciculatum*** | **81** | **1.0** | **0.2** | **7.2** | | **X** | | **X** |
| | ***Simmondsia chinensis*** | **75** | **1.1** | **0.2** | **4.0** | | X | | X |
| | *Ephedra nevadensis* | 67 | 0.9 | 0.2 | 4.0 | | | | X |
| | *Yucca schidigera* | 58 | 0.4 | 0.2 | 2.0 | | | | X |
| | *Acacia greggii* | 56 | 0.6 | 0.2 | 5.0 | | | | X |
| | *Salazaria mexicana* | 47 | 0.5 | 0.2 | 4.0 | | | | |
| | *Sphaeralcea ambigua* | 47 | 0.2 | 0.2 | 3.0 | | | | |
| | *Galium stellatum* | 44 | 0.1 | 0.2 | 0.5 | | | | |
| | *Ambrosia dumosa* | 42 | 0.3 | 0.2 | 2.2 | | | | |
| | *Lycium andersonii* | 33 | 0.3 | 0.2 | 3.0 | | | | |
| | *Larrea tridentata* | 33 | 0.2 | 0.2 | 3.0 | | | | |
| | *Opuntia basilaris* | 33 | 0.1 | 0.2 | 0.2 | | | | |
| | *Krameria grayi* | 31 | 0.1 | 0.2 | 1.0 | | | | |
| | *Krameria erecta* | 31 | 0.1 | 0.2 | 2.0 | | | | |
| **Herb** | | | | | | | | | |
| | *Achnatherum speciosum* | 64 | 0.2 | 0.2 | 1.2 | | | | X |
| | *Pleuraphis rigida* | 50 | 0.8 | 0.2 | 10.0 | | | | X |
| | *Mirabilis laevis* var. *villosa* | 47 | 0.1 | 0.2 | 1.0 | | | | |
| | *Eriogonum inflatum* | 36 | 0.1 | 0.2 | 0.5 | | | | |
| | *Lotus rigidus* | 33 | 0.2 | 0.2 | 3.0 | | | | |
| | *Bromus rubens* | 31 | 1.9 | 0.2 | 20.0 | | | | |
| **Nonvascular** | | | | | | | | | |
| | Unknown Lichen | 31 | 0.1 | 0.2 | 0.5 | | | | |

## *Juniperus californica* Woodland Alliance

**California Juniper Woodland Alliance (Mapping code 10020)**

The *Juniperus californica* Woodland Alliance occurs in the central California coast ranges, Southern California mountains and valleys, Northern California interior coast ranges, Sierra Nevada, Sierra Nevada foothills, and Mojave Desert (Sawyer et al. 2009). Conservation rank: G4, S4.

Fire intervals have decreased substantially in vegetation types dominated by California juniper since the introduction of non-native, annual grasses. Summer or fall fire in stands with an intermittent to continuous understory of non-native annual grasses leads to the near complete loss of California Juniper within the fire perimeter. Brooks (personal communication 2000) has observed substantial losses of stands of California juniper types in Joshua Tree National Park as a result of fire. Since this alliance has been subjected to several fires in recent years within the Park, it is represented by a somewhat confusing array of samples, in part, as a result of postfire seral conditions.

With more study, the preliminary descriptions of these associations have been revised to a more simplified set of associations. They are partly delineated, for example, by slope position such as upper fans/bajadas and lower slopes with higher *Yucca schidigera* and *Pleuraphis rigida* cover versus hills and mountains having larger surface area covered by rock with more *Coleogyne ramosissima, Quercus cornelius-mulleri* and/or *Nolina parryi.*

This alliance is represented in Joshua Tree National Park by three associations; *Juniperus californica / Coleogyne ramosissima* Woodland Association, *Juniperus californica / Yucca schidigera / Pleuraphis rigida* Woodland Association, and *Juniperus californica / Quercus cornelius-mulleri – Coleogyne ramosissima* Woodland Association. Two additional associations were initially defined in the Keeler-Wolf et al. (2005) report; *Juniperus californica / Coleogyne ramosissima – Yucca schidigera* Woodland Association, and *Juniperus californica / Nolina parryi* Woodland Association. Following reanalysis and simplification, the first three associations are primarily distinguishable. In addition to these associations described below, three alliance-level samples during the classification phase and four map assessment samples suggest further variation:

*Juniperus californica* (Watts: n=3; MapAA: 50-1304, 50-1312, 50-1314, 50-1319)

### *Juniperus californica / Coleogyne ramosissima* Association
**California Juniper / Blackbush Association (Mapping code 10025)**

#### Range

Globally: This association is known from the central Mojave Desert (Keeler-Wolf and Thomas 2000), Anza-Borrego Desert State Park, (Keeler-Wolf et al. 1998), and Joshua Tree National Park.

JOTR: Stands of the *Juniperus californica / Coleogyne ramosissima* Woodland Association are found in the western part of the park. Plots were located in Cottonwood Spring, East Deception Canyon, Indian Cove, Joshua Tree South, Keys View, Malapai Hill, Queen Mountain, and Yucca Valley South 7.5-minute quadrangles.

#### Environmental Description

Globally: This association is common on higher slopes on the east side of Earthquake Valley and in Pinyon Mountain area of Anza-Borrego Desert State Park (Keeler-Wolf et al. 1998), and it occurs on upper bajadas and onto mountain slopes in the southern Mojave.

JOTR: Stands of the *Juniperus californica / Coleogyne ramosissima* Woodland Association are found at mid to high elevations (3,300–5,100 ft.; 1,000–1,600 m), most frequently on the upper portions of bajadas near the base of mountains and on south-facing mountain slopes. Slopes vary from moderate to steep (6 to 28 degrees). Soil texture ranges from coarse sand to loam. Soils are formed primarily from granitic parent material. The substrate surface consists of 0–20 percent bedrock cover, 0–20 percent boulder cover, 0–20 percent stone cover, 0–25 percent cobble cover, 3–60 percent gravel cover, and 6–82 percent fines cover. Litter cover varies from 0–18 percent. These sites generally experience low to high levels of competition from exotic species.

#### Vegetation Description

Globally: In the Anza-Borrego desert, *Juniperus californica* occurs over an under story dominated by *Coleogyne ramosissima* (Keeler-Wolf et al. 1998) and with various other shrubs including *Eriogonum fasciculatum*.

JOTR: Stands of the *Juniperus californica / Coleogyne ramosissima* Woodland Association form a sparse to intermittent woodland with 0–19 percent cover for the tree/tall stratum, 6–48 percent cover for the shrub/medium stratum, and 0–64 percent cover for the herb/low stratum. Total vegetative cover ranges from 7–53 percent.

This association is dominated by the woody species *Juniperus californica* and *Coleogyne ramosissima.* The exotic species *Bromus rubens* and/or *B. tectorum* is

also dominant in the herb layer. *Yucca brevifolia* is characteristically present at low cover. Characteristic shrub and herbaceous species include *Ephedra nevadensis, Eriogonum fasciculatum,* and *Yucca schidigera,* and *Achnatherum speciosum.* Cryptobiotic crust is abundant in the understory. Often, *Cylindropuntia echinocarpa, Echinocereus engelmannii, Opuntia basilaris, Pleuraphis rigida,* and the exotic species *Bromus tectorum* are found contributing minor cover in this association.

**Other Noteworthy Species**
N/A

**Conservation Rank:** Rare

**Rank Justification**
Likely to be threatened by increased fire frequency resulting from invasive grass fuels and a distribution that is naturally limited to relatively small areas of upper elevations in the Mojave Desert.

**Comments**
Globally : N/A

JOTR: Several of the locally described *Juniperus californica* types contain *Achnatherum speciosum*. This grass is considered to be a normal, postfire, successional species of stands in the general zone of *Coleogyne ramosissima* dominance (M. Brooks, personal communication 2000, Sawyer et al. 2009).

Also, several plots with low or no cover of *Coleogyne ramosissima* but having *Nolina parryi* (JOTRA: 06A-08-3, 32-08-3, 14-10-1, 18-27-2) suggest a distinctive phase. Other environmental conditions are similar to this association.

Plots used for this description: N=14; JOTRA: 03-14-4, 06A-08-3, 08A-02-1, 08A-02-6, 09A-05-1, 11B-06-2, 14-10-1, 14-10-2, 18-27-2, 18-27-7, 19-21-1, 32-08-3; Long: VBRC97-1[1], VMAL97-25.

Map Accuracy Assessment plots: N=109; 50-0445, 50-1117, 50-1121, 50-1122, 50-1123, 50-1133a, 50-1133b, 50-1134, 50-1137, 50-1142, 50-1143, 50-1145, 50-1146, 50-1147, 50-1149, 50-1150, 50-1151, 50-1152, 50-1155, 50-1158, 50-1159, 50-1160, 50-1162, 50-1163, 50-1164, 50-1165, 50-1166, 50-1168, 50-1171, 50-1172, 50-1173, 50-1206, 50-1207, 50-1208, 50-1209, 50-1210, 50-1211, 50-1212, 50-1213, 50-1214, 50-1215, 50-1217, 50-1219, 50-1220, 50-1221, 50-1222, 50-1224, 50-1225, 50-1226, 50-1227, 50-1228, 50-1229a, 50-1229b, 50-1230, 50-1232, 50-1233, 50-1235, 50-1244, 50-1245, 50-1246, 50-1247a, 50-1247b, 50-1248, 50-1249, 50-1250, 50-1251, 50-1252, 50-1253, 50-1254, 50-1255, 50-1256, 50-1257, 50-1258, 50-1259, 50-1260, 50-1261, 50-1262, 50-1263, 50-1264, 50-1265, 50-1266, 50-1267, 50-1268, 50-1270, 50-1271, 50-1272, 50-1273, 50-1274, 50-1276, 50-1277, 50-1279, 50-1280, 50-1282, 50-1285, 50-1286, 50-1287, 50-1289, 50-1290, 50-1291, 50-1292, 50-1293, 50-1294, 50-1296, 50-1297, 50-1298, 50-1300, 50-1301, 50-1303, 50-1882.

## Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Tree** | | | | | | | | | |
| | ***Juniperus californica*** | **100** | **6.8** | **1.0** | **19.0** | **X** | **X** | **X** | **X** |
| | *Yucca brevifolia* | 86 | 0.5 | 0.2 | 2.4 | | X | | X |
| **Shrub** | | | | | | | | | |
| | ***Coleogyne ramosissima*** | **93** | **13.0** | **0.2** | **35.2** | **X** | **X** | **X** | **X** |
| | *Eriogonum fasciculatum* | 86 | 1.2 | 0.2 | 4.0 | | X | | X |
| | *Yucca schidigera* | 79 | 0.8 | 0.2 | 3.0 | | X | | X |
| | *Ephedra nevadensis* | 79 | 0.8 | 0.2 | 4.0 | | X | | X |
| | *Cylindropuntia echinocarpa* | 64 | 0.2 | 0.2 | 1.2 | | | | X |
| | *Echinocereus engelmannii* | 57 | 0.1 | 0.2 | 0.4 | | | | X |
| | *Opuntia basilaris* | 57 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Lycium andersonii* | 43 | 0.2 | 0.2 | 2.2 | | | | |
| | *Gutierrezia microcephala* | 43 | 0.1 | 0.2 | 0.2 | | | | |
| | *Sphaeralcea ambigua* | 36 | 0.1 | 0.2 | 0.2 | | | | |
| | *Viguiera parishii* | 36 | 0.7 | 0.4 | 5.2 | | | | |
| | *Salazaria mexicana* | 36 | 0.6 | 0.2 | 7.0 | | | | |
| | *Nolina parryi* | 36 | 0.6 | 0.2 | 4.0 | | | | |
| **Herb** | | | | | | | | | |
| | *Achnatherum speciosum* | 93 | 0.9 | 0.2 | 4.0 | | X | | X |
| | *Bromus rubens* | 79 | 5.4 | 0.2 | 30.0 | X | X | X | X |
| | *Bromus tectorum* | 57 | 2.8 | 0.2 | 30.0 | | | | X |
| | *Pleuraphis rigida* | 57 | 0.3 | 0.2 | 2.0 | | | | X |
| | *Mirabilis laevis* var. *villosa* | 43 | 0.2 | 0.2 | 2.2 | | | | |
| **Nonvascular** | | | | | | | | | |
| | Cryptogammic crust | 57 | 0.5 | 0.2 | 2.6 | | | X | X |
| | Unknown Lichen | 36 | 0.1 | 0.2 | 0.2 | | | | |

### *Juniperus californica / Quercus cornelius-mulleri – Coleogyne ramosissima* Woodland Association

**California Juniper / Muller's Oak – Blackbush Woodland Association (Mapping code 10032)**

#### Range

Globally: This association is described only from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory. This type may also occur in other portions of the desert slopes of the transverse and Peninsular Ranges of Southern California.

JOTR: Stands of the *Juniperus californica / Quercus cornelius-mulleri – Coleogyne ramosissima* Woodland Association are found in the western part of the park in pinyon/juniper areas, in the Covington Flats area, and in the Little San Bernardino Mountains. This association was sampled in the East Deception Canyon, Indian Cove, Joshua Tree South, Keys View, Malapai Hill, and Yucca Valley South 7.5-minute quadrangles.

#### Environmental Description

Globally: This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of *Juniperus californica / Quercus cornelius-mulleri – Coleogyne ramosissima* Woodland Association are found at high elevations (3,800–5,100 ft.; 1,200–1,600 m) on variable slope exposures. This association is found on gentle to steep (1–>25 degree) slopes of erosional montane highlands, alluvial plains, and intramontane alluvial plains. The substrate surface consists of 0–70 percent bedrock, 0–10 percent boulder, 0–10 percent stone, 0–20 percent cobble, 0–65 percent gravel, and 0–72 percent fines cover. Litter consists of <1–10 percent cover. Soil textures range from coarse sands to loams. Soil is derived from gneissose, granitic, or metamorphic parent materials. These sites generally experience low to high competition from exotic species.

#### Vegetation Description

Globally: This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of the *Juniperus californica / Quercus cornelius-mulleri – Coleogyne ramosissima* Woodland Association form an open woodland with 0–12 percent cover for the tree/tall stratum, 6–29 percent cover for the shrub/medium stratum, and <1–50 percent cover for the herb/low stratum. Total vegetative cover ranges from 8–50 percent.

This association is dominated by *Juniperus californica* and *Quercus cornelius-mulleri* in the tree and shrub layers. *Juniperus californica* appears shrub-like in Joshua Tree National Park, although the National Vegetation Classification System (NVCS) considers it a tree. Characteristic species include *Achnatherum speciosum, Eriogonum fasciculatum, Yucca brevifolia,* and *Yucca schidigera. Coleogyne ramosissima* and the non-native *Bromus rubens* are abundant. *Pinus monophylla, Ericameria linearifolia,* and *Ephedra nevadensis* are often present in these stands.

**Other Noteworthy Species**
N/A

**Conservation Rank:** N/A

**Rank Justification**
This vegetation is likely limited to the desert edge of the Peninsular Range of Southern California and adjacent Baja California (Mexico). Throughout most of its range, it has suffered decimation through increased fire frequency, and in several areas, large stands have been fragmented by housing developments. Its conservation rank may need to be reassessed once these factors and other sampling and mapping in southern California are completed.

**Comments**
Globally: This association is known only from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Many areas near Covington Flats have been burned within the last five years.

Plots used for this description: N=17; JOTRA: 03-14-3, 08A-02-4, 08A-04-5, 08A-04-6, 08A-04-7, 09A-05-3, 14-10-3,15-25-2; JOTR: JOTR108, JOTR109, JOTR18, JOTR19, JOTR60; MDEI: 118-1-4, 118-1-6, 120-4-7, 120-4-8, 120-4-8.

Map Accuracy Assessment plots: N=25; 50-0869, 50-0870, 50-0872, 50-0873, 50-0877, 50-0878, 50-0879, 50-0880, 50-0881, 50-0882, 50-0884, 50-0885, 50-0887, 50-0889, 50-1782, 50-1783, 50-1784, 50-1785, 50-1787, 50-1788, 50-1789, 50-1790, 50-1791, 50-1793, 50-1797.

## Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Tree** | | | | | | | | | |
| | ***Juniperus californica*** | **100** | **4.6** | **1.0** | **12.0** | **X** | **X** | **X** | **X** |
| | *Yucca brevifolia* | 76 | 0.5 | 0.2 | 2.0 | | X | | X |
| | *Pinus monophylla* | 53 | 0.4 | 0.2 | 2.0 | | | | X |
| **Shrub** | | | | | | | | | |
| | ***Quercus cornelius-mulleri*** | **94** | **4.1** | **0.2** | **12.0** | **X** | **X** | **X** | **X** |
| | *Eriogonum fasciculatum* | 76 | 1.2 | 0.2 | 7.0 | | X | | X |
| | *Yucca schidigera* | 76 | 0.7 | 0.2 | 2.0 | | X | | X |
| | ***Coleogyne ramosissima*** | **65** | **4.7** | **0.2** | **14.0** | | | **X** | **X** |
| | *Ericameria linearifolia* | 65 | 0.4 | 0.2 | 2.0 | | | | X |
| | *Ephedra nevadensis* | 59 | 0.5 | 0.2 | 3.5 | | | | X |
| | *Prunus fasciculata* | 41 | 0.5 | 0.2 | 4.0 | | | | |
| | *Ericameria teretifolia* | 41 | 0.4 | 0.2 | 2.0 | | | | |
| | *Cylindropuntia echinocarpa* | 41 | 0.2 | 0.2 | 1.2 | | | | |
| | *Opuntia basilaris* | 35 | 0.1 | 0.2 | 0.5 | | | | |
| | *Acacia greggii* | 35 | 0.2 | 0.2 | 2.0 | | | | |
| **Herb** | | | | | | | | | |
| | *Achnatherum speciosum* | 88 | 0.3 | 0.2 | 1.0 | | X | | X |
| | *Bromus rubens* | 71 | 4.1 | 0.2 | 20.0 | | | X | X |
| **Nonvascular** | | | | | | | | | |
| | Unknown Lichen | 41 | 0.1 | 0.2 | 0.5 | | | | |

### *Juniperus californica / Yucca schidigera / Pleuraphis rigida* Woodland Association
**California Juniper / Mojave Yucca / Big Galleta Woodland Association (Mapping code 10031)**

**Range**

Globally: This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of the *Juniperus californica / Yucca schidigera / Pleuraphis rigida* Woodland Association are found in the western part of the park. Plots were located within the Joshua Tree South, Malapai Hill, Rockhouse Canyon and Yucca Valley South 7.5-minute topographic quadrangles.

**Environmental Description**

Globally: This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory. This type may also occur in other portions of the desert slopes of the southern Mojave Desert.

JOTR: Stands of *Juniperus californica / Yucca schidigera / Pleuraphis rigida* Woodland Association are found at mid to high elevations (3,500–4,400 ft.; 1,000–1,400 m) on gentle to steep (1–>25 degree) slopes and fans that are on rocky highlands and upland, alluvial deposits. Aspect is variable. The substrate surface consists of 0–8 percent bedrock, 0–12 percent boulder, 0–30 percent stone, 0–38 percent cobble, 5-68 percent gravel, and 21–80 percent fines cover. Litter consists of <1–35 percent cover. Soil textures range from medium sands to loams derived from gneissose, granitic, or metamorphic parent materials. These sites generally experience low to moderate competition from exotic species.

**Vegetation Description**

Globally: This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of the *Juniperus californica / Yucca schidigera / Pleuraphis rigida* Woodland Association form open woodlands with 0–11 percent cover for the tree/tall stratum, 6–29 percent cover for the shrub/medium stratum, and <1–50 percent cover for the herb/low stratum. Total vegetative cover ranges from 8–50 percent. Stands in the park are often extensive.

This association is dominated by *Juniperus californica* in the tree layer, and the non-native *Bromus rubens* is dominant in the understory herb layer. Characteristic shrub species include *Cylindropuntia echinocarpa, Echinocerus engelmannii, Eriogonum fasciculatum, Ephedra nevadensis,* and *Yucca schidigera.* Characteristic herb species include *Achnatherum speciosum, Mirabilis laevis* var. *villosa,* and *Pleuraphis*

*rigida.* Other shrubs, *Ericameria cooperi, Krameria erecta, Simmondsia chinensis, Salazaria mexicana,* and *Thamnosa montana,* are occasionally present.

**Other Noteworthy Species**
N/A

**Conservation Rank:** N/A

**Rank Justification**
This association is likely to be restricted to the southwestern Mojave Desert and subject to detrimental increases in fire frequency.

**Comments**
Globally : This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Several plots lacking *Pleuraphis rigida* but having *Eriogonum fasciculatum* and usually *Yucca schidigera* (JOTRA: 20-13-1; Long: VMAL97-13, VMAL97-14, VMAL97-15, VMAL97-21, VMAL97-48) suggest a distinctive phase. Other environmental conditions are similar to this association.

Plots used for this description: N=12; JOTRA: 06A-08-4, 20-13-1, 20-13-5, 20-13-6, 21-14-4, Long: VMAL97-13, VMAL97-14, VMAL97-15, VMAL97-21, VMAL97-48; MDEI: 118-1-7, 141-2-8; Watts n=1.

Map Accuracy Assessment plots: N=21; 50-1176, 50-1177, 50-1178, 50-1179, 50-1180 , 50-1181, 50-1182, 50-1184, 50-1185, 50-1186, 50-1187, 50-1188, 50-1189, 50-1190, 50-1191, 50-1194, 50-1200, 50-1201, 50-1203, 50-1204, 50-1240.

## Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Tree** | | | | | | | | | |
| | ***Juniperus californica*** | **100** | **5.2** | **2.0** | **13.5** | **X** | **X** | **X** | **X** |
| | *Yucca brevifolia* | 75 | 0.4 | 0.2 | 1.4 | | X | | X |
| **Shrub** | | | | | | | | | |
| | *Eriogonum fasciculatum* | 100 | 3.9 | 0.2 | 10.0 | | X | | X |
| | *Cylindropuntia echinocarpa* | 92 | 0.5 | 0.2 | 1.2 | | X | | X |
| | *Echinocereus engelmannii* | 83 | 0.2 | 0.2 | 0.5 | | X | | X |
| | *Ephedra nevadensis* | 83 | 0.9 | 0.2 | 3.0 | | X | | X |
| | ***Yucca schidigera*** | **83** | **1.9** | **1.0** | **5.2** | | **X** | | **X** |
| | *Salazaria mexicana* | 67 | 1.1 | 0.2 | 4.0 | | | | X |
| | *Thamnosma montana* | 67 | 0.4 | 0.2 | 2.0 | | | | X |
| | *Ericameria cooperi* | 67 | 0.4 | 0.2 | 1.2 | | | | X |
| | *Viguiera parishii* | 67 | 0.3 | 0.2 | 1.2 | | | | X |
| | *Krameria erecta* | 58 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Opuntia basilaris* | 58 | 0.2 | 0.2 | 1.0 | | | | X |
| | *Ambrosia salsola* | 50 | 0.4 | 0.2 | 2.2 | | | | X |
| | *Sphaeralcea ambigua* | 50 | 0.1 | 0.2 | 0.5 | | | | X |
| | *Simmondsia chinensis* | 50 | 0.1 | 0.2 | 0.4 | | | | X |
| | *Ambrosia dumosa* | 42 | 0.1 | 0.2 | 0.5 | | | | |
| | *Cylindropuntia ramosissima* | 42 | 0.2 | 0.2 | 1.2 | | | | |
| | *Gutierrezia microcephala* | 42 | 0.2 | 0.2 | 1.2 | | | | |
| | *Salvia mohavensis* | 33 | 0.2 | 0.2 | 1.0 | | | | |
| **Herb** | | | | | | | | | |
| | *Bromus rubens* | 92 | 8.8 | 0.2 | 25.0 | X | X | X | X |
| | *Achnatherum speciosum* | 92 | 0.6 | 0.2 | 2.0 | | X | | X |
| | *Mirabilis laevis* var. *villosa* | 92 | 0.4 | 0.2 | 2.0 | | X | | X |
| | ***Pleuraphis rigida*** | **83** | **1.2** | **0.2** | **5.0** | | **X** | | **X** |
| | *Lolium rigidum* | 42 | 0.3 | 0.2 | 1.2 | | | | |
| | *Erodium cicutarium* | 42 | 0.2 | 0.2 | 1.0 | | | | |
| | *Lotus rigidus* | 33 | 0.2 | 0.2 | 1.0 | | | | |

## *Lycium andersonii* Shrubland Alliance

### Anderson's Box-Thorn Shrubland Alliance (Mapping code 28190, not mapped)

The *Lycium andersonii* Shrubland Alliance occurs in the southern Great Basin and the higher elevations of the Mojave Desert, stretching sporadically to cismontane Southern California (including western Riverside County) (Sawyer et al. 2009). Conservation rank: G4, S3.

*Lycium andersonii* is a spiny, rounded, much-branched shrub obtaining a height of 3 m. Its root system is extensive, often extending up to 10 m from the plant. This species tolerates poorly drained soils with high alkalinity and/or salinity, and highly calcareous soils with desert pavement and caliche layers (Tesky 1992). Reproduction occurs via dispersal by birds and small mammals, and root and stem sprouting. *L. andersonii* is a common species in many hot desert alliances. It and related scrubs such as *Ephedra nevadensis* and *Grayia spinosa* dominate in a narrow zone that is generally above the *Larrea tridentata–Ambrosia dumosa* alliance and below the *Coleogyne ramosissima* zone (Beatley 1975, Keeler-Wolf et al. 2007).

Stands of this alliance may be dominated by *L. andersonii* or co-dominated by this and other species. Fire is likely infrequent in stands of *L. andersonii* due to lack of fuels and the characteristic wide spacing of shrubs. Plants may sprout from the root crown after being only partially burned, but high mortality (> 50%) occurs when plants are more severely burned (Brooks and Minnich 2006). Since *L. andersonii* is a long-lived, slow-growing shrub, it takes decades to regain preburn stature and density (Tesky 1992).

*Lycium andersonii* is sensitive to relatively short-term climatic shifts, which may have implications for the alliance's long-range viability. Webb et al. (2003) found decreases in density and cover of *Grayia spinosa, L. andersonii,* and *Menodora spinescens* in the northern Mojave Desert between 1964 and 2002. They suggest that regional droughts in 1989 to 1991, and to a lesser extent the drought years of 1996 and 1999 to 2002, may be responsible.

This alliance is represented in JOTR by one association, *Lycium andersonii–Simmondsia chinensis–Pleuraphis rigida* Association. It is found in similar topographic settings as *Viguiera parishii* Shrubland Alliance.

Also, the following samples classified at the alliance level from Joshua Tree National Park suggest further variation than what is currently reported:

*Lycium andersonii – Lycium cooperi* (Watts n=4)

### *Lycium andersonii – Simmondsia chinensis / Pleuraphis rigida* Association

**Anderson's Desert-Thorn – Jojoba / Big Galleta Grass Association (Mapping code 28192, not mapped)**

**Range**

Globally: This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of the *Lycium andersonii – Simmondsia chinensis / Pleuraphis rigida* Shrubland Association were sampled in the park within the Fried Liver Wash, Malapai Hill, and Queen Mountain 7.5-minute topographic quadrangles.

**Environmental Description**

Globally: This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of *Lycium andersonii – Simmondsia chinensis / Pleuraphis rigida* Shrubland Association are found at mid elevations (2,900–3,700 ft.; 800–1,100 m) on northerly slope aspects. Slopes are steep (21–27 degrees) with concave or undulating topographies. Soils range from sands to moderately fine sandy clay loams derived from gneissose or plutonic parent materials. Ground cover in this association consists of 0–10 percent bedrock, 0–20 percent boulder, 10–20 percent stone, 10–30 percent cobble, 18–38 percent gravel, and 2–20 percent fines cover. Litter consists of 2–10 percent cover. This association sometimes experiences low to moderate levels of disturbance from competition from exotics.

**Vegetation Description**

Globally: This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of the *Lycium andersonii – Simmondsia chinensis / Pleuraphis rigida* Shrubland Association form an open shrubland with 0 percent cover in the tree/tall stratum, 5–14 percent cover in the shrub/mid stratum, and 3–10 percent cover in the herb/low stratum. Total vegetation cover ranges from 10–23 percent.

This association is dominated by the shrub *Lycium andersonii,* the herb *Bromus rubens,* and nonvascular lichens. Characteristic species are *Ambrosia dumosa, Simmondsia chinensis, Viguiera parishii, Adenostoma porophylloides, Mirabilis laevis* var. *villosa, Pleuraphis rigida,* and *Xylorhiza tortifolia.* Several additional species often occur including *Ephedra nevadensis, Ephedra viridis, Eriogonum fasciculatum, Galium stellatum, Larrea tridentata, Salvia mohavensis, Senna armata, Sphaeralcea ambigua, Salazaria mexicana, Achnatherum speciosum, Eriogonum inflatum,* and *Erodium cicutarium.*

**Other Noteworthy Species** N/A

**Conservation Rank:** Rare

**Rank Justification**
This association is currently identified only from Joshua Tree National Park, making it vulnerable to extirpation. The status of this association can be reconsidered if a broader geographic distribution is identified.

**Comments**
Globally: N/A

JOTR: N/A

Plots used for this description: n=9, JOTRA 21-34-1, 22-26-2; MDEI: 129-2-6, 154-3-8; Watts: n=5.

Map Accuracy Assessment plots: N=0.

**STAND TABLE**

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Shrub** | | | | | | | | | |
| | ***Lycium andersonii*** | **100** | **5.1** | **3.0** | **7.5** | **X** | **X** | **X** | **X** |
| | ***Simmondsia chinensis*** | **100** | **2.1** | **1.0** | **4.0** | | **X** | | **X** |
| | *Ambrosia dumosa* | 100 | 1.2 | 0.2 | 2.0 | | X | | X |
| | *Viguiera parishii* | 100 | 1.0 | 0.2 | 2.0 | | X | | X |
| | *Larrea tridentata* | 50 | 2.8 | 0.2 | 11.0 | | | | X |
| | *Galium stellatum* | 50 | 0.9 | 1.5 | 2.0 | | | | X |
| | *Ephedra nevadensis* | 50 | 0.4 | 0.2 | 1.5 | | | | X |
| | *Ephedra viridis* | 50 | 0.4 | 0.5 | 1.0 | | | | X |
| | *Salvia mohavensis* | 50 | 0.2 | 0.2 | 0.5 | | | | X |
| | *Salazaria mexicana* | 50 | 0.2 | 0.2 | 0.4 | | | | X |
| | *Eriogonum fasciculatum* | 50 | 0.2 | 0.2 | 0.4 | | | | X |
| | *Sphaeralcea ambigua* | 50 | 0.2 | 0.2 | 0.5 | | | | X |
| | *Senna armata* | 50 | 0.2 | 0.2 | 0.5 | | | | X |
| **Herb** | | | | | | | | | |
| | ***Pleuraphis rigida*** | **100** | **2.4** | **0.5** | **3.0** | | **X** | | **X** |
| | *Bromus rubens* | 100 | 4.8 | 0.2 | 8.0 | X | X | X | X |
| | *Mirabilis laevis* var. *villosa* | 75 | 0.5 | 0.4 | 1.0 | | X | | X |
| | *Xylorhiza tortifolia* | 75 | 0.4 | 0.4 | 0.5 | | X | | X |
| | *Adenophyllum porophylloides* | 75 | 0.3 | 0.2 | 0.5 | | X | | X |
| | *Erodium cicutarium* | 50 | 0.5 | 1.0 | 1.0 | | | | X |
| | *Eriogonum inflatum* | 50 | 0.2 | 0.2 | 0.5 | | | | X |
| | *Achnatherum speciosum* | 50 | 0.2 | 0.2 | 0.5 | | | | X |
| **Nonvascular** | | | | | | | | | |
| | Unknown Lichen | 75 | 0.4 | 0.2 | 1.0 | X | X | X | X |

## *Pleuraphis rigida* Herbaceous Alliance

### Big Galletta Grass Herbaceous Alliance (Mapping code 59010)

The *Pleuraphis rigida* Grassland Alliance occurs in the Mojave Desert, Sonoran Desert, Colorado Desert of California; in the Southern California mountain and valley region; and in southern Nevada, Arizona, and Mexico (NatureServe 2011). Conservation status: G3, S3.

*Pleuraphis rigida* is a highly branched, perennial grass that has a bushlike appearance. Its coarse, rigid culms reach 100 cm in length, and they may be erect or decumbent. Seed production is low and seedling establishment rare; reproduction occurs primarily by rhizomes and tillers. *Pleuraphis rigida* is a relatively rare alliance in the California deserts. It is considered a warm rain season species and does not occur in the western Mojave, where cold season rain predominates (G. Harris, personal communication 2000).

*Pleuraphis rigida* may be a common ground layer species in shrub- or tree-dominated stands. As such, stands of this alliance often form fine-grain mosaics with stands *of Larrea tridentata, Larrea tridentata – Ambrosia dumosa*, *Yucca brevifolia,* or *Yucca schidigera.* Scattered trees and shrubs are typically emergent over a more continuous ground layer of *Pleuraphis rigida* in most stands of this alliance. If *Pleuraphis rigida* is present without an emergent overstory of shrubs or trees, it is classified as a different alliance according to NVCS standards. This is unusual in California, however, as many stands have at least 1 percent emergent shrubs or trees.

*Pleuraphis rigida* has a bimodal distribution: it occurs either in open stands around the margins of dunes or other sandy areas at low elevations; or in more closed, mid-elevation, upland sites on slopes and bajadas. In dune areas, it gives way to very open stands of *Panicum urvilleanum* on the deepest sand deposits and is often interspersed with small stands of the *Abronia villosa* alliance. Further separation of the sandy stands without shrubs into a medium tall bunch grassland may be warranted. In ecological literature, *Pleuraphis rigida* is referred to as *Hilaria rigida.*

*Pleuraphis rigida* tolerates drought better than any other species in the genus (Matthews 2000). Fire effects are not well known compared to other species in its genus, though it is likely to be relatively sensitive to fire particularly in its dried state (Matthews 2000). Some of the upland stands have clearly been affected by recent fire and seem to have maintained or extended themselves (Keeler-Wolf, personal observation), although they may be invaded by other shrubby, disturbance-related species.

Although evidence is scant, conventional wisdom suggests that *Pleuraphis rigida* stands have declined in areas with long-term, moderate to heavy grazing pressure (CNPS Desert Workshop 2000). In the lower Colorado River Valley of the Sonoran Desert and in some Mojave Desert communities, *Pleuraphis rigida* serves as the main stabilizer over wide areas of sand dunes. Stands in dune areas are relatively open and less likely to carry fire than even the open stands

on rocky substrates. Thus, shifting sand and wind deflation are the primary agents of disturbance.

Altered fire frequencies and increased livestock grazing have likely affected the non-sandy stands of *Pleuraphis rigida* throughout its range. It is particularly susceptible to these impacts when the grass is dry (which is most of the time). Further studies should be conducted to monitor change in the particularly sensitive upper-elevation, nonsandy stands. Stands on shallow, sandy soil are frequently invaded by the aggressive, non-native, annual *Brassica tournefortii*.

This alliance is represented in Joshua Tree National Park by two associations: *Pleuraphis rigida / Ambrosia dumosa* Association and *Pleuraphis rigida / Atriplex canescens* Association.

In addition to the associations described below, there are two alliance-level samples that suggest further variation:

*Pleuraphis rigida* (JOTR: JOTR101, Watts: n=1)

### *Pleuraphis rigida / Ambrosia dumosa* Association

**Big Galleta Grass / White Bursage Association (Mapping code 59011)**

#### Range

Globally: The related *Ambrosia dumosa / Pleuraphis rigida* association is described from southwestern Arizona and the Sonoran state of Mexico (NatureServe 2011) and from Anza-Borrego Desert State Park in California (Keeler-Wolf et al. 1998).

JOTR: Stands of the *Pleuraphis rigida / Ambrosia dumosa* Association were sampled within the Fried Liver Wash, Indian Cove, Malapai Hill, Rockhouse Canyon 7.5-minute topographic quadrangles.

#### Environmental Description

Globally: In the related *Ambrosia dumosa / Pleuraphis rigida* Association, stands are found on active to partially stabilized desert sand dunes and sand sheets at low to mid elevations (88–305 m) (NatureServe 2011).

JOTR: Stands of *Pleuraphis rigida / Ambrosia dumosa* Association are found at mid to high elevations (3,100–4,200 ft.; 900–1,300 m) on northerly aspects. Slopes are gentle to somewhat steep (3–19 degrees) with concave, convex, flat, or undulating topographies. Sites are found on rocky highlands, erosional highlands, and the upper third of slopes. Soils are loams or medium to very fine sandy loams derived from gneissose or granitic parent materials. Ground cover in this association consists of 0–3 percent bedrock, 0–10 percent boulder, 0–15 percent stone, <1–35 percent cobble, 25–62 percent gravel, and 5–30 percent fines. Litter consists of <1–40 percent cover. This association experiences low to high levels of disturbance from competition from exotics.

#### Vegetation Description

Globally: In the *Ambrosia dumosa / Pleuraphis rigida* Association, both *A. dumosa* and *P. rigida* codominate, though a number of other dune-adapted, shrubby perennial plants and a high number of ephemeral forbs are common. Total vegetation cover ranges from 5–20% depending on slope aspect and sand activity (NatureServe 2011).

JOTR: Stands of the *Pleuraphis rigida / Ambrosia dumosa* Association form a sparse to open shrubland with 0 percent cover in the tree/tall stratum, 1–24 percent cover in the shrub/mid stratum, and 1–21 percent cover in the herb/low stratum. Total vegetation cover ranges from 9–18 percent.

This association is dominated by *Ambrosia dumosa* and *Pleuraphis rigida.* Characteristic species are *Lycium andersonii, Sphaeralcea ambigua, Viguiera parishii, Mirabilis laevis* var. *villosa,* and the non-natives *Bromus rubens and Erodium cicutarium.* Other often occurring species include *Cylindropuntia echinocarpa,*

*Ephedra californica, Eriogonum fasciculatum, Krameria grayi, Larrea tridentata, Opuntia basilaris, Salazaria mexicana, Simmondsia chinensis, Yucca schidigera, Eriogonum inflatum,* and *Schismus* spp.

**Other Noteworthy Species**
N/A

**Conservation Rank:** Rare

**Rank Justification**
Stands of *Pleuraphis rigida* have become rare in California as a result of large scale land conversion, over grazing, and competition from exotic plant species.

**Comments**
Globally: Diagnostic herb species include *Abronia villosa var. villosa* and *Dicoria canescens,* and various rare taxa (NatureServe 2011).

JOTR: Other seasonal, native annual herbs may also be present.

Plots used for this description: JOTRA: 22-26-4, 23-20-3; Long: VIND97-1; MDEI: 154-3-6.

Map Accuracy Assessment plots: N=2; 50-0145, 50-0154.

**Stand Table**

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Shrub** | | | | | | | | | |
| | ***Ambrosia dumosa*** | **100** | **8.3** | **4.0** | **15.0** | **X** | **X** | **X** | **X** |
| | *Viguiera parishii* | 75 | 1.2 | 0.4 | 3.0 | | X | | X |
| | *Lycium andersonii* | 75 | 1.0 | 0.4 | 2.5 | | X | | X |
| | *Sphaeralcea ambigua* | 75 | 0.2 | 0.2 | 0.5 | | X | | X |
| | *Opuntia basilaris* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Larrea tridentata* | 50 | 0.8 | 0.2 | 3.0 | | | | X |
| | *Salazaria mexicana* | 50 | 0.2 | 0.2 | 0.5 | | | | X |
| | *Yucca schidigera* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Simmondsia chinensis* | 50 | 0.7 | 0.4 | 2.5 | | | | X |
| | *Krameria grayi* | 50 | 0.3 | 0.2 | 1.0 | | | | X |
| | *Eriogonum fasciculatum* | 50 | 0.3 | 0.2 | 1.0 | | | | X |
| | *Cylindropuntia echinocarpa* | 50 | 0.4 | 0.5 | 1.2 | | | | X |
| | *Ephedra californica* | 50 | 0.3 | 0.2 | 1.0 | | | | X |
| **Herb** | | | | | | | | | |
| | ***Pleuraphis rigida*** | **100** | **5.8** | **1.2** | **11.0** | **X** | **X** | **X** | **X** |
| | *Erodium cicutarium* | 100 | 0.3 | 0.2 | 0.5 | | X | | X |
| | *Mirabilis laevis* var. *villosa* | 75 | 0.2 | 0.2 | 0.5 | | X | | X |
| | *Bromus rubens* | 75 | 1.8 | 0.2 | 6.0 | | X | | X |
| | *Eriogonum inflatum* | 50 | 0.2 | 0.2 | 0.5 | | | | X |
| | *Schismus* | 50 | 0.1 | 0.2 | 0.2 | | | | X |

## *Pleuraphis rigida / Atriplex canescens* Grassland Association

**Big Galleta Grass / Four-Wing Saltbush Association (Mapping code 59012)**

### Range

Globally: This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of the *Pleuraphis rigida / Atriplex canescens* Grassland Association were sampled in the park within the Malapai Hill 7.5-minute topographic quadrangle.

### Environmental Description

Globally: This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of the *Pleuraphis rigida / Atriplex canescens* Grassland Association are found at mid elevations (3,200–3,300 ft.; 970–1,000 m) on flats and gently sloping (1 degree) alluvial fans and washes. Stands are typically on fine-textured soils with soils ranging from coarse loamy sands to medium to very fine sandy loams, derived from granitic or sandy alluvial parent materials. Ground cover in this association consists of 0 percent bedrock, 0 percent boulder, 0 percent stone, <1–5 percent cobble, <1–88 percent gravel, and 0–88 percent fines cover. Litter consists of <1–30 percent cover. This association experiences low to high levels of disturbance from competition from exotics.

### Vegetation Description

Globally: This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of the *Pleuraphis rigida / Atriplex canescens* Grassland Association form a sparse to open grassland with 0 percent cover in the tree/tall stratum, 3–6 percent cover in the shrub/mid stratum, and 8–48 percent cover in the herb/low stratum. Total vegetation cover ranges from 6–11 percent.

This association is dominated by the shrub species *Atriplex canescens* and the herb species *Pleuraphis rigida*. The non-natives herbs *Bromus rubens* and *Erodium cicutarium* are characteristic of this association, and the non-native *Schismus barbatus* also often occurs.

### Other Noteworthy Species

N/A

**Conservation Rank:** Rare

### Rank Justification

This association is known only from Joshua Tree National Park.

### Comments

Globally: N/A

JOTR: N/A

Plots used for this description: N=3; MDEI: 151-1-1, 151-1-6; Long: VMAL97-1[1].

Map Accuracy Assessment plots: N=28; 50-0142, 50-0143, 50-0144, 50-0146, 50-0147, 50-0148, 50-0149, 50-0150, 50-0151, 50-0152, 50-0153, 50-0155, 50-0156, 50-0157, 50-0158, 50-0159, 50-0160, 50-0161, 50-0162, 50-0163, 50-0164, 50-0165, 50-0166, 50-0167, 50-0168, 50-0169, 50-0170, 50-0171.

### Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Tree** | | | | | | | | | |
| | *Yucca brevifolia* | 33 | 0.1 | 0.2 | 0.2 | | | | |
| **Shrub** | | | | | | | | | |
| | ***Atriplex canescens*** | **100** | **3.3** | **2.0** | **6.0** | **X** | **X** | **X** | **X** |
| | *Cylindropuntia echinocarpa* | 33 | 0.1 | 0.2 | 0.2 | | | | |
| **Herb** | | | | | | | | | |
| | ***Pleuraphis rigida*** | **100** | **11.0** | **4.0** | **20.0** | **X** | **X** | **X** | **X** |
| | *Bromus rubens* | 100 | 8.3 | 2.0 | 20.0 | | X | | X |
| | *Erodium cicutarium* | 100 | 3.0 | 0.5 | 8.0 | | X | | X |
| | *Schismus barbatus* | 67 | 2.3 | 2.0 | 5.0 | | | | X |
| | *Achnatherum speciosum* | 33 | 0.2 | 0.5 | 0.5 | | | | |
| | *Lolium rigidum* | 33 | 0.1 | 0.2 | 0.2 | | | | |

## *Salazaria mexicana* Shrubland Alliance

**Bladder-Sage Shrubland Alliance (Mapping code 28140, not mapped)**

The *Salazaria mexicana* Shrubland Alliance has been observed throughout the Colorado Desert; Sonoran Desert; the northern, eastern, southern, and central Mojave Desert of California; and in Arizona (NatureServe 2011). In Joshua Tree National Park, stands of this alliance occur in the postburn areas in Covington Flat in the Little San Bernardino Mountains (Keeler-Wolf et. al. 2005). Conservation rank: G4, S4.

Most stands of the *Salazaria mexicana* Shrubland Alliance occur in washes within upper bajadas or and arroyos in the lower mountainslopes, although some are on slopes with disturbance in the Mojave Desert. In Joshua Tree National Park, a sample occurs on a rocky northeast facing steep slopes without evident recent disturbance. Soils were metamorphic. It was found at an elevation of 2,800 ft. (900 m), and the alliance is fairly common in the Mojave Desert at mid to upper elevations (875–1680 m).

Many other mid- and upper-elevation alliances have *Salazaria mexicana,* including *Juniperus californica, Ambrosia salsola, Coleogyne ramosissima, Ephedra nevadensis, Eriogonum fasciculatum, Larrea tridentata – Ambrosia dumosa, Yucca brevifolia,* and *Yucca schidigera.* This alliance appears to be local and largely disturbance-related. It is characterized by the dominance of *Salazaria mexicana* but, most frequently, is mixed with several other shrubs.

Small stands of this alliance occur in washes and on disturbed, upland sites (disturbed by livestock or OHV activity). The life history attributes of *Salazaria mexicana* are not well known. Webb et al. (1988) demonstrate that *Salazaria mexicana* can reestablish ghost town sites readily. It is also common on actively eroding edges of alluvial terraces, along with other disturbance-related taxa such as *Acamptopappus sphaerocephalus, Ambrosia salsola, Ephedra nevadensis,* and *Eriogonum inflatum*.

This alliance is represented in Joshua Tree National Park by a single sample (see Stand Table on next Page):

*Salazaria mexicana* (MDEI: 141-2-6).

## Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Shrub** | | | | | | | | | |
| | ***Salazaria mexicana*** | **100** | **3.5** | **3.5** | **3.5** | | **X** | | **X** |
| | *Bebbia juncea* | 100 | 2.5 | 2.5 | 2.5 | | X | | X |
| | *Viguiera parishii* | 100 | 2.5 | 2.5 | 2.5 | | X | | X |
| | *Krameria grayi* | 100 | 1.5 | 1.5 | 1.5 | | X | | X |
| | *Encelia farinosa* | 100 | 1.0 | 1.0 | 1.0 | | X | | X |
| | *Eriogonum fasciculatum* | 100 | 1.0 | 1.0 | 1.0 | | X | | X |
| | *Peucephyllum schottii* | 100 | 1.0 | 1.0 | 1.0 | | X | | X |
| | *Acacia greggii* | 100 | 0.5 | 0.5 | 0.5 | | X | | X |
| | *Ambrosia dumosa* | 100 | 0.5 | 0.5 | 0.5 | | X | | X |
| | *Prunus andersonii* | 100 | 0.5 | 0.5 | 0.5 | | X | | X |
| | *Gutierrezia* | 100 | 0.5 | 0.5 | 0.5 | | X | | X |
| | *Salvia mohavensis* | 100 | 0.5 | 0.5 | 0.5 | | X | | X |
| | *Tetracoccus hallii* | 100 | 0.5 | 0.5 | 0.5 | | X | | X |
| **Herb** | | | | | | | | | |
| | *Mirabilis laevis var. villosa* | 100 | 2.0 | 2.0 | 2.0 | | X | | X |
| | *Eriogonum inflatum* | 100 | 1.0 | 1.0 | 1.0 | | X | | X |
| | *Erodium cicutarium* | 100 | 0.5 | 0.5 | 0.5 | | X | | X |
| | *Achnatherum speciosum* | 100 | 0.5 | 0.5 | 0.5 | | X | | X |
| | *Bromus rubens* | 100 | 0.5 | 0.5 | 0.5 | | X | | X |
| | *Cheilanthes parryi* | 100 | 0.5 | 0.5 | 0.5 | | X | | X |
| | *Dudleya saxosa* | 100 | 0.5 | 0.5 | 0.5 | | X | | X |
| | *Lotus rigidus* | 100 | 0.5 | 0.5 | 0.5 | | X | | X |
| | *Poa secunda* | 100 | 0.5 | 0.5 | 0.5 | | X | | X |
| | *Schismus barbatus* | 100 | 0.5 | 0.5 | 0.5 | | X | | X |
| | *Stephanomeria pauciflora* | 100 | 0.5 | 0.5 | 0.5 | | X | | X |

## *Tetracoccus hallii* Provisional Shrubland Alliance

### Hall's Tetracoccus Provisional Shrubland Alliance (Mapping code 28180)

The *Tetracoccus hallii* Provisional Alliance is found in Imperial, Riverside, and San Bernardino Counties and in Arizona and Baja California. Within Joshua Tree National Park it is has been identified from only one stand. Conservation rank: G2, S1.

Stands of *Tetracoccus hallii* are located on colluvial slopes as the dominant shrub with *Ambrosia dumosa, Ephedra nevadensis*, *Nolina bigelovii*, *Simmondsia chinensis*, *Yucca schidigera,* and *Xylorhiza tortifolia.* They are also found in small stringers along low elevation washes surrounded by upland stands with *Acacia greggii*, *Ambrosia dumosa*, *Senna armata*, *Viguiera parishii*, and *Yucca schidigera* (Keeler- Wolf et al. 2005).

In Joshua Tree National Park, *Tetracoccus hallii* has been sampled at mid elevation (3,300 ft., 1,000 m) on a convex surface with loam soils. *T. hallii* is dominant. No exotic plant species were identified in the stand. *Tetracoccus hallii* also occurs as a member of other alliances (*Coleogyne ramosissima*, *Larrea – Ambrosia*, and *Juniperus californica*) at mid elevations in the south-central portion of the park.

The plant species *Tetracoccus hallii* is a CRPR 4 plant (CNPS 2011). It is found in Imperial, Riverside, and San Bernardino Counties at low to high elevations (100–4,000 ft.; 30–1,200 m).

Additional sampling is needed to fully describe this provisional alliance. Currently, this alliance is represented in Joshua Tree National Park by the *Tetracoccus hallii* Provisional Association by one sample during the classification phase (see Stand Table next page). Five additional map accuracy assessment samples provide some information to define this alliance.

> *Tetracoccus hallii* (JOTRA: 34-06-2; MapAA: 25-1417, 25-1418, 25-1419, 25-1420, 25-1421).

## Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Shrub** | | | | | | | | | |
| | ***Tetracoccus hallii*** | **100** | **4.2** | **4.2** | **4.2** | | **X** | | **X** |
| | *Simmondsia chinensis* | 100 | 3.2 | 3.2 | 3.2 | | X | | X |
| | *Ephedra nevadensis* | 100 | 1.2 | 1.2 | 1.2 | | X | | X |
| | *Nolina bigelovii* | 100 | 1.2 | 1.2 | 1.2 | | X | | X |
| | *Galium stellatum* | 100 | 0.4 | 0.4 | 0.4 | | X | | X |
| | *Lepidium fremontii* | 100 | 0.4 | 0.4 | 0.4 | | X | | X |
| | *Salazaria mexicana* | 100 | 0.4 | 0.4 | 0.4 | | X | | X |
| | *Acacia greggii* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Ambrosia dumosa* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Bebbia juncea* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Brickellia arguta* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Brickellia desertorum* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Encelia farinosa* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Eriogonum fasciculatum* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Gutierrezia microcephala* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Gutierrezia sarothrae* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Lycium andersonii* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Opuntia basilaris* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Peucephyllum schottii* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Pleurocoronis pluriseta* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Trixis californica* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Viguiera parishii* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Yucca schidigera* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| **Herb** | | | | | | | | | |
| | *Xylorhiza tortifolia* | 100 | 1.2 | 1.2 | 1.2 | X | X | X | X |
| | *Eriogonum inflatum* | 100 | 0.4 | 0.4 | 0.4 | | X | | X |
| | *Achnatherum speciosum* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Adenophyllum porophylloides* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Camissonia* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Dasyochloa pulchella* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Mirabilis laevis var. villosa* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Perityle emoryi* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Pleuraphis rigida* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Porophyllum gracile* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Salvia columbariae* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| **Nonvascular** | | | | | | | | | |
| | Cryptogammic crust | 100 | 0.2 | 0.2 | 0.2 | X | X | X | X |
| | Unknown Lichen | 100 | 0.2 | 0.2 | 0.2 | X | X | X | X |
| | Unknown Moss | 100 | 0.2 | 0.2 | 0.2 | X | X | X | X |

The *Yucca brevifolia* Woodland Alliance occurs in the Mojave Desert, southern California mountains and valleys, and southeastern Great Basin regions of California (Sawyer et al. 2009); and in southern Nevada, western Arizona, and southwestern Utah (NatureServe 2011). Conservation rank: G4, S3.

*Yucca brevifolia* is a long-lived plant (>150 years); however, the exact age is difficult to determine since annual rings are not produced, and many individuals may regenerate vegetatively. Juvenile *Yucca brevifolia* are generally unbranched; middle-aged plants are forked and dense. Older trees generally have a single stem and an open crown. Seedlings are uncommon on many harsh sites, except following a series of wet years. Some researchers believe that sexual reproduction was much more important during more favorable climatic regimes (late Pleistocene), when summers were cooler and annual precipitation greater (Webb et al. 2003). Vegetative reproduction is now the most important mode of regeneration on many sites. *Yucca brevifolia* can sprout from roots and underground rhizomes, which are fast growing and numerous.

Natural stand dynamics are at least partially related to fire, although many associations are not strongly related. Summer lighting strikes are relatively frequent in the high desert stands in the northern, southern, and eastern Mojave with large individuals of *Yucca brevifolia* making suitable targets. The fire resistance of trees increases with age. The thick mat of dried leaves along the trunk decreases with age, and the corky bark of older trunks serve as a firebreak between surface fuels and the flammable shag on upper limbs (Gucker 2006). However, observations by R. Minnich (personal communication 2000) suggest that even large trees are susceptible to fire, with many scorched trees dying within five years. Grazing history has changed the fire regime by increasing non-native, annual grasses. The former regime was probably once per century.

*Yucca brevifolia* is generally capable of vigorous root and stump sprouting after fire. Seed can remain viable in the soil for several years. Reestablishment through on-site or off-site seed is possible, particularly on more mesic sites or in favorable years. Little is known of the resprouting response of *Yucca brevifolia* to variable timing of fires and of various ecotypes' responses to fire. According to R. Minnich (personal communication), although vigorous sprouting may take place in some populations following fire, others will not sprout. Those that do sprout tend to die within a few years either by rodent predation or by other causes.

Certain associations, including *Yucca brevifolia / Lycium andersonii, Yucca brevifolia / Salazaria mexicana,* and *Yucca brevifolia / Cylindropuntia acanthocarpa,* are probably related to or have more frequent disturbance including fire and grazing. Other associations, including *Yucca brevifolia – Juniperus californica / Ephedra nevadensis, Yucca brevifolia / Artemisia tridentata,* and *Yucca brevifolia / Coleogyne ramosissima,* probably have relatively low fire frequencies.

Fire frequencies in areas invaded by annual, exotic grasses (*Bromus rubens, B. tectorum, Schismus* spp.) are likely to have increased, as a result of both natural and human-caused ignitions, and have changed the understory composition and density of *Yucca brevifolia*. There has likely been a reduction in *Y. brevifolia* stands with fire sensitive shrubs (*e.g., Larrea tridentata, Coleogyne*) as a result, or a seral change to other alliances. Destruction or degradation of individual stands also has resulted from off-highway vehicle (OHV) activity and vandalism, and extensive vandalism in many *Yucca brevifolia* woodlands in California.

Livestock have heavily grazed many *Yucca brevifolia* woodlands. Grazing systems do not improve range conditions because of the extreme aridity and harshness of the environment. Efforts to improve these ranges tend to be expensive and yield few beneficial results.

The *Yucca brevifolia* Woodland Alliance is represented in Joshua Tree National Park by five associations. These include *Yucca brevifolia / Coleogyne ramosissima* Association, *Yucca brevifolia – Juniperus californica / Ephedra nevadensis* Association, *Yucca brevifolia / Larrea tridentata – Yucca schidigera / Pleuraphis rigida* Association, *Yucca brevifolia / Pleuraphis rigida* Association, and *Yucca brevifolia / Prunus fasciculata* Association.

In addition to these associations, there is an alliance-level sample that may suggest additional variation:

*Yucca brevifolia* (Watts: n=1)

## *Yucca brevifolia / Coleogyne ramosissima* Woodland Association

**Joshua Tree / Blackbush Association (Mapping code 13012)**

### Range

Globally: This association occurs in California and Arizona (Sawyer et al. 2009, NatureServe 2011), and may also occur elsewhere in the Mojave Desert. This association has been sampled but not described from the central Mojave Desert (Keeler-Wolf and Thomas 2000), including stands in the Mojave National Preserve at/near Cima Dome and north of I-15 below the Kingston and Clark Mountain ranges (J. Evens, personal observation 1998).

JOTR: Stands of the *Yucca brevifolia / Coleogyne ramosissima* Association are found in the northwestern part of the park and were sampled within the Indian Cove, Joshua Tree South and Queen Mountain 7.5-minute topographic quadrangles.

### Environmental Description

Globally: N/A

JOTR: Stands of *Yucca brevifolia / Coleogyne ramosissima* Association are found at mid to high elevations (3,700–4,300 ft.; 1,100–1,300 m) on flat, southwest, northwest, and northeast facing slopes. This association generally occurs on flat to gentle (1–5 degree) slopes. Sites are found in intramontane, alluvial plains and old alluvial deposits undergoing dissection. Soil textures are coarse sand to loam derived from granitic parent material. These sites tend to be gravelly with gravel cover of 20–40 percent and fines cover of 37–85 percent. Litter ranges from <1–3 percent cover. Sites generally experience low to moderate levels of competition from exotics.

### Vegetation Description

Globally : Stands occur in the higher elevation portions of the distribution of *Y. brevifolia* where it overlaps in range with *Coleogyne ramosissima, Ephedra nevadensis, Lycium* spp., *Thamnosma montana,* and many other shrub species.

JOTR: Stands of the *Yucca brevifolia / Coleogyne ramosissima* Association form an open woodland with 1–10 percent cover for the tree/tall stratum, 8–20 percent cover for the shrub/medium stratum, and 1–12 percent cover for the herb/low stratum. Total vegetative cover ranges from 11–30 percent.

This association is dominated by *Yucca brevifolia* in the tree layer, and *Coleogyne ramosissima* in shrub layer, and *Achnatherum speciosum* in the herbaceous layer. *Ambrosia salsola* is a characteristic species, and often occurring are *Cylindropuntia echinocarpa*, *Ephedra nevadensis, Juniperus californica, Pleuraphis rigida,* and *Yucca schidigera*.

**Other Noteworthy Species** N/A

**Conservation Rank:** Rare

**Rank Justification**

This association occurs at upper elevations of the range of *Y. brevifolia* in Arizona and California, and may occur into Nevada, and is likely to be somewhat threatened by increased fire frequency and development.

**Comments**

Globally : This type occurs in the Mojave Desert in Arizona and California and is likely to occur in Nevada. Both the main nominate species of this association have similar ecological amplitudes, and they overlap in the upper elevation portions of *Y. brevifolia* in the Mojave Desert.

JOTR: Much of this type has undergone recent burning in the Covington Flats area.

Plots used for this description: N=8; JOTRA; 21-31-1; JOTR: JOTR01, JOTR9; MDEI: 101-7-1, 101-7-3, 101-7-4, 118-1-1, 118-1-8.

Map Accuracy Assessment plots: N=29; 50-0989, 50-0990, 50-0991, 50-0992, 50-0993, 50-0994, 50-0995, 50-0996, 50-0997, 50-0998, 50-0999, 50-1000, 50-1001, 50-1002, 50-1003, 50-1004, 50-1005, 50-1006, 50-1008, 50-1009, 50-1010, 50-1011, 50-1012, 50-1013, 50-1014, 50-1015, 50-1016, 50-1018, 50-1886.

## Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Tree** | | | | | | | | | |
| | ***Yucca brevifolia*** | **100** | **2.3** | **1.0** | **4.0** | **X** | **X** | **X** | **X** |
| | *Juniperus californica* | 50 | 0.3 | 0.2 | 1.0 | | | | X |
| **Shrub** | | | | | | | | | |
| | ***Coleogyne ramosissima*** | **100** | **8.7** | **2.0** | **16.5** | **X** | **X** | **X** | **X** |
| | *Ambrosia salsola* | 88 | 1.6 | 0.4 | 4.0 | | X | | X |
| | *Ephedra nevadensis* | 63 | 1.0 | 1.0 | 3.0 | | | | X |
| | *Cylindropuntia echinocarpa* | 63 | 0.4 | 0.2 | 1.0 | | | | X |
| | *Yucca schidigera* | 50 | 0.6 | 0.5 | 2.2 | | | | X |
| | *Atriplex* | 38 | 0.3 | 0.5 | 1.0 | | | | |
| | *Salazaria mexicana* | 38 | 0.3 | 0.2 | 1.5 | | | | |
| | *Lycium andersonii* | 38 | 0.3 | 0.2 | 2.0 | | | | |
| | *Lycium cooperi* | 38 | 0.2 | 0.2 | 0.5 | | | | |
| | *Ephedra viridis* | 38 | 0.2 | 0.5 | 0.5 | | | | |
| | *Eriogonum fasciculatum* | 38 | 0.2 | 0.2 | 1.0 | | | | |
| | *Cylindropuntia ramosissima* | 38 | 0.2 | 0.4 | 1.0 | | | | |
| **Herb** | | | | | | | | | |
| | *Achnatherum speciosum* | 75 | 1.4 | 0.5 | 5.0 | X | X | X | X |
| | *Pleuraphis rigida* | 63 | 1.1 | 0.5 | 3.0 | | | | X |
| | *Bromus rubens* | 38 | 1.3 | 0.2 | 6.0 | | | | |
| | *Erodium cicutarium* | 38 | 0.3 | 0.5 | 1.0 | | | | |
| | *Eriogonum inflatum* | 38 | 0.2 | 0.2 | 0.5 | | | | |
| | *Salvia columbariae* | 38 | 0.2 | 0.2 | 0.5 | | | | |

## *Yucca brevifolia – Juniperus californica / Ephedra nevadensis* Woodland Association

**Joshua Tree – California Juniper / Nevada Ephedra Association (Mapping code 13015)**

### Range

Globally: This association is only known from Joshua Tree National Park in the southern Mojave (Pinto Basin and Mountains subsection) and southern California Mountains and Valleys (Little San Bernardino and Bighorn Basin subsection). Information about its global characteristics is not available without additional inventory.

JOTR: Stands of the *Yucca brevifolia – Juniperus californica / Ephedra nevadensis* Association occur in the western portion of the park and were sampled within the East Deception Canyon, Joshua Tree South, Keys View, Rockhouse Canyon, and Yucca Valley South 7.5-minute topographic quadrangles.

### Environmental Description

Globally: This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of *Yucca brevifolia – Juniperus californica / Ephedra nevadensis* Association are found at high elevations (4,300–5,000 ft.; 1,300–1,500 m) on linear sites of bottom/plains and toeslopes of alluvial fans. The topography is flat and slopes are gentle to moderate (3–6 degrees). Soils range from coarse sand to very fine sandy loam derived from granitic parent material. The ground surface consists of 0– <1 percent bedrock, 0– <1 percent stone, 0–<1 percent cobble, <1–55 percent gravel, and 25–80 percent fines. Litter cover varies from 4–30 percent. These sites generally experience moderate to high levels of disturbance from exotic species.

### Vegetation Description

Globally: This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of the *Yucca brevifolia – Juniperus californica / Ephedra nevadensis* Association form an open shrubland with 0–5 percent cover for the tree/tall stratum, 4–42 percent cover for the shrub/medium stratum, and <1–50 percent cover for the herb/low stratum. Total vegetative cover ranges from 14–25 percent.

This association is dominated by *Juniperus californica* and *Yucca brevifolia* in the tree layer, although the exotic species *Bromus rubens* is dominant in the herbaceous layer. Shrub species characteristically present in this association include *Ephedra nevadensis*, *Eriogonum fasciculatum,* and *Cylindropuntia echinocarpa*. Characteristically in the herb layer is *Achnatherum speciosum.* Often present in the shrub layer are *Coleogyne ramosissima* and *Salzaria mexicana*.

**Other Noteworthy Species**
N/A

**Conservation Rank:** Rare.

**Rank Justification**
This association is probably restricted to the western Mojave Desert in California and reduced by development and increased fire due to fine fuels from invasive exotic grasses.

**Comments**
Globally: N/A

JOTR: In this association, the shrub layer contains a variety of shrub species where *Ephedra nevadensis* appeared most frequently, but it did not always exhibit the highest cover. Other shrubs, including *Coleogyne ramosissima* and *Eriogonum fasciculatum,* sometimes are higher in cover though these stands typically had a mixture of shrub species, and *E. nevadensis* is the strongest indicator in the shrub layer. In addition, the previously defined *Yucca brevifolia / Juniperus californica / Coleogyne ramosissima* Association from the Keeler-Wolf et al. (2005) report is now considered as a phase in this association.

Plots used for this description: N=8; JOTRA: 06A-08-1, 08A-02-2, 08A-02-5, 08A-04-4, 15-09-1, 20-13-2; Long: VBRC97-1, VKEY97-1.

Map Accuracy Assessment plots: N=32; 50-0959, 50-0960, 50-0961, 50-0962, 50-0963, 50-0964, 50-0965, 50-0966, 50-0967, 50-0968, 50-0969, 50-0970, 50-0971, 50-0972a, 50-0972b, 50-0973, 50-0974, 50-0975, 50-0976, 50-0977, 50-0978a, 50-0978b, 50-0979, 50-0980, 50-0981, 50-0982, 50-0983, 50-0984, 50-0985, 50-0986, 50-0988, 50-1781.

## Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Tree** | | | | | | | | | |
| | ***Juniperus californica*** | **100** | **4.6** | **2.0** | **8.0** | **X** | **X** | **X** | **X** |
| | ***Yucca brevifolia*** | **100** | **3.2** | **1.0** | **6.0** | **X** | **X** | **X** | **X** |
| **Shrub** | | | | | | | | | |
| | ***Ephedra nevadensis*** | **88** | **2.7** | **0.2** | **10.0** | | **X** | | **X** |
| | *Eriogonum fasciculatum* | 88 | 2.5 | 0.2 | 11.0 | | X | | X |
| | *Cylindropuntia echinocarpa* | 88 | 0.6 | 0.2 | 2.2 | | X | | X |
| | *Coleogyne ramosissima* | 63 | 4.8 | 0.2 | 20.0 | | | | X |
| | *Salazaria mexicana* | 50 | 0.9 | 0.2 | 3.0 | | | | X |
| | *Ambrosia salsola* | 50 | 1.9 | 1.0 | 8.0 | | | | X |
| | *Lycium andersonii* | 38 | 0.1 | 0.2 | 0.4 | | | | |
| | *Gutierrezia microcephala* | 38 | 0.2 | 0.2 | 1.0 | | | | |
| | *Ericameria linearifolia* | 38 | 0.1 | 0.2 | 0.4 | | | | |
| | *Opuntia basilaris* | 38 | 0.1 | 0.2 | 0.2 | | | | |
| | *Sphaeralcea ambigua* | 38 | 0.1 | 0.2 | 0.2 | | | | |
| | *Atriplex canescens* | 38 | 0.1 | 0.2 | 0.2 | | | | |
| **Herb** | | | | | | | | | |
| | *Bromus rubens* | 100 | 11.8 | 0.2 | 50.0 | X | X | X | X |
| | *Achnatherum speciosum* | 100 | 0.7 | 0.2 | 2.0 | | X | | X |
| | *Bromus tectorum* | 38 | 4.5 | 4.0 | 25.0 | | | | |
| | *Pleuraphis rigida* | 38 | 0.3 | 0.2 | 2.0 | | | | |
| **Nonvascular** | | | | | | | | | |
| | Cryptogammic crust | 38 | 0.4 | 0.6 | 2.0 | | | | |

### *Yucca brevifolia / Larrea tridentata – Yucca schidigera / Pleuraphis rigida* Woodland Association

**Joshua Tree / Creosote Bush – Mojave Yucca / Big Galleta Grass Association (Mapping code 13016)**

#### Range

Globally: This association is only known from Joshua Tree National Park in the southern Mojave (Pinto Basin and Mountains subsection) and southern California Mountains and Valleys (Little San Bernardino and Bighorn Basin subsection). Information about its global characteristics is not available without additional inventory.

JOTR: Stands of the *Yucca brevifolia / Larrea tridentata – Yucca schidigera / Pleuraphis rigida* Wooded Shrubland Association are found in the western portion of the park and were sampled within the Malapai Hill, Queen Mountain and Rockhouse Canyon 7.5-minute topographic quadrangles.

#### Environmental Description

Globally: This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of *Yucca brevifolia / Larrea tridentata – Yucca schidigera / Pleuraphis rigida* Wooded Shrubland Association are found at mid to high elevations (3,300–4,600 ft.; 1,000–1,400 m) on flat and undulating toeslopes and washes. Steepness is gentle to moderate (2-6 degrees). Soil texture ranges from coarse sand to moderately fine sandy clay loam. Soils are formed primarily from sandy alluvium and granitic parent material, although some may include Gneiss. The ground surface consists of 0–<1 percent bedrock, 0–3 percent boulder, 0–4 percent stone, 0–8 percent cobble, 4–71 percent gravel, and 48–64 percent fines cover. Litter cover varies from 1–38 percent. These sites generally experience moderate disturbance levels from competition from exotics, and occasionally moderate levels of disturbance from foot traffic/trampling.

#### Vegetation Description

Globally: This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of the *Yucca brevifolia / Larrea tridentata – Yucca schidigera / Pleuraphis rigida* Wooded Shrubland Association form an open woodland with 0–2 percent cover for the tree/tall stratum, 12–40 percent cover for the shrub/medium stratum, and 0–48 percent cover for the herb/low stratum. Total vegetative cover ranges from 16–26 percent.

This association is dominated by the tree and shrub species *Yucca brevifolia* is the dominant woody species and the exotic species *Bromus rubens* is dominant in the

understory herb layer. Characteristic shrub species include *Acamptopappus sphaerocephalus, Ambrosia salsola, Cylindropuntia echinocarpa*, *Ephedra nevadensis*, *Eriogonum fasciculatum*, *Krameria grayi*, *Larrea tridentata*, *Salazaria mexicana* and *Yucca schidigera*. Herbaceous species characteristically in this association are *Pleuraphis rigida,* and the exotic species *Erodium cicutarium.*

**Other Noteworthy Species**
*Coryphantha alversonii* was found in one of three plots. *Coryphantha alversonii* is a CRPR 4 plant (CNPS 2011). It is found in Imperial, Riverside, and San Bernardino Counties at low to high elevations (240–5,000 ft.; 73–1,500 m). (Syn: *Escobaria vivipara* var. *alversonii* in the Jepson Manual.)

**Conservation Rank:** N/A

**Rank Justification**
This association is likely to be found in the upper elevations of the Mojave Desert in California, Arizona, and Nevada, though more sampling is needed to fully assess distribution and rarity.

**Comments**
Globally: N/A

JOTR: The Keeler-Wolf et al. (2005) report included the *Yucca brevifolia / Larrea tridentata – Yucca schidigera* Association and the *Yucca brevifolia / Larrea tridentata – Pleuraphis rigida* Association. However, these two have been merged together into this *Yucca brevifolia / Larrea tridentata – Yucca schidigera / Pleuraphis rigida* Association since they were so floristically and environmentally similar. The two previous associations may now be considered phases in this association.

In addition, the *Yucca brevifolia* / *Larrea tridentata – Ambrosia dumosa – Eriogonum fasiculatum* Association defined by Keeler-Wolf and Thomas (2000) from the central Mojave is similar to this currently defined association from Joshua Tree National Park.

Plots used for this description: N=9; JOTRA: 18-27-4, 21-14-2; JOTR: JOTR45; Long: VMAL97-12, VMAL97-31, VMAL97-34, VMAL97-37, VMAL97-4, VMAL97-7.

Map Accuracy Assessment plots: N=29; 50-0002, 50-0450, 50-0929, 50-0930, 50-0931, 50-0933, 50-0935, 50-0936, 50-0937, 50-0938, 50-0939, 50-0940, 50-0941, 50-0942, 50-0944, 50-0945, 50-0946, 50-0947a, 50-0947b, 50-0948, 50-0949, 50-0950, 50-0952, 50-0953, 50-0954, 50-0955, 50-0956, 50-0957, 50-0958.

## Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Tree** | | | | | | | | | |
| | ***Yucca brevifolia*** | **100** | **2.4** | **1.2** | **3.4** | **X** | **X** | **X** | **X** |
| | *Juniperus californica* | 67 | 0.6 | 0.2 | 2.2 | | | | X |
| **Shrub** | | | | | | | | | |
| | *Ambrosia salsola* | 100 | 4.3 | 0.2 | 14.0 | | X | | X |
| | ***Larrea tridentata*** | **100** | **4.2** | **1.0** | **15.2** | | **X** | | **X** |
| | *Eriogonum fasciculatum* | 100 | 2.2 | 0.2 | 7.0 | | X | | X |
| | *Cylindropuntia echinocarpa* | 100 | 1.0 | 0.2 | 3.0 | | X | | X |
| | *Salazaria mexicana* | 89 | 2.0 | 0.2 | 7.2 | | X | | X |
| | ***Yucca schidigera*** | **89** | **1.8** | **0.2** | **5.0** | | **X** | | **X** |
| | *Ephedra nevadensis* | 89 | 0.9 | 0.2 | 2.2 | | X | | X |
| | *Krameria grayi* | 78 | 1.2 | 0.2 | 3.2 | | X | | X |
| | *Acamptopappus sphaerocephalus* | 78 | 0.8 | 0.2 | 4.0 | | X | | X |
| | *Ericameria cooperi* | 67 | 1.0 | 0.2 | 3.0 | | | | X |
| | *Echinocereus engelmannii* | 67 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Coleogyne ramosissima* | 44 | 1.0 | 1.0 | 6.0 | | | | |
| | *Lycium andersonii* | 44 | 0.5 | 0.2 | 4.0 | | | | |
| | *Cylindropuntia ramosissima* | 44 | 0.2 | 0.2 | 1.2 | | | | |
| | *Opuntia basilaris* | 44 | 0.1 | 0.2 | 0.2 | | | | |
| | *Ephedra viridis* | 33 | 0.7 | 1.0 | 3.0 | | | | |
| | *Gutierrezia microcephala* | 33 | 0.1 | 0.2 | 0.4 | | | | |
| | *Thamnosma montana* | 33 | 0.1 | 0.2 | 0.4 | | | | |
| | *Ephedra californica* | 33 | 0.1 | 0.2 | 0.4 | | | | |
| **Herb** | | | | | | | | | |
| | *Bromus rubens* | 89 | 15.2 | 2.0 | 30.0 | X | X | X | X |
| | ***Pleuraphis rigida*** | **89** | **6.3** | **1.0** | **16.0** | | **X** | | **X** |
| | *Erodium cicutarium* | 78 | 4.2 | 2.0 | 8.0 | | X | | X |
| | *Eriogonum inflatum* | 44 | 0.1 | 0.2 | 0.4 | | | | |
| | *Achnatherum speciosum* | 44 | 0.1 | 0.2 | 0.2 | | | | |

## *Yucca brevifolia / Pleuraphis rigida* Woodland Association

**Joshua Tree / Big Galleta Association (Mapping code 13021)**

### Range

Globally: This association is known to occur in California and Nevada (NatureServe 2011), including Joshua Tree National Park in the southern Mojave (Pinto Basin and Mountains subsection) and southern California Mountains and Valleys (Little San Bernardino and Bighorn Basin subsection).

JOTR: Stands of the *Yucca brevifolia / Pleuraphis rigida* Association occur in the western portion of the park, such as in Lost Horse Valley and Black Rock Valley, and were sampled within the Indian Cove, Joshua Tree South Malapai Hill, and Yucca Valley South 7.5-minute topographic quadrangles.

### Environmental Description

Globally: This association is known to occur in California and Nevada at mid-elevations along alluvial fans and plains and low slopes.

JOTR: Stands of *Yucca brevifolia / Pleuraphis rigida* Association are found at mid elevations (3,300–4,500 ft.; 1,000–1,400 m) on linear slopes of arroyos, bottom/plains, toe slopes (alluvial fans or bajadas), and alluvial deposits undergoing dissection. These sites tend to be on mostly north facing and occasionally west facing, gentle (1–2 degree) slopes. Soil textures range from coarse loamy sand to loam derived from granite and sometimes silty alluvium parent material. Surface cover consists of 0 percent bedrock, 0 percent boulder, 0 percent stone, 0–<1 percent cobble, 2–93 percent gravel, and 20–65 percent fines. Litter cover ranges from <1–16 percent. These sites generally experience high levels of disturbance from exotic species.

### Vegetation Description

Globally: This association is dominated by *Yucca brevifolia* in the tree layer and *Pleuraphis rigida* in the herbaceous layer. Stands are typically open woodlands, and shrubs are usually present and variable in species and cover.

JOTR: Stands of the *Yucca brevifolia / Pleuraphis rigida* Association have a variable structure with an open shrubland 0–6 percent cover in the emergent tree layer, 2–29 percent cover in the open shrub layer, and 2–18 percent cover in the sparse to open herb layer. Total vegetative cover in this association can range from 11–43 percent.

This association is dominated by *Yucca brevifolia* in the emergent tree layer and in the herbaceous layer *Pleuraphis rigida* and the exotic *Bromus rubens*. The sparse to open shrub layer includes a variety of characteristic species such as *Ambrosia salsola, Cylindopuntia echinocarpa and Salazaria mexicana.* Often in the shrub layer are *Acamptopappus sphaerocephalus*, *Ephedra nevadensis*, *Lycium andersonii*,

*Lycium cooperi* and *Yucca schidigera*. Often in the understory herb layer is *Amaranthus* sp. and the exotic species *Erodium cicutarium*.

**Other Noteworthy Species**
N/A

**Conservation Rank:** Rare

**Rank Justification**
This association is likely localized on alluvial fans and plains at mid-elevations in the Mojave Desert.

**Comments**
Globally: N/A

JOTR: N/A

Plots used for this description: N=8; JOTRA: 03-14-5, 10B-01-3, 11B-06-3, 16-23-1, 19-21-2; Long: VMAL97-6; MDEI: 101-7-7, 157-2-6.

Map Accuracy Assessment Plots: N=26; 50-0899, 50-0901, 50-0902, 50-0903, 50-0904, 50-0905, 50-0908, 50-0909, 50-0910, 50-0911, 50-0912, 50-0913, 50-0914, 50-0915, 50-0916, 50-0917, 50-0918, 50-0919, 50-0920, 50-0921, 50-0922, 50-0923, 50-0924, 50-0925, 50-0926, 50-0928.

## Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Tree** | | | | | | | | | |
| | ***Yucca brevifolia*** | **100** | **2.3** | **0.4** | **6.4** | **X** | **X** | **X** | **X** |
| **Shrub** | | | | | | | | | |
| | *Cylindropuntia echinocarpa* | 100 | 0.6 | 0.4 | 1.0 | | X | | X |
| | *Ambrosia salsola* | 88 | 0.9 | 0.2 | 2.0 | | X | | X |
| | *Salazaria mexicana* | 75 | 0.3 | 0.2 | 0.5 | | X | | X |
| | *Ephedra nevadensis* | 63 | 1.6 | 0.2 | 10.0 | | | | X |
| | *Lycium andersonii* | 63 | 0.8 | 0.2 | 4.0 | | | | X |
| | *Yucca schidigera* | 50 | 1.0 | 0.2 | 4.2 | | | | X |
| | *Lycium cooperi* | 50 | 0.8 | 1.0 | 3.2 | | | | X |
| | *Acamptopappus sphaerocephalus* | 50 | 0.1 | 0.2 | 0.5 | | | | X |
| | *Ericameria cooperi* | 38 | 0.3 | 0.2 | 2.0 | | | | |
| | *Cylindropuntia ramosissima* | 38 | 0.3 | 0.2 | 1.0 | | | | |
| | *Krameria grayi* | 38 | 0.1 | 0.2 | 0.2 | | | | |
| **Herb** | | | | | | | | | |
| | ***Pleuraphis rigida*** | **100** | **13.3** | **2.2** | **24.0** | **X** | **X** | **X** | **X** |
| | *Bromus rubens* | 100 | 6.4 | 1.0 | 17.0 | X | X | X | X |
| | *Erodium cicutarium* | 50 | 0.2 | 0.2 | 1.0 | | | | X |
| | *Amaranthus* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Chamaesyce* | 38 | 0.1 | 0.2 | 0.2 | | | | |
| | *Achnatherum speciosum* | 38 | 0.1 | 0.2 | 0.4 | | | | |
| **Nonvascular** | | | | | | | | | |
| | Cryptogammic crust | 50 | 0.3 | 0.2 | 1.0 | | | X | X |

## *Yucca brevifolia / Prunus fasciculata* Association

**Joshua Tree / Desert Almond Association (Mapping code 13014)**

### Range

Globally: This association is only known from Joshua Tree National Park, in the southern Mojave (Pinto Basin and Mountains subsection) and southern California Mountains and Valleys section (Little San Bernardino and Bighorn Basin subsection) (Sawyer et al. 2009). Information about its global characteristics is not available without additional inventory.

JOTR: Stands of the *Yucca brevifolia / Prunus fasciculata* Association were mapped in the western portion of the park and were sampled in the park within the Joshua Tree South, Malapai Hill, and Queen Mountain 7.5-minute topographic quadrangles.

### Environmental Description

Globally: This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of *Yucca brevifolia / Prunus fasciculata* Association are found at high elevations (4,500–4,900 ft.; 1,400–1,500 m) on flat to gentle (0–1 degree) slopes. The topography is linear and undulating on upland, alluvial deposits and washes. Soils have textures ranging from coarse sand to fine, loamy sand, and occur on evaporate (playa), metamorphic, and granitic parent material. Ground cover consists of 0 percent bedrock, 0 percent boulder, 0–<1 percent stone, 0-3 percent cobble, 12–60 percent gravel, and 37–57 percent fines. Litter cover ranges from 7–30 percent. These sites generally experience high levels of disturbance from exotic species, and moderate levels of disturbance from grazing, and moderate levels of disturbance from foot traffic and trampling.

### Vegetation Description

Globally: This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of the *Yucca brevifolia / Prunus fasciculata* Association form an open shrubland with 0 percent cover at <1 cm tall, 10–15 percent cover at 1–25 cm tall, 1–3 percent cover at 25–50 cm tall, 1–2 percent cover at 50 cm to 1 m tall, 6–11 percent cover at 1–3 m tall, and 2–8 percent cover at 3–5 m tall. Total vegetative cover ranges from 23–30 percent.

This association is dominated by *Yucca brevifolia* and *Prunus fasciculata* in the tree/shrub layer. The exotic species *Bromus rubens* is dominant in the herbaceous layer. Characteristically present in the shrub layer are *Cylindropuntia echinocarpa* and *Lycium cooperi*. *Achnatherum speciosum* is characteristic in the herbaceous

layer. *Acacia greggii*, *Ambrosia salsola*, *Atriplex canescens*, *Ephedra nevadensis*, *Eriogonum plumatella*, *Eriogonum fasciculatum*, *Gutierrezia microcephala*, *Larrea tridentata*, *Phoradendron californicum*, *Purshia tridentata*, *Salazaria mexicana* and *Yucca schidigera* are often present in the shrub layer. *Achnatherum hymenoides* is also often in the understory herb layer.

**Other Noteworthy Species**
N/A

**Conservation Rank**: Rare

**Rank Justification**
This association is likely localized in higher elevations of southern and eastern Mojave Desert of California.

**Comments**
Globally: N/A

JOTR: This is a provisional association that may be related to other upper-elevation *J. brevifolia* alliance stands but appears to be largely restricted to wash edges and upper fans and valleys.

Plots used for this description: N=4; JOTRA: 08A-04-1, 18-27-1; Long: VMAL97-4[2].

Map Accuracy Assessment plots: N=0.

## Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Tree** | | | | | | | | | |
| | ***Yucca brevifolia*** | **100** | **4.3** | **2.4** | **8.4** | **X** | **X** | **X** | **X** |
| **Shrub** | | | | | | | | | |
| | ***Prunus fasciculata*** | **100** | **5.8** | **2.0** | **11.0** | **X** | **X** | **X** | **X** |
| | *Cylindropuntia echinocarpa* | 75 | 0.7 | 0.2 | 2.0 | | X | | X |
| | *Lycium cooperi* | 75 | 0.2 | 0.2 | 0.4 | | X | | X |
| | *Atriplex canescens* | 50 | 2.0 | 1.0 | 7.0 | | | | X |
| | *Ambrosia salsola* | 50 | 1.6 | 1.2 | 5.0 | | | | X |
| | *Acacia greggii* | 50 | 1.5 | 2.0 | 4.0 | | | | X |
| | *Salazaria mexicana* | 50 | 1.3 | 2.0 | 3.0 | | | | X |
| | *Larrea tridentata* | 50 | 1.1 | 2.0 | 2.2 | | | | X |
| | *Purshia tridentata* | 50 | 1.1 | 2.0 | 2.2 | | | | X |
| | *Ephedra nevadensis* | 50 | 0.8 | 0.2 | 3.0 | | | | X |
| | *Eriogonum plumatella* | 50 | 0.7 | 0.4 | 2.2 | | | | X |
| | *Eriogonum fasciculatum* | 50 | 0.4 | 0.4 | 1.0 | | | | X |
| | *Yucca schidigera* | 50 | 0.3 | 0.2 | 1.0 | | | | X |
| | *Gutierrezia microcephala* | 50 | 0.2 | 0.2 | 0.4 | | | | X |
| | *Phoradendron californicum* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| **Herb** | | | | | | | | | |
| | *Bromus rubens* | 100 | 9.5 | 2.0 | 15.0 | X | X | X | X |
| | *Achnatherum speciosum* | 100 | 2.4 | 0.2 | 6.0 | | X | | X |
| | Unknown Graminoid | 50 | 0.2 | 0.4 | 0.4 | | | | X |
| | *Achnatherum hymenoides* | 50 | 0.1 | 0.2 | 0.2 | | | | X |

## *Yucca schidigera* Shrubland Alliance

### Mojave Yucca Shrubland Alliance (Mapping code 29030)

The *Yucca schidigera* Shrubland Alliance occurs in the Mojave Desert, Southern California mountains and valleys, Colorado Desert, and Sonoran Desert regions of California and in Nevada, Utah, Arizona, and Baja California, Mexico (NatureServe 2011). Conservation rank: GT4, S4.

This alliance is often considered part of the Creosote bush scrub, which is better thought of as a collection of alliances. *Yucca schidigera* is one of the most characteristic shrubs of the mid-elevation eastern and central Mojave Desert and desert slopes of the transverse and Peninsular Ranges. *Yucca schidigera* rarely is a dominant. However, it is a good indicator species even at relatively low cover values. Ordination and classification of plots in the central Mojave Desert (Keeler-Wolf, personal communication) suggest that *Yucca schidigera* alliance is ecologically similar to the *Yucca brevifolia* and *Viguiera parishii* alliances. It grades into *Larrea tridentata* – *Ambrosia dumosa* alliance at lower elevations and is similar to several other mid-elevation alliances including *Ephedra nevadensis* (rockier slopes), *Coleogyne ramosissima* (often caliche layer), *Grayia spinosa* (deeper alluvial soils), and *Eriogonum fasciculatum* and *Salazaria mexicana* (higher disturbance).

*Yucca schidigera* is a long-lived species indicative of long, persisting stands of vegetation that have not recently been brought back to primary succession. Evidence suggests that slow - growing species, such as *Yucca schidigera,* are particularly susceptible to deep soil disturbances and recover very slowly (Tratz 1978). Although *Y. schidigera* may persist for long periods, other components of the stand may be less persistent. Unlike a number of associated desert species, *Y. schidigera* is generally not killed by fire even when above ground vegetation is totally consumed. In chaparral-desert ecotones of southern California, less than 10 percent of all Mojave yuccas were actually killed by fire (Tratz 1978). In desert grassland, only a few plants were killed by a summer fire, which removed old shoots to or near the ground level (Vasek et al. 1975). Mechanical injury other than fire can also result in resprouting, although the more severe the injury, the less vigorous the sprouting (Vasek et al. 1995). It can sprout from roots protected by overlying soil, or from surviving active tissues at the stem base. Certain dry, rocky sites occupied by *Y. schidigera* may lack sufficient fuels to carry a fire under ordinary circumstances. It is likely that stands with a high understory cover of *Pleuraphis* or disturbance-related shrubs may have had higher fire frequencies than those with long-lived, non-sprouting desert shrubs.

Very few seedlings have been observed in many of the *Yucca schidigera* stands. Reproduction by seed may have been much more important during more favorable climatic regimes. Most regeneration today probably occurs through root sprouting, after fire or mechanical disturbance.

This is a naturally diverse upland scrub, and much of its biodiversity can be accounted for by the nonfire-adapted, slow growing, non-sprouting shrubs. Continued high-fire frequencies in stands of *Yucca schidigera* should reduce the diversity of nonfire resistant species and increase the cover of fire-adapted grasses and short-lived, colonizing perennials. Other disturbance-adapted alliances, such as *Acacia greggii, Ericameria teretifolius, Eriogonum fasciculatum,* and *Salazaria mexicana,* may increase relative to *Yucca schidigera* stands if fire and the fire carrying annual grasses continue to increase in the desert. Response of *Yucca schidigera* to fire may vary according to fire severity and intensity, season of burn, and specific site characteristics. These should be investigated.

This alliance is represented in Joshua Tree National Park by three associations. These include the *Yucca schidigera – Coleogyne ramosissima, Yucca schidigera – Larrea tridentata – Ambrosia dumosa*, and *Yucca schidigera / Pleuraphis rigida* associations.

In addition to the associations described below, a few unclassified, alliance-level samples were taken that suggest further variation:

*Yucca schidigera* (Watts: n=3)

### *Yucca schidigera – Coleogyne ramosissima* Association
**Mojave Yucca – Blackbush Association (Mapping code 29032)**

**Range**

Globally: This association is known from California in Joshua Tree National Park and the central Mojave Desert (Keeler-Wolf and Thomas 2000).

JOTR: Stands of the *Yucca schidigera – Coleogyne ramosissima* Shrubland Association occur in the south and west-central and northwest central portions of the park and were sampled within the Cottonwood Springs, Indian Cove, Queen Mountain and Rockhouse Canyon 7.5-minute topographic quadrangles.

**Environmental Description**

Globally: This association is known from Joshua Tree National Park at mid to high elevations on rocky slopes. Information about its global characteristics from other areas has not been described.

JOTR: Stands of *Yucca schidigera – Coleogyne ramosissima* Shrubland Association are found at mid to high elevations (3,200–4,400 ft.; 1,000–1,300 m) on gentle to moderate (1–6 degrees) convex and concave slopes of rocky highlands. Soil textures range from sand to loam formed on metamorphic parent material. Rock content in this association consists of 0–2 percent bedrock, 0–1 percent boulder, 0–5 percent stone, 2–19 percent cobble, 3–33 percent gravel, and 29–69 percent fines cover. Litter consists of 0–8 percent cover. This association often experiences low to high levels of disturbance from competition from exotics.

**Vegetation Description**

Globally: Stands of this association are typically co-dominated by *Coleogyne ramosissima* and *Yucca schidigera* in the shrub layer, though a variety of other shrubs are characteristically present at varying cover including *Ambrosia dumosa, Ephedra nevadensis, Eriogonum fasciculatum,* and *Viguiera parishii*. Characteristic herbs include *Bromus rubens* and *Pleuraphis rigida.*

JOTR: Stands of the *Yucca schidigera – Coleogyne ramosissima* Shrubland Association form an open shrubland with 0–<1 percent cover for the tree/tall stratum, 4–26 percent cover for the shrub/medium stratum, and <1–10 percent cover for the herb/low stratum. Total vegetative cover ranges from 9–29 percent.

This association contains a variety of characteristic shrub species including *Acacia greggii, Ambrosia dumosa, Coleogyne ramosissima, Cylindropuntia echinocarpa, Echinocereus engelmannii, Ephedra nevadensis, Eriogonum fasciculatum, Salazaria mexicana, Sphaeralcea ambigua, Yucca schidigera* and *Viguiera parishii.* However, *C. ramosissima* and *Y. schidigera* have the highest average cover values of these

shrubs. The ground and herbaceous layers are dominated by rock lichen and the exotic species *Bromus rubens*. Herbaceous species characteristic of this association are *Adenophyllum porophylloides*, *Pleuraphis rigida* and *Xylorhiza tortifolia*. Shrubs often present are *Ambrosia salsola*, *Encelia actonii*, *Escobaria vivipara*, *Krameria grayi*, *Larrea tridentata*, *Lycium andersonii, Galium stellatum* and *Opuntia basilaris*. Herbaceous species often present in this association are *Achnatherum speciosum*, *Erodium cicutarium*, *Stephanomeria pauciflora* and species of *Chamaesyce*.

**Other Noteworthy Species**
*Tetracoccus hallii* was found in one of the plots. *Tetracoccus hallii* is a CRPR 4 plant in the Inventory of Rare and Endangered Plants of California (CNPS 2011). It is found in Imperial, Riverside, and San Bernardino Counties and in Arizona and Baja California at low to high elevations (100–4,000 ft.; 30–1,200 m).

**Conservation Rank**: N/A

**Rank Justification**
This association is fairly common in upper elevations of the Mojave Desert and is likely to occur in Nevada and Arizona as well as California.

**Comments**
Globally: N/A

JOTR: N/A

Plots used for this description: N=4; JOTRA: 11B-06-1, 19-27-1, 23-20-1, 31-07-3; Watts n=2.

Map Accuracy Assessment plots: N=18; 50-0343, 50-0344, 50-0346, 50-0348, 50-0349, 50-0351, 50-0352, 50-0353, 50-0354, 50-0357, 50-0361, 50-0364, 50-0365, 50-0369, 50-1899, 50-1900, 50-1903, 50-1904.

## Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Shrub** | | | | | | | | | |
| | ***Coleogyne ramosissima*** | **100** | **6.4** | **0.4** | **13.0** | | **X** | | **X** |
| | ***Yucca schidigera*** | **100** | **6.2** | **2.2** | **15.4** | | **X** | | **X** |
| | *Eriogonum fasciculatum* | 100 | 1.0 | 0.2 | 3.2 | | X | | X |
| | *Viguiera parishii* | 100 | 0.6 | 0.2 | 1.2 | | X | | X |
| | *Ephedra nevadensis* | 100 | 0.5 | 0.2 | 1.0 | | X | | X |
| | *Echinocereus engelmannii* | 100 | 0.3 | 0.2 | 0.4 | | X | | X |
| | *Ambrosia dumosa* | 75 | 2.3 | 0.2 | 6.0 | | X | | X |
| | *Salazaria mexicana* | 75 | 1.0 | 0.4 | 2.2 | | X | | X |
| | *Sphaeralcea ambigua* | 75 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Acacia greggii* | 75 | 0.2 | 0.2 | 0.4 | | X | | X |
| | *Cylindropuntia echinocarpa* | 75 | 0.2 | 0.2 | 0.4 | | X | | X |
| | *Lycium andersonii* | 50 | 0.4 | 0.2 | 1.2 | | | | X |
| | *Larrea tridentata* | 50 | 0.2 | 0.2 | 0.4 | | | | X |
| | *Galium stellatum* | 50 | 0.2 | 0.2 | 0.4 | | | | X |
| | *Encelia actonii* | 50 | 0.2 | 0.2 | 0.4 | | | | X |
| | *Ambrosia salsola* | 50 | 0.2 | 0.2 | 0.4 | | | | X |
| | *Krameria grayi* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Escobaria vivipara* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Opuntia basilaris* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| **Herb** | | | | | | | | | |
| | *Pleuraphis rigida* | 100 | 0.5 | 0.2 | 1.2 | | X | | X |
| | *Adenophyllum porophylloides* | 75 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Bromus rubens* | 75 | 2.3 | 0.2 | 7.0 | X | X | X | X |
| | *Xylorhiza tortifolia* | 75 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Stephanomeria pauciflora* | 50 | 0.2 | 0.2 | 0.4 | | | | X |
| | *Eriogonum inflatum* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Achnatherum speciosum* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Erodium cicutarium* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Chamaesyce* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| **Nonvascular** | | | | | | | | | |
| | Unknown Lichen | 100 | 0.2 | 0.2 | 0.2 | X | X | X | X |

### *Yucca schidigera – Larrea tridentata – Ambrosia dumosa* Association
**Mojave Yucca – Creosote Bush – White Bursage Association (Mapping code 29033)**

#### Range

Globally: This association is known from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona (NatureServe 2011), and various portions of the hot deserts of California (Sawyer et al. 2009) including Joshua Tree National Park.

JOTR: Stands of the *Yucca schidigera – Larrea tridentata – Ambrosia dumosa* Association occur mostly near the Hexie Mountains and north of the Little San Bernardino Mountains and were sampled within the Conejo Well, Cottonwood Springs, Fried Liver Wash, Joshua Tree South, Malapai Hill, Porcupine Wash, Queen Mountains, Rockhouse Canyon and Washington Wash 7.5-minute topographic quadrangles.

#### Environmental Description

Globally: This association is found at low to mid elevations (550–1,300 m) on usually gentle to moderate slopes, and occasionally steep slopes. Stands occur on bajadas, as well as erosional sideslopes, ridges, plateaus, and in drainage channels (NatureServe 2011).

JOTR: Stands of *Yucca schidigera – Larrea tridentata – Ambrosia dumosa* Association are found at mid elevations (2,700–4,300 ft.; 800–1,300 m) on gentle to moderate (2–10 degrees) slopes. The slopes are linear and undulating on bajadas and erosional highlands. Aspects are variable yet mostly facing northeast, and northwest. Soil textures range from medium sand to loam, formed on plutonic, metamorphic, and granitic parent material. Ground cover consists of 0–20 percent bedrock, 0–10 percent boulder, 0–3 percent stone, 1–78 percent cobble, 0–88 percent gravel, and 2–80 percent fines cover. Litter consists of <1–7 percent cover. This association experiences high levels of disturbance from competition from exotics.

#### Vegetation Description

Globally: Stands contain a co-dominance of Stands contain dominance of *Yucca schidigera* and *Larrea tridentata* in the mid to tall shrub stratum and *Ambrosia dumosa* in the short shrub stratum. Other shrubs may include *Cylindropuntia echinocarpa*, *C. ramosissima, Krameria grayi* and various others.

JOTR: Stands of the *Yucca schidigera – Larrea tridentata – Ambrosia dumosa* Shrubland Association form an open shrubland with 0–4 percent cover for the tree/tall stratum, 4–24 percent cover for the shrub/medium stratum, and <1–12 percent cover for the herb/low stratum. Total vegetative cover ranges from 8–27 percent.

Charactaristic shrub species include *Ambrosia dumosa, Cylindropuntia echinocarpa*, *Larrea tridentata, Simmondsia chinensis* and *Yucca schidigera*. Species that often occur in the shrub layer are *Ambrosia salsola, Cylindropuntia ramosissima, Ephedra nevadensis, Eriogonum fasciculatum*, *Krameria grayi, Senna armata, Simmondsia chinensis,* and *Viguiera parishii*. The exotic *Erodium cicutarium* often occurs in this association.

**Other Noteworthy Species**

*Tetracoccus hallii* was found in one of four plots. *Tetracoccus hallii* is a CRPR 4 plant in the CNPS Inventory of Rare and Endangered Plants of California (CNPS 2011). It is found in Imperial, Riverside, and San Bernardino Counties and in Arizona and Baja California at low to high elevations (98–4,000 ft.; 30–1,200 m).

**Conservation Rank**: N/A

**Rank Justification**

N/A

**Comments**

Globally: More survey and classification work are needed to fully characterize and rank this type (NatureServe 2011).

JOTR: N/A

Plots used for this description: N=18; JOTRA: 20-13-4, 20B-04-1, 21-34-2, 32-18-1, 32-18-2, 33-07-2, 33-11-1, 33-11-3, 33-16-2, 34-06-4, 34B-07-2; JOTR: JOTR32, JOTR34, JOTR35; MDEI: 128-1-8, 128-6-6, 154-1-6, 155-1-8.

Map Accuracy Assessment plots: N=36; 50-0251, 50-0253, 50-0254, 50-0255, 50-0256, 50-0257, 50-0261, 50-0262, 50-0265, 50-0267, 50-0269, 50-0270, 50-0274, 50-0277, 50-0279, 50-0313, 50-0315, 50-0317, 50-0318, 50-0323, 50-0326, 50-0328, 50-0332, 50-0334, 50-0337, 50-0523, 50-1880, 50-1906, 50-1907, 50-1908, 50-1910, 50-1911, 50-1913, 50-1926, 50-1927, 50-1928.

## Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Shrub** | | | | | | | | | |
| | ***Yucca schidigera*** | **100** | **2.8** | **1.0** | **5.2** | | **X** | | **X** |
| | ***Larrea tridentata*** | **89** | **5.8** | **0.2** | **14.0** | | **X** | | **X** |
| | ***Ambrosia dumosa*** | **83** | **2.2** | **0.2** | **10.0** | | **X** | | **X** |
| | *Cylindropuntia echinocarpa* | 83 | 0.4 | 0.2 | 1.2 | | X | | X |
| | *Simmondsia chinensis* | 78 | 0.9 | 0.2 | 3.5 | | X | | X |
| | *Cylindropuntia ramosissima* | 72 | 0.5 | 0.2 | 2.2 | | | | X |
| | *Krameria grayi* | 72 | 0.4 | 0.2 | 2.0 | | | | X |
| | *Eriogonum fasciculatum* | 61 | 0.7 | 0.2 | 4.0 | | | | X |
| | *Viguiera parishii* | 56 | 0.4 | 0.2 | 2.0 | | | | X |
| | *Ephedra nevadensis* | 50 | 0.6 | 0.2 | 4.0 | | | | X |
| | *Senna armata* | 50 | 0.6 | 0.2 | 3.0 | | | | X |
| | *Ambrosia salsola* | 50 | 0.5 | 0.2 | 5.2 | | | | X |
| | *Salazaria mexicana* | 44 | 0.1 | 0.2 | 0.5 | | | | |
| | *Acacia greggii* | 39 | 0.4 | 0.2 | 3.2 | | | | |
| | *Lycium andersonii* | 39 | 0.2 | 0.2 | 1.0 | | | | |
| **Herb** | | | | | | | | | |
| | *Erodium cicutarium* | 56 | 1.3 | 0.2 | 18.0 | | | | X |
| | *Mirabilis laevis* var. *villosa* | 44 | 0.2 | 0.2 | 1.0 | | | | |
| | *Eriogonum inflatum* | 39 | 0.1 | 0.2 | 0.5 | | | | |
| | *Pectis papposa* | 33 | 0.1 | 0.2 | 1.0 | | | | |
| **Nonvascular** | | | | | | | | | |
| | Cryptogammic crust | 39 | 0.2 | 0.2 | 1.4 | | | | |

### *Yucca schidigera / Pleuraphis rigida* Association
**Mojave Yucca / Big Galleta Association (Mapping code 29034)**

#### Range
Globally: This association is known from hot deserts of California, including in Anza-Borrego State Park, Joshua Tree National Park, and generally in the central Mojave Desert (Sawyer et al. 2009).

JOTR: Stands of the *Yucca schidigera / Pleuraphis rigida* Association occur in the Little San Bernardino Mountains, often in postburn areas, and were sampled within the Indian Cove, Malapai Hill, Rockhouse Canyon, and Washington Wash 7.5-minute topographic quadrangles.

#### Environmental Description
Globally: Stands of this association are found at mid to high elevations on alluvial fans and rocky lower slopes.

JOTR: Stands of *Yucca schidigera / Pleuraphis rigida* Association are found at mid to high elevations (3,500–4,100 ft.; 1,000–1,200 m) on flat to moderate (0–6 degrees) slopes. These sites are found on bajadas and rocky hillslopes facing southwest, northeast and northwest. Soils range from medium sand to moderately fine silty clay loams derived from granitic parent material. Ground cover in this association consists of 0–3 percent bedrock, 0–5 percent boulder, 0–10 percent stone, 10–38 percent cobble, 10–67 percent gravel, and <1–64 percent fines cover. Litter consists of <1–64 percent cover. This association experiences low to high levels of disturbance from competition from exotics.

#### Vegetation Description
Globally: This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of the *Yucca schidigera / Pleuraphis rigida* Association form a sparse shrubland with 0–2 percent cover for the tree/tall stratum, 7–37 percent cover for the shrub/medium stratum, and <1–15 percent cover for the herb/low stratum. Total vegetative cover ranges from 10–38 percent.

This association is dominated by *Pleuraphis rigida* in the understory herb layer. Characteristically present in the shrub layer is *Ambrosia dumosa, Cylindropuntia echinocarpa, Larrea tridentata, Simmondsia chinensis,* and *Yucca schidigera*, though *Y. schidigera* exhibits highest average cover, and *A. dumosa* and *L. tridentata* have variable though next highest average cover values. *Y. brevifolia* is abundant in the shrub layer. Species that are often present in the shrub layer are *Cylindropuntia ramosissima, Echinocereus engelmannii, Ephedra nevadensis, Eriogonum*

*fasciculatum*, *Salazaria mexicana,* and *Senna armata. Xylorhiza tortifolia* often occurs in the herb layer.

**Other Noteworthy Species**
*Coryphantha alversonii* was found in one of the plots. *Coryphantha alversonii* is a CRPR 4 plant (CNPS 2011). It is found in Imperial, Riverside, and San Bernardino Counties at low to high elevations (240–5,000 ft.; 73–1,500 m). (Syn: *Escobaria vivipara* var. *alversonii* in the Jepson Manual.)

Evidence of tortoises was noted in one of the plots.

**Conservation Rank**: N/A

**Rank Justification**
N/A

**Comments**
Globally: N/A

JOTR: Stands of this association are related to and intergrade with *Larrea tridentata / Pleuraphis rigida* Association and with *Yucca brevifolia / Pleuraphis rigida* and *Yucca brevifolia / Larrea tridentata – Yucca schidigera / Pleuraphis rigida* associations.

Plots used for this description: N=10; JOTRA: 14-27-2, 21-14-3, 21-27-1, 29B-02-1 ; JOTRA: JOTR46, JOTR47, JOTR48; MDEI: 157-2-8.

Map Accuracy Assessment Plots: N=26; 50-0283, 50-0285, 50-0286, 50-0287, 50-0292, 50-0294, 50-0295, 50-0298, 50-0299, 50-0300, 50-0303, 50-0307, 50-0309, 50-0310, 50-1914, 50-1915, 50-1916, 50-1917, 50-1918, 50-1919, 50-1920, 50-1921, 50-1922, 50-1923, 50-1924, 50-1925.

## Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Tree** | | | | | | | | | |
| | *Yucca brevifolia* | 60 | 0.6 | 0.4 | 2.0 | | | X | X |
| **Shrub** | | | | | | | | | |
| | ***Yucca schidigera*** | **100** | **5.0** | **2.0** | **15.0** | | **X** | | **X** |
| | *Ambrosia dumosa* | 90 | 6.6 | 0.2 | 30.0 | | X | | X |
| | *Cylindropuntia echinocarpa* | 90 | 0.5 | 0.2 | 2.7 | | X | | X |
| | *Larrea tridentata* | 80 | 3.3 | 0.2 | 15.2 | | X | | X |
| | *Simmondsia chinensis* | 80 | 0.3 | 0.2 | 1.0 | | X | | X |
| | *Krameria grayi* | 70 | 2.4 | 0.2 | 17.5 | | | | X |
| | *Cylindropuntia ramosissima* | 70 | 0.2 | 0.2 | 0.5 | | | | X |
| | *Ephedra nevadensis* | 60 | 1.0 | 0.2 | 5.0 | | | | X |
| | *Salazaria mexicana* | 60 | 0.6 | 0.2 | 2.5 | | | | X |
| | *Senna armata* | 60 | 0.3 | 0.2 | 1.0 | | | | X |
| | *Echinocereus engelmannii* | 60 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Eriogonum fasciculatum* | 50 | 0.1 | 0.2 | 0.4 | | | | X |
| | *Lycium andersonii* | 30 | 1.8 | 0.2 | 15.2 | | | | |
| | *Viguiera parishii* | 30 | 0.3 | 1.0 | 1.2 | | | | |
| | *Acacia greggii* | 30 | 0.1 | 0.2 | 1.0 | | | | |
| | *Thamnosma montana* | 30 | 0.1 | 0.2 | 0.2 | | | | |
| | *Tetradymia stenolepis* | 30 | 0.1 | 0.2 | 1.0 | | | | |
| **Herb** | | | | | | | | | |
| | ***Pleuraphis rigida*** | **100** | **4.9** | **0.2** | **17.5** | **X** | **X** | **X** | **X** |
| | *Xylorhiza tortifolia* | 60 | 0.2 | 0.2 | 0.4 | | | | X |
| | *Bromus rubens* | 40 | 0.3 | 0.2 | 2.0 | | | | |
| | *Achnatherum speciosum* | 40 | 0.1 | 0.2 | 0.2 | | | | |
| | *Erodium cicutarium* | 30 | 0.3 | 0.2 | 3.0 | | | | |
| | *Schismus* | 30 | 0.2 | 0.2 | 2.0 | | | | |
| | *Amaranthus* | 30 | 0.1 | 0.2 | 0.2 | | | | |
| | *Eriogonum inflatum* | 30 | 0.1 | 0.2 | 0.5 | | | | |
| **Nonvascular** | | | | | | | | | |
| | Cryptogammic crust | 30 | 0.2 | 0.2 | 1.2 | | | | |

## Sonoran – Mojave Creosotebush – White Bursage Desert Scrub Group

### *Ambrosia dumosa* Shrubland Alliance

**White Bursage Shrubland Alliance (Mapping code 28300, not mapped)**

The *Ambrosia dumosa* Shrubland Alliance occurs in California, Nevada, Arizona, New Mexico, and in northwestern Sonora, Mexico (NatureServe 2011). In California, this alliance occurs in the Mojave Desert, Sonoran Desert, Colorado Desert, and southeastern Great Basin regions (Sawyer et al. 2009). Conservation rank: G5, S4.

The *Ambrosia dumosa* Shrubland Alliance is considered as part of creosote bush scrub zone. In this alliance, *Ambrosia dumosa* dominates or shares dominance with other low shrubs. Increased sampling throughout much of the California desert over the past several years has refined the description of this alliance. It is now considered partly disturbance related and ecologically similar to *Larrea tridentata – Ambrosia dumosa, Larrea tridentata – Encelia farinosa, Encelia farinosa,* and *Atriplex hymenelytra* Shrubland Alliances at elevations to 5,400 feet (1,600 meters). At elevations greater than this, it related closely with *Atriplex confertifolia* Shrubland and *Juniperus osteosperma* Woodland Alliances. Species diversity is highly variable ranging from three to 20 perennial species.

*Ambrosia dumosa* is a short-lived shrub, living generally <50 years, although it does have limited cloning abilities (Wright and Howe 1989). It has relatively shallow and restricted roots and is able to colonize sites that have had vegetation removed mechanically more quickly than does *Larrea tridentata* (Vasek 1980). Due to its high recruitment and mortality rates, *Ambrosia dumosa* dominates early seral stages of many locally disturbed *Larrea tridentata – Ambrosia* stands in the Mojave and Sonoran Desert. *Ambrosia dumosa* is poorly adapted to fire because of its limited sprouting ability (Marshall 1994).

Despite its adaptation to early seral transition states, *Ambrosia dumosa* stands often seem to be defined more by substrate than by disturbance frequency relative to the modal *Larrea tridentata – Ambrosia dumosa* Shrubland Alliance. As a dominant indicator, *Ambrosia dumosa* occurs on sandy substrates (dune aprons, shallow blowsand, wash terraces), rocky hills (of calcareous, igneous, or sedimentary rock), or alluvial fans, particularly older ones with a developed caliche or clay layer and tends to replace *Larrea tridentata* on soils with high clay content (McAuliffe 1988). *Ambrosia dumosa* is a species tolerant of harsh substrates (limestone); and also recovers well from local site disturbance due to high seedling recruitment and retention. However, *Ambrosia dumosa* is absent from areas subjected to long-term, moderate-to-intense grazing, where the palatable foliage is selected over less palatable and more browse resistant *Larrea tridentata* and other large species.

Sensitivity to fire carried by non-native, annual grasses and to overgrazing makes the absence of *Ambrosia dumosa* a good indicator of these types of unnatural disturbances. Fire and long-term, intensive grazing should be excluded from *Ambrosia dumosa* stands. Typical small-scale disturbance patterns that initiate small stands of *Ambrosia dumosa* (blading, excavation, spot

fires) are not a normal part of the processes in the hot deserts of California. Natural stands of *Ambrosia dumosa* Shrubland Alliance are more related to particular substrate preferences.

This alliance is well represented in Joshua Tree National Park by the *Ambrosia dumosa* Shrubland Association. In addition to this association, another type was sampled and classified to the following association, suggesting further variation for Joshua Tree National Park:

*Ambrosia dumosa – Ephedra californica* (No-Ea-ColoradoDesert: NECO780)

### *Ambrosia dumosa Shrubland* Association

**White Bursage Shrubland Association (Mapping code 28301, not mapped)**

#### Range

Globally: This association is known from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona (NatureServe 2011), and it was described from the Bullion Mountains - Bristol Lake, Piute Valley - Sacramento Mountains, and Providence Mountains - Lanfair Valley subsections in California (Evens and Hartman 2007) as well as Joshua Tree National Park.

JOTR: Stands of the *Ambrosia dumosa* Shrubland Association have been sampled in the East Deception Canyon and Porcupine Wash 7.5-minute topographic quadrangles.

#### Environmental Description

Globally: In Arizona, this association occurs on sideslopes and plateaus at 475 to 575 m (1600 to 1875 feet) elevation on flat to moderately sloping sites that are rapidly-drained sands or sandy loams that lie on top of limestone or sandstone (NatureServe 2011). In California, it occurs on gravelly alluvium to more rocky granitic and volcanic substrates with similar substrate cover ranges as Joshua Tree NP (Evens and Hartman 2007).

JOTR: Stands of the *Ambrosia dumosa* Shrubland Association are found at mid elevations (2,400–3,100 ft.; 700–900 m) on northerly slope exposures. This association is found on gentle to somewhat steep (4–22 degrees) undulating slopes. Soils range from loam to moderately fine silty clay loams formed from granitic parent material. Ground cover consists of <1–20 percent bedrock, 10–20 percent boulder, 10–20 percent stone, 10–37 percent cobble, <1–37 percent gravel, and 10–20 percent fines. Litter ranges from <1–3 percent cover. These sites generally experience low to moderate disturbance levels from exotics species.

#### Vegetation Description

Globally: *Ambrosia dumosa* dominates this association and *Larrea tridentata* occasionally occurs at low cover. *Cylindropuntia acanthocarpa, Echinocereus engelmannii, Ephedra* spp., *Encelia farinosa*, *Opuntia basilaris* and other cacti are also commonly found at low cover, and various herbs are present as well including *Pleuraphis rigida, Eriogonum inflatum, Erioneuron pulchellum,* and *Sphaeralcea ambigua* (NatureServe 2011, Evens and Hartman 2007).

JOTR: Stands of the *Ambrosia dumosa* Shrubland Association form open shrublands with 0 percent cover for the tree/tall stratum, 3–13 percent cover for the shrub/medium stratum, and <8–14 percent cover for the herb/low stratum. Total vegetative cover is 11–15 percent.

*Ambrosia dumosa* is the dominant species in this association. Species characteristic in this association include *Eriogonum fasciculatum, Erodium cicutarium, Mirabilis laevis* var. *villosa, Pleuraphis rigida,* and *Schismus barbatus.* Other species that are often present are *Encelia farinosa, Galium stellatum, Krameria grayi, Opuntia basilaris, Salvia* spp.*, Viguiera parishii, Achnatherum speciosum, Bromus rubens, Eriogonum* spp., *Stephanomeria pauciflora,* and *Xylorhiza tortifolia.*

**Other Noteworthy Species**
N/A

**Conservation Rank:** Rare

**Rank Justification**
This association has been identified from only two restricted regions in Arizona, and in California occurs only in the Mojave Desert.

**Comments**
Globally:

JOTR: N/A

Plots used for this description: N=3, MDEI: 162-1-6, 162-1-8, 57-15-4.

Map Accuracy Assessment plots: N=0.

## Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Shrub** | | | | | | | | | |
| | ***Ambrosia dumosa*** | **100** | **8.0** | **4.0** | **10.0** | **X** | **X** | **X** | **X** |
| | *Eriogonum fasciculatum* | 100 | 0.7 | 0.5 | 1.0 | | X | | X |
| | *Salvia* | 67 | 0.3 | 0.5 | 0.5 | | | | X |
| | *Galium stellatum* | 67 | 0.5 | 0.5 | 1.0 | | | | X |
| | *Viguiera parishii* | 67 | 0.5 | 0.5 | 1.0 | | | | X |
| | *Encelia farinosa* | 67 | 0.3 | 0.5 | 0.5 | | | | X |
| | *Opuntia basilaris* | 67 | 0.3 | 0.5 | 0.5 | | | | X |
| | *Krameria grayi* | 67 | 0.3 | 0.5 | 0.5 | | | | X |
| | *Bebbia juncea* | 33 | 0.8 | 2.5 | 2.5 | | | | |
| | *Ephedra nevadensis* | 33 | 0.8 | 2.5 | 2.5 | | | | |
| | *Larrea tridentata* | 33 | 0.2 | 0.5 | 0.5 | | | | |
| | *Pleurocoronis pluriseta* | 33 | 0.2 | 0.5 | 0.5 | | | | |
| | *Hyptis emoryi* | 33 | 0.2 | 0.5 | 0.5 | | | | |
| | *Trixis californica* | 33 | 0.2 | 0.5 | 0.5 | | | | |
| | *Krameria* | 33 | 0.2 | 0.5 | 0.5 | | | | |
| | *Simmondsia chinensis* | 33 | 0.2 | 0.5 | 0.5 | | | | |
| **Herb** | | | | | | | | | |
| | *Mirabilis laevis* var. *villosa* | 100 | 1.2 | 0.5 | 2.0 | | X | | X |
| | *Schismus barbatus* | 100 | 1.0 | 0.5 | 2.0 | | X | | X |
| | *Pleuraphis rigida* | 100 | 0.5 | 0.5 | 0.5 | | X | | X |
| | *Erodium cicutarium* | 100 | 0.5 | 0.5 | 0.5 | | X | | X |
| | *Bromus rubens* | 67 | 1.3 | 1.0 | 3.0 | | | | X |
| | *Xylorhiza tortifolia* | 67 | 0.3 | 0.5 | 0.5 | | | | X |
| | *Stephanomeria pauciflora* | 67 | 0.5 | 0.5 | 1.0 | | | | X |
| | *Eriogonum* | 67 | 0.3 | 0.5 | 0.5 | | | | X |
| | *Achnatherum speciosum* | 67 | 0.3 | 0.5 | 0.5 | | | | X |
| | *Amsonia tomentosa* | 33 | 0.2 | 0.5 | 0.5 | | | | |
| | *Physalis crassifolia* | 33 | 0.2 | 0.5 | 0.5 | | | | |
| | *Adenophyllum porophylloides* | 33 | 0.2 | 0.5 | 0.5 | | | | |
| | *Rafinesquia neomexicana* | 33 | 0.2 | 0.5 | 0.5 | | | | |
| | *Perityle emoryi* | 33 | 0.2 | 0.5 | 0.5 | | | | |
| | *Cheilanthes parryi* | 33 | 0.2 | 0.5 | 0.5 | | | | |
| | *Eriogonum inflatum* | 33 | 0.2 | 0.5 | 0.5 | | | | |
| | *Neogaerrhinum filipes* | 33 | 0.2 | 0.5 | 0.5 | | | | |
| **Nonvascular** | | | | | | | | | |
| | Cryptogammic crust | 33 | 0.2 | 0.5 | 0.5 | | | | |

## *Ambrosia salsola (= Hymenoclea salsola)* Shrubland Alliance
### Cheesebush Alliance (Mapping code 28110)

The *Ambrosia salsola* Shrubland Alliance occurs in Arizona and California. Within California, this alliance occurs in the Central Coast Ranges; the Colorado, Mojave, and Sonoran deserts; the southeastern Great Basin, and throughout mountains and valley of southern California including the Anza-Borrego Desert State Park. A few stands are also present in the Central Valley and the Sierra Nevada Foothills (Sawyer et al. 2009). Conservation rank: G5, S4.

*Ambrosia salsola* is a short-lived shrub with shallow roots. Germination rates are high, and not only does it seed in from adjacent sites and colonize bare mineral soil, but it also sprouts following damage from flood or fire. Seedlings are prolific and opportunistic whenever water is available. It occupies upland sites as well as bottomland sites (Tesky 1993a). Characteristic habitats for this alliance are valleys, flats, rarely-flooded low-gradient deposits, arroyos, and intermittent channels and washes. Soils are typically alluvial, sandy and gravelly, and disturbed desert pavement (Sawyer et al. 2009).

*Ambrosia salsola* is a classic disturbance species in the desert; it is associated commonly with washes, but also with burned and heavily grazed areas, military camps, OHV areas, abandoned town and old farming sites, and roadsides. In arroyo and wash settings, flooding regimes are generally high in frequency and variable in intensity. Relationships to other vegetation types vary given the alliance's wide geographic range. However, its current distribution may differ with its historic one. The coincidence of non-native, annual grass invasions and human-related fires has changed the vegetation's species composition and structure in many cases. Frequency and cover of *A. salsola* were greater on burned sites than on nearby unburned sites in the western Colorado Desert (O'Leary and Minnich 1981). Similarly, more than 90% of *A. salsola* survived and sprouted after fire in the San Ysidro Mountains (Tram 1978). This species is co-dominant or dominant in Lanfair Valley of the Mojave Desert nearly 70 years following other disturbance by plowing and dry-farming. Longer-lived perennials, such as *Larrea tridentata* and *Yucca brevifolia*, require a long time to establish in this region (Carpenter et al. 1986).

Within Joshua Tree National Park, this alliance is represented by the *Ambrosia salsola* and *Ambrosia salsola – Senna armata* associations. In addition to these associations, four other samples during the classification phase and one during the map accuracy assessment phase were classified to the alliance level, suggesting further variation:

*Ambrosia salsola* (Watts: n=3)
*Ambrosia salsola – Psorothamnus schottii* (MDEI: 153-1-1)

## *Ambrosia salsola (= Hymenoclea salsola)* Shrubland Association

**Cheesebush Shrubland Association (Mapping code 28111)**

### Range

Globally: This association commonly occurs in the Colorado and Mojave deserts of California (Sawyer et al. 2009).

JOTR: Stands of the *Ambrosia salsola* Shrubland Association have been sampled in the Clarks Pass, East Deception Canyon, Indian Cove, Keys View, Malapai Hill, and Seven Palms Valley 7.5-minute topographic quadrangles.

### Environmental Description

Globally: In the Anza-Borrego Desert National Park, this association is associated with washes and disturbed areas on bajadas below approximately 2,000 ft. (Keeler-Wolf et al. 1998), and in the Mojave Desert it is associated with large and small washes with sandy soils (Evens 2000).

JOTR: Stands of the *Ambrosia salsola* Shrubland Association are found at mid elevations (2,400–3,100 ft.; 700–900 m) on northerly slope exposures. This association is found in washes with gentle to somewhat steep (4–22 degrees) undulating slopes. Soils range from loam to moderately fine silty clay loams formed from granitic parent material. Ground cover consists of <1–20 percent bedrock, 10–20 percent boulder, 10–20 percent stone, 10–37 percent cobble, <1–37 percent gravel, and 10–20 percent fines. Litter ranges from <1–3 percent cover. These sites generally experience low to moderate disturbance levels from exotics species.

### Vegetation Description

Globally: *Ambrosia salsola* is the dominant shrub species ranging from 2-10%. Other characteristic species include *Psorothamnus arborescens, Mirabilis laevis* var. *villosa, Krameria grayi, Eriogonum fasciculatum,* and *Senna armata.* Other common associates are *Ambrosia dumosa, Erodium cicutarium, Larrea tridentata, Schismus barbatus,* and *Stephanomeria pauciflora* at low cover (Evens 2000).

JOTR: Stands of the *Ambrosia salsola* Shrubland Association form open shrublands with 0 percent cover for the tree/tall stratum, 3–13 percent cover for the shrub/medium stratum, and <8–14 percent cover for the herb/low stratum. Total vegetative cover is 11–15 percent.

*Ambrosia salsola* is the dominant species in this association. Species characteristic of this association include *Eriogonum fasciculatum, Erodium cicutarium, Mirabilis laevis* var. *villosa, Pleuraphis rigida,* and *Schismus barbatus.* Other species that are often present are *Encelia farinosa, Galium stellatum, Krameria grayi, Opuntia*

*basilaris, Salvia* spp.*, Viguiera parishii, Achnatherum speciosum, Bromus rubens, Eriogonum* spp., *Stephanomeria pauciflora,* and *Xylorhiza tortifolia.*

**Other Noteworthy Species**
N/A

**Conservation Rank:** N/A

**Rank Justification**
N/A

**Comments**
Globally: N/A

JOTR: N/A
Plots used for this description: N=8: JOTRA: 01-02-2, 08-03-1, 43-20-1; Long: VKEY97-1, VMAL97-35, VMAL97-41; MDEI: 57-1-1, 157-2-1

Map Accuracy Assessment plots: N=0.

**Stand Table**

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Tree** | | | | | | | | | |
| | *Yucca brevifolia* | 38 | 0.6 | 0.6 | 3.0 | | | | |
| **Shrub** | | | | | | | | | |
| | ***Ambrosia salsola*** | **100** | **6.6** | **3.5** | **9.2** | **X** | **X** | **X** | **X** |
| | *Larrea tridentata* | 75 | 0.4 | 0.2 | 1.0 | | X | | X |
| | *Salazaria mexicana* | 63 | 0.6 | 0.2 | 3.0 | | | | X |
| | *Cylindropuntia echinocarpa* | 63 | 0.5 | 0.4 | 2.0 | | | | X |
| | *Acacia greggii* | 63 | 0.2 | 0.2 | 0.5 | | | | X |
| | *Petalonyx thurberi* | 50 | 1.0 | 0.5 | 5.0 | | | | X |
| | *Ephedra californica* | 50 | 0.4 | 0.2 | 1.2 | | | | X |
| | *Eriogonum fasciculatum* | 50 | 0.3 | 0.2 | 1.0 | | | | X |
| | *Cylindropuntia ramosissima* | 38 | 0.3 | 0.5 | 1.2 | | | | |
| | *Ephedra nevadensis* | 38 | 0.4 | 0.2 | 2.2 | | | | |
| | *Yucca schidigera* | 38 | 0.3 | 0.2 | 1.0 | | | | |
| | *Krameria grayi* | 38 | 0.2 | 0.2 | 1.0 | | | | |
| | *Ambrosia dumosa* | 38 | 0.1 | 0.2 | 0.5 | | | | |
| | *Encelia farinosa* | 38 | 0.1 | 0.2 | 0.4 | | | | |
| | *Eriogonum plumatella* | 38 | 0.9 | 0.4 | 4.0 | | | | |
| **Herb** | | | | | | | | | |
| | *Bromus rubens* | 63 | 5.9 | 1.0 | 37.0 | | | X | X |
| | *Pleuraphis rigida* | 50 | 0.4 | 0.2 | 2.2 | | | | X |
| | *Eriogonum inflatum* | 38 | 0.1 | 0.2 | 0.5 | | | | |
| | *Erodium cicutarium* | 38 | 0.2 | 0.2 | 1.0 | | | | |
| **Nonvascular** | | | | | | | | | |
| | Cryptogammic crust | 38 | 0.2 | 0.2 | 0.6 | | | | |

### *Ambrosia salsola – Senna armata* Shrubland Association

**Cheesebush – Desert Senna Shrubland Association (Mapping code 28112, not mapped)**

#### Range

Globally: This association is occurs in the central Mojave Desert (Keeler-Wolf and Thomas 2000) and in Joshua Tree National Park.

JOTR: Stands of the *Ambrosia salsola – Senna armata* Shrubland Association have been sampled in the East Deception Canyon and Porcupine Wash 7.5-minute topographic quadrangles.

#### Environmental Description

Globally: This association is known only from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of the *Ambrosia salsola – Senna armata* Shrubland Association are found at mid elevations (3,000–3,800 ft.; 900–1,200 m) on variable slope aspects. This association is found on gentle to somewhat steep (5–25 degrees) flat or undulating slopes. Soils range from coarse sands to medium to very fine sandy loams formed from granitic parent material. Ground cover consists of 0 percent bedrock, 0 percent boulder, 0–3 percent stone, 0–10 percent cobble, 30–71 percent gravel, and 47 percent fines. Litter ranges from 5–37 percent cover. These sites generally experience low to moderate disturbance levels from exotics species.

#### Vegetation Description

Globally: In the Mojave Desert, stands include *Ambrosia salsola* and *Senna armata* as well as *Psorothamnus fremontii* and *Lycium andersonii* (Keeler-Wolf and Thomas 2000).

JOTR: Stands of the *Ambrosia salsola – Senna armata* Shrubland Association form sparse to open shrublands with 0–6 percent cover for the tree/tall stratum, 4–29 percent cover for the shrub/medium stratum, and 0–40 percent cover for the herb/low stratum. Total vegetative cover is 4–27 percent.

Shrub species characteristic of this association include *Ambrosia salsola, Cylindropuntia echinocarpa, Cylindropuntia ramosissima, Larrea tridentata, Senna armata,* and *Salazaria mexicana. Yucca brevifolia* and *Bromus rubens* occur as dominants at low cover in the tree and herbs layers. Other species that are often present are *Ephedra californica, Eriogonum plumatella, Krameria grayi, Acamptopappus sphaerocephalus, Yucca schidigera, Erodium cicutarium,* and *Pleuraphis rigida.*

**Other Noteworthy Species**
N/A

**Conservation Rank:** N/A

**Rank Justification**
N/A

**Comments**
Globally: N/A

JOTR: N/A

Plots used for this description: N=7: JOTRA: 31-07-4; Long: LIZ-1, LIZ-1, VMAL97-10, VMAL97-18, VMAL97-24, VMAL97-5; Watts: n=2.

Map Accuracy Assessment plots: N=0.

**Stand Table**

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Tree** | | | | | | | | | |
| | *Yucca brevifolia* | 86 | 0.9 | 0.2 | 1.4 | X | X | X | X |
| **Shrub** | | | | | | | | | |
| | ***Ambrosia salsola*** | **100** | **7.5** | **4.0** | **10.0** | | **X** | | **X** |
| | ***Senna armata*** | **100** | **4.9** | **0.2** | **10.0** | | **X** | | **X** |
| | *Cylindropuntia echinocarpa* | 100 | 1.1 | 0.4 | 2.2 | | X | | X |
| | *Larrea tridentata* | 100 | 3.3 | 0.2 | 12.0 | | X | | X |
| | *Salazaria mexicana* | 86 | 2.4 | 0.2 | 6.0 | | X | | X |
| | *Cylindropuntia ramosissima* | 86 | 0.9 | 0.4 | 2.2 | | X | | X |
| | *Ephedra californica* | 71 | 1.1 | 0.4 | 2.2 | | | | X |
| | *Krameria grayi* | 71 | 0.5 | 0.2 | 2.0 | | | | X |
| | *Eriogonum plumatella* | 71 | 0.2 | 0.2 | 0.4 | | | | X |
| | *Acamptopappus sphaerocephalus* | 57 | 0.7 | 0.2 | 3.2 | | | | X |
| | *Yucca schidigera* | 57 | 0.4 | 0.2 | 2.0 | | | | X |
| | *Lycium andersonii* | 43 | 0.2 | 0.2 | 1.0 | | | | |
| | *Acacia greggii* | 43 | 0.2 | 0.2 | 1.0 | | | | |
| | *Eriogonum fasciculatum* | 43 | 0.4 | 1.0 | 1.0 | | | | |
| | *Ambrosia dumosa* | 43 | 0.1 | 0.2 | 0.4 | | | | |
| **Herb** | | | | | | | | | |
| | *Bromus rubens* | 100 | 19.5 | 0.2 | 30.0 | X | X | X | X |
| | *Erodium cicutarium* | 71 | 3.5 | 0.2 | 8.0 | | | | X |
| | *Pleuraphis rigida* | 71 | 2.7 | 0.2 | 9.0 | | | | X |
| | *Eriogonum inflatum* | 43 | 0.1 | 0.2 | 0.4 | | | | |

## *Cylindropuntia bigelovii* Shrubland Alliance

### Teddy-Bear Cholla Shrubland Alliance (Mapping code 29050)

This alliance occurs in California and Arizona in the Colorado, Mojave, and Sonoran deserts (NatureServe 2011). Within California, typical habitats include alluvial fan deposits and gentle to moderate slopes of rocky highlands from 75–1500 m in elevation (Sawyer et al. 2009). Conservation rank: G4, S3.

*Cylindropuntia bigelovii* is a distinctive, jointed cholla with a vertical trunk; the plant grows to 1.5 m in height. Side branches are dense, and older, lower side branches die and fall off. The yellow green flowers ripen into spineless fruits that usually contain no fertile seeds. The joints have dense spines, which are especially sharp and strongly barbed. Young spines are yellow and become black with age. During the cooler months, the terminal joints detach with the slight touch of a passing animal or even strong winds. The joints that attach to animals may be transported considerable distances. Detached joints readily grow into new plants.

Typically, stands develop from clones of one or a few individuals (Turner et al. 1995). They occur in the southern Mojave Desert and in the Colorado Desert in a mosaic with other desert alliances, such as the *Larrea tridentata* and *Encelia farinosa* scrubs. Stands are often dense and species rich, with many succulents. Most plants are on well-drained, upper bajadas or rocky slopes with south- or southwest-facing aspects, representing a long-lived, successional species in large, almost pure stands (Vasek 1983). Information regarding the fire regime of this alliance is not available.

This alliance is represented in Joshua Tree National Park by one association defined first in this project and also defined for the southern Mojave Desert from the Sacramento Mountains (Evens and Hartman 2007), by the *Cylindropuntia bigelovii* Shrubland Association.

## *Cylindropuntia bigelovii* Shrubland Association

**Teddy-Bear Cholla Shrubland Association (Mapping code 29050)**

### Range

Globally: This association is known from Mexico, Grand Canyon National Park in Arizona, and California (NatureServe 2011), and it also occurs in Lake Mead National Recreation Area (J. Evens, personal observation 2010). In California, it has been sampled in the Piute Valley - Sacramento Mountains subsection of the southern Mojave (Evens and Hartman 2007) and in Joshua Tree National Park.

JOTR: Stands of the *Cylindropuntia bigelovii* Shrubland Association were sampled within the Fried Liver Wash, Hayfield, and Victory Pass 7.5-minute topographic quadrangles.

### Environmental Description

Globally: This association occurs at lower elevation (461-670 m) on flats to gentle slopes of bajadas and low hills with gravelly and cobbly surface cover. Soils are alluvium, granite and mixed igneous and metamorphic rock (Evens and Hartman 2007).

JOTR: Stands of the *Cylindropuntia bigelovii* Shrubland Association are found at low elevations (1,500–2,100 ft.; 500–600 m) on gentle to moderate (3 degrees), undulating and concave slopes of rocky highlands and upland, alluvial deposits. Soil textures range from coarse sand to loam derived from granitic parent material. Surface cover in this association consists of 0–1 percent bedrock, 0–4 percent boulder, 0–6 percent stone, 5–20 percent cobble, 25–80 percent gravel, and 5–42 percent fines cover. Litter cover is 1–5 percent. These sites generally experience low levels of disturbance from competition from exotic species.

### Vegetation Description

Globally: This association is dominated or co-dominated by *Cylindropuntia bigelovii* with *Larrea tridentata*, *Cylindropuntia acanthocarpa,* and *Ambrosia dumosa.* Other shrubs often or characteristically present are *Acacia greggii, Bebbia juncea, Encelia farinosa, Ferocactus cylindraceus, Hyptis emoryi,* and *Krameria erecta* (Evens and Hartman 2007).

JOTR: Stands of the *Cylindropuntia bigelovii* Shrubland Association form a sparse to open shrubland with 0 percent cover for the tree/tall stratum, 3–23 percent cover for the shrub/medium stratum, and <1–2 percent cover for the herb/low stratum. Total vegetative cover is 4–23 percent.

This association is dominated by *Cylindropuntia bigelovii*. Characteristic shrub species include *Encelia farinosa and Larrea tridentata*. Often present are

*Cylindropuntia echinocarpa, Cylindropuntia ramosissima, Echinocereus engelmannii, Hyptis emoryi, Psorothamnus schottii, Chamaesyce* spp. *and Pectis papposa.*

**Other Noteworthy Species**
*Coryphantha alversonii* was found in one of the plots. *Coryphantha alversonii* is a CRPR 4 plant (CNPS 2011). It is found in Imperial, Riverside, and San Bernardino Counties at low to high elevations (240–5,000 ft.; 73–1,500 m). (Syn: *Escobaria vivipara* var. *alversonii* in the Jepson Manual.)

**Conservation Rank:** Rare

**Rank Justification**
This association is local in the Sonoran Desert of Mexico, Arizona, and the Mojave Desert of Southern California.

**Comments**
Globally: N/A

JOTR: N/A
Plots used for this description: N=5; JOTRA: 39-02-2, 53-08-6, 53-08-9; JOTR: JOTR42, JOTR44.

Map Accuracy Assessment plots: N=25; 50-0232, 50-0233, 50-0234, 50-0235a, 50-0235b, 50-0236, 50-0237, 50-0238, 50-0239, 50-0240, 50-0241, 50-0242, 50-0243, 50-0244, 50-0245, 50-0246, 50-0247, 50-0248, 50-0249, 50-0250, 50-1931, 50-1932, 50-1933, 50-1934, 50-1935.

## Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Shrub** | | | | | | | | | |
| | ***Cylindropuntia bigelovii*** | **100** | **6.5** | **2.2** | **18.2** | **X** | **X** | **X** | **X** |
| | *Larrea tridentata* | 100 | 2.3 | 0.2 | 4.0 | | X | | X |
| | *Encelia farinosa* | 80 | 0.6 | 0.2 | 2.2 | | X | | X |
| | *Cylindropuntia ramosissima* | 60 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Psorothamnus schottii* | 60 | 0.4 | 0.2 | 1.0 | | | | X |
| | *Hyptis emoryi* | 60 | 0.3 | 0.2 | 1.0 | | | | X |
| | *Echinocereus engelmannii* | 60 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Cylindropuntia echinocarpa* | 60 | 0.2 | 0.2 | 0.4 | | | | X |
| | *Ambrosia dumosa* | 40 | 0.2 | 0.2 | 1.0 | | | | |
| | *Krameria grayi* | 40 | 0.2 | 0.2 | 1.0 | | | | |
| | *Bebbia juncea* | 40 | 0.1 | 0.2 | 0.4 | | | | |
| | *Trixis californica* | 40 | 0.1 | 0.2 | 0.2 | | | | |
| | *Asclepias albicans* | 40 | 0.1 | 0.2 | 0.2 | | | | |
| | *Senna armata* | 40 | 0.1 | 0.2 | 0.2 | | | | |
| **Herb** | | | | | | | | | |
| | *Chamaesyce* | 60 | 0.3 | 0.2 | 1.0 | | | | X |
| | *Pectis papposa* | 60 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Allionia incarnata* | 40 | 0.2 | 0.2 | 1.0 | | | | |
| | *Marina parryi* | 40 | 0.1 | 0.2 | 0.2 | | | | |
| **Nonvascular** | | | | | | | | | |
| | Cryptogammic crust | 40 | 0.4 | 0.4 | 1.4 | | | | |

## *Encelia farinosa* Shrubland Alliance

**Brittlebush Shrubland Alliance (Mapping code 28030)**

The *Encelia farinosa* Shrubland Alliance occurs in the southern mountains and valleys, Mojave Desert, Sonoran Desert, Colorado Desert, Mono Section (Sawyer et al. 2009), and southeast Great Basin regions of California and in Nevada, Arizona, and Utah (NatureServe 2011). It is found scattered throughout Joshua Tree National Park with the exception of the northern areas. Conservation rank: G5, S4.

The *Encelia farinosa* alliance represents a drought tolerant extension of the *Larrea tridentata*-dominated American desert scrub, which is less cold hardy and more heat tolerant than the *Larrea tridentata-Ambrosia dumosa* alliance. It also does not tolerate clay-rich soils as well as *Larrea tridentata-Ambrosia dumosa.* The virtual absence of *Larrea* in the overstory is due in part to disturbance history of the stand, or may also be due to the steep, rocky slopes where *Encelia farinosa* tends to occur. With many steep rocky stands, cover is variable and averaging less than 10 percent vegetation cover and 22 percent maximum cover, while the disturbance-related stands may approach upwards of 50 percent maximum cover.

*Encelia farinosa*, like *Ambrosia dumosa*, is a short-lived subshrub that forms an open to intermittent subshrub canopy. However, it is even more tolerant of hot, dry conditions and is a more aggressive colonizer than *Ambrosia dumosa.* Leafing and flowering is opportunistic and occurs whenever moisture is available. *Encelia farinosa* rapidly colonizes burns and other disturbance, both in the south coastal scrub and desert vegetation (Tesky 1993). It reproduces entirely by seed and resprouts weakly from damaged stems. It is frost sensitive, which limits the elevational and geographic range in which it is found. *E. farinosa* grows poorly on clay soils but survives on coarse, steep, and very rocky soils better than *Ambrosia dumosa*. It may replace longer-lived perennials after fire and, once established, may persist for decades (Tesky 1993).

It is intolerant of heat from fire, making resprouting weak or nonexistent; however, it does recruit successfully from off-site seed. For this reason, recurrent desert fire would select *Encelia farinosa* over longer-lived shrubs. Despite the colonizing properties of *Encelia farinosa*, some stands of the *Encelia farinosa* alliance are generally stable, occupying rocky sites too harsh for the *Larrea tridentata – Encelia farinosa* alliance. Seral stages following fire or other unnatural disturbance are likely to involve a state dominated by *Encelia farinosa* for several years before *Larrea tridentata* and other long-lived shrubs reestablish. Once *Larrea tridentata* does reestablish, the stand generally transitions to *Larrea tridentata – Encelia farinosa* alliance.

The combination of non-native, annual grass invasions and human-related fires threatens the structure and diversity of the *Encelia farinosa* alliance and related alliances. In the deserts, fires should be excluded at all times of the year, and core areas should be identified where grass cover is low and stands therefore defensible. Unlike the *Larrea tridentata – Ambrosia dumosa* alliance, the rocky and extremely xeric nature of many of the stands precludes the establishment of dense cover of *Bromus rubens* and thus, the resistance of this alliance to non-

natural fire and weed invasion is relatively high. It is likely that this alliance is increasing relative to *Larrea tridentata-Encelia farinosa* or *Larrea tridentata-Ambrosia dumosa* in less rocky/steep parts of the desert where fires are relatively frequent.

This alliance is represented in Joshua Tree National Park by two associations: *Encelia farinosa* Association (unmapped) and *Encelia farinosa – Ambrosia dumosa* Association. Since the three samples classified to the *Encelia farinosa* Association are from a dataset with little information, it is listed here without a description written:

*Encelia farinosa* Association (Watts: n=3)

### *Encelia farinosa – Ambrosia dumosa* Association
**Brittlebush – White Bursage Association (Mapping code 28033)**

**Range**

Globally: This association is known only from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: This alliance occurs scattered over much except the northwest portion of the park and was sampled within the, Cadiz Valley Southwest, Cottonwood Basin, Coxcomb Mountains, and East of Victory Pass, Malapai Hill, Queen Mountain, Rockhouse Canyon and Seven Palms Valley 7.5-minute quadrangles.

**Environmental Description**

Globally: This association is known only from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of the *Encelia farinosa – Ambrosia dumosa* Association are found at low to mid elevations (1,800–3,700 ft.; 600–1,100 m) on variable slope aspects. This association occurs on gentle to steep (4–30 degrees) concave or undulating slopes. Soil textures range from coarse sand to loam derived from granitic parent material. Surface cover in this association consists of 0–70 percent bedrock, 0–27 percent boulder, 1–22 percent stone, 2–45 percent cobble, 5–35 percent gravel, and <1–40 percent fines cover. Litter cover is <1–3 percent. These sites generally experience low levels of disturbance from competition from exotic species.

**Vegetation Description**

Globally*:* This association is known only from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of the *Encelia farinosa – Ambrosia dumosa* Association form a sparse to open shrubland with 0 percent cover for the tree/tall stratum, <1–19 percent cover for the shrub/medium stratum, and <1–15 percent cover for the herb/low stratum. Total vegetative cover is 6–22 percent.

This association is usually dominated by *Encelia farinosa*; *Ambrosia dumosa* is considered characteristic though sometimes may be codominant with *E. farinosa*. Often present are *Bebbia juncea, Ephedra nevadensis, Krameria grayi, Larrea tridentata, Eriogonum inflatum,* and *Pleuraphis rigida.*

**Other Noteworthy Species** N/A

**Conservation Rank:** N/A

**Rank Justification** N/A

**Comments**

Globally: This association is similar to the *Encelia farinosa – Ambrosia dumosa – Senna armata* Association, which was defined by Evens and Hartman (2007) as occurring in the Colorado Desert within the Chocolate Mountains and Valleys subsection, where *E. farinosa* co-dominates with *A. dumosa,* and a variety of other shrubs characteristically occur at low cover including *S. armata, L. tridentata, Krameria grayi, Ziziphus obtusifolia,* and *Lycium andersonii*.

JOTR: N/A

Plots used for this description: N=9; JOTRA: 01-02-4, 22-26-3, 25-04-5, 57-18-2, 57-18-5; JOTR: JOTR72, JOTR74, JOTR80; No-Ea-ColoradoDesert: NECO0776.

Map Accuracy Assessment plots: N=10; 50-0403, 50-0406, 50-0410, 50-0413, 50-0418, 50-0421, 50-0431, 50-1870, 50-1872, 50-1873.

## Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Shrub** | | | | | | | | | |
| | ***Encelia farinosa*** | **100** | **7.6** | **2.0** | **30.0** | **X** | **X** | **X** | **X** |
| | ***Ambrosia dumosa*** | **100** | **2.2** | **1.0** | **5.0** | | **X** | | **X** |
| | *Larrea tridentata* | 67 | 0.4 | 0.2 | 2.7 | | | | X |
| | *Krameria grayi* | 56 | 1.8 | 0.2 | 15.2 | | | | X |
| | *Ephedra nevadensis* | 56 | 0.2 | 0.2 | 0.4 | | | | X |
| | *Bebbia juncea* | 56 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Viguiera parishii* | 44 | 0.3 | 0.2 | 1.0 | | | | |
| | *Opuntia basilaris* | 44 | 0.1 | 0.2 | 0.2 | | | | |
| | *Sphaeralcea ambigua* | 44 | 0.1 | 0.2 | 0.4 | | | | |
| | *Trixis californica* | 44 | 0.1 | 0.2 | 0.4 | | | | |
| | *Echinocactus polycephalus* | 44 | 0.1 | 0.2 | 0.2 | | | | |
| | *Lycium andersonii* | 33 | 1.0 | 0.2 | 5.2 | | | | |
| | *Krameria erecta* | 33 | 0.4 | 0.2 | 2.2 | | | | |
| | *Simmondsia chinensis* | 33 | 0.4 | 0.4 | 2.0 | | | | |
| | *Acacia greggii* | 33 | 0.3 | 0.2 | 2.0 | | | | |
| | *Psorothamnus schottii* | 33 | 0.3 | 0.2 | 2.0 | | | | |
| | *Peucephyllum schottii* | 33 | 0.2 | 0.2 | 1.0 | | | | |
| | *Echinocereus engelmannii* | 33 | 0.1 | 0.2 | 0.2 | | | | |
| | *Fagonia laevis* | 33 | 0.1 | 0.2 | 0.2 | | | | |
| | *Galium stellatum* | 33 | 0.1 | 0.2 | 0.2 | | | | |
| | *Pleurocoronis pluriseta* | 33 | 0.1 | 0.2 | 0.4 | | | | |
| **Herb** | | | | | | | | | |
| | *Eriogonum inflatum* | 67 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Pleuraphis rigida* | 56 | 0.2 | 0.2 | 0.4 | | | | X |
| | *Stephanomeria pauciflora* | 33 | 0.3 | 0.2 | 2.7 | | | | |
| | *Mirabilis laevis* var. *villosa* | 33 | 0.1 | 0.2 | 0.2 | | | | |
| **Nonvascular** | | | | | | | | | |
| | Unknown Moss | 33 | 0.2 | 0.2 | 1.0 | | | | |
| | Unknown Lichen | 33 | 0.1 | 0.2 | 0.2 | | | | |

## *Larrea tridentata* Shrubland Alliance

### Creosote Bush Shrubland Alliance (Mapping code 27010)

The *Larrea tridentata* Shrubland Alliance occurs in the Mojave, Colorado and Sonoran Deserts of California (Sawyer et al. 2009) and in Arizona, Nevada, New Mexico, and Texas, and south into Mexico in the states of Baja California, Chihuahua, Coahuila, Durango, Nuevo León, San Luis Potosi, and Sonora (NatureServe 2011). Conservation rank: G5, S5.

*Larrea tridentata* is a very long-lived clonal shrub (10,000+ years as a clone) with low seedling recruitment. It is an evergreen and extremely resistant to high temperatures. Plants may die during severe droughts, though they typically persist longer than other shrubs, and can sprout from the base when moisture returns. Individuals of *L. tridentata* grow better in deep, sandy soils than other desert shrubs because of their deep, spreading root systems (Marshall 1995b). They also grow on weakly developed soils of alluvial sites that permit water infiltration. In largely unaltered settings, they grow with other shrub species, especially *Ambrosia dumosa*, which may act as a nurse plant for *L. tridentata* (McAuliffe 1988). Mature plants may be allelopathic to their own seedlings, encouraging an open community structure (Vasek and Barbour 1977). In sandy sites, it often co-occurs with perennial grasses, and along certain washes and wash terrace deposits with somewhat alkaline soils, it co-occurs with *Atriplex polycarpa*. Stands also may form along low-gradient sandy or silty washes.

*Larrea tridentata* is poorly adapted to fire because of its limited sprouting ability and resinous foliage, which is highly flammable (Marshall 1995b). Even light intensity fires can cause almost 100 percent mortality (Brown and Minnich 1986). Recent invasions of non-native grasses into California's deserts have increased fire frequencies and have led to the destruction and degradation of large areas of this alliance, particularly in the western Mojave and Colorado deserts. Although thought of as a natural exclusionary process in desert grasslands of the southwest (Marshall 1995b), fire destabilizes stand dynamics in the wetter, cooler range of the species where stands have historically lacked fire.

This alliance is less common and less diverse than other alliances where *L. tridentata* is a co-dominant. The presence of this alliance can indicate a disturbance history that degrades stands of the more modal *Larrea tridentata–Ambrosia dumosa* alliance. In contrast, open stands of large individual shrubs of *L. tridentata* that occupy sandy expanses do not carry fires. Typical habitats for this alliance include alluvial fans, bajadas, upland slopes, and minor intermittent washes at elevations ranging from 75–1,000 m.

This alliance is represented in JOTR by three associations: *Larrea tridentata* (Undifferentiated) Shrubland Association, *Larrea tridentata / Pleuraphis rigida* Shrubland Association, and *Larrea tridentata – Ambrosia salsola* Shrubland Association.

In addition to the associations described below, four unclassified, alliance-level samples were taken that suggest further variation. These include:

*Larrea tridentata* mixed scrub (N=4; JOTRA: JOTRA194, JOTRA222; No-Ea-ColoradoDesert: NECO781; Watts n=1).

## *Larrea tridentata* Association

**Creosote Bush Association (Mapping Code 27019)**

### Range

Globally: This association is known from the northern and eastern Colorado Desert and southern Mojave Desert (Evens and Hartman 2007) and from Joshua Tree National Park.

JOTR: Stands of the *Larrea tridentata* Association occur in the central and eastern portions of the park and were sampled within the Clarks Pass, Conejo Well, Coxcomb Mts., East Deception Canyon, East Of Victory Pass, Pinto Wells and San Bernardino Wash 7.5-minute topographic quadrangles.

### Environmental Description

Globally: Stands are simple and generally found on gravelly, lower bases of fans and bajadas or have had past disturbance. Annual plants may be seasonally present and abundant. Sites are usually flat to gentle, and the ground surface is usually sandy and gravelly with little rock cover (Evens and Hartman 2007).

JOTR: Stands of *Larrea tridentata* Association are found at low to mid elevations (500–3,100 ft.; 200–900 m) on slopes with a primarily easterly aspect. Slopes range from flat to gentle (0–5 degrees) and are concave, convex, undulating, or flat. Soils range from coarse sand to medium to very fine sandy loams derived from basaltic, dioritic, or granitic parent materials. Ground cover consists of 0–<1 percent bedrock, 0–<1 percent boulder,0 –<1 percent stone, 0–<20 percent cobble, <1–72 percent gravel, and <1–99 percent fines. Litter ranges from 0–10 percent cover. These sites experience low to high levels of disturbance from exotic species, low levels of disturbance from foot traffic/trampling, and low levels of disturbance from vandalism/dumping/litter.

### Vegetation Description

Globally: *Larrea tridentata* is the sole dominant shrub, with little else in the shrub or herb layers. The range of the tree cover is from 0-2.5% and shrub cover is from 2.5-68%. *Ambrosia dumosa* is often present at low (<1% average) cover (Evens and Hartman 2007).

JOTR: Stands of the *Larrea tridentata* Association form a sparse to open shrubland with 0 percent cover in the tree/tall stratum, 2–68 percent cover in the shrub/mid stratum, and 0–6 percent cover in the herb/low stratum. Total vegetative cover ranges from 2–16 percent.

This association is dominated by *Larrea tridentata* in the shrub layer, and *Ambrosia dumosa* is often present at low (<1% average) cover.

**Other Noteworthy Species**
N/A

**Conservation Rank:** N/A

**Rank Justification**
N/A

**Comments**
Globally: N/A

JOTR: N/A

Plots used for this description: N=11; JOTRA: 08-03-3, 37B-21-4, 41-40-2, 56-06-4; JOTR: JOTR20, JOTR30, JOTR31, JOTR93; Long: VBAR97-1-1 (2); No-Ea-ColoradoDesert: NECO764.

Map Accuracy Assessment plots: N=7; 50-0112, 50-0116, 50-0118, 50-0122, 50-0736a, 50-1812, 50-1820.

**Stand Table**

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Shrub** | | | | | | | | | |
| | ***Larrea tridentata*** | **100** | **8.9** | **2.0** | **15.0** | **X** | **X** | **X** | **X** |
| | *Ambrosia dumosa* | 73 | 0.3 | 0.2 | 1.2 | | | | X |
| | *Krameria grayi* | 36 | 0.1 | 0.2 | 0.4 | | | | |
| **Herb** | | | | | | | | | |
| | *Schismus* | 36 | 0.6 | 0.2 | 6.0 | | | | |

### *Larrea tridentata – Ambrosia salsola* Shrubland Association

**Creosote Bush – Cheesebush Association (Mapping code 27013, unmapped)**

#### Range

Globally: This association is known from Anza-Borrego Desert State Park (Keeler-Wolf et al.1998) and Joshua Tree National Park.

JOTR: Stands of the *Larrea tridentata – Ambrosia salsola* Shrubland Association were sampled within the Conejo Well, Cottonwood Spring, Malapai Hill, Queen Mountain, San Bernardino Wash and Seven Palms Valley 7.5-minute topographic quadrangles.

#### Environmental Description

Globally: Stands are found on bajadas and intermittently flooded, low gradient washes with variable aspect and flat to gentle slopes. The surface cover is primarily gravelly and fine-textured with low cover of rock.

JOTR: Stands of *Larrea tridentata – Ambrosia salsola* Shrubland Association are found at low to mid elevations (1,500–3,900 ft.; 500–1,200 m) on variable slope aspects. This association is found on gentle (2–5 degrees) slopes including linear bajadas, washes, and midslopes; that may be flat, hummocky or swaley, or undulating. Soils range from coarse sands to medium to very fine sandy loams derived from granitic parent material. Ground cover consists of 0 percent bedrock, 0–<1 percent boulder, 0–1 percent stone, 0–8 percent cobble, 3–88 percent gravel, and 20–88 percent fines cover. Litter cover is 1–20 percent. These sites generally experience low to high levels of disturbance from competition from exotic species and low levels of disturbance from vandalism/dumping/litter.

#### Vegetation Description

Globally: *Larrea tridentata* occurs as a dominant to co-dominant with and *Ambrosia salsola*, and forms a simple association where no other shrubs are common or characteristic. Stands may vary in understory herbs with seasonal rainfall.

JOTR: Stands of the *Larrea tridentata – Ambrosia salsola* Shrubland Association form a sparse to open shrubland with 0–1 percent cover in the tree layer, 6–24 percent cover in the shrub layer, and <1–25 percent cover in the herb layer. Total vegetative cover ranges from 6–26 percent.

This association is dominated by *Larrea tridentata* in the shrub layer; characteristic shrub species include *Ambrosia salsola* and *Cylindropuntia ramosissima.* Other commonly occurring species include *Ambrosia dumosa, Acacia greggii, Cylindropuntia echinocarpa, Simmondsia chinensis, Yucca schidigera,* and the non-native *Erodium cicutarium.*

**Other Noteworthy Species**
N/A

**Conservation Rank:** N/A

**Rank Justification**
N/A

**Comments**
Globally: N/A

JOTR: N/A

Plots used for this description: N=7; JOTRA: 01-02-1, 32-06-2, 37B-17-3; MDEI: 128-6-1, 158-1-1; Long: VMAL97-40, VMAL97-5.

Map Accuracy Assessment plots: N=0.

## Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Shrub** | | | | | | | | | |
| | ***Larrea tridentata*** | **100** | **5.4** | **3.0** | **10.0** | **X** | **X** | **X** | **X** |
| | ***Ambrosia salsola*** | **100** | **3.5** | **1.0** | **9.5** | | **X** | | **X** |
| | *Cylindropuntia ramosissima* | 86 | 0.3 | 0.2 | 0.5 | | X | | X |
| | *Ambrosia dumosa* | 71 | 0.7 | 0.2 | 3.0 | | | | X |
| | *Cylindropuntia echinocarpa* | 71 | 0.4 | 0.2 | 1.0 | | | | X |
| | *Acacia greggii* | 57 | 0.5 | 0.2 | 2.0 | | | | X |
| | *Yucca schidigera* | 57 | 0.4 | 0.4 | 1.2 | | | | X |
| | *Simmondsia chinensis* | 57 | 0.2 | 0.2 | 0.5 | | | | X |
| | *Krameria grayi* | 43 | 0.5 | 0.2 | 2.5 | | | | |
| | *Salazaria mexicana* | 43 | 0.5 | 0.5 | 2.0 | | | | |
| | *Ephedra californica* | 43 | 0.4 | 0.2 | 1.2 | | | | |
| | *Senna armata* | 43 | 0.4 | 0.4 | 2.0 | | | | |
| | *Cleome isomeris* | 43 | 0.2 | 0.2 | 1.0 | | | | |
| | *Eriogonum plumatella* | 43 | 0.2 | 0.2 | 1.0 | | | | |
| | *Phoradendron californicum* | 43 | 0.2 | 0.2 | 1.0 | | | | |
| | *Lycium andersonii* | 43 | 0.1 | 0.2 | 0.5 | | | | |
| **Herb** | | | | | | | | | |
| | *Erodium cicutarium* | 71 | 1.1 | 0.2 | 3.0 | | | | X |
| | *Bromus rubens* | 43 | 3.9 | 4.0 | 15.0 | | | | |
| | *Mirabilis laevis* var. *villosa* | 43 | 0.2 | 0.2 | 0.5 | | | | |
| **Nonvascular** | | | | | | | | | |
| | Cryptogammic crust | 43 | 0.4 | 0.2 | 2.2 | | | | |

### *Larrea tridentata – Atriplex hymenyletra* Shrubland Association
**Creosote Bush – Desert Holly Shrubland Association (Mapping code 27023)**

**Range**

Globally: This association is known from the Mojave Desert of California and Nevada (Sawyer et al. 2009) and Joshua Tree National Park.

JOTR: Stands of the *Larrea tridentata – Atriplex hymenyletra* Shrubland Association were sampled in the park within the East of Victory Pass 7.5-minute topographic quadrangle. It is found in the southeast portion of the park adjacent to Highway 177 (AIS, personal communication). Leary (1977) observed one isolated spot southwest of Pinto Wells on volcanic tuff.

**Environmental Description**

Globally: N/A

JOTR: Stands of the *Larrea tridentata – Atriplex hymenelytra* Shrubland Association are found at low elevations (450–550 ft.; 150 m) on flat to undulating substrates with sandy soils. Ground cover consists of 0 percent bedrock, 0 percent boulder, 0–8 percent stone, 15–50 percent cobble, 30–51 percent gravel, and <1–30 percent fines cover. Litter cover is <1–2 percent. These sites generally exhibit no disturbance from exotic plant species.

**Vegetation Description**

Globally: N/A

JOTR: Stands of the *Larrea tridentata – Atriplex hymenelytra* Shrubland Association form a sparse shrubland with 0 percent cover in the tree/tall stratum, 2–3 percent cover in the shrub/mid stratum, and <1–1 percent cover in the herb/low stratum. Total vegetative cover ranges from 2–3 percent.

This association is dominated by *Atriplex hymenelytra*, *Chamaesyce polycarpa,* and *Oenothera deltoids*; *Larrea tridentata* is characteristic. Often occurring species include *Ambrosia dumosa* and *Encelia farinosa.*

**Other Noteworthy Species**

N/A

**Conservation Rank:** N/A

**Rank Justification**

N/A

**Comments**

Globally: Whether this association should be placed in the *Larrea tridentata* Shrubland Alliance or the *Atriplex hymenelytra* Shrubland Alliance is debatable. Associations with similar characteristics to this association include the *Atriplex hymenelytra–Larrea tridentata–Ambrosia dumosa* Shrubland Association defined for the Central Mojave Desert (Keeler-Wolf and Thomas 2000) and the *Atriplex hymenelytra* Shrubland Association defined for the Colorado Desert (Evens and Hartman 2007) in the *Atriplex hymenelytra* Shrubland Alliance, while other plots such as these from Joshua Tree with *A. hymenelytra* and *L. tridentata* co-occuring have been placed in the *Larrea* alliance.

With low cover of shrubs and *A. hymenelytra* dominant in this association, it may be better placed in the *Atriplex hymenelytra* Shrubland Alliance. With more desert-wide classification analysis, this issue should be resolved.

JOTR: N/A

Plots used for this description: N=3; JOTRA: 66-02-1, 66-02-4, 66-02-7.

Map Accuracy Assessment plots: N=5; 25-1459, 25-1460, 25-1461, 25-1462, 25-1463.

**Stand Table**

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Shrub** | | | | | | | | | |
| | ***Atriplex hymenelytra*** | **100** | **1.5** | **1.2** | **2.0** | **X** | **X** | **X** | **X** |
| | ***Larrea tridentata*** | **100** | **0.8** | **0.2** | **2.0** | | **X** | | **X** |
| | *Ambrosia dumosa* | 67 | 0.3 | 0.4 | 0.4 | | | | X |
| | *Encelia farinosa* | 67 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Suaeda moquinii* | 33 | 0.1 | 0.4 | 0.4 | | | | |
| **Herb** | | | | | | | | | |
| | *Chamaesyce polycarpa* | 100 | 0.2 | 0.2 | 0.2 | X | X | X | X |
| | *Oenothera deltoides* | 100 | 0.2 | 0.2 | 0.2 | X | X | X | X |
| | *Eriogonum inflatum* | 33 | 0.1 | 0.2 | 0.2 | | | | |
| | *Plantago ovata* | 33 | 0.1 | 0.2 | 0.2 | | | | |
| **Nonvascular** | | | | | | | | | |
| | Cryptogammic crust | 33 | 0.1 | 0.4 | 0.4 | | | | |

### *Larrea tridentata / Pleuraphis rigida* Association
**Creosote Bush / Big Galleta Association (Mapping code 27021)**

#### Range

Globally: This association is known from the central Mojave (Keeler-Wolf and Thomas 2000), southern Mojave and northern and eastern Colorado deserts (Evens and Hartman 2007), and Joshua Tree National Park.

JOTR: Stands of the *Larrea tridentata / Pleuraphis rigida* Shrubland Association were sampled in the park within the following 7.5-minute topographic quadrangles: Cadiz Valley Southwest, Clarks Pass, East Deception Canyon, East of Victory Pass, Indian Cove, Malapai Hill, New Dale, Pinto Mountain, Pinto Wells, Porcupine Wash, and San Bernardino Wash.

#### Environmental Description

Globally: This association is usually found on fine-textured soils, with lower cover of gravel and little rock cover. It is found on bajadas and sand dune deposits (Evens and Hartman 2007). Elevations are low to moderate (133–1,200 m), and slopes are usually flat to gentle or hummocky and undulating.

JOTR: Stands of *Larrea tridentata / Pleuraphis rigida* Association are found at low to mid elevations (600–3,900 ft.; 200–1,200 m) on variable slope aspects. Slopes are flat to moderate (0–13 degrees) with level, convex, concave, hummocky or swaley, or undulating topography. Soils range from coarse sands to clays derived from basaltic, sedimentary or granitic parent material. Ground cover in this association consists of 0–2 percent bedrock, 0–<1 percent boulder, 0–20 percent stone, 0–88 percent cobble, 0–81 percent gravel, and 10–90 percent fines cover. Litter cover is <1–25 percent. These sites generally experience low to high levels of disturbance from competition from exotic species and low levels of disturbance from off-road vehicle activity.

#### Vegetation Description

Globally: This association is dominated by *Larrea tridentata* in the shrub layer and *Pleuraphis rigida* in the herb layer. *Ambrosia dumosa* is characteristically present and *Cylindropuntia echinocarpa* and *Krameria grayi* are often present, at lower (<1% average) cover.

JOTR: Stands of the *Larrea tridentata / Pleuraphis rigida* Shrubland Association form a sparse to intermittent shrubland with 0–1 percent cover in the tree layer, <1–25 percent cover in the shrub layer, and <1–70 percent cover in the herb layer. Total vegetative cover ranges from 2–25 percent.

This association is dominated by *Larrea tridentata* and *Pleuraphis rigida*. *Ambrosia dumosa* is a characteristic species at low (<1% average) cover.

**Other Noteworthy Species**
N/A

**Conservation Rank:** Rare

**Rank Justification**
Stands of *Pleuraphis rigida* have become rare in California as a result of large scale land conversion, over grazing, and competition from exotic plant species.

**Comments**
Globally: N/A

JOTR: Some plots containing desert pavement support high cover of cryptobiotic crusts (>50 percent cover).

Plots used for this description: N=29; JOTRA: 08-03-5, 21-27-3, 21-27-4, 31-09-1, 32-26-1, 32-26-2, 32-26-3, 37B-21-3, 38-28-1, 41-40-1, 44-18-3, 46-19-1, 49A-14-1, 49A-14-3, 49A-14-4, 49A-14-5, 56-06-1, 57-18-3; JOTR: JOTR27, JOTR28, JOTR89; Long: VEGE-2, VEGE-3, VMAL97-53, VPAN97-1, VPWELL97-1; MDEI: 61-7-3; No-Ea-ColoradoDesert: NECO159, NECO160; Watts: n=2.

Map Accuracy Assessment plots: N=0.

**Stand Table**

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Shrub** | | | | | | | | | |
| | ***Larrea tridentata*** | **100** | **6.6** | **1.2** | **25.0** | **X** | **X** | **X** | **X** |
| | *Ambrosia dumosa* | 79 | 0.8 | 0.2 | 3.0 | | X | | X |
| | *Krameria grayi* | 48 | 0.4 | 0.2 | 5.0 | | | | |
| | *Cylindropuntia echinocarpa* | 41 | 0.2 | 0.2 | 1.2 | | | | |
| | *Ambrosia salsola* | 31 | 0.1 | 0.2 | 0.4 | | | | |
| **Herb** | | | | | | | | | |
| | ***Pleuraphis rigida*** | **100** | **4.4** | **0.2** | **26.0** | **X** | **X** | **X** | **X** |
| | *Pectis papposa* | 34 | 0.1 | 0.2 | 1.0 | | | | |
| | *Brassica tournefortii* | 31 | 0.1 | 0.2 | 0.4 | | | | |
| **Nonvascular** | | | | | | | | | |
| | Cryptogammic crust | 38 | 0.3 | 0.2 | 4.2 | | | | |

## *Larrea tridentata – Ambrosia dumosa* Shrubland Alliance

**Creosote Bush – White Bursage Shrubland Alliance (Mapping code 27030)**

The *Larrea tridentata – Ambrosia dumosa* Shrubland Alliance is widespread, occuring in the Mojave Desert, Sonoran Desert, Colorado Desert, southeastern Great Basin, Nevada, and Arizona, and Sonora and Baja California, Mexico (NatureServe 2011). Conservation rank: G5, S5.

The co-occurrence of the medium to tall shrub *Larrea tridentata* over the shorter shrub *Ambrosia dumosa* defines the matrix vegetation of the vast majority of California's hot deserts. This is the most widespread and abundant desert alliance in California; it is the modal vegetation of the bajadas, alluvial fans, and lower slopes with a wide range of variability defined within the alliance. Conditions range from extremely hot, dry stands with very low species diversity and located below sea level in the Salton Sink and Death Valley; to relatively diverse, mesic stands at >3,500 feet (1,000 m) in the eastern Mojave.

Much has been written on the ecology of these two species (Vasek and Barbour 1977; Marshall 1994, 1995). *Larrea tridentata* is a very long-lived shrub (up to 10,000+ years in clones) and, under good conditions, develops a deep and widely spreading root system. *Ambrosia dumosa* is a short-lived shrub living generally < 50 (100) years, (although it does have limited cloning abilities, Wright and Howe 1989) with relatively shallow and restricted roots. Both species tap different water resources and employ different strategies for desert survival. *Ambrosia dumosa*, with its high recruitment and mortality rates, dominates in the colonizing stage; *Larrea tridentata*, with low recruitment and mortality, eventually dominates the landscape, although colonizing species usually remain present. In the Sonoran Desert, *Larrea tridentata* uses *Ambrosia dumosa* as a nurse plant (McAuliffe 1988). *Larrea tridentata* exhibits root-mediated allelopathy. In a laboratory study, test roots grew freely through soil occupied by *Ambrosia dumosa* roots, but *Ambrosia dumosa* test roots grew at reduced rates through soil occupied by *Larrea tridentata.* Mature *Larrea tridentata* may be allelopathic to its own seedlings, encouraging an open community structure (Marshall 1995).

Natural disturbance in most *Larrea tridentata – Ambrosia dumosa* stands involves shifting moisture availability related to series of wet and dry years. Both species may die following long periods of severe drought, but *Larrea tridentata* typically will persist longer and can resprout from the base when moisture returns. *Ambrosia dumosa* individuals die more quickly from drought stress but will regenerate from seed banks and off-site dispersal quickly following sufficient precipitation. Wind and substrate deflation also act as disturbance agents in some stands on sandy substrates. Both species will grow in sand; however*, Larrea tridentata* tends to persist and dominate on deeper, mobile sand dunes, while both *Ambrosia dumosa* and *Larrea tridentata* occupy dune aprons, sand sheets, and stabilized dunes. Succession on a cleared and bulldozed site in the eastern Mojave has been studied by Vasek (1980). He found rapid recolonization by *Ambrosia dumosa, Encelia farinosa, Cylindropuntia bigelovii,* and *Stephanomeria pauciflora*, while *Larrea tridentata* colonized more slowly.

In the modal Mojave, Colorado, and Sonoran Desert landscapes, both species tend to co-occur in mixed stands. *Ambrosia dumosa* occurs without *Larrea tridentata* in active wash terraces with a higher salinity or alkalinity than *Larrea tridentata* can tolerate. *Ambrosia dumosa* also occurs in recently disturbed areas where it can more quickly recolonize by seed than *Larrea tridentata*. *Larrea tridentata* occurs without *Ambrosia dumosa* in areas where grazing or drought stress has eliminated *Ambrosia dumosa.* The *Larrea tridentata-Ambrosia dumosa* Shrubland Alliance is replaced by *Atriplex polycarpa, Atriplex canescens,* or *Atriplex spinescens* in alkaline soils and gives way to the *Larrea tridentata – Encelia farinosa or Atriplex hymenelytra* alliances in extremely hot, dry situations.

*Larrea tridentata* and *Ambrosia dumosa* are poorly adapted to fire because of their limited sprouting ability (Marshall 1995). The resinous foliage of *Larrea tridentata* is very flammable, and even light intensity fires can cause close to 100 percent mortality in both shrubs (Brown and Minnich 1986). The recent invasion of non-native grasses in the hot deserts of California has rapidly increased fire frequencies and has led to the destruction and degradation of many acres of *Larrea tridentata – Ambrosia dumosa* Shrubland Alliance, particularly in the western Mojave and Colorado Deserts. Although fire is thought of as a natural exclusionary process for *Larrea tridentata* in Arizona, New Mexico, and Texas desert grasslands (Marshall 1995), it is a de-stabilizing influence in the California deserts where desert grasslands typically occur without fire (*Pleuraphis rigida*) or are in cooler or wetter areas than *Larrea tridentata – Ambrosia dumosa* stands (*Achnatherum speciosum, Pleuraphis jamesii*, *Poa secunda*).

The *Larrea tridentata – Ambrosia dumosa* Shrubland Alliance is represented in Joshua Tree National Park by eight associations. Five are represented by three or more samples for the descriptions. These are the *Larrea tridentata – Ambrosia dumosa* Association, *Larrea tridentata – Ambrosia dumosa – Krameria grayi* Association, *Larrea tridentata – Ambrosia dumosa – Psorothamnus schottii* Association, *Larrea tridentata – Ambrosia dumosa – Senna armata* Association, and *Larrea tridentata – Ambrosia dumosa – Yucca schidigera* Association. Two additional associations are not described here because additional samples are needed to characterize them: *Larrea tridentata – Ambrosia dumosa – Fouquieria splendens* and *Larrea tridentata – Ambrosia dumosa / Pleuraphis rigida.* In addition, samples taken in Joshua Tree National Park suggest further variation in two additional associations than what is defined in the descriptions below:

> *Larrea tridentata – Ambrosia dumosa /* Cryptogamic crust (No-Ea-ColoradoDesert: NECO552, NECO553; see Evens and Hartman 2007, for a brief description)
>
> *Larrea tridentata – Ambrosia dumosa – Simmondsia chinensis* (Long: VMAL97-43)

Map accuracy assessment samples provide some information to define this alliance.

> *Larrea tridentata – Ambrosia dumosa – Simmondsia chinensis* (MapAA: 50-0451, 50-0552, 50-0553, 50-0556, 50-0558, 50-0560, 50-0561, 50-0563, 50-0564, 50-0565, 50-

0566, 50-0569, 50-0570, 50-0573, 50-0574, 50-0575, 50-0578, 50-0581, 50-1848, 50-1850, 50-1851).

### *Larrea tridentata – Ambrosia dumosa* Association

**Creosote Bush – White Bursage Association (Mapping code 27031)**

#### Range

Globally: This association is currently known to occur in the Colorado, Sonoran and Mojave Deserts in California (Evens and Hartman 2007, Sawyer et al. 2009) and in the Mojave Desert of Nevada and in Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona (NatureServe 2011).

JOTR: This association is the most common type in the Park. Stands of *Larrea tridentata – Ambrosia dumosa* Shrubland Association occur throughout the park and are best developed in the Pinto Basin and east of the Coxcomb Mountains. Stands have been sampled within the Clarks Pass, Conejo Well, Desert Center, Fried Liver Wash, Pinto Wells, Porcupine Wash, and San Bernardino Wash 7.5-minute topographic quadrangles.

#### Environmental Description

Globally: The *Larrea tridentata – Ambrosia dumosa* Shrubland Association typically occurs on alluvial fans and sideslopes, but also on mesas and drainage channels, ranging from 72–900 m elevation. It is typically found on low gradients (0–10 degrees), across all aspects, but occasionally occurs on steeper slopes (10–30 degrees). Soils are well- to rapidly-drained silty or sandy clays to sandy loams, and the underlying geology is variable (Evens and Hartman 2007, NatureServe 2011).

JOTR: Stands of *Larrea tridentata – Ambrosia dumosa* Shrubland Association are found at low to mid elevations (1,200–3,100 ft.; 400–900 m) on variable slope aspects. Slopes are flat to steep (0–29 degrees) with convex, concave, flat, undulating, or hummocky or swaley topography. This association usually occurs on upland, alluvial deposits; however, it can sometimes occur on rocky highlands. Soils are usually sandy but range to fine clay derived from igneous, metamorphic, or sedimentary parent materials. Ground cover in this association consists of 0–10 percent bedrock, 0–10 percent boulder, 0–20 percent stone, 0-45 percent cobble, 2–70 percent gravel, and 15–68 percent fines cover. Litter cover is 0-15 percent. These sites generally experience low to moderate levels of disturbance from competition from exotic species.

#### Vegetation Description

Globally: Vegetation is characterized by the codominance of the tall shrub *Larrea tridentata* and the shorter or dwarf-shrub *Ambrosia dumosa*. *Ferocactus cylindraceus*, *Cylindropuntia acanthocarpa,* and *C. echinocarpa* occur most frequently in the sparse mid-shrub layer. The dwarf-shrub layer also occasionally includes the cactus *Opuntia basilaris*. *Dasyochloa pulchella* or *Vulpia octoflora* can be common in a very sparse graminoid layer. *Cryptantha* spp., *Plantago* sp., *Eriogonum inflatum*, and

*Erodium cicutarium* are seasonally present in the forb understory (Evens and Hartman 2007, NatureServe 2011).

JOTR: Stands of the *Larrea tridentata – Ambrosia dumosa* Shrubland Association form a sparse to intermittent shrubland with 0–5 percent cover in the tree/tall stratum, 1–38 percent cover in the shrub/mid stratum, and <1–7 percent cover in the herb/low stratum. Total vegetative cover ranges from 2–38 percent.

This association is dominated by *Larrea tridentata* in the tall shrub layer. *Ambrosia dumosa* may be relatively less abundant, though characteristic in this association. Cryptobiotic crust is often found on the ground at low cover. Occasionally, *Cylindropuntia ramosissima* and *Krameria grayi* are also present.

**Other Noteworthy Species**
N/A

**Conservation Rank:** N/A

**Rank Justification**
This association is likely to be widespread and common throughout the Mojave and northern Sonoran Desert.

**Comments**
Globally : Many samples from the *Larrea tridentata – Ambrosia dumosa* alliance collected in the central Mojave Vegetation database (Thomas et al. 2004) are likely to fall into this association.

JOTR: N/A

Plots used for this description: N=14; JOTRA: 35C-08-2, 37B-21-2, 40A-07-4, 43-20-4, 44-16-2, 44-18-1; MDEI: 156-2-6, 156-2-7, 63-2-6; No-Ea-ColoradoDesert: NECO153, NECO555, NECO560, NECO763, NECO785.

Map Accuracy Assessment plots: N=51; 50-0052, 50-0113, 50-0117, 50-0120, 50-0125, 50-0131, 50-0134, 50-0136, 50-0137, 50-0138, 50-0530, 50-0532, 50-0549, 50-0550, 50-0642, 50-0643, 50-0644, 50-0645, 50-0648, 50-0649, 50-0651, 50-0652, 50-0654, 50-0655, 50-0657, 50-0658, 50-0659, 50-0660, 50-0665, 50-0666, 50-0667, 50-0732, 50-0733, 50-0736b, 50-0740, 50-0744, 50-0755, 50-0757, 50-0792, 50-0794, 50-0795, 50-0796, 50-0798, 50-0799, 50-0800, 50-0801, 50-0802, 50-0803, 50-0804, 50-0805, 50-0808.

## Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Shrub** | | | | | | | | | |
| | ***Larrea tridentata*** | **100** | **6.9** | **1.2** | **37.5** | **X** | **X** | **X** | **X** |
| | ***Ambrosia dumosa*** | **100** | **2.5** | **0.2** | **6.5** | | **X** | | **X** |
| | *Krameria grayi* | 71 | 0.6 | 0.2 | 2.7 | | | | X |
| | *Cylindropuntia ramosissima* | 64 | 0.2 | 0.2 | 0.5 | | | | X |
| | *Encelia farinosa* | 43 | 0.2 | 0.2 | 1.0 | | | | |
| **Nonvascular** | | | | | | | | | |
| | Cryptogammic crust | 64 | 0.4 | 0.2 | 2.5 | | | X | X |

### *Larrea tridentata – Ambrosia dumosa – Krameria grayi* Association
**Creosote Bush – White Bursage – White Rhatany Association (Mapping code 27034)**

**Range**

Globally: This association is currently described from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona, and Joshua Tree National Park in California.

JOTR: Stands of the *Larrea tridentata – Ambrosia dumosa – Krameria grayi* Association were sampled in the park within the Buzzard Spring, Clarks Pass, Conejo Well, and San Bernardino Wash 7.5-minute topographic quadrangles.

**Environmental Description**

Globally: *Larrea tridentata – Ambrosia dumosa – Krameria (erecta, grayi)* Association occurs on a variety of landforms including sideslopes, drainage bottoms, and ridges at 37–1000 m. It is typically found on low gradients (1–5 degrees), but occasionally occurs on steeper slopes (10–30 degrees). The community seems to occur across all aspects besides west-facing, and seems to occur in various soil types (NatureServe 2011).

JOTR: Stands of *Larrea tridentata – Ambrosia dumosa – Krameria grayi* Shrubland Association are found at low to mid elevations (1,400–3,200 ft.; 400–1,000 m) on slope with variable aspects. Slopes are flat to moderate (0–17 degrees) with flat or undulating topography. Soils range from coarse sand to moderately fine clay loams derived from granitic parent materials. Ground cover in this association consists of 0–<1 percent bedrock, 0–3 percent boulder, 0–10 percent stone, 10–67 percent cobble, 20–63 percent gravel and 10–56 percent fines cover. Litter cover is <1–11 percent. These sites generally experience low to moderate levels of disturbance from competition from exotic species.

**Vegetation Description**

Globally: Vegetation is characterized by the codominance of three species: the tall shrub *Larrea tridentata*, the short shrub *Krameria grayi*, and the dwarf-shrub *Ambrosia dumosa*. However, sometimes *K. grayi* may be lower in cover as a characteristic species in the association. The short shrub layer also frequently supports the cactus *Cylindropuntia acanthocarpa* and occasionally *Krameria erecta*. *Opuntia basilaris* is the only other dwarf-shrub that occurs regularly. The non-native *Bromus rubens* and *Vulpia octoflora* are common in the sparse graminoid understory. *Plantago ovata, Antheropeas lanosum*, and the non-native *Erodium cicutarium* are common members of the very sparse forb stratum.

JOTR: Stands of the *Larrea tridentata – Ambrosia dumosa – Krameria grayi* Shrubland Association form a sparse to open shrubland with 0-percent cover in the tree/tall

strata, 4–33 percent cover in the shrub/mid strata, and <1–3 percent cover in the herb/low strata  Total vegetation cover ranges from 7–33 percent.

This association is dominated by *Larrea tridentata* in the shrub layer.  Characteristic species include *Ambrosia dumosa, Cylindropuntia ramosissima,* and *Krameria grayi.* Other species that often occur are *Acacia greggii, Cylindropuntia echinocarpa,* and *Senna armata.*

**Other Noteworthy Species**
N/A

**Conservation Rank:** N/A

**Rank Justification**
N/A

**Comments**
Globally: N/A

JOTR: N/A

Plots used for this description: N=6; Long:  VBE97-1, VBE97-2; JOTR:  JOTR29, JOTR91, JOTR92; MDEI:  156-2-8.

Map Accuracy Assessment plots:  N=12; 25-1723, 25-1724a, 25-1725a, 25-1726, 25-1727, 25-1728, 25-1729, 25-1730, 25-1739a, 25-1748a, 25-1749a, 25-1750a.

**Stand Table**

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Shrub** | | | | | | | | | |
| | ***Larrea tridentata*** | **100** | **6.9** | **3.2** | **20.0** | **X** | **X** | **X** | **X** |
| | ***Krameria grayi*** | **100** | **3.2** | **1.0** | **11.0** | | **X** | | **X** |
| | ***Ambrosia dumosa*** | **100** | **0.9** | **0.2** | **2.2** | | **X** | | **X** |
| | *Cylindropuntia ramosissima* | 83 | 0.3 | 0.2 | 1.0 | | X | | X |
| | *Cylindropuntia echinocarpa* | 50 | 0.3 | 0.2 | 1.0 | | | | X |
| | *Acacia greggii* | 50 | 0.2 | 0.2 | 1.0 | | | | X |
| | *Senna armata* | 50 | 0.2 | 0.2 | 1.0 | | | | X |
| | *Encelia farinosa* | 33 | 0.1 | 0.2 | 0.5 | | | | |
| | *Bebbia juncea* | 33 | 0.1 | 0.2 | 0.2 | | | | |
| **Herb** | | | | | | | | | |
| | *Eriogonum inflatum* | 33 | 0.1 | 0.2 | 0.5 | | | | |
| | *Pleuraphis rigida* | 33 | 0.1 | 0.2 | 0.2 | | | | |

### *Larrea tridentata – Ambrosia dumosa – Psorothamnus arborescens* Association
**Creosote Bush – White Bursage – Indigo Bush Association (Mapping code 27044)**

#### Range

Globally: This association is known from the central Mojave in California (Keeler-Wolf and Thomas 2000) and from Joshua Tree National Park.

JOTR: Stands of the *Larrea tridentata – Ambrosia dumosa – Psorothamnus arborescens* Association were sampled in the Cadiz Valley SW, East Deception Canyon, and Malapai Hill 7.5-minute topographic quadrangles.

#### Environmental Description

Globally: This association is known from the central Mojave (Keeler-Wolf and Thomas 2000) typically on alluvial fans with obvious large or small washes; soils are usually gravelly with smaller amounts of cobbles and fines and few larger rocks. It is on low to mid elevations (500–1,200 m).

JOTR: Stands of the *Larrea tridentata – Ambrosia dumosa – Psorothamnus arborescens* Association are found at low to mid elevations (1,700–4,000 ft.; 500–1,200 m) on primarily westerly slopes. This alliance occurs on gentle to somewhat steep slopes (2–20 degrees) with concave, convex, or undulating topographies. Soils range from coarse sand to loams derived from granitic parent materials. Ground cover in this association consists of 0–80 percent bedrock, 0–2 percent boulder, 0–6 percent stone, 2–10 percent cobble, 4–62 percent gravel, and <1–84 percent fines cover. Litter cover is 0–3 percent. These sites generally experience low to moderate levels of disturbance from competition from exotic species.

#### Vegetation Description

Globally: Stands contain a shifting dominance to co-dominance of *Ambrosia dumosa, Larrea tridentata,* and *Psorothamnus arborescens*. Other shrubs that are often present include *Ambrosia salsola, Bebbia juncea,* and *Opuntia basilaris,* and herbs include *Eriogonum inflatum, Mirabilis laevis* var. *villosa,* and *Stephanomeria pauciflora*.

JOTR: Stands of the *Larrea tridentata – Ambrosia dumosa – Psorothamnus arborescens* Shrubland Association form an open to intermittent shrubland with 0 percent cover in the tree/tall stratum, 5–40 percent cover in the shrub/mid strata, and <1–13 percent cover in the herb/low strata. Total vegetation cover is 11–40 percent.

Characteristic species in this association include *Ambrosia dumosa, Larrea tridentata,* and *Psorothamnus arborescens* at more than 2% average cover each, and *Acacia greggii, Bebbia juncea, Encelia farinosa, Ephedra nevadensis, Senna armata, Eriogonum inflatum, and Xylorhiza tortifolia* at lower cover. Often present

are *Fagonia laevis, Krameria erecta, Krameria grayi, Sphaeralcea ambigua, Viguiera parishii,* and *Stephanomeria pauciflora.*

**Other Noteworthy Species**
Evidence of desert tortoises was noted in one of the plots.

**Conservation Rank:** N/A

**Rank Justification**
N/A

**Comments**
Globally : N/A

JOTR: N/A

Plots used for this description: N=12; JOTRA: 08-03-4, 21-27-2, 56-22-1, 57-18-4; JOTR: JOTR102, JOTR103, JOTR104, JOTR105, JOTR106, JOTR107, JOTR69, JOTR71.

Map Accuracy Assessment plots: N=27; 50-0203, 50-0204, 50-0205, 50-0206, 50-0207, 50-0208, 50-0209, 50-0210, 50-0211, 50-0212, 50-0213, 50-0214, 50-0215, 50-0216, 50-0217, 50-0218, 50-0219, 50-0220, 50-0222, 50-0223, 50-0225, 50-0226, 50-0227, 50-0228, 50-0229, 50-0230, 50-0231.

## Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Shrub** | | | | | | | | | |
| | ***Psorothamnus arborescens*** | **100** | **3.2** | **1.0** | **6.0** | | **X** | | **X** |
| | ***Larrea tridentata*** | **100** | **2.7** | **0.2** | **6.0** | | **X** | | **X** |
| | ***Ambrosia dumosa*** | **92** | **2.9** | **1.0** | **6.0** | | **X** | | **X** |
| | *Senna armata* | 83 | 2.3 | 0.2 | 6.0 | | X | | X |
| | *Encelia farinosa* | 83 | 1.9 | 0.2 | 5.0 | | X | | X |
| | *Bebbia juncea* | 83 | 1.5 | 0.2 | 4.0 | | X | | X |
| | *Acacia greggii* | 75 | 1.3 | 0.2 | 3.0 | | X | | X |
| | *Ephedra nevadensis* | 75 | 0.9 | 0.2 | 2.0 | | X | | X |
| | *Sphaeralcea ambigua* | 67 | 0.2 | 0.2 | 0.4 | | | | X |
| | *Krameria erecta* | 58 | 1.4 | 0.2 | 5.0 | | | | X |
| | *Krameria grayi* | 50 | 0.5 | 0.2 | 2.0 | | | | X |
| | *Viguiera parishii* | 50 | 0.1 | 0.2 | 0.4 | | | | X |
| | *Fagonia laevis* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Lycium andersonii* | 42 | 0.3 | 0.2 | 2.0 | | | | |
| | *Ephedra californica* | 33 | 0.1 | 0.2 | 1.0 | | | | |
| | *Galium stellatum* | 33 | 0.1 | 0.2 | 0.2 | | | | |
| **Herb** | | | | | | | | | |
| | *Xylorhiza tortifolia* | 83 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Eriogonum inflatum* | 75 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Stephanomeria pauciflora* | 67 | 0.2 | 0.2 | 0.4 | | | | X |
| | *Adenophyllum porophylloides* | 33 | 0.1 | 0.2 | 0.2 | | | | |
| | *Porophyllum gracile* | 33 | 0.1 | 0.2 | 0.2 | | | | |

### *Larrea tridentata – Ambrosia dumosa – Senna armata* Association

**Creosote Bush – White Bursage – Desert Senna Association (Mapping code 27047)**

#### Range

Globally: This association is known from the northern and eastern Colorado and southern Mojave deserts (Evens and Hartman 2007) and from Joshua Tree National Park.

JOTR: Stands of the *Larrea tridentata – Ambrosia dumosa – Senna armata* Shrubland Association occur primarily in the central portion of the park and were sampled within the Cadiz Valley Southwest, Fried Liver Wash, Indian Cove, Porcupine Wash, Queen Mountain, San Bernardino Wash, and Washington Wash 7.5-minute topographic quadrangles.

#### Environmental Description

Globally: In the northern and eastern Colorado and southern Mojave deserts, this association is usually associated with small, gravelly washes on mid alluvial fans (Evens and Hartman 2007) at low to mid elevations (400–1,000 m).

JOTR: Stands of the *Larrea tridentata – Ambrosia dumosa – Senna armata* Shrubland Association are found at low to mid elevations (1,300–3,400 ft.; 400–1,000 m) at variable slope aspects. Slopes are gentle (0–6 degrees) with flat, concave, undulating, or hummocky or swaley topography. Soils range from coarse sands to loams formed from granitic parent material. Ground cover in this association consists of 0–60 percent bedrock, 0–15 percent boulder, 0–30 percent stone, 0–20 percent cobble, 3–63 percent gravel, and 2–82 percent fines cover. Litter cover is <1–5 percent. These sites generally experience low to high levels of disturbance from competition from exotic species.

#### Vegetation Description

Globally: Stands are usually co-dominated by *Larrea tridentata* and *Ambrosia dumosa,* and have a characteristic presence of *Senna armata* (with at least 1% absolute cover). Commonly occurring species include *Acacia greggii*, *Ambrosia salsola, Eriogonum fasciculatum,* and cacti (e.g., *Cylindropuntia echinocarpa, Ferocactus cylindraceus,* etc.) (Evens and Hartman 2007).

JOTR: Stands of the *Larrea tridentata – Ambrosia dumosa – Senna armata* Association form an open shrubland with 0–2 percent cover in the tree/tall stratum, <1–17 percent cover in the shrub/mid stratum, and <1–16 percent cover in the herb/low stratum. Total vegetation cover ranges from 7–19 percent.

This association is dominated by the shrub species *Larrea tridentata.* Characteristic species include *Ambrosia dumosa and Senna armata.* Other commonly occurring species are *Ambrosia salsola, Cylindropuntia echinocarpa,* and *C. ramosissima.*

**Other Noteworthy Species**
N/A

**Conservation Rank:** N/A

**Rank Justification**
N/A

**Comments**
Globally: This is another wash margin or bajada/fan association that is typically found in positions slightly higher up the fan and along less frequently flooded washes and channels than the *Larrea tridentata – Ambrosia dumosa – Psorothamnus spinosus* Association (Evens and Hartman 2007).

JOTR: N/A

Plots used for this description: N=16; JOTRA: 26-26-1, 27B-12-3, 27B-12-4, 28-11-1, 28-11-2, 29B-02-3, 31-09-2, 31-09-4, 33-16-1; JOTR: JOTR17, JOTR25, JOTR65; MDEI: 157-1-6, 158-1-8, 160-2-6; No-Ea-ColoradoDesert: NECO707.

Map Accuracy Assessment plots: N=60; 25-1480, 25-1698, 25-1700, 25-1724b, 25-1725b, 25-1731, 25-1732, 25-1733, 25-1734, 25-1739b, 25-1741, 25-1743, 25-1746, 25-1747, 25-1748b, 25-1749b, 25-1750b, 25-1751, 25-1752b, 50-0526, 50-0743, 50-0749, 50-0753, 50-0764, 50-0767, 50-0771, 50-0775, 50-0776a, 50-0776b, 50-0777, 50-0778, 50-0781, 50-0782a, 50-0782b, 50-0784, 50-0789, 50-0790, 50-0791, 50-1752, 50-1755, 50-1756, 50-1757, 50-1759, 50-1760, 50-1761, 50-1762, 50-1766, 50-1767, 50-1768, 50-1770, 50-1771, 50-1772, 50-1773, 50-1778a, 50-1808, 50-1818, 50-1853, 50-1854, 50-1856, 50-1857.

## Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Shrub** | | | | | | | | | |
| | ***Larrea tridentata*** | **100** | **6.5** | **2.5** | **13.2** | **X** | **X** | **X** | **X** |
| | ***Ambrosia dumosa*** | **100** | **2.4** | **0.2** | **6.0** | | **X** | | **X** |
| | ***Senna armata*** | **94** | **1.4** | **0.2** | **3.2** | | **X** | | **X** |
| | *Cylindropuntia ramosissima* | 69 | 0.3 | 0.2 | 1.5 | | | | X |
| | *Cylindropuntia echinocarpa* | 63 | 0.3 | 0.2 | 1.0 | | | | X |
| | *Ambrosia salsola* | 50 | 0.2 | 0.2 | 0.5 | | | | X |
| | *Krameria grayi* | 44 | 0.5 | 0.2 | 3.0 | | | | |
| | *Yucca schidigera* | 44 | 0.2 | 0.2 | 1.0 | | | | |
| | *Lycium andersonii* | 31 | 0.1 | 0.2 | 0.5 | | | | |
| **Herb** | | | | | | | | | |
| | *Pleuraphis rigida* | 38 | 0.3 | 0.2 | 2.2 | | | | |
| | *Bromus rubens* | 38 | 0.1 | 0.2 | 1.0 | | | | |
| | *Chamaesyce* | 38 | 0.1 | 0.2 | 0.2 | | | | |
| **Nonvascular** | | | | | | | | | |
| | Cryptogammic crust | 38 | 0.1 | 0.2 | 0.6 | | | | |

### *Larrea tridentata – Ambrosia dumosa – Yucca schidigera* Association
**Creosote Bush – White Bursage – Mojave Yucca Association (Mapping code 27045)**

**Range**

Globally: In California, this association is known from the northern and eastern Colorado Desert and southern Mojave (Evens and Hartman 2007) and from Joshua Tree National Park, and stands have also been identified throughout much of the central Mojave Desert (Thomas et al. 2004).

JOTR: Stands of the *Larrea tridentata – Ambrosia dumosa – Yucca schidigera* Shrubland Association occur in the south central and west central part of the park and were sampled within the Fried Liver Wash, Indian Cove, Malapai Hill, Porcupine Wash, and Queen Mountain 7.5-minute topographic quadrangles.

**Environmental Description**

Globally: In the northern and eastern Colorado and southern Mojave deserts, this association is usually associated with sandy and gravelly, upland bajadas (Evens and Hartman 2007) on mid elevations (500–1,100 m).

JOTR: Stands of *Larrea tridentata – Ambrosia dumosa – Yucca schidigera* Association are found at mid elevations (2,700–3,500 ft.; 800–1,100 m) on variable slope aspects. Slopes are gentle (2–4 degrees) with a flat, convex, or undulating topography. This association occurs on upland, alluvial deposits, washes, erosional highlands, alluvial fan/bajadas, and ridgetops. Soils range from coarse sands to medium to very fine sandy loams derived from gneissose, granitic, or sandy alluvial parent materials. Ground cover consists of 0–4 percent bedrock, 0 percent boulder, 0–10 percent stone, 0–24 percent cobble, 29–87 percent gravel, and 10–63 percent fines cover. Litter cover is <1–30 percent. These sites generally experience low to high levels of disturbance from competition from exotic species.

**Vegetation Description**

Globally: *Larrea tridentata* and *Ambrosia dumosa* are usually co-dominant, and *Yucca schidigera* is characteristically present at low cover. Other species that commonly occur are *Senna armata, Krameria erecta,* and cacti (e.g., *Cylindropuntia echinocarpa, C. ramosissima*). (Evens and Hartman 2007).

JOTR: Stands of the *Larrea tridentata – Ambrosia dumosa – Yucca schidigera* Shrubland Association form an open shrubland with 0 percent cover in the tree/tall stratum, 9–36 percent cover in the shrub/mid stratum, and 1–49 percent cover in the herb/low stratum. Total vegetation cover ranges from 15–49 percent.

This association is dominated to co-dominated by *Ambrosia dumosa* and *Larrea tridentata* in the shrub layer and by the non-native annual *Bromus rubens* in the herb

layer. *Yucca schidigera* characteristically occurs in the shrub layer. Other characteristic species at low cover are *Cylindropuntia echinocarpa, C. ramosissima, Krameria grayi, Senna armata, Simmondsia chinensis,* and *Pleuraphis rigida.* Species often occurring are *Ephedra californica, Acamptopappus sphaerocephalus, Eriogonum fasciculatum, Lycium andersonii, Salazaria mexicana, Thamnosma montana,* and *Eriogonum inflatum.*

**Other Noteworthy Species**
Evidence of tortoises was noted in one of the plots.

**Conservation Rank:** N/A

**Rank Justification**
N/A

**Comments**
Globally: N/A

JOTR: This is a common type in the park. It occurs on a variety of substrates and landforms in the mid elevations, and usually with a diverse mixture of shrubs. Stands of this association intergrade with the *Yucca brevifolia / Larrea tridentata – Yucca schidigera / Pleuraphis rigida* Association.

Plots used for this description: N=9; JOTRA: 33-11-5; Long: VIND97-1, VMAL97-16, VMAL97-17, VMAL97-8, VMAL97-9; MDEI: 154-3-4, 155-1-6, 160-2-1.

Map Accuracy Assessment plots: N=56; 50-0527, 50-0545, 50-0584, 50-0586, 50-0587, 50-0591, 50-0592, 50-0594, 50-0598, 50-0600, 50-0601, 50-0603, 50-0606, 50-0610, 50-0612, 50-0615, 50-0616a, 50-0616b, 50-0617, 50-0619, 50-0621, 50-0622a, 50-0622b, 50-0624, 50-0625a, 50-0625b, 50-0627a, 50-0627b, 50-0628, 50-0629, 50-0630a, 50-0630b, 50-0631a, 50-0631b, 50-0632, 50-0633, 50-0634, 50-0637, 50-0638, 50-0639, 50-0640, 50-0641, 50-1237, 50-1238, 50-1239, 50-1241, 50-1242, 50-1243, 50-1623, 50-1815a, 50-1815b, 50-1836, 50-1837, 50-1841, 50-1846, 50-1847.

## Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Tree** | | | | | | | | | |
| | *Yucca brevifolia* | 44 | 0.4 | 0.2 | 1.4 | | | | |
| **Shrub** | | | | | | | | | |
| | ***Ambrosia dumosa*** | **100** | **7.4** | **2.5** | **19.0** | **X** | **X** | **X** | **X** |
| | ***Larrea tridentata*** | **100** | **4.4** | **2.2** | **8.0** | | **X** | | **X** |
| | ***Yucca schidigera*** | **100** | **1.4** | **0.4** | **4.2** | | **X** | | **X** |
| | *Cylindropuntia echinocarpa* | 100 | 0.9 | 0.4 | 2.2 | | X | | X |
| | *Krameria grayi* | 89 | 1.1 | 0.2 | 4.0 | | X | | X |
| | *Cylindropuntia ramosissima* | 89 | 1.0 | 0.2 | 2.2 | | X | | X |
| | *Senna armata* | 89 | 0.6 | 0.2 | 1.5 | | X | | X |
| | *Simmondsia chinensis* | 78 | 0.5 | 0.2 | 2.0 | | X | | X |
| | *Salazaria mexicana* | 67 | 0.5 | 0.2 | 1.2 | | | | X |
| | *Ephedra californica* | 56 | 0.8 | 0.4 | 3.2 | | | | X |
| | *Acamptopappus sphaerocephalus* | 56 | 0.7 | 0.2 | 3.2 | | | | X |
| | *Eriogonum fasciculatum* | 56 | 0.6 | 0.2 | 2.0 | | | | X |
| | *Thamnosma montana* | 56 | 0.2 | 0.2 | 0.5 | | | | X |
| | *Lycium andersonii* | 56 | 0.2 | 0.2 | 1.0 | | | | X |
| | *Ambrosia salsola* | 44 | 0.3 | 0.2 | 1.2 | | | | |
| | *Echinocereus engelmannii* | 33 | 0.1 | 0.2 | 0.5 | | | | |
| | *Opuntia basilaris* | 33 | 0.1 | 0.2 | 0.5 | | | | |
| **Herb** | | | | | | | | | |
| | *Bromus rubens* | 78 | 6.7 | 0.2 | 34.0 | X | X | X | X |
| | *Pleuraphis rigida* | 78 | 2.5 | 0.2 | 11.0 | | X | | X |
| | *Eriogonum inflatum* | 56 | 0.4 | 0.4 | 1.2 | | | | X |
| | *Erodium cicutarium* | 44 | 0.8 | 0.5 | 4.0 | | | | |
| | *Xylorhiza tortifolia* | 33 | 0.1 | 0.2 | 0.2 | | | | |
| | *Schismus barbatus* | 33 | 1.9 | 4.0 | 7.0 | | | | |

## *Larrea tridentata – Encelia farinosa* Shrubland Alliance
### Creosote Bush – Brittlebush Shrubland Alliance (Mapping code 27050)

The *Larrea tridentata – Encelia farinosa* Shrubland Alliance occurs in the Mojave, Sonoran, and Colorado Desert regions of California (Sawyer et al. 2009) and in Arizona, Nevada, Utah, and Mexico; and extends into the southeastern Great Basin (NatureServe 2011). Conservation rank: G5, S4.

*Larrea tridentata – Encelia farinosa* Alliance occurs on small washes, rills, alluvial fans, bajadas, colluvium and rocky upland slopes at elevation between 75 and 1,400 m. Soils are well drained, rocky, and may have desert pavement surfaces, and are often derived from granitic or volcanic rock. This alliance represents a drought tolerant extension of the *Larrea tridentata*-dominated American desert scrub, which is less cold hardy and more heat tolerant than the *Larrea tridentata – Ambrosia dumosa* Alliance. However, stand dynamics and relationships between *Larrea tridentata* and *Encelia farinosa* are similar to the *Larrea tridentata – Ambrosia dumosa* Alliance.

*Encelia farinosa* is, like *Ambrosia dumosa*, a short-lived subshrub (32 years maximum, Tesky 1993c) that forms an open to intermittent subcanopy beneath the taller *Larrea tridentata* shrubs. It reproduces entirely by seed and resprouts weakly from damaged stems. Its elevational and geographic range is limited by frost sensitivity. Although it grows poorly on clay soils, it survives on coarse, steep, and very rocky soils better than *Ambrosia dumosa*; it is more tolerant of hot, dry conditions and is more of an aggressive colonizer than *Ambrosia dumosa*. Leafing and flowering is opportunistic whenever moisture is available. *Encelia farinosa* may replace longer-lived perennials after fire and, once established, may persist for decades (Tesky 1993c).

In areas where both alliances occur, *Larrea tridentata – Encelia farinosa* tends to occupy steeper, southerly or westerly exposures, while *Larrea tridentata – Ambrosia dumosa* stands occupy more gentle northerly or neutral exposures. Compared to *Larrea tridentata – Ambrosia dumosa* Alliance, it tends to be less diverse with a lower proportion of annual herbs (in good rain years). It also does not tolerate sandy or clay rich soils as much as the *Larrea tridentata – Ambrosia dumosa* Alliance.

Although it is intolerant of heat from fire, *Encelia farinosa* rapidly colonizes burns and other disturbance in both the south coastal scrub and desert vegetation (Tesky 1993c). Seral stages following fire or other unnatural disturbance are likely to involve a state dominated by *Encelia farinosa* for several years before *Larrea tridentata* and other long-lived shrubs reestablish.

This is another alliance where the coincidence of non-native, annual grass invasion and human-related fires has conspired to threaten the structure and diversity of the vegetation. Fires should be excluded at all times of the year, and core areas should be identified where grass cover is low and thus stands are defensible. Unlike the *Larrea tridentata – Ambrosia dumosa* alliance,

the rocky, steep nature of many of the stands could preclude the establishment of dense cover of *Bromus rubens,* and thus, the resistance of this alliance to nonnatural fire and weed invasion is relatively high.

The *Larrea tridentata – Encelia farinosa* Shrubland Alliance is represented by four associations in Joshua Tree National Park: *Larrea tridentata – Encelia farinosa* Association, *Larrea tridentata – Encelia farinosa – Ambrosia dumosa* Association*, Larrea tridentata – Encelia farinosa – Fouquieria splendens* Association*,* and *Larrea tridentata – Encelia farinosa – Pleurocoronis pluriseta* Association.

### *Larrea tridentata – Encelia farinosa* Shrubland Association

**Creosote Bush – Brittlebush Association (Mapping code 27051, not mapped)**

#### Range

Globally: This association is known from the northern and eastern Colorado Desert and southern Mojave Desert (Evens and Hartman 2007) and Joshua Tree National Park in California, and from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona (NatureServe 2011). However, it is suspected within much of the central and eastern Mojave and also from the western Sonoran Desert (Thomas et al. 2004, Keeler-Wolf et al. 1998).

JOTR: Stands of the *Larrea tridentata – Encelia farinosa* Shrubland Association were sampled in the park within the Buzzard Spring, Cadiz Valley Southeast, Conejo Well, Cottonwood Basin, Coxcomb Mts., East Deception Canyon, East of Victory Pass, Fried Liver Wash, Pinto Wells, Queen Mountain, Rockhouse Canyon, San Bernardino Wash, and Victory Pass 7.5-minute topographic quadrangles.

#### Environmental Description

Globally: In the northern and eastern Colorado Desert, this association occurs on lower elevation, rocky slopes or on steep, south facing slopes (Evens and Hartman 2007).

JOTR: Stands of the *Larrea tridentata – Encelia farinosa* Shrubland Association are found at low to mid elevations (500–3,000 ft.; 200–900 m) on primarily southerly slope aspects. Slopes are flat to steep (0–30 degrees) on slopes with flat, concave, or undulating topographies. Soils range from coarse sands to moderately fine silty clay loams derived from basaltic, dioritic, gneissose, and granitic parent materials. Ground cover in this association consists of 0–87 percent bedrock, 0–20 percent boulder, 0–20 percent stone, 2–50 percent cobble, 10–87 percent gravel, and <1–46 percent fines cover. Litter cover is <1–7 percent. These sites usually experience low levels of disturbance from competition from exotic species and low to moderate levels of disturbance from vandalism, dumping, and litter.

#### Vegetation Description

Globally: *Encelia farinosa* and *Larrea tridentata* are usually codominant in stands while other shrubs occur less often and are lower in cover (at <1% absolute cover), including *Ambrosia dumosa* and *Ferocactus cylindraceus.*

JOTR: Stands of the *Larrea tridentata – Encelia farinosa* Shrubland Association form a sparse to open shrubland with 0–<1 percent cover in the tree/tall stratum, 1–22 percent cover in the shrub/mid stratum, and <1–16 percent cover in the herb/low stratum. Total vegetation cover ranges from 2–20 percent.

This association is dominated by *Encelia farinosa* and *Larrea tridentata* in the shrub layer. *Ambrosia dumosa* is characteristic to this association at low cover (less than or equal to 1% absolute cover).

**Other Noteworthy Species**

*Coryphantha alversonii* was found in one of the plots. *Coryphantha alversonii* is a CRPR 4 plant (CNPS 2011). It is found in Imperial, Riverside, and San Bernardino Counties at low to high elevations (240–5,000 ft.; 73–1,500 m). (Syn: *Escobaria vivipara* var. *alversonii* in the Jepson Manual.)

**Conservation Rank:** N/A

**Rank Justification** N/A

**Comments**

Globally: N/A

JOTR: As with most drought deciduous dominant vegetation, the shrub cover may vary substantially between leaf on and leaf off conditions. *Encelia farinosa* responds relatively rapidly to significant precipitation and may produce new leaves within a week or two following rain.

Plots used for this description: N=31; JOTRA: 17-03-2, 25-04-3, 26-24-3, 27B-12-1, 28B-13-1, 28B-13-3, 32-26-5, 40A-07-1, 40A-07-2, 53-08-3, 59-05-4, 60B-07-3, 63-18-4, 63-18-5, 66-02-3, 66-02-6 ; JOTR: JOTR21, JOTR22, JOTR24, JOTR43, JOTR96; MDEI: 129-2-7, 129-2-8, 153-1-7, 153-1-8, 154-3-7, 158-1-7, 162-1-7, 63-2-8, 63-7-7, 63-7-8.

Map Accuracy Assessment plots: N=0.

## Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Shrub** | | | | | | | | | |
| | ***Larrea tridentata*** | **100** | **3.5** | **1.0** | **8.0** | **X** | **X** | **X** | **X** |
| | ***Encelia farinosa*** | **100** | **4.3** | **0.2** | **16.0** | **X** | **X** | **X** | **X** |
| | *Ambrosia dumosa* | 77 | 0.3 | 0.2 | 1.0 | | X | | X |
| | *Bebbia juncea* | 48 | 0.4 | 0.2 | 3.0 | | | | |
| | *Krameria grayi* | 39 | 0.3 | 0.2 | 1.5 | | | | |
| | *Hyptis emoryi* | 32 | 0.1 | 0.2 | 0.5 | | | | |
| **Herb** | | | | | | | | | |
| | *Pleuraphis rigida* | 45 | 0.2 | 0.2 | 1.0 | | | | |
| | *Eriogonum inflatum* | 42 | 0.1 | 0.2 | 0.5 | | | | |
| | *Allionia incarnata* | 32 | 0.3 | 0.2 | 3.0 | | | | |
| | *Argythamnia neomexicana* | 32 | 0.1 | 0.2 | 0.5 | | | | |
| **Nonvascular** | | | | | | | | | |
| | Cryptogammic crust | 32 | 0.3 | 0.2 | 2.4 | | | | |

## *Larrea tridentata – Encelia farinosa – Ambrosia dumosa* Shrubland Association
**Creosote Bush – Brittlebush – White Bursage Association (Mapping code 27057)**

### Range

Globally: This association is defined from the northern and eastern Colorado Desert and southern Mojave Desert (Evens and Hartman 2007) and from Joshua Tree National Park in California. However, plots with similar characteristics have been found throughout much of the central Mojave Desert (Thomas et al. 2004).

JOTR: Stands of the *Larrea tridentata – Encelia farinosa – Ambrosia dumosa* Shrubland Association were sampled in the park in the Cadiz Valley southeast, Cadiz Valley Southwest, East Clarks Pass, Cottonwood Springs, Coxcomb Mountains, East Deception Canyon, Fried Liver Wash, Hayfield, Malapai Hill, Pinto Wells, Porcupine Wash, Queen Mountain, Seven Palms Valley, and Washington Wash 7.5-minute topographic quadrangles.

### Environmental Description

Globally: In the northern and eastern Colorado Desert, this alliance occurs on neutral, rocky slopes or on steep, south-facing slopes at low to mid elevations (Evens and Hartman 2007). In addition, similar if not identical stands were inventoried by Thomas et al. (2004) from rocky uplands, usually on southerly facing exposures below 1,000 m in the south-central and eastern Mojave Desert of California.

JOTR: Stands of the *Larrea tridentata – Encelia farinosa – Ambrosia dumosa* Shrubland Association are found at low to mid elevations (1,000–3,500 ft.; 300–1,100 m) on variable slope aspects. Slopes range from flat to steep (0–40 degrees) on all topographic settings. It can be found on rocky highlands, upland, alluvial fans, erosional highlands, and bottomlands/plains. Soil textures range from coarse sands to moderately fine sandy clay loams derived from gneissose and granitic parent materials. Ground cover consists of 0–65 percent bedrock, 0–10 percent boulder, 0–45 percent stone, <1–75 percent cobble, 5–50 percent gravel, and <1–73 percent fines. Litter cover is 0–5 percent. These sites usually experience low to rarely high levels of disturbance from competition from exotic species and moderate levels of disturbance from vandalism/dumping/litter.

### Vegetation Description

Globally: N/A

JOTR: Stands of the *Larrea tridentata – Encelia farinosa – Ambrosia dumosa* Shrubland Association form an open to sparse shrubland with 0–<1 percent cover in the tree/tall stratum, 2–23 percent cover in the shrub/mid stratum, and 1–10 percent cover in the herb/low stratum. Total vegetation cover ranges from 4–17 percent.

This association is dominated and characterized by the shrub species *Larrea tridentata.* Characteristic species are *Ambrosia dumosa* and *Encelia farinosa* as subdominants to co-dominants with *Larrea. Bebbia juncea* is often present.

**Other Noteworthy Species**
*Coryphantha alversonii* was found in one of the plots. *Coryphantha alversonii* is a CRPR 4 plant (CNPS 2011). It is found in Imperial, Riverside, and San Bernardino Counties at low to high elevation (240–5,000 ft.; 73–1,500 m). (Syn: *Escobaria vivipara* var. *alversonii* in Jepson Manual).

*Tetracoccus hallii* was found in one of the plots. *Tetracoccus hallii* is a CRPR 4 plant (CNPS 2011). It is found in Imperial, Riverside, and San Bernardino Counties and in Arizona and Baja California at low to high elevation (100–4,000 ft.; 30–1,200 m).

**Conservation Rank:** N/A

**Rank Justification** N/A

**Comments**
Globally: N/A

JOTR: N/A

Plots used for this description: N=24; JOTRA: 01-02-3, 01-02-6, 08-03-2, 18B-06-2, 27B-12-5, 31-07-2, 33-11-4, 39-02-3, 43-20-3, 44-18-5, 56-06-5, 59-05-1, 60B-07-1, 63-18-1; JOTR: JOTR33, JOTR63, JOTR66, JOTR67, JOTR68, JOTR70; Long: VEGE-1; MDEI: 153-1-6, 154-1-8, 63-7-6.

Map Accuracy Assessment plots: N=15; 50-0444, 50-0458, 50-0463, 50-0465, 50-0470, 50-0476, 50-0480, 50-0481, 50-0484, 50-0486, 50-0491, 50-0533, 50-0544, 50-1862, 50-1864.

## Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Shrub** | | | | | | | | | |
| | ***Larrea tridentata*** | **100** | **4.1** | **1.0** | **10.0** | **X** | **X** | **X** | **X** |
| | ***Ambrosia dumosa*** | **100** | **2.6** | **0.2** | **7.0** | | **X** | | **X** |
| | ***Encelia farinosa*** | **100** | **2.3** | **0.2** | **13.0** | | **X** | | **X** |
| | *Bebbia juncea* | 50 | 0.2 | 0.2 | 2.5 | | | | X |
| | *Opuntia basilaris* | 33 | 0.1 | 0.2 | 0.5 | | | | |
| | *Krameria erecta* | 33 | 0.1 | 0.2 | 0.5 | | | | |
| **Herb** | | | | | | | | | |
| | *Pleuraphis rigida* | 42 | 0.2 | 0.2 | 1.2 | | | | |
| | *Eriogonum inflatum* | 38 | 0.1 | 0.2 | 1.0 | | | | |
| **Nonvascular** | | | | | | | | | |
| | Cryptogammic crust | 42 | 0.2 | 0.2 | 2.4 | | | | |

### *Larrea tridentata – Encelia farinosa – Fouquieria splendens* Association

**Creosote Bush – Brittlebush – Ocotillo Association (Mapping code 27056)**

#### Range

Globally: This association is known from Grand Canyon National Park in Arizona (NatureServe 2011) and from Joshua Tree National Park in California. It is suspected throughout much of the Sonoran Desert of California, Arizona, and adjacent Mexico.

JOTR: Stands of the *Larrea tridentata – Encelia farinosa – Fouquieria splendens* Association occur mostly along the southern edge of the park and were sampled within the Cottonwood Basin and Cottonwood Springs 7.5-minute topographic quadrangles.

#### Environmental Description

Globally: In Grand Canyon National Park, this association occurs primarily on xeric desert sideslopes at 475 to 575 m in elevation, but can be found as high as 645 m. It is typically found on low gradients (2–10 degrees) and on south- or east-facing aspects, but is also common on steeper slopes (20–28 degrees). Soils are well- to rapidly-drained sandy loams or clays, and the bedrock is typically limestone (NatureServe 2011).

JOTR: Stands of *Larrea tridentata – Encelia farinosa – Fouquieria splendens* Shrubland Association are found at mid elevations (2,300–3,300 ft.; 700–1,000 m) on flat, convex, and undulating slopes. Soils are sands and loams. Ground cover in this association consists of 0–20 percent bedrock, 0–<1 percent boulder, 0–10 percent stone, 5–25 percent cobble, 12–30 percent gravel, and 15–65 percent fines cover. Litter cover is 1–4 percent. These sites usually experience low levels of disturbance from competition from exotic species.

#### Vegetation Description

Globally: In Grand Canyon National Park, vegetation in the short-shrub layer is characterized by the codominance of three shrub species: the tall shrubs *Larrea tridentata* (3-5%) and *Fouquieria splendens* (3-5%), and the short shrub *Encelia farinosa* (5-10%). In the short-shrub layer, *Ephedra fasciculata, Krameria erecta, Ferocactus cylindraceus*, and *Cylindropuntia acanthocarpa* also occur fairly frequently. A minor dwarf-shrub layer exists with *Opuntia basilaris* occasionally occurring. *Vulpia octoflora* and *Dasyochloa pulchella* are occasionally present as minor graminoid component. *Plantago ovata, Phacelia* sp., and *Allionia incarnata* sporadically occur in the forb layer (NatureServe 2011).

JOTR: Stands of the *Larrea tridentata – Encelia farinosa – Fouquieria splendens* Association form a sparse to open shrubland with <1 percent cover in the tree/tall

stratum, 3–14 percent cover in the shrub/mid stratum, and <1–2 percent cover in the herb/low stratum. Total vegetation cover ranges from 6–16 percent.

This association is dominated by *Fouquieria splendens, Encelia farinosa, Larrea tridentata,* and cryptobiotic crusts. Characteristic species include *Ambrosia dumosa, Bebbia juncea, Cylindropuntia echinocarpa, C. ramosissima, Encelia farinosa, Krameria grayi, Larrea tridentata,* and *Opuntia basilaris.* Plant species that are often present are *Acacia greggii, Echinocereus engelmannii, Ferocactus cylindraceus, Hyptis emoryi, Simmondsia chinensis, Stephanomeria pauciflora, Trixis californica, Brassica tournefortii, Chamaesyce* spp., and *Schismus* spp.

**Other Noteworthy Species**
*Coryphantha alversonii* was found in one of three plots. *Coryphantha alversonii* is a CRPR 4 plant (CNPS 2011). It is found in Imperial, Riverside, and San Bernardino Counties at low to high elevations (240–5,000 ft.; 73–1,500 m). (Syn: *Escobaria vivipara* var. *alversonii* in the Jepson Manual.)

**Conservation Rank:** N/A

**Rank Justification**
N/A

**Comments**
Globally: N/A

JOTR: N/A

Plots used for this description: N=5; JOTRA: 24-06-1, 24-06-3, 24-06-4, 32-06-5, 34-06.

Map Accuracy Assessment plots: N=29; 50-0492, 50-0493, 50-0494, 50-0495, 50-0496, 50-0497, 50-0498, 50-0499, 50-0500, 50-0501, 50-0502, 50-0503, 50-0504, 50-0505, 50-0506, 50-0507, 50-0508, 50-0509, 50-0510, 50-0511, 50-0512, 50-0513, 50-0514, 50-0515, 50-0516, 50-0517, 50-0518, 50-0520, 50-0521.

## Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Tree** | | | | | | | | | |
| | ***Fouquieria splendens*** | **100** | **2.2** | **1.2** | **4.0** | | **X** | | **X** |
| | *Parkinsonia florida* | 80 | 0.7 | 0.2 | 2.2 | X | X | X | X |
| **Shrub** | | | | | | | | | |
| | ***Encelia farinosa*** | **100** | **3.0** | **0.4** | **6.2** | | **X** | | **X** |
| | *Ambrosia dumosa* | 100 | 0.8 | 0.2 | 1.2 | | X | | X |
| | *Cylindropuntia ramosissima* | 100 | 0.3 | 0.2 | 0.4 | | X | | X |
| | *Opuntia basilaris* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | ***Larrea tridentata*** | **80** | **2.6** | **1.0** | **4.2** | | **X** | | **X** |
| | *Bebbia juncea* | 80 | 0.6 | 0.2 | 1.2 | | X | | X |
| | *Acacia greggii* | 60 | 0.3 | 0.2 | 1.2 | | | | X |
| | *Cylindropuntia echinocarpa* | 80 | 0.3 | 0.4 | 0.4 | | X | | X |
| | *Krameria grayi* | 80 | 0.2 | 0.2 | 0.4 | | X | | X |
| | *Trixis californica* | 60 | 0.2 | 0.2 | 0.4 | | | | X |
| | *Echinocereus engelmannii* | 60 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Simmondsia chinensis* | 60 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Hyptis emoryi* | 60 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Ferocactus cylindraceus* | 60 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Escobaria alversonii* | 40 | 0.1 | 0.2 | 0.2 | | | | |
| | *Ephedra nevadensis* | 40 | 0.1 | 0.2 | 0.2 | | | | |
| | *Ambrosia salsola* | 40 | 0.1 | 0.2 | 0.4 | | | | |
| | *Viguiera parishii* | 40 | 0.1 | 0.2 | 0.4 | | | | |
| **Herb** | | | | | | | | | |
| | *Schismus* | 60 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Chamaesyce* | 60 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Stephanomeria pauciflora* | 60 | 0.2 | 0.2 | 0.4 | | | | X |
| | *Brassica tournefortii* | 60 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Adenophyllum porophylloides* | 40 | 0.1 | 0.2 | 0.2 | | | | |
| | *Eriogonum inflatum* | 40 | 0.1 | 0.2 | 0.4 | | | | |
| **Nonvascular** | | | | | | | | | |
| | Cryptogammic crust | 80 | 0.2 | 0.2 | 0.4 | X | X | X | X |

### *Larrea tridentata –Encelia farinosa – Pleurocornis pluriseta* Association
**Creosote Bush – Brittlebush – Arrowleaf Association (Mapping code 27059)**

**Range**

Globally: This association is described only from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of the *Larrea tridentata – Encelia farinosa – Pleurocoronis pluriseta* Association were sampled within the Cadiz Valley Southwest, Pinto Mountain, Porcupine Wash, and Seven Palms Valley 7.5-minute topographic quadrangles.

**Environmental Description**

Globally: This association is described only from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of *Larrea tridentata – Encelia farinosa – Pleurocoronis pluriseta* Association are found at low to mid elevations (1,800–2,700 ft.; 600–800 m) on variable slope aspects. Slopes are gentle to somewhat steep with on convex or undulating topographies. Soils range from coarse sands to moderately coarse sandy loams derived from granitic parent materials. Ground cover in this association consists of 2–90 percent bedrock, 0–63 percent boulder, 0–20 percent stone, <1–33 percent cobble, 0–43 percent gravel, and 0–20 percent fines cover. Litter cover is <1–5 percent. Disturbance from exotic species is typically low.

**Vegetation Description**

Globally: N/A

JOTR: Stands of the *Larrea tridentata – Encelia farinosa – Pleurocoronis pluriseta* Association form a sparse to open shrubland with 0 percent cover in the tree/tall stratum, 2–18 percent cover in the shrub/mid stratum, and <1–4 percent cover in the herb/low stratum. Total vegetation cover ranges from 5–20 percent.

Characteristic species in this association are *Larrea tridentata, Encelia farinosa,* and *Pleurocoronis pluriseta* at variable cover (<1 to 8%). Species that are often present include *Ambrosia dumosa, Bebbia juncea, Galium stellatum, Krameria grayi,* and *Mirabilis laevis* var. *villosa.*

**Other Noteworthy Species**

N/A

**Conservation Rank:** N/A

**Rank Justification**
N/A

**Comments**
Globally: N/A

JOTR: Some stands have trace cover but characteristic presence of the nominate species in this alliance. In one phase of this association, *Pleurocoronis pluriseta* is (co-) dominant with *Trixis californica* or other plants that prefer rocky substrates and with little or no cover of the *Larrea* or *Encelia,* and in another phase *P. pluriseta* is trace in cover while the *Larrea* and *Encelia* are co-dominant.

Plots used for this description: N=10; JOTRA: 01-02-5, 33-16-4, 57-18-1; JOTR: JOTR16, JOTR37, JOTR39, JOTR40, JOTR41; MDEI: 57-15-6, 57-15-8.

Map Accuracy Assessment plots: N=13; 50-0810, 50-0813, 50-0816, 50-0821, 50-0823, 50-0825, 50-0828, 50-0830, 50-0831, 50-0832, 50-0833, 50-0834, 50-1804.

**Stand Table**

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Shrub** | | | | | | | | | |
| | ***Larrea tridentata*** | **100** | **2.8** | **0.2** | **7.0** | | **X** | | **X** |
| | ***Encelia farinosa*** | **90** | **3.0** | **0.2** | **8.0** | | **X** | | **X** |
| | ***Pleurocoronis pluriseta*** | **90** | **1.6** | **0.2** | **7.0** | | **X** | | **X** |
| | *Ambrosia dumosa* | 70 | 0.5 | 0.2 | 3.2 | | | | X |
| | *Galium stellatum* | 70 | 0.2 | 0.2 | 0.5 | | | | X |
| | *Bebbia juncea* | 60 | 0.4 | 0.2 | 1.5 | | | | X |
| | *Krameria grayi* | 50 | 0.2 | 0.2 | 1.0 | | | | X |
| | *Trixis californica* | 40 | 0.4 | 0.2 | 2.0 | | | | |
| | *Ephedra nevadensis* | 40 | 0.3 | 0.2 | 1.2 | | | | |
| | *Simmondsia chinensis* | 40 | 0.3 | 0.2 | 2.0 | | | | |
| | *Viguiera parishii* | 40 | 0.2 | 0.2 | 1.5 | | | | |
| | *Eriogonum fasciculatum* | 40 | 0.2 | 0.2 | 1.2 | | | | |
| | *Peucephyllum schottii* | 30 | 0.2 | 0.2 | 1.2 | | | | |
| | *Lycium andersonii* | 30 | 0.1 | 0.2 | 1.0 | | | | |
| **Herb** | | | | | | | | | |
| | *Mirabilis laevis* var. *villosa* | 70 | 0.3 | 0.2 | 1.5 | | | | X |
| | *Stephanomeria pauciflora* | 40 | 0.1 | 0.2 | 0.5 | | | | |
| | *Achnatherum speciosum* | 30 | 0.1 | 0.2 | 0.5 | | | | |
| | *Adenophyllum porophylloides* | 30 | 0.1 | 0.2 | 0.5 | | | | |
| | *Eriogonum inflatum* | 30 | 0.1 | 0.2 | 0.2 | | | | |
| **Nonvascular** | | | | | | | | | |
| | Unknown Lichen | 30 | 0.1 | 0.2 | 0.2 | | | | |

## M092. North American Warm-Desert Xero-Riparian Macrogroup

## Sonoran-Coloradan Semi-Desert Wash Woodland / Scrub Group

### *Chilopsis linearis* Woodland Alliance

**Desert Willow Woodland Alliance (Mapping code 15010)**

The *Chilopsis linearis* alliance occurs strictly in washes and arroyos in Arizona, California, New Mexico, Nevada, Texas and Colorado, in the Colorado, Mojave and Sonoran Deserts (NatureServe 2011, Sawyer et al. 2009). Although the alliance is widely distributed, stands are local and do not occur in many of the washes that would seem suitable. Conservation rank: G4, S3.

*Chilopsis linearis* is a relatively long lived tall shrub or tree that attains 6m in height. Plants are part facultatively winter deciduous phreatophytes (Uchytil 1990b). Stands typically occur in sandy or gravelly washes with relatively wide flood paths across pediments and in natural "narrows" in valleys; most large-stature stands are on small terraces above the active wash channels. Inherently, fluvial processes are the primary disturbance to these stands rather than fire, though *C. linearis* can sprout after fire and continue to dominate.

Most stands of this alliance are small and scattered, suggesting that seedling establishment has rather exacting requirements. Moderate flooding in wet years provides favorable conditions for seedling establishment, and most stands of *C. linearis* receive sheet flooding at least every 10–20 years (Uchytil 1990). Long-time sustainability of these small, scattered stands may involve several flood events and periods of sprouting on wet sands before seedling establishment occurs. In addition, this plant can resprout vegetatively and rebound quickly in actively flooded stream channels, where other species may come back only from seed.

This alliance is represented in Joshua Tree National Park by two associations. The *Chilopsis linearis* Association is defined below with a large sample size, and another is only listed below because it is represented by one plot sample suggesting further variation:

*Chilopsis linearis / Ambrosia salsola* (Long: VMAL97-19)

## *Chilopsis linearis* Association

**Desert Willow Association (Mapping code 15013)**

### Range

Globally: This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory. It is likely that, as currently treated, this association is widespread and occurs in the southern Mojave and adjacent, northwestern Sonoran Desert. Similar stands have been inventoried in Anza-Borrego Desert State Park (Keeler-Wolf et al. 1998).

JOTR: Stands of the *Chilopsis linearis* Shrubland Association occur primarily in the central and eastern parts of the park and were sampled within the Cottonwood Springs, Indian Cove, Joshua Tree South, Pinto Wells, and Porcupine Wash 7.5-minute topographic quadrangles.

### Environmental Description

Globally: This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of *Chilopsis linearis* Shrubland Association are found at low to mid elevations (1,000–3,800 ft.; 300–1,200 m) within drainages and on gentle (1-6 degree) slopes. This association is found primarily on linear and sometimes convex wash surfaces. Soil textures are sandy and derived from granitic parent material. Ground cover consists of 0 percent bedrock, 0–1 percent boulder, 0–3 percent stone, 0–12 percent cobble, 1–20 percent gravel, and 40–86 percent fines cover. Litter cover ranges from 1–8 percent. These sites generally experience low to high levels of disturbance from exotic species, moderate levels of disturbance from vandalism and dumping, and high levels of disturbance from foot traffic/trampling.

### Vegetation Description

Globally: This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of the *Chilopsis linearis* Association form a sparse to open shrubland with 0–30 percent cover for the tree/tall stratum, 3–22 percent cover for the shrub/medium stratum, and <1–4 percent cover for the herb/low stratum. Total vegetative cover ranges from 8–52 percent. Exotic species tend to be low but can occasionally be moderate.

This association is dominated by *Chilopsis linearis*. *Ambrosia salsola* is characteristically present at sparse average cover in the shrub layer. *Acacia greggii* and *Amaranthus* spp. are often in the shrub and herb layers respectively.

**Other Noteworthy Species**
N/A

**Conservation Rank:** Rare

**Rank Justification**
This association currently is known only from Joshua Tree National Park.

**Comments**
Globally: N/A

JOTR: N/A

Plots used for this description: N=7; JOTRA: 10B-01-1, 10B-01-5, 14-27-3, 32-26-4, 33-07-4, 33-16-5, 56-06-6.

Map Accuracy Assessment plots: N=30; 25-1662, 25-1664, 25-1665, 25-1666, 25-1667, 25-1668, 25-1669, 25-1670, 25-1671, 25-1673, 25-1675, 25-1676, 25-1677, 25-1678, 25-1679, 25-1680, 25-1681, 25-1682, 25-1684, 25-1685, 25-1688, 25-1690, 25-1695, 25-1709, 25-1711, 25-1712, 25-1718, 25-1721, 25-1753, 25-1755.

**Stand Table**

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Tree** | | | | | | | | | |
| | ***Chilopsis linearis*** | **100** | **13.0** | **2.0** | **40.0** | **X** | **X** | **X** | **X** |
| **Shrub** | | | | | | | | | |
| | *Ambrosia salsola* | 100 | 1.2 | 0.2 | 3.2 | | X | | X |
| | *Acacia greggii* | 71 | 1.9 | 0.4 | 5.0 | | | | X |
| | *Petalonyx thurberi* | 43 | 0.1 | 0.2 | 0.4 | | | | |
| | *Phoradendron californicum* | 43 | 0.1 | 0.2 | 0.2 | | | | |
| **Herb** | | | | | | | | | |
| | *Amaranthus* | 57 | 0.1 | 0.2 | 0.4 | | | | X |
| | *Erodium cicutarium* | 43 | 0.1 | 0.2 | 0.2 | | | | |

## *Hyptis emoryi* Shrubland Alliance

### Desert Lavender Shrubland Alliance (Mapping code 28200)

The *Hyptis emoryi* Shrubland Alliance occurs in the Colorado Desert, Sonoran Desert, and southern Mojave Desert in California; it also possibly occurs in the Sonoran Desert in Arizona, and in Baja California, Mexico (NatureServe 2011). Conservation rank: G4, S3.

*Hyptis emoryi* forms sparse to open stands along many of the minor washes in the low, hot, and very dry Colorado and Sonoran Deserts of California. They tend to occupy narrow washes with moderate to steep gradients. These stands generally occur along washes that are not big enough to support stands of the microphyllous legume trees of the desert. The *Hyptis emoryi* alliance appears to prefer the rocky and bouldery stretches of washes, rather than the broad and sandier portions. Stands are often only narrow strips that ascend drainages in old, dissected alluvial fans or badlands. This alliance seems to be limited by temperature since it does not ascend >2,800 feet (900 m) in the desert mountains or occur very far north into the Mojave Desert.

*Hyptis emoryi* appears to tolerate a high degree of flood disturbance. It is a long-lived species that resprouts following flood or fire damage. Shrubs are often positioned in the center of small washes and have clearly sustained repeated damage from flooding. Stems appear to ramify following damage. Flooding in the smaller washes probably occurs at least every 10 years. The relationship between the *Hyptis emoryi* alliance and other similar ones, such as *Acacia greggii,* needs to be determined. Seeds are probably dispersed in water. Flowering and seed set is opportunistic, following rain and flooding (CNPS Desert Workshop 2000).

Many small washes of *H. emoryi* in the Sonoran and Colorado Deserts are impacted by burro and OHV use. Effects of these impacts to this alliance have not been quantified.

This alliance is represented in Joshua Tree National Park by one association defined in this project, the *Hyptis emoryi* Association.

## *Hyptis emoryi* Association

**Desert-Lavender Association (Mapping code 28203)**

### Range

Globally: This association is only described from Joshua Tree National Park. However, similar stands have been sampled in Anza-Borrego Desert State Park (Keeler-Wolf et al. 1998) and in the southern portion of the eastern Mojave Desert (Thomas et al. 2004).

JOTR: Stands of the *Hyptis emoryi* Shrubland Association occur in the central and eastern portions of the park and were sampled within the Cadiz Valley southeast, Clark's Pass Fried Liver Wash, Queen Mountain, and Victory Pass 7.5-minute topographic quadrangles.

### Environmental Description

Globally: This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of the *Hyptis emoryi* Shrubland Association are found at low to mid elevations (1,400–2,800 ft.; 400–900 m) on convex, linear, concave, and undulating slopes of drainages on rocky highlands, washes, and arroyos. Soils are typically sandy. Ground cover is comprised of 0–10 percent bedrock, 0–15 percent boulder, 0–20 percent stone, 19–47 percent cobble, 10–31 percent gravel, and 10–65 percent fines cover. Litter consists of 1–10 percent cover. This association experiences low levels of disturbance from competition from exotics.

Stands are common in narrow and steep, high energy, rocky washes throughout the mountain ranges in the eastern portions of the park (AIS, personal communication). Some of the best stands occur in the Pinto Mountains (Leary 1977).

### Vegetation Description

Globally: This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of the *Hyptis emoryi* Shrubland Association form a sparse to open shrubland with 0–1 percent cover for the tree/tall stratum, 8–21 percent cover for the shrub/medium stratum, and <1–3 percent cover for the herb/low stratum. Total vegetative cover ranges from 8–21 percent.

This association is dominated by *Hyptis emoryi*. Characteristic shrub species include *Ambrosia salsola*, *Bebbia juncea*, *Encelia farinosa and Larrea tridentata*. The characteristic herb species is *Mirabilis bigelovii. Ambrosia dumosa* and *Chamaesyce* often occur in the shrub and herb layers.

**Other Noteworthy Species**
Evidence of tortoises was noted in one of the plots.

**Conservation Rank:** Rare

**Rank Justification**
This association is currently known only from the Mojave National Park.

**Comments**
Globally: N/A

JOTR: N/A

Plots used for this description: N=9; JOTRA: 20D-05-1, 26-24-1, 26-24-2, 27B-12-2, 27B-12-7, 28B-13-2, 43-20-2, 53-08-10, 60B-07-2.

Map Accuracy Assessment plots: N=17; 25-1387, 25-1388, 25-1389, 25-1390, 25-1391, 25-1393, 25-1395, 25-1398, 25-1402, 25-1405, 25-1406, 25-1407, 25-1409, 25-1411, 25-1412, 25-1413, 25-1414.

## Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Shrub** | | | | | | | | | |
| | ***Hyptis emoryi*** | **100** | **8.1** | **2.0** | **15.2** | **X** | **X** | **X** | **X** |
| | *Larrea tridentata* | 78 | 1.8 | 0.2 | 4.0 | | X | | X |
| | *Ambrosia salsola* | 78 | 0.6 | 0.2 | 2.2 | | X | | X |
| | *Bebbia juncea* | 78 | 0.5 | 0.2 | 2.2 | | X | | X |
| | *Encelia farinosa* | 78 | 0.4 | 0.2 | 2.2 | | X | | X |
| | *Ambrosia dumosa* | 67 | 0.2 | 0.2 | 0.4 | | | | X |
| | *Acacia greggii* | 44 | 0.9 | 0.2 | 5.2 | | | | |
| | *Psorothamnus schottii* | 44 | 0.5 | 0.2 | 2.2 | | | | |
| | *Brandegea bigelovii* | 44 | 0.2 | 0.2 | 0.4 | | | | |
| | *Krameria grayi* | 44 | 0.2 | 0.2 | 1.0 | | | | |
| | *Lycium andersonii* | 44 | 0.2 | 0.2 | 1.2 | | | | |
| | *Simmondsia chinensis* | 44 | 0.2 | 0.2 | 1.0 | | | | |
| | *Opuntia basilaris* | 44 | 0.1 | 0.2 | 0.2 | | | | |
| | *Sphaeralcea ambigua* | 44 | 0.1 | 0.2 | 0.4 | | | | |
| | *Ephedra nevadensis* | 33 | 0.2 | 0.2 | 1.0 | | | | |
| **Herb** | | | | | | | | | |
| | *Mirabilis laevis* var. *villosa* | 78 | 0.2 | 0.2 | 0.4 | | X | | X |
| | *Chamaesyce* | 67 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Allionia incarnata* | 44 | 0.4 | 0.2 | 2.2 | | | | |
| | *Eriogonum inflatum* | 44 | 0.1 | 0.2 | 0.2 | | | | |
| | *Stephanomeria* | 44 | 0.1 | 0.2 | 0.4 | | | | |
| | *Pleuraphis rigida* | 33 | 0.1 | 0.2 | 0.4 | | | | |
| | *Perityle emoryi* | 33 | 0.1 | 0.2 | 0.2 | | | | |
| **Nonvascular** | | | | | | | | | |
| | Cryptogammic crust | 44 | 0.2 | 0.2 | 0.6 | | | | |
| | Unknown Moss | 44 | 0.1 | 0.2 | 0.2 | | | | |

## *Justicia californica* Provisional Shrubland Alliance

### Chuparosa Provisional Shrubland Alliance (Mapping code 28171)

The shrub *Justicia californica* forms occasional stands in washes, arroyos, seeps and springs in Joshua Tree National Park. Other stands have been observed throughout the Anza-Borrego Desert State Park (Keeler-Wolf et al. 1998). Conservation rank: G2, S2 (?).

The shrub *Justicia californica* forms occasional stands in washes, arroyos, seeps and springs in Joshua Tree National Park. *Justicia californica* is a medium-sized shrub that is cold and drought deciduous. Plants are frost hardy and thy can reach 2m in height. The showy flowers are an attractive red color and tubular shape that hummingbirds visit.

Stands of this alliance have *Justicia californica* as a characteristic species with highest average cover (and ranging from 0.2 to 14% absolute cover). Various other shrubs such as *Encelia farinosa, Larrea tridentata,* and *Hyptis emoryi* also characteristically occur at low cover (ranging from 0.2 to 3% absolute cover). Emergent trees include characteristic presence of *Parkinsonia florida* and *Fouquieria splendens* (ranging from 0.2 to 3% absolute cover).

One classification plot and multiple map accuracy assessment samples provide some information to define this alliance, and a few stands appeared mappable with distinct photo signature. We need further information to understand the relationship of this type within the state's desert vegetation.

*Justicia californica* (JOTRA: 32-06-6; MapAA: 25-1347a, 25-1422, 25-1423, 25-1424, 25-1425, 25-1426, 25-1427, 25-1428, 25-1429, 25-1430, 25-1431, 25-1432, 25-1433, 25-1434, 25-1435, 25-1436, 25-1438, 25-1439, 25-1440, 25-1441, 25-1442, 25-1443, 25-1444, 25-1445, 25-1447, 25-1448, 25-1449, 25-1450, 25-1451, 25-1452)

## Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Shrub** | | | | | | | | | |
| | ***Justicia californica*** | **100** | **14.2** | **14.2** | **14.2** | **X** | **X** | **X** | **X** |
| | *Larrea tridentata* | 100 | 2.0 | 2.0 | 2.0 | | X | | X |
| | *Lycium* | 100 | 1.2 | 1.2 | 1.2 | | X | | X |
| | *Hyptis emoryi* | 100 | 1.0 | 1.0 | 1.0 | | X | | X |
| | *Encelia farinosa* | 100 | 0.4 | 0.4 | 0.4 | | X | | X |
| | *Sphaeralcea ambigua* | 100 | 0.4 | 0.4 | 0.4 | | X | | X |
| | *Trixis californica* | 100 | 0.4 | 0.4 | 0.4 | | X | | X |
| | *Viguiera parishii* | 100 | 0.4 | 0.4 | 0.4 | | X | | X |
| | *Acacia greggii* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Ambrosia dumosa* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Ephedra nevadensis* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Eriogonum fasciculatum* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Fagonia laevis* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Ferocactus cylindraceus* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Fouquieria splendens* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Galium stellatum* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Hibiscus denudatus* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Tetracoccus hallii* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Trixis* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| **Herb** | | | | | | | | | |
| | *Adenophyllum porophylloides* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Allionia incarnata* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Argythamnia neomexicana* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Mirabilis laevis var. villosa* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Pleuraphis rigida* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| **Nonvascular** | | | | | | | | | |
| | Cryptogammic crust | 100 | 0.2 | 0.2 | 0.2 | X | X | X | X |
| | Unknown Lichen | 100 | 0.2 | 0.2 | 0.2 | X | X | X | X |

## *Parkinsonia florida – Olneya tesota* Woodland Alliance

### Blue Palo Verde – Ironwood Woodland Alliance (Mapping code 16010)

The *Parkinsonia florida – Olneya tesota Woodland Alliance* occurs in scattered locations in southern California and possibly southwestern Arizona and adjacent Mexico. In California, the *Parkinsonia florida – Olneya tesota Alliance* is indicative of wash environments with a relatively high flood intensity and relatively high water availability. These woodlands usually occur as two strips of vegetation along the banks of a broad, sandy wash bed. Conservation Rank: G4, S3.

*Parkinsonia florida* is a relatively slow growing and long-lived species. *Parkinsonia florida* germinates well on sandy deposits (Pavek 1994). Shade and litter beneath mature *Parkinsonia florida* alters seed microsites and make germination more likely (Pavek 1994). Rapid, deep root development is important for *Parkinsonia florida* establishment. Mature *Parkinsonia florida* has deep root systems that reach groundwater and make *Parkinsonia florida* less vulnerable to drought.

The flat seeds of *Parkinsonia florida* prevent air loft and allow downward dispersal into washes, and fruits and seeds do not float; occasionally, *Parkinsonia florida* fruits disperse unopened. Some seed dispersal occurs via animals such as birds, which probably move seed upstream. Large seed banks of *Parkinsonia florida* may be present. Scarification from flash floods or other abrasive processes facilitates germination.

Natural recovery following disturbance is slow, and optimal conditions for reestablishment occur only infrequently. It may take up to 60 years for these woodlands to reach predisturbance levels of biomass and 180 years to reach predisturbance levels of species diversity (Pavek 1994). In southeastern California, *Parkinsonia florida* is a nurse plant for saguaro *(Carnegiea gigantea)* (Pavek 1994), which ultimately outlive or contribute to the death of paloverde species. *Parkinsonia florida* is susceptible to fire; its photosynthetic stems are probably easily killed by fire. It may sprout from the root crown if its postfire response is similar to its response to clipping.

*Olneya tesota* is also drought sensitive, particularly in the upland portions of its range. Most large individuals show characteristic limb drop during drought, and most older trees have several dead stems and limbs. The leaves are evergreen (or very rarely drought or frost deciduous) and will remain on the tree until an osmotic threshold is reached or until a few weeks following a frost (Shreeve and Wiggins 1964). Prolonged saturation of the soil will also kill trees (Shreeve and Wiggins 1964), although this is more likely to happen in Sonora, Mexico, than in California. It is most abundant in areas of the Sonoran Desert with <200 mm of annual rainfall. Thus, there are clear, physiological limits bounding the ecological distribution of the character species for this alliance.

The *Parkinsonia florida — Olneya tesota Woodland Alliance* has decreased in some areas of Arizona, partly due to the erosion of broad, flat washes into narrow, steep-sided channels (Pavek 1994). In the microphyll woodlands of the desert washes, disturbance by off-road vehicles decreases density and biomass of perennial plants such as *Parkinsonia florida* and *Olneya tesota*.

This alliance is well represented in Joshua Tree National Park by five associations: *Olneya tesota* Association, *Parkinsonia florida / Hyptis emoryi* Association, *Parkinsonia florida* / *Larrea tridentata – Peucephyllum schottii* Association, and *Parkinsonia florida – Olneya tesota* / *Cylindropuntia* sp. Association. The following additional sample from Joshua Tree National Park suggests further variation than what is currently reported:

*Parkinsonia florida – Olneya tesota / Hyptis emoryi* Association (JOTRA: 53-08-7)

## *Olneya tesota* Association

**Ironwood Association (Mapping code 16016)**

### Range

Globally: This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of the *Olneya tesota* Association have been sampled within the East of Victory Pass and Victory Pass 7.5-minute quadrangles.

### Environmental Description

Globally: This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of the *Olneya tesota* Association are found at low elevations (400–1,600 ft.; 100–500 m). Slopes are low (2 to 3 degrees), flat or undulating and usually southeast facing. Soil texture ranges from sand to fine sand derived from basaltic parent material. Ground cover consists of 0 percent bedrock, 0 percent boulder, 2–10 percent stone, 5–30 percent cobble, 25–76 percent gravel, and 5–40 percent fines cover. Litter cover varies from <1–5 percent.

### Vegetation Description

Globally: This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of *Olneya tesota* form sparse to open woodlands with 0–8 percent cover for the tree/tall stratum, 2–11 percent cover for the shrub/medium stratum, and <1–1 percent cover for the herb/low stratum. Total vegetative cover ranges from 5–20 percent.

This association is dominated by species *Olneya tesota* and the shrub *Larrea tridentata. Encelia farinosa* is a characteristic shrub species. Often present in the shrub layer are *Hyptis emoryi, Ambrosia salsola,* and *Krameria erecta*. Herbaceous species often present are *Allionia incarnata* and *Chamaesyce*.

### Other Noteworthy Species

*Ditaxis serrata* var. *californica* was found in one of the plots. *Ditaxis serrata* var. *californica* is a List 3 plant in the CRPR (CNPS 2010). It is found in Riverside and San Diego Counties and in the Sonoran Desert in Mexico at low to mid elevations (100–3,300 ft.; 30–1,000 m). (Syn: *Ditaxis californica* in the Jepson Manual.)

**Conservation Rank:** Rare

**Rank Justification**

*Olneya tesota* is highly valued for its wood, which has been used for charcoal and wood carvings. The latter fact has led to severely diminished stands in Sonora, Mexico. In California, threats come from OHV activity in washes. Fire does not seem to be an issue.

**Comments**

Globally : N/A

JOTR: This association is likely to occur in much of the California Sonoran (eastern Colorado) Desert and adjacent Mexico and Arizona.

Plots used for this description: N= 4; JOTRA: 53-08-2, 62-02-1; JOTR: JOTR23, JOTR88.

Map Accuracy Assessment plots: N=0.

**Stand Table**

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Tree** | | | | | | | | | |
| | ***Olneya tesota*** | **100** | **8.3** | **2.0** | **14.2** | **X** | **X** | **X** | **X** |
| **Shrub** | | | | | | | | | |
| | *Larrea tridentata* | 100 | 1.8 | 0.2 | 3.0 | X | X | X | X |
| | *Encelia farinosa* | 100 | 0.3 | 0.2 | 0.4 | | X | | X |
| | *Hyptis emoryi* | 50 | 1.3 | 2.0 | 3.0 | | | | X |
| | *Ambrosia salsola* | 50 | 0.2 | 0.2 | 0.4 | | | | X |
| | *Krameria erecta* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| **Herb** | | | | | | | | | |
| | *Allionia incarnata* | 50 | 0.4 | 0.2 | 1.2 | | | | X |
| | *Chamaesyce* | 50 | 0.1 | 0.2 | 0.2 | | | | X |

### *Parkinsonia florida / Hyptis emoryi* Association

**Blue Palo Verde / Desert Lavender Association (Mapping code 16015)**

#### Range

Globally: This association is only known from Joshua Tree National Park; however, similar stands have been sampled in Anza-Borrego Desert State Park (Keeler-Wolf et al. 1998). Information about its global characteristics is not available without additional inventory and analysis.

JOTR: Stands of the *Parkinsonia florida / Hyptis emoryi* Association occur primarily along the southern edge and eastern portions of the park and were sampled within the Buzzard Springs, Cottonwood Basin, Cottonwood Spring, Hayfield, Hayfield Springs and Pinto Wells, and Victory Pass 7.5-minute topographic quadrangles.

#### Environmental Description

Globally: This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of the *Parkinsonia florida / Hyptis emoryi* Association are found at low to mid elevations (1,000–2,700 ft.; 300–800 m). This association is usually found in drainages and on flat ground. Macrotopography varies, but these stands are often found in washes and occasionally in fluvial floodplains and channels; arroyos; and upland, alluvial deposits. *Parkinsonia florida / Hyptis emoryi* association is typically located on a loamy or sandy substrate derived from granitic parent material. Ground cover consists of 0 percent bedrock, 0–5 percent boulder, 0–30 percent stone, 0–40 percent cobble, 0–38 percent gravel, and 4–85 percent fines cover. Litter cover ranges from 1–7 percent. Disturbance levels from exotic species are low to moderate. Disturbance levels from vandalism/dumping/litter are low.

#### Vegetation Description

Globally: This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of the *Parkinsonia florida / Hyptis emoryi* Association form open woodlands with 0–24 percent cover for the tree/tall stratum, 2–12 percent cover for the shrub/medium stratum, and 2–12 percent cover for the herb/low stratum. Total vegetative cover ranges from 8–27 percent. Disturbance resulting from competition by exotic species is typically low.

This association is dominated by *Parkinsonia florida* in the tree layer. Characteristic shrub species are *Ambrosia salsola* and *Hyptis emoryi*. Cryptobiotic crust is an important characteristic understory component in this association. Often present in the shrub layer are *Acacia greggii, Bebbia juncea, Encelia farinosa* and *Opuntia*

*basilaris.* *Chamaesyce* spp.and the exotic species *Schismus* spp. are often present in the herb layer.

**Other Noteworthy Species**
*Coryphantha alversonii* was found in one of the plots. *Coryphantha alversonii* is a CRPR 4 plant (CNPS 2011). It is found in Imperial, Riverside, and San Bernardino Counties at low to high elevations (240–5,000 ft.; 73–1,500 m). (Syn: *Escobaria vivipara* var. *alversonii* in the Jepson Manual.)

**Conservation Rank:** Rare

**Rank Justification**
This type is relatively rare in California but may be more common in the Sonoran Desert outside the state in Arizona and Baja California.

**Comments**
Globally: N/A

JOTR: N/A

Plots used for this description: N=15; JOTRA: 24-06-2, 24-06-5, 25-04-2, 25-04-4, 32-06-3, 32-06-4, 39-02-1, 51-08-1, 53-08-1, 53-08-4, 53-08-5, 53-08-8, 56-06-7, 59-05-2; No-Ea ColoradoDesert: NECO788.

Map Accuracy Assessment plots: N=35; 25-1589, 25-1591, 25-1592, 25-1593, 25-1594, 25-1596, 25-1597, 25-1601, 25-1602, 25-1604, 25-1605, 25-1606, 25-1607, 25-1608, 25-1609, 25-1610, 25-1611, 25-1612, 25-1613, 25-1616, 25-1617, 25-1618, 25-1694, 25-1696, 25-1704, 25-1705, 25-1706, 25-1707, 25-1714, 25-1715, 25-1717, 25-1752a, 25-1757, 25-1759, 25-1760.

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Tree** | | | | | | | | | |
| | ***Parkinsonia florida*** | **100** | **7.0** | **1.0** | **22.2** | **X** | **X** | **X** | **X** |
| | *Psorothamnus spinosus* | 33 | 1.0 | 0.2 | 7.0 | | | | |
| **Shrub** | | | | | | | | | |
| | *Ambrosia salsola* | 93 | 1.2 | 0.2 | 3.2 | | X | | X |
| | ***Hyptis emoryi*** | **87** | **2.2** | **0.2** | **7.0** | | **X** | | **X** |
| | *Acacia greggii* | 73 | 0.5 | 0.2 | 2.0 | | | | X |
| | *Bebbia juncea* | 73 | 0.3 | 0.2 | 1.0 | | | | X |
| | *Encelia farinosa* | 67 | 0.4 | 0.2 | 2.2 | | | | X |
| | *Opuntia basilaris* | 60 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Larrea tridentata* | 47 | 0.4 | 0.2 | 3.0 | | | | |
| | *Brandegea bigelovii* | 47 | 0.2 | 0.2 | 1.2 | | | | |
| | *Ambrosia dumosa* | 47 | 0.1 | 0.2 | 0.2 | | | | |
| | *Cylindropuntia ramosissima* | 40 | 0.1 | 0.2 | 0.4 | | | | |
| | *Cylindropuntia echinocarpa* | 40 | 0.1 | 0.2 | 0.4 | | | | |
| | *Phoradendron californicum* | 40 | 0.1 | 0.2 | 0.6 | | | | |
| | *Psorothamnus schottii* | 33 | 0.3 | 0.2 | 2.0 | | | | |
| **Herb** | | | | | | | | | |
| | *Schismus* | 60 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Chamaesyce* | 53 | 0.1 | 0.2 | 0.4 | | | | X |
| | *Allionia incarnata* | 40 | 0.3 | 0.2 | 2.0 | | | | |
| | *Mirabilis laevis* var. *villosa* | 33 | 0.1 | 0.2 | 0.2 | | | | |
| **Nonvascular** | | | | | | | | | |
| | Cryptogammic crust | 60 | 0.3 | 0.2 | 1.4 | | | X | X |

### *Parkinsonia florida / Larrea tridentata – Peucephyllum schottii* Association
**Blue Palo Verde / Creosote Bush – Desert Fir Association (Mapping code 16013)**

**Range**

Globally: This association is known from California in the northern and eastern Colorado Desert and southern Mojave (Evens and Hartman 2007), including stands in Joshua Tree National Park.

JOTR: Stands of the *Parkinsonia florida / Larrea tridentata – Peucephyllum schottii* Association have been sampled within the Cottonwood Spring, Malapai Hill ,and Pinto Wells 7.5-minute topographic quadrangles.

**Environmental Description**

Globally: This association occurs at low to mid-elevations of the southern Mojave, found on dissected alluvial fans and flats.

JOTR: Stands of the *Parkinsonia florida / Larrea tridentata – Peucephyllum schottii* Association are found at low to mid elevations (1,000–3,800 ft.; 300–1,200 m). This association is usually found in dissected alluvial fans and washes on, flat to gentle to moderate (<1–6 degree) slopes facing northeast or southeast. Macrotopography is undulating. Soils range from sands to medium silt loams derived from basalt or granitic parent material. Ground cover consists of 0–9 percent bedrock, 0 percent boulder, 0–7 percent stone, <1–20 percent cobble, 17–77 percent gravel, and 40–65 percent fines cover. Litter cover ranges from 1–20 percent.

**Vegetation Description**

Globally: *Parkinsonia florida* occurs as the dominant emergent tree with *Larrea tridentata, Ambrosia salsola*, and *Peucephyllum schottii* (Evens and Hartman 2007). Other species are common in plots are few and include *Encelia farinosa, Acamptopappus sphaerocephalus,* and *Cylindropuntia* spp. at low cover.

JOTR: Stands of the *Parkinsonia florida / Larrea tridentata – Peucephyllum schottii* Association form an sparse to open woodland with 0–3 percent cover for the tree/tall stratum, 3–9 percent cover for the shrub/medium stratum, and <1–4 percent cover for the herb/low stratum. Total vegetative cover ranges from 7–12 percent.

This association is dominated by *Parkinsonia florida* in the tree layer and *Larrea tridentata* in the shrub layer. Another characteristic shrub species is *Ambrosia salsola*. *Acamptopappus sphaerocephalus*, *Cylindropuntia ramosissima,* and *Encelia farinosa* often occur in the shrub layer, and *Pleuraphis rigida* is often present in the herb layer.

**Other Noteworthy Species**
N/A
**Conservation Rank:** Rare

**Rank Justification**
This type is relatively rare in California but may be more common in the Sonoran Desert outside the state in Arizona and Baja California.

**Comments**
Globally: N/A

JOTR: N/A

Plots used for this description: N=5; JOTRA: 32-08-6, 59-05-3; Long: VMAL97-20, VPWELL97-1, VPWELL97-1.

Map Accuracy Assessment plots: N=30; 25-0010, 25-1619, 25-1620, 25-1622, 25-1623, 25-1624, 25-1625, 25-1626, 25-1628, 25-1629, 25-1630, 25-1631, 25-1632, 25-1633, 25-1634, 25-1635, 25-1636, 25-1637, 25-1638, 25-1639, 25-1640, 25-1642, 25-1643, 25-1644, 25-1646, 25-1647, 25-1648, 25-1649, 25-1697, 50-0539.

**Stand Table**

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Tree** | | | | | | | | | |
| | ***Parkinsonia florida*** | **100** | **3.4** | **0.4** | **8.2** | **X** | **X** | **X** | **X** |
| **Shrub** | | | | | | | | | |
| | *Ambrosia salsola* | 100 | 0.8 | 0.2 | 3.0 | | X | | X |
| | ***Larrea tridentata*** | **80** | **2.0** | **1.0** | **3.0** | **X** | **X** | **X** | **X** |
| | *Acamptopappus sphaerocephalus* | 60 | 1.2 | 0.2 | 3.0 | | | X | X |
| | *Cylindropuntia ramosissima* | 60 | 0.2 | 0.2 | 0.4 | | | | X |
| | *Cylindropuntia echinocarpa* | 40 | 0.2 | 0.4 | 0.4 | | | | |
| | *Phoradendron californicum* | 40 | 0.1 | 0.2 | 0.2 | | | | |
| | *Encelia farinosa* | 40 | 0.1 | 0.2 | 0.2 | | | | |
| **Herb** | | | | | | | | | |
| | *Pleuraphis rigida* | 60 | 0.8 | 1.0 | 2.0 | | | | X |

### *Parkinsonia florida – Olneya tesota / Cylindropuntia sp.* Association
**Blue Palo Verde – Ironwood / Cholla Association (Mapping code 16024)**

**Range**

Globally: This association is known from the southern Mojave in Joshua Tree National Park and in the northern and eastern Colorado Desert (Evens and Hartman 2007).

JOTR: Stands of the *Parkinsonia florida – Olneya tesota* / *Cylindropuntia* sp. Association have been sampled within the Cottonwood Spring, Hayfield, and Hayfield Spring 7.5-minute topographic quadrangles.

**Environmental Description**

Globally: This association is found at low to mid elevations (125–660 m) in washes, arroyos and dissected alluvial fans in the Colorado, Sonoran and southern Mojave desert sections of California (Evens and Hartman 2007)

JOTR: Stands of the *Parkinsonia florida – Olneya tesota* / *Cylindropuntia sp*. Association are found at low elevations (1,800–2,000 ft.; 600–660 m). This association is usually found on gentle (1–5 degrees) slopes in washes and occasionally in fluvial floodplains and channels; arroyos; and upland, alluvial deposits. This association is typically located on a sandy substrate derived from granitic parent material. Ground cover consists of 0 percent bedrock, 0 percent boulder, 0–3 percent stone, <1–2 percent cobble, 35–50 percent gravel, and 15–50 percent fines cover. Litter cover ranges from 3–8 percent.

**Vegetation Description**

Globally: The tree layer is dominated by *Olneya tesota* or codominated by *O. tesota* with *Parkinsonia florida.* The shrub layer is variable, though it is characterized by presence of cactus species such as *Cylindropuntia bigelovii, C. echinocarpa, C. munzii,* and *C. ramosissima*. Other shrubs regularly occurring in stands include *Ambrosia salsola, Encelia farinosa, Hyptis emoryi,* and *Larrea tridentata.*

JOTR: Stands of the *Parkinsonia florida – Olneya tesota* / *Cylindropuntia* sp. Association form an open woodland with 0–6 percent cover for the tree/tall stratum, 1–27 percent cover for the shrub/medium stratum, and 1–27 percent cover for the herb/low stratum. Total vegetative cover ranges from 10–15 percent.

This association is dominated by *Olneya tesota* in the tree layer. Characteristic shrub species are *Ambrosia salsola, Cylindropuntia echinocarpa, Cylindropuntia ramosissima, Encelia farinosa* and *Larrea tridentata.* Often occurring species include *Ambrosia dumosa* and *Hyptis emoryi*. Another often occurring species from the map accuracy assessment samples includes *Cylindropuntia bigelovii.* The exotic species

*Schismus* sp. is characteristically present. Cryptobiotic crust is abundant and is an important characteristic understory component in this association.

**Other Noteworthy Species**
N/A

**Conservation Rank:** Rare

**Rank Justification**
This type is relatively rare in California but may also occur in the Sonoran Desert outside the state in Arizona and Baja California.

**Comments**
Globally: The *Parkinsonia florida – Olneya tesota / Cylindropuntia munzii* Association defined by Evens and Hartman (2007) is corollary with this *Parkinsonia florida – Olneya tesota / Cylindropuntia* spp. Association defined from Joshua Tree National Park.

JOTR: N/A

Plots used for this description: N=5; JOTRA: 33-02-1, 38-02-1; Long: VCOT97-1, VCOT97-1; No-Ea ColoradoDesert: NECO789.

Map Accuracy Assessment plots: N=29; 25-1559, 25-1560, 25-1561, 25-1563, 25-1564, 25-1565, 25-1566, 25-1567, 25-1568, 25-1569, 25-1570, 25-1571, 25-1572, 25-1573, 25-1574, 25-1575, 25-1576, 25-1577, 25-1578, 25-1579, 25-1580, 25-1581, 25-1582, 25-1583, 25-1584, 25-1585, 25-1586, 25-1587, 25-1588.

## Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Tree** | | | | | | | | | |
| | ***Olneya tesota*** | **100** | **3.0** | **1.2** | **6.0** | **X** | **X** | **X** | **X** |
| | ***Parkinsonia florida*** | **60** | **1.0** | **0.2** | **2.7** | | | | **X** |
| **Shrub** | | | | | | | | | |
| | *Ambrosia salsola* | 100 | 1.4 | 0.2 | 3.2 | | X | | X |
| | ***Cylindropuntia ramosissima*** | **100** | **0.8** | **0.2** | **2.2** | | **X** | | **X** |
| | *Encelia farinosa* | 100 | 2.2 | 0.2 | 4.0 | | X | | X |
| | ***Cylindropuntia echinocarpa*** | **80** | **0.2** | **0.2** | **0.4** | | **X** | | **X** |
| | *Larrea tridentata* | 80 | 5.0 | 1.0 | 15.0 | | X | | X |
| | *Ambrosia dumosa* | 60 | 2.2 | 0.4 | 10.0 | | | | X |
| | *Hyptis emoryi* | 60 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Echinocereus engelmannii* | 40 | 0.1 | 0.2 | 0.2 | | | | |
| | *Opuntia basilaris* | 40 | 0.1 | 0.2 | 0.2 | | | | |
| **Herb** | | | | | | | | | |
| | *Schismus* | 80 | 3.5 | 0.2 | 15.0 | | X | | X |
| | *Erodium cicutarium* | 40 | 3.0 | 3.0 | 12.0 | | | | |
| | *Chamaesyce* | 40 | 0.4 | 0.2 | 2.0 | | | | |
| | *Pectis papposa* | 40 | 0.2 | 0.2 | 1.0 | | | | |
| | *Palafoxia arida* | 40 | 0.1 | 0.2 | 0.4 | | | | |
| | *Eriogonum inflatum* | 40 | 0.1 | 0.2 | 0.2 | | | | |
| | *Physalis crassifolia* | 40 | 0.1 | 0.2 | 0.2 | | | | |
| **Nonvascular** | | | | | | | | | |
| | Cryptogammic crust | 60 | 0.2 | 0.2 | 0.4 | | | X | X |

## *Prosopis glandulosa* Woodland Alliance

**Honey Mesquite Woodland Alliance (Mapping code 16040)**

The *Prosopis glandulosa* Woodland Alliance occurs in the desert portions of California, the Big Bend and west to the plains and coastal prairies of southern Texas; as well as in the western states of Oklahoma, New Mexico, Nevada, and Arizona. It also is found in the Mexican states of Chihuahua, Coahuila, Nuevo León, Sonora, Tamaulipas (NatureServe 2011), and Baja California. In California, it occurs in the southern San Joaquin Valley, Mojave Desert, Colorado Desert, Sonoran Desert, and southeastern Great Basin regions (Sawyer et al. 2009). Conservation rank: G5, S3.

Plants in California are represented by *P. glandulosa* var. *torreyana*, a deciduous, thorny shrub or small tree, which are restricted to areas with access to permanent underground water sources. The physiognomy of this species varies with habitat. Along river margins, stands of broad-crowned trees grow to 10 m in height; on sandy, windswept soils where dunes often form, shrubs are low spreading and multistemmed, growing to 4 m in height; at springs and playa edges shrubs are somewhat intermediate in height. Plants produce abundant seed that remain viable for > 40 years. Germination requires stratification, and seeds germinate commonly from rodent caches. In the hot deserts, conditions favoring plant establishment follow periods of intense rain, usually once every 5–10 years (Steinberg 2001).

Natural disturbance processes include frost, flooding, shifting sand, and locally occurring fires. Frost sensitivity of *P. glandulosa* limits the alliance's distribution to below 1,100 m in California, and low, shrubby forms may result from occasional periods of cold weather at their extreme northern and higher-elevation occurrences. Fluvial processes and shifting, wind-blown sand rather than fire typically affect stands. Floods allow seedling establishment, but they also deplete stands by undercutting and erosion. Shifting sand buries clones at dune and playa margins, and it rarely augments seedling recruitment (Sawyer et al. 2009). Little specific information exists on its fire response. Top kill and mortality of other mesquites *(P. g.* var. *glandulosa, P. velutina)* are most influenced by the size of plants and the intensity of fire. Observations (T. Keeler-Wolf 1998) in Anza-Borrego State Park and Joshua Tree National Park, and along the Colorado River, suggest that *P. g.* var. *torreyana* responds similarly.

The primary extractive use of *P. glandulosa* is firewood. Some stands in California have been decimated. The sweet tasting pods are high in protein and sugars and are avidly eaten by most livestock. Livestock often remove fruits as high as they can reach and eat fallen pods lying on the ground (Becker 1982). *Tamarix* spp. have become established along many rivers and desert wetlands and replaced *P. glandulosa* stands. Groundwater pumping or alterations of the flooding regime have precipitated the decline of numerous stands in the deserts.

This alliance is represented in Joshua Tree National Park by two associations: *Prosopis glandulosa* Association and *Prosopis glandulosa / Atriplex* spp. Association.

## *Prosopis glandulosa* Association

**Honey Mesquite Association (Mapping code 16041)**

### Range

Globally: This association is known from the central Mojave Desert (Keeler-Wolf and Thomas 2000), southern Mojave Desert including Joshua Tree National Park, and the Sonoran Desert. Stands are apparent at Mesquite Dunes and adjacent to Palen Lake along sand dunes near the Park, though these stands have not been described.

JOTR: The *Prosopis glandulosa* Association was sampled in the Cottonwood Spring, Indian Cove, and Queen Mtn. 7.5-minute topographic quadrangles.

### Environmental Description

Globally: This association is has only been described from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of *Prosopis glandulosa* Association occur at mid elevation (2,800–3,300 ft.; 90–1,000 m) on concave, flat, or undulating surfaces. Stands primarily occur in and adjacent to sandy washes. Soils are primarily sands or sometimes loams. Ground cover consists of 0–3 percent cover bedrock, 0–3 percent cover boulders, 0 percent cover stone, 0–1 percent cobble, 0–2 percent gravel, and 3–22 percent fines. Litter cover ranges from 1–5 percent.

### Vegetation Description

Globally: This association has only been described from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of the *Prosopis glandulosa* Association form a continuous woodland with 0–21 percent cover in the tall/tree stratum, 58–88 percent cover in the shrub/mid stratum, and 0–1 percent cover in the herb/low stratum. Total vegetation cover ranges from 75–88 percent.

Stands are dominated by *Prosopis glandulosa* and characteristic species include *Acacia greggii* and *Lycium andersonii*. Often occurring species include *Baccharis sergiloides, Bebbia juncea, Cleome isomeris, Larrea tridentata, Phoradendron californicum, Viguiera parishii,* and *Muhlenbergia rigens.*

### Other Noteworthy Species

N/A

**Conservation Rank:** Rare

**Rank Justification**
Stands are localized in washes and canyon bottoms of the Cottonwood Spring, Indian Cove, and Palms Canyon areas in Joshua Tree National Park, and other stands in the Mojave are also localized where permanent underground water is available.

**Comments**
Globally : Plots have been classified as this association in the central Mojave Project (Keeler-Wolf and Thomas 2000, Thomas et al. 2004), and have been observed near the Park, but they have not been described. These stands occur along dunes as well as washes where plants can tap into groundwater.

JOTR: N/A

Plots used for this description: N=3, JOTRA: 16-26-3, 18B-06-1, 32-06-1, 32-08-5.

Map Accuracy Assessment plots: N=3; 25-1464, 25-1466, 25-1467.

**Stand Table**

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Tree** | | | | | | | | | |
| | ***Prosopis glandulosa*** | **100** | **69.1** | **60.0** | **84.0** | **X** | **X** | **X** | **X** |
| **Shrub** | | | | | | | | | |
| | *Lycium andersonii* | 100 | 0.9 | 0.2 | 3.0 | | X | | X |
| | *Acacia greggii* | 75 | 2.9 | 1.0 | 5.2 | | X | | X |
| | *Cleome isomeris* | 50 | 1.5 | 2.0 | 4.0 | | | | X |
| | *Larrea tridentata* | 50 | 1.0 | 1.0 | 3.0 | | | | X |
| | *Baccharis sergiloides* | 50 | 0.6 | 1.0 | 1.2 | | | | X |
| | *Phoradendron californicum* | 50 | 0.3 | 0.2 | 1.0 | | | | X |
| | *Bebbia juncea* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Viguiera parishii* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| **Herb** | | | | | | | | | |
| | *Muhlenbergia rigens* | 50 | 0.2 | 0.4 | 0.4 | | | | X |

### *Prosopis glandulosa / Atriplex spp. – Suaeda moquinii* Association
**Honey Mesquite / Saltbush – Bush Seepweed Association (Mapping code 16043)**

**Range**

Globally: The *Prosopis glandulosa / Atriplex* spp. – *Suaeda moquinii* Assocation (cf. Evens and Hartman 2007) was identified in the Palen Lake area of the Chuckwalla Valley in the Sonoran Desert. Two other associations identified in Anza-Borrego Desert State Park, the *Prosopis glandulosa* alkaline Association with *Atriplex* spp. and the *Prosopis glandulosa* alkaline spring Association, are corollary to this type.

JOTR: The *Prosopis glandulosa / Atriplex* spp. – *Suaeda moquinii* Association was sampled in the East of Victory Pass 7.5-minute topographic quadrangle.

**Environmental Description**

Globally: This association occurs on sand dunes and sand flats near Palen Lake (Evens and Hartman 2007), and other similar stands occur at Mesquite Lake and Mesquite Dunes north of Twentynine Palms. The association also occurs around edges of Clark Dry Lake, Borrego Sink, and major wetlands adjacent to low elevation washes such as Carrizo Marsh and Middle and Lower Willows, as well as at springs adjacent to mud hills and badlands as at Palm Spring, within Anza-Borrego Desert State Park (Keeler-Wolf et al. 1998).

JOTR: Stands of *Prosopis glandulosa / Atriplex* spp. – *Suaeda moquinii* Association occur at low elevation (400–500 ft.; 100 m) on the lower third of southeasterly slope aspects. Slopes are gentle (1 degree) with flat or undulating topography. Soils are sands derived from basaltic parent material, and the soils are alkaline and primarily with fine sediments. Ground cover consists of 0 percent cover bedrock, 0 percent cover boulders, 0–4 percent cover stone, 8–21 percent cobble, 45–78 percent gravel, and 8–21 percent fines. Litter cover ranges from <1–2 percent. Two stands were sampled in a wash and nearby southeastern base of Coxcomb Mountains, which receive seasonal flooding.

**Vegetation Description**

Globally: A stand sampled on the periphery of Palen Lake of this association forms an open to intermittent woodland with 38 percent tree cover of *Prosopis glandulosa,* and 3 percent cover shrub cover of *Atriplex hymenelytra, A. polycarpa,* and *Suaeda moquinii* (Evens and Hartman 2007). Stands sampled in Anza-Borrego Desert State Park occur with *Atriplex* spp. along dry lakes, sinks and washes, and at springs with *Atriplex* spp. and *Suaeda moquinii* (Keeler-Wolf et al. 1998).

JOTR: Stands of the *Prosopis glandulosa / Atriplex* spp. – *Suaeda moquinii* Association form an open woodland with 0–8 percent cover in the tall/tree stratum, 11 percent

cover in the shrub/mid stratum, and 0–<1 percent cover in the herb/low stratum. Total vegetation cover ranges from 11–19 percent.

**Other Noteworthy Species**
N/A

**Conservation Rank:** Rare

**Rank Justification**
Stands appear to occur in the Mojave and Sonoran Deserts of California as localized woodlands along alkaline washes, adjacent to playas, and at spring sinks.

**Comments**
Globally : This report takes a more inclusive approach for defining this association. Stands sampled in the adjacent Palen Lake area (identified as *Prosopis glandulosa / Atriplex* spp.) as well as stands defined from Anza-Borrego Desert State Park (identified as two different Mesquite alkaline associations) have been combined into this one association since all of these stands appear to have presence of *Atriplex spp.* and *Suaeda moquinii* at varying cover.

JOTR: N/A
Plots used for this description: N=2, JOTRA: 66-02-2; JOTR: JOTR97.

Map Accuracy Assessment plots: N=2; 25-1465, 25-1468.

**Stand Table**

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Tree** | | | | | | | | | |
| | ***Prosopis glandulosa*** | **100** | **6.0** | **4.0** | **8.0** | **X** | **X** | **X** | **X** |
| **Shrub** | | | | | | | | | |
| | ***Suaeda moquinii*** | **100** | **3.1** | **3.0** | **3.2** | **X** | **X** | **X** | **X** |
| | ***Atriplex hymenelytra*** | **100** | **2.1** | **1.2** | **3.0** | | **X** | | **X** |
| | *Larrea tridentata* | 100 | 2.0 | 1.0 | 3.0 | | X | | X |
| | ***Atriplex canescens*** | **50** | **1.1** | **2.2** | **2.2** | | | | **X** |
| | *Phoradendron californicum* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| **Herb** | | | | | | | | | |
| | ***Atriplex californica*** | **50** | **1.0** | **2.0** | **2.0** | | | **X** | **X** |
| | *Oenothera deltoides* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Chamaesyce polycarpa* | 50 | 0.1 | 0.2 | 0.2 | | | | X |

## *Psorothamnus spinosus* Woodland Alliance

**Smoketree Woodland Alliance (Mapping code 16030)**

The *Psorothamnus spinosus* Shrubland Alliance occurs in the Mojave Desert, Sonoran Desert, and Colorado Desert regions of California; in southern Nevada and western Arizona; and in Baja California and Sonora, Mexico (NatureServe 2011). In California, it occurs strictly in washes throughout the hot deserts and is strongly tied to active wash and arroyo channels where flooding is relatively common. Conservation rank: G4, S3.

Compared to other wash alliances characterized by tall, woody shrubs or small trees, *Psorothamnus spinosus* occurs in the most active channels; prefers sandy, not bouldery or cobbly substrates; and stands are relatively short lived. It occurs farther north in the Mojave (vicinity of Baker, Cady Mountains) and ascends to higher elevations (more cold tolerant) than *Olneya* or *Cercidium* alliances. In many cases, this alliance is part of a matrix with other shrub and small tree alliances comprising a patchwork of small stands within a wash system. Compared to the *Chilopsis linearis* alliance, it is less cold tolerant and more likely to occupy active wash bottoms as compared to margins.

*Psorothamnus spinosus* is a relatively short-lived species (probably not over 50 years) and is dependent upon intermittent flooding events for stand establishment. Seeds have a hard seed coat that requires scarification to germinate (Turner et al. 1995). Even-aged stands are common, although some stands have two or three age classes represented. It is possible that seeds survive for relatively long periods in the substrate and may even out survive existing plants. Flood intensities are highly variable and range from < 2 cfs to >10,000 cfs (Waananen and Crippen 1977). Peak discharge in many of the washes at 100-year flood intervals is <500 cfs (Waananen and Crippen 1977). It is likely that 25-year peak discharges as low as 16 cfs are adequate to initiate significant stand regeneration. The largest and densest stands occur primarily on sand or small gravel within channels of a wash, suggesting that flooding is responsible for establishment of the denser stands in most cases. Resprouting is evident after mechanical damage.

Because this species is short lived and requires intermittent flood events for establishment, stands may wink in and out of existence. Therefore, big wash systems are needed to represent this alliance over the long term in conservation planning. Intensive human use of washes (OHV use and gravel mining) is detrimental to stands of the alliance.

This alliance is represented in Joshua Tree National Park by the *Psorothamnus spinosus* / *Ephedra californica – Ambrosia salsola* Association and the *Psorothamnus spinosus / Hyptis emoryi – Acacia greggii* Association.

### *Psorothamnus spinosus / Ephedra californica – Ambrosia salsola* Association

**Smoketree / California Joint Fir – Cheesebush Association (Mapping code 16036, not mapped)**

#### Range

Globally: Stands of this association have been defined from the southern and eastern Mojave Desert of California (Evens 2000) and including stands from Joshua Tree National Park. Also, the *Psorothamnus spinosus – Ephedra (californica) – Ambrosia salsola* Association has been defined from the northern and eastern Colorado Desert and southern Mojave Desert (Evens and Hartman 2007).

JOTR: Stands of the *Psorothamnus spinosus / Ephedra californica – Ambrosia salsola* Association have been sampled in the central and eastern parts of the park and were sampled within the San Bernardino Wash and Queen Mountains 7.5-minute topographic quadrangles.

#### Environmental Description

Globally: In the northern and eastern Colorado Desert, this association typically occurs within sandy or mixed sandy-gravelly, active washes at low to mid elevations (250–800 m). These washes are usually gentle or moderate (0–7 degrees) in slope (Evens and Hartman 2007). In the southeastern Mojave Desert, stands occurred on gently sloping, gravelly and sandy washes at mid elevations (below 1000 m), including below the Granite Mountains in Willow Wash (Evens 2000).

JOTR: Stands of the *Psorothamnus spinosus / Ephedra californica – Ambrosia salsola* Association are found at low to mid elevations (1,600–2,800 ft.; 500–800 m) on gently sloping surfaces (2 degrees) with a slightly northeasterly aspect. Soils are usually sands derived from plutonic parent material. Ground cover in these stands consists of 0 percent bedrock, 0 percent boulder, 0–<1 percent stone, <2 percent cobble, 2–87 percent gravel, and 10–87 percent fines. Litter ranges from <1–3 percent cover. These sites generally experience low levels of disturbance from competition from exotics and moderate levels of disturbance from road/trail construction/maintenance.

#### Vegetation Description

Globally: This association is dominated in the tree layer by *Psorothamnus spinosus*, though *Chilopsis linearis* may sometimes occur at low cover. Characteristic shrubs include *Ambrosia salsola, Ephedra californica (*or *E. nevadensis*), and *Cleome isomeris.* Other shrubs often present include *Ambrosia dumosa*, *Bebbia juncea, Cylindropuntia echinocarpa,* and *Larrea tridentata.* The herb layer is typically sparse, with the most often occurring herbs being *Chamaesyce* spp. and *Stephanomeria pauciflora.*

JOTR: Stands of the *Psorothamnus spinosus / Ephedra californica – Ambrosia salsola* Association form a sparse shrubland with 1 percent cover in the tree/tall stratum, 7

percent cover in the shrub/mid stratum, and <1–1 percent cover in the herb/low stratum. Total vegetation cover is typically 8 percent.

This association is dominated by *Psorothamnus spinosus* in the tree layer. Characteristic species are *Ambrosia salsola, Cleome isomeris,* and *Petalonyx thurberi. Stephanomeria pauciflora* occurs commonly and exhibits highest average cover in the herb layer. Often occurring species are *Ambrosia dumosa, Brandegea bigelovii, Cylindropuntia echinocarpa, C. ramosissima, Ephedra californica, Larrea tridentata, Psorothamnus schottii, Chamaesyce* spp., *Cucurbita palmata, Datura wrightii, Erodium cicutarium,* and *Schismus* spp.

**Other Noteworthy Species** N/A

**Conservation Rank:** Rare

**Rank Justification**
Stands are scattered in sandy and gravelly washes of the Sonoran and Mojave Deserts.

**Comments**
Globally: N/A

JOTR: Additional reference sampling of these stands is needed to better describe this association within the Park.

Plots used for this description: N=2, JOTRA: 37B-17-1; MDEI: 158-1-6

Map Accuracy Assessment plots: N=0.

## Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Tree** | | | | | | | | | |
| | ***Psorothamnus spinosus*** | **100** | **4.1** | **3.0** | **5.2** | **X** | **X** | **X** | **X** |
| **Shrub** | | | | | | | | | |
| | ***Ambrosia salsola*** | **100** | **2.4** | **1.2** | **3.5** | | **X** | | **X** |
| | *Petalonyx thurberi* | 100 | 0.9 | 0.2 | 1.5 | | X | | X |
| | *Cleome isomeris* | 100 | 0.6 | 0.2 | 1.0 | | X | | X |
| | *Larrea tridentata* | 50 | 1.0 | 2.0 | 2.0 | | | | X |
| | *Cylindropuntia ramosissima* | 50 | 0.3 | 0.5 | 0.5 | | | | X |
| | *Cylindropuntia echinocarpa* | 50 | 0.3 | 0.5 | 0.5 | | | | X |
| | ***Ephedra californica*** | **50** | **0.1** | **0.2** | **0.2** | | | | **X** |
| | *Brandegea bigelovii* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Ambrosia dumosa* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Psorothamnus schottii* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| **Herb** | | | | | | | | | |
| | *Stephanomeria pauciflora* | 50 | 0.5 | 1.0 | 1.0 | | | X | X |
| | *Chamaesyce* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Schismus* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Erodium cicutarium* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Cucurbita palmata* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Datura wrightii* | 50 | 0.1 | 0.2 | 0.2 | | | | X |

### *Psorothamnus spinosus / Hyptis emoryi – Acacia greggii* Association
**Smoketree / Desert-Lavender – Catclaw Association (Mapping code 16035)**

#### Range

Globally: This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory. This type is likely to occur in the adjacent parts of the Mojave and Sonoran deserts.

JOTR: Stands of the *Psorothamnus spinosus / Hyptis emoryi – Acacia greggii* Association are found primarily in the central and eastern portions of the park and were sampled in the Cadiz Valley Southwest, Clarks Pass, Cottonwood Basin, Cottonwood Spring, Coxcomb Mountains, Fried Liver Wash, Porcupine Wash, San Bernardino Wash, and Washington Wash 7.5-minute topographic quadrangles.

#### Environmental Description

Globally: This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of *Psorothamnus spinosus / Hyptis emoryi – Acacia greggii* Association are found at low to mid elevations (1,200–3,200 ft.; 400–1,000 m) on primarily northeasterly slope aspects in sandy and gravelly, active washes. Slopes are gentle (2 degrees) with flat, undulating, or hummocky and swaley topographies. Soils range from sands to loams derived from granitic parent materials. Ground cover consists of 0–3 percent bedrock, 0 percent boulder, 0 percent stone, 0–25 percent cobble, 3–63 percent gravel, and 25–85 percent fines. Litter ranges from 0–5 percent cover. These sites generally experience low levels of disturbance from competition from exotics and moderate levels of disturbance from vandalism/dumping/litter.

#### Vegetation Description

Globally: This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of the *Psorothamnus spinosus / Hyptis emoryi – Acacia greggii* Association form a sparse to open shrubland with 0–6 percent cover in the tree/tall stratum, 4–14 percent cover in the shrub/mid stratum, and –5 percent cover in the herb/low stratum. Total vegetation cover ranges from 5–15 percent.

Characteristic species of this association are *Psorothamnus spinosus* in the tree layer and *Acacia greggii, Ambrosia salsola,* and *Larrea tridentata* in the shrub layer. *Hyptis emoryi* along with *Acacia greggii* and *Ambrosia salsola* exhibit the highest cover of shrubs. Cryptobioic crusts and *Chamaesyce* spp. are often present.

**Other Noteworthy Species**

*Coryphantha alversonii* was found in two of the plots. *Coryphantha alversonii* is a List 4 plant in the CRPR (CNPS 2010). It is found in Imperial, Riverside, and San Bernardino counties at low to high elevations (240–5,000 ft.; 73–1,500 m). (Syn: *Escobaria vivipara* var. *alversonii* in the Jepson Manual.)

**Conservation Rank:** Rare

**Rank Justification**

This association is restricted to small stands along washes in the warm deserts of California and perhaps adjacent Arizona and Mexico.

**Comments**

Globally: A related *Psorothamnus spinosus – Acacia greggii – Ericameria nauseosa* Assocation was described from four samples in the Bullion Mountains – Bristol Lake subsection in the southern Mojave Desert. More sampling of this type is needed to confirm if this type should be differentiated from this *Psorothamnus spinosus / Hyptis emoryi – Acacia greggii* Association.

JOTR: Vegetation Accuracy Assessment data of this association exhibits *P. spinosus* as the dominant tree, while *Acacia greggii* is often present without *Hyptis emoryi.* Other shrubs, including *Ambrosia salsola* and *Larrea tridentata* are characteristic in this dataset.

Plots used for this description: N=11, JOTRA: 25-04-1, 27B-12-6, 29B-02-2, 31-07-5, 35C-08-1, 38-28-2, 44-18-4, 58B-01-1, 58B-01-2, 63-18-3; MDEI: 155-1-1.

Map Accuracy Assessment plots: N=52; 25-1399, 25-1470, 25-1471, 25-1473, 25-1475, 25-1477, 25-1478, 25-1482, 25-1483, 25-1488, 25-1489, 25-1491, 25-1492, 25-1493, 25-1495, 25-1497, 25-1498, 25-1501, 25-1502, 25-1503, 25-1504, 25-1505, 25-1506, 25-1507, 25-1508, 25-1509, 25-1510, 25-1511, 25-1512, 25-1514, 25-1519, 25-1520, 25-1521, 25-1523, 25-1524, 25-1526, 25-1527, 25-1528, 25-1693.

## Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Tree** | | | | | | | | | |
| | ***Psorothamnus spinosus*** | **100** | **2.9** | **0.2** | **6.2** | **X** | **X** | **X** | **X** |
| **Shrub** | | | | | | | | | |
| | *Ambrosia salsola* | 100 | 2.4 | 0.4 | 5.2 | | X | | X |
| | ***Acacia greggii*** | **91** | **1.5** | **0.2** | **4.2** | | **X** | | **X** |
| | *Larrea tridentata* | 82 | 0.6 | 0.2 | 2.0 | | X | | X |
| | *Psorothamnus schottii* | 45 | 0.2 | 0.2 | 1.0 | | | | |
| | *Cylindropuntia echinocarpa* | 45 | 0.1 | 0.2 | 0.5 | | | | |
| | ***Hyptis emoryi*** | **36** | **0.9** | **1.2** | **4.2** | | | | |
| | *Ephedra californica* | 36 | 0.6 | 1.0 | 4.0 | | | | |
| | *Cleome isomeris* | 36 | 0.3 | 0.2 | 2.0 | | | | |
| | *Bebbia juncea* | 36 | 0.2 | 0.2 | 1.2 | | | | |
| | *Phoradendron californicum* | 36 | 0.2 | 0.2 | 1.0 | | | | |
| | *Brandegea bigelovii* | 36 | 0.1 | 0.2 | 0.4 | | | | |
| | *Funastrum cynanchoides* ssp. | 36 | 0.1 | 0.2 | 0.4 | | | | |
| | *Krameria grayi* | 36 | 0.1 | 0.2 | 0.2 | | | | |
| **Herb** | | | | | | | | | |
| | *Chamaesyce* | 55 | 0.1 | 0.2 | 0.4 | | | | X |
| | *Chamaesyce polycarpa* | 36 | 0.1 | 0.2 | 0.2 | | | | |
| | *Mirabilis laevis* var. *villosa* | 36 | 0.1 | 0.2 | 0.5 | | | | |
| **Nonvascular** | | | | | | | | | |
| | Cryptogammic crust | 55 | 0.1 | 0.2 | 0.5 | | | X | X |

## *Ziziphus obtusifolia* Shrubland Special Stands

### Lotebush Special Stands (Mapping code 15070, not mapped)

*Ziziphus obtusifolia* Shrubland Special Stands are not well described. These stands are known from Joshua Tree National Park along small washes, and from the Little Maria and Palen mountains of the southern Mojave and Sonoran Deserts, and in the Chihuahuan Desert (Sawyer et al. 2009). Conservation rank: G2, S2(?).

*Ziziphus obtusifolia* is a large shrub with robust, gray stems that end in stout thorns, forming thickets to 3 m in height. The nectar-rich flowers are inconspicuous and appear in summer after rains. Seed coats are impermeable to water, and they require scarification of the seed coat to initiate germination. Plants sprout from branches and root crowns, and growth can be rapid if moisture in available (Nellessen 2002).

*Ziziphus obtusifolia* forms occasional stands in small drainages and near springs in washes at low elevations in the Colorado and Sonoran deserts of California. Plants here, recognized as var. *canescens*, have smaller leaves than the form that grows in the Chihuahuan Desert.

This alliance is represented in Joshua Tree National Park by one sampled stand (see Stand Table on next page), occurring just upstream from a *Washingtonia filifera* stand in the Cottonwood Springs area:

*Ziziphus obtusifolia – Salix exigua – Atriplex canescens* (JOTR: 32-08-4)

## Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Tree** | | | | | | | | | |
| | *Prosopis glandulosa* | 100 | 2.0 | 2.0 | 2.0 | X | X | X | X |
| | *Populus fremontii* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| **Shrub** | | | | | | | | | |
| | ***Ziziphus obtusifolia*** | **100** | **35.0** | **35.0** | **35.0** | **X** | **X** | **X** | **X** |
| | *Atriplex canescens* | 100 | 17.0 | 17.0 | 17.0 | | X | | X |
| | *Salix exigua* | 100 | 13.2 | 13.2 | 13.2 | | X | | X |
| | *Baccharis sergiloides* | 100 | 2.0 | 2.0 | 2.0 | | X | | X |
| | *Cleome isomeris* | 100 | 2.0 | 2.0 | 2.0 | | X | | X |
| | *Acacia greggii* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Phoradendron californicum* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Rhus trilobata* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| **Herb** | | | | | | | | | |
| | *Epilobium canum* | 100 | 3.2 | 3.2 | 3.2 | X | X | X | X |
| | *Lotus* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Phacelia campanularia* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Salvia columbariae* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Schismus* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| **Nonvascular** | | | | | | | | | |
| | Unknown Moss | 100 | 0.2 | 0.2 | 0.2 | X | X | X | X |

## Warm Semi-Desert Shrub & Herb Wash-Arroyo Group

### *Acacia greggii* Shrubland Alliance

**Catclaw Acacia Shrubland Alliance (Mapping code 36010)**

The *Acacia greggii* Shrubland Alliance occurs in the Mojave Desert, Sonoran Desert, Colorado Desert, and mountain and valley regions of southern California (Sawyer et al. 2009); and in southern Nevada, western Arizona, Texas, Utah, New Mexico and Baja California, Mexico (NatureServe 2011). Conservation rank: G5, S4.

In washes, the *Acacia greggii* Shrubland Alliance occupies habitat similar to other leguminous microphyll alliances in the Colorado and Sonoran Deserts. The *Acacia greggii* Shrubland Alliance extends farther north into the Mojave than any of these. Because it is relatively frost tolerant, it also ascends into the desert mountains and the adjacent desert transition zone of the Peninsular Ranges. It is considered a warm season rain species and does not occur in the western Mojave (CNPS Desert Workshop 2000).

Although commonly of washes, arroyos, and lower canyons, the *Acacia greggii* Shrubland Alliance may also occupy rocky slopes and valleys away from fluvial disturbance (Reid et al. 1999). In Anza-Borrego Desert State Park (Keeler-Wolf et al. 1998), it occurs in upland valleys up to 3,800 feet (1,260 m) and on south facing rocky, granitic slopes up to 4,500 feet (1,370 m). Evens (2000) indicates that of the various *Acacia greggii* associations she describes as occurring in washes and arroyos, only one occurs in lower-elevation canyons.

*Acacia greggii* is a large shrub or small tree of the southwest deserts. It is tied to fluvial disturbance in much of its range, lining small to relatively large active washes and arroyos. It is a vigorous sprouter, following flood damage, heavy browsing, or fire, and may be long lived (Gucker 2005). It is winter deciduous and requires greater concentrations of water than available in the modal desert landscape. It thus occupies washes, valley bottoms, and in some cases, slopes where outcrops and boulders channel surface water to roots. Stands are typically aged unevenly.

*Acacia* seeds are nutritious and often cached and dispersed by small mammals. Seeds require scarification either through guts or abrasion of the seed coat for germination (Young and Young 1986). Recruitment is sporadic. Little information exists on variation in flood frequencies in the wash associations.

Fire was not likely to be an important disturbance prior to the advent of Eurasian annual grasses in portions of its upland distribution. However, in stands with *Pleuraphis rigida* understory, fire may have played a natural disturbance role. Once established, *Acacia greggii* individuals are notoriously difficult to kill (CNPS Desert Workshop 2000).

Natural flooding regimes in most wash and riparian settings are adequate for perpetuating the alliance rangewide. Some evidence points to the increase relative to less disturbance resistant desert alliances in upland stands. It its likely that continued high fire frequency in the upper-desert stands with non-native grasses will benefit the *Acacia greggii* Shrubland Alliance to the detriment of stands of other nonfire tolerant alliances.

This alliance is represented in Joshua Tree National Park by three associations. These include the *Acacia greggii – (Bebbia juncea – Hyptis emoryi)* Association, the *Acacia greggii – Eriogonum* Association, and *Acacia greggii – Prunus fasciculata* Association.

In addition to the associations described below, two unclassified, alliance-level samples were collected that may suggest further variation:

*Acacia greggii* (JOTRA: JOTR007, Watts: n=1)

### *Acacia greggii – (Bebbia juncea – Hyptis emoryi)* Association

**Catclaw Acacia – (Sweetbush – Desert Lavender) Association (Mapping code 36015)**

#### Range

Globally: This association is known from Joshua Tree National Park, while the related *Acacia greggii / Bebbia juncea* Association is defined from the northern and eastern Colorado Desert and southern Mojave Desert (Evens and Hartman 2007) and *Acacia greggii / Hyptis emoryi* from the central Mojave Desert (Keeler-Wolf and Thomas 2000). Similar *Acacia greggii /* wash stands have also been sampled in Anza-Borrego Desert State Park (Keeler-Wolf et al. 1998).

JOTR: Stands of the *Acacia greggii – (Bebbia juncea – Hyptis emoryi)* Association occur throughout the park and were sampled within the Clarks Pass, Conejo Well, Coxcomb Moutains, Fried Liver Wash, Porcupine Wash, and Rockhouse Canyon 7.5-minute topographic quadrangles.

#### Environmental Description

Globally: This association occurs in washes and arroyos, and sometimes on rocky slopes (Evens and Hartman 2007) from low to mid elevations. Ground surfaces primarily contain cobble, gravel and fine sediments, and some larger rocks.

JOTR: Stands of *Acacia greggii – (Bebbia juncea – Hyptis emoryi)* Association are found at low to mid elevations (1,200 – 2,800 ft.; 400 – 900 m) on linear, concave, and undulating alluvial drainages on rocky highlands. Slopes vary from gentle to moderate (1–15 degrees). Soil texture ranges from coarse sand to medium sand. Soils are formed primarily from granitic and metamorphic parent material. Ground cover in this association consists of 0–12 percent bedrock, 0–10 percent boulder, 0–10 percent stone, 3–20 percent cobble, 10–38 percent gravel, and 10–80 percent fines cover. Litter consists of 0–4 percent cover. This association occasionally experiences low levels of disturbance from competition from exotics and high levels of disturbance from foot traffic and trampling.

#### Vegetation Description

Globally: This association contains a characteristic presence and usually codominance of *Acacia greggii* with other shrubs. *Bebbia juncea* and/or *Hyptis emoryi* are usually present as characteristic species along with other wash species such as *Ambrosia salsola* and *Salazaria mexicana* as well as upland species such as *Ambrosia dumosa* and *Larrea tridentata* (Evens and Hartman 2007).

JOTR: Stands of the *Acacia greggii – (Bebbia juncea – Hyptis emoryi)* Association form a sparse to open shrubland with 0–<1 percent cover for the tree/tall stratum, 2–18 percent cover for the shrub/medium stratum, and <1–7 percent cover for the herb/low stratum. Total vegetative cover ranges from 2-21 percent.

Characteristic shrub species include *Acacia greggii, Ambrosia dumosa, Bebbia juncea, Larrea tridentata,* and *Phoradendron californicum.* Cryptobiotic crust is present in abundance. Shrub species often present are *Encelia farinosa*, *Hyptis emoryi, Krameria grayi*, *Sphaeralcea ambigua,* and *Viguiera parishii*. Often in the herbaceous stratum are *Eriogonum inflatum* and *Mirabilis laevis* var. *villosa*.

**Other Noteworthy Species**
N/A

**Conservation Rank:** N/A

**Rank Justification**
N/A

**Comments**
Globally: N/A

JOTR: This association has been redefined from the previous Keeler-Wolf et al. (2005) report and other desert reports, where the *Acacia greggii / Bebbia juncea* and *Acacia greggii / Hyptis emoryi* associations are now merged into this *Acacia greggii* – (*Bebbia juncea – Hyptis emoryi*) association. This is based on the similarity of floristic and environmental factors among the plots sampled and described.

Plots used for this description: N=11; JOTRA: 17-05-1, 32-17-2, 33-16-3, 40A-07-3, 40A-07-5, 44-16-1, 44-18-2, 63-18-2; MDEI: 63-2-1.

Map Accuracy Assessment plots: N=20; 25-1359, 25-1360, 25-1362, 25-1364, 25-1369, 25-1370, 25-1371, 25-1379, 25-1383, 25-1384, 25-1769, 25-1770, 25-1771, 25-1772, 25-1773, 25-1774, 25-1775, 25-1777, 50-1372, 50-1778b.

## Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Shrub** | | | | | | | | | |
| | ***Acacia greggii*** | **100** | **3.1** | **1.0** | **6.0** | | **X** | | **X** |
| | *Ambrosia dumosa* | 91 | 0.6 | 0.2 | 1.2 | | X | | X |
| | *Larrea tridentata* | 82 | 1.5 | 0.2 | 4.0 | | X | | X |
| | ***Bebbia juncea*** | **82** | **0.7** | **0.2** | **2.2** | | **X** | | **X** |
| | *Phoradendron californicum* | 82 | 0.2 | 0.2 | 0.5 | | X | | X |
| | *Ambrosia salsola* | 73 | 0.9 | 0.2 | 4.2 | | | | X |
| | ***Hyptis emoryi*** | **73** | **2.4** | **0.2** | **7.5** | | | | **X** |
| | *Viguiera parishii* | 64 | 0.3 | 0.2 | 1.0 | | | | X |
| | *Krameria grayi* | 55 | 0.8 | 0.2 | 5.0 | | | | X |
| | *Encelia farinosa* | 55 | 0.2 | 0.2 | 0.6 | | | | X |
| | *Sphaeralcea ambigua* | 55 | 0.2 | 0.2 | 0.5 | | | | X |
| | *Ephedra nevadensis* | 45 | 0.2 | 0.2 | 1.0 | | | | |
| | *Senna armata* | 45 | 0.4 | 0.2 | 2.0 | | | | |
| | *Lycium andersonii* | 36 | 0.7 | 0.2 | 5.0 | | | | |
| **Herb** | | | | | | | | | |
| | *Eriogonum inflatum* | 64 | 0.2 | 0.2 | 0.5 | | | | X |
| | *Mirabilis laevis* var. *villosa* | 55 | 0.3 | 0.2 | 1.5 | | | | X |
| | *Chamaesyce polycarpa* | 45 | 0.1 | 0.2 | 0.2 | | | | |
| | *Pleuraphis rigida* | 36 | 0.2 | 0.2 | 1.2 | | | | |
| | *Stephanomeria pauciflora* | 36 | 0.2 | 0.2 | 1.0 | | | | |
| | *Plantago ovata* | 36 | 0.1 | 0.2 | 0.2 | | | | |
| | *Brassica tournefortii* | 36 | 0.1 | 0.2 | 0.2 | | | | |
| | *Perityle emoryi* | 36 | 0.1 | 0.2 | 1.0 | | | | |
| | *Allionia incarnata* | 36 | 0.1 | 0.2 | 0.2 | | | | |
| **Nonvascular** | | | | | | | | | |
| | Cryptogammic crust | 55 | 0.2 | 0.2 | 0.6 | | | X | X |

## *Acacia greggii – Eriogonum fasciculatum* Association

**Catclaw Acacia – California Buckwheat Association (Mapping code 36018)**

### Range

Globally: This association is known from Anza-Borrego State Park (Keeler-Wolf et al. 1998) and Joshua Tree National Park in California.

JOTR: Stands of the *Acacia greggii – Eriogonum fasciculatum* Association were sampled within the Cadiz Valley Southwest, Indian Cove, Keys View, and Porcupine Wash 7.5-minute topographic quadrangles.

### Environmental Description

Globally: This association occurs on slopes above washes, shallow valleys, flats in hills (Keeler-Wolf et al. 1998) at mid to high elevations. Sites appear rocky though variable in coarse fragments on the ground surface.

JOTR: Stands of the *Acacia greggii –Eriogonum fasciculatum* Association are found at mid to high elevations (3,100–4,800 ft.; 900–1,500 m) on concave or undulating topography on northeast facing slopes. Slopes are moderate (4 degrees). Soil texture ranges from coarse sand to loam formed primarily from granitic parent material. Ground cover consists of 0–38 percent bedrock, <1–27 percent boulder, 3–18 percent stone, 3–12 percent cobble, 5–25 percent gravel, and <1–62 percent fines cover. Litter cover varies from <1–7 percent.

### Vegetation Description

Globally: In this association, *Acacia greggii* dominates as a tall shrub and the mid to low shrubs may be scattered to dense and include *Eriogonum fasciculatum* and other shrubs such as *Viguiera parishii* and *Yucca schidigera*. *Bromus rubens* is usually present as a non-native grass in the herbaceous layer, though natives such as *Achnatherum speciosum* often occur.

JOTR: Stands of the *Acacia greggii –Eriogonum fasciculatum* Association form a sparse to open woodland with 0–<1 percent cover for the tree/tall stratum, 6–19 percent cover for the shrub/medium stratum, and 1–5 percent cover for the herb/low stratum. Total vegetative cover ranges from 11–20 percent.

This association characteristically contains the shrubby species *Acacia gregii, Eriogonum fasciculatum, Keckiella antirrhinoides, Salazaria mexicana, Sphaeralcea ambigua, Viguiera parishii, and Yucca schidigera.* Characteristic herbaceous species are *Achnatherum speciosum*, *Bromus rubens*, *Erodium cicutarium*, *Lotus rigidus*, *Mirabilis laevis* var. *villosa,* and *Xylorhiza tortifolia*. Mosses and lichens are

present in abundance. Shrub species that often occur are *Ambrosia salsola, Coleogyne ramosissima, Echinocereus engelmannii, Ephedra nevadensis, Ericameria teretifolia, Galium stellatum, Larrea tridentata, Lycium andersonii, Opuntia basilaris, Opuntia chlorotica, Pleurocoronis pluriseta,* and *Salvia mohavensis*.

**Other Noteworthy Species**
N/A

**Conservation Rank:** N/A

**Rank Justification**
N/A
**Comments**
Globally : N/A

JOTR: N/A

Plots used for this description: JOTRA: 16-17-1, 16-24-2, 58A-04-1; MDEI: 128-1-1.

Map Accuracy Assessment plots: N=18; 50-1019, 50-1020, 50-1021, 50-1023, 50-1025, 50-1026, 50-1027, 50-1030, 50-1032, 50-1033, 50-1034, 50-1035, 50-1037, 50-1040, 50-1041, 50-1044, 50-1046, 50-1047.

## Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Shrub** | | | | | | | | | |
| | ***Acacia greggii*** | **100** | **4.7** | **3.0** | **6.2** | | **X** | | **X** |
| | ***Eriogonum fasciculatum*** | **100** | **3.1** | **2.0** | **4.0** | | **X** | | **X** |
| | *Yucca schidigera* | 75 | 1.4 | 0.5 | 3.2 | | X | | X |
| | *Viguiera parishii* | 75 | 0.9 | 0.4 | 2.2 | | X | | X |
| | *Salazaria mexicana* | 75 | 0.5 | 0.2 | 1.2 | | X | | X |
| | *Keckiella antirrhinoides* | 75 | 0.4 | 0.2 | 1.0 | | X | | X |
| | *Sphaeralcea ambigua* | 75 | 0.2 | 0.2 | 0.4 | | X | | X |
| | *Ephedra nevadensis* | 50 | 0.9 | 1.2 | 2.2 | | | | X |
| | *Lycium andersonii* | 50 | 0.5 | 1.0 | 1.0 | | | | X |
| | *Ambrosia salsola* | 50 | 0.4 | 0.4 | 1.0 | | | | X |
| | *Salvia mohavensis* | 50 | 0.4 | 0.2 | 1.2 | | | | X |
| | *Ericameria teretifolia* | 50 | 0.4 | 0.4 | 1.0 | | | | X |
| | *Coleogyne ramosissima* | 50 | 0.3 | 0.2 | 1.0 | | | | X |
| | *Galium stellatum* | 50 | 0.2 | 0.2 | 0.5 | | | | X |
| | *Larrea tridentata* | 50 | 0.2 | 0.2 | 0.5 | | | | X |
| | *Opuntia chlorotica* | 50 | 0.2 | 0.2 | 0.4 | | | | X |
| | *Pleurocoronis pluriseta* | 50 | 0.2 | 0.2 | 0.5 | | | | X |
| | *Echinocereus engelmannii* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Opuntia basilaris* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| **Herb** | | | | | | | | | |
| | *Bromus rubens* | 100 | 1.7 | 0.2 | 5.0 | | X | | X |
| | *Achnatherum speciosum* | 100 | 0.7 | 0.2 | 1.2 | | X | | X |
| | *Lotus rigidus* | 75 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Erodium cicutarium* | 75 | 0.2 | 0.2 | 0.5 | | X | | X |
| | *Mirabilis laevis* var. *villosa* | 75 | 0.2 | 0.2 | 0.5 | | X | | X |
| | *Xylorhiza tortifolia* | 75 | 0.2 | 0.2 | 0.5 | | X | | X |
| **Nonvascular** | | | | | | | | | |
| | Unknown Moss | 50 | 0.1 | 0.2 | 0.2 | | | X | X |
| | Unknown Lichen | 50 | 0.1 | 0.2 | 0.2 | | | X | X |

### *Acacia greggii – Prunus fasciculata* Association

**Catclaw Acacia – Desert Almond Association (Mapping code 36016)**

#### Range

Globally: This association is known from the central Mojave Desert (Evens 2000, Keeler-Wolf and Thomas 2000) and from Joshua Tree National Park in California, and it is likely to occur in other parts of the Mojave Desert.

JOTR: Stands of the *Acacia greggii – Prunus fasciculata* Association are common in the western and southwest central portion of the park but also at higher elevations in the eastern part of the park. Stands were sampled within the Cottonwood Springs, Indian Cove, Joshua Tree South, Malapai Hill, Porcupine Wash, and Queen Moutain 7.5-minute topographic quadrangles.

#### Environmental Description

Globally: Stands occur within upper washes, arroyos, and lower canyon drainages in the Mojave Desert on alluvium and variable parent material including granite and limestone (Evens 2000).

JOTR: Stands of *Acacia greggii – Prunus fasciculata* Association are found at mid to high elevations (3,000 to 5,000 ft.; 900 to 1,500 m) within drainages of washes and bajadas. Microtopography varies and may be flat, convex, linear or concave. Slopes are variable and gentle to moderate (1–8 degrees). Soil textures typically range from coarse sand to loam derived from granitic parent material. Ground cover consists of 0–90 percent bedrock, 0–24 percent boulder, 0–20 percent stone, 3–57 percent cobble, 2–56 percent gravel, and 1–80 percent fines cover. Litter cover is <1–35 percent. These sites experience low to high levels of disturbance from competition from exotics, and low to moderate levels of disturbance from foot traffic and trampling.

#### Vegetation Description

Globally: This association is dominated or codominated by *Acacia greggii* with *Prunus fasciculatum.* Other shrub species that are often to characteristically present include *Ambrosia salsola, Eriogonum fasciculatum, Keckiella antirrhinoides, Salazaria mexicana* and *Viguiera parishii.* Commonly associated herbs include *Achnatherum speciosum* and the nonnative exotic *Bromus rubens* (Evens 2000).

JOTR: Stands of the *Acacia greggii – Prunus fasciculata* Shrubland Association form a sparse to open shrubland with 0–6 percent cover for the tree/tall stratum, 4–29 percent cover for the shrub/medium stratum, and 0–40 percent cover for the herb/low stratum. Total vegetative cover ranges from 4–27 percent.

This association is dominated by the shrub species *Acacia greggii.* The characteristic shrub species is *Prunus fasciculata*. Often present in the shrub layer are *Ambrosia salsola, Cylindropuntia echinocarpa Eriogonum fasciculatum, Salazaria mexicana, Simmondsia chinensis,* and *Yucca schidigera.* The understory herb layer often contains the exotic species *Bromus rubens* and *Erodium cicutarium*.

**Other Noteworthy Species**
*Tetracoccus hallii* was found in two of the plots. *Tetracoccus hallii* is a CRPR 4 plant in the CNPS Inventory of Rare and Endangered Plants of California (CNPS 2001). It is found in Imperial, Riverside, and San Bernardino Counties and in Arizona and Baja California at low to high elevations (100–4,000 ft.; 30–1,200 m).

Evidence of tortoises was noted in one of the plots.

**Conservation Rank:** N/A

**Rank Justification**
N/A

**Comments**
Globally: N/A

JOTR: N/A

Plots used for this description: N=14; JOTRA: 10B-01-2, 10B-01-4, 14-23-1, 18-28-1, 22-32-1, 31-07-1, 33-07-3, 33-07-6, 33-11-2; JOTR: JOTR11, JOTR13, JOTR6, JOTR8.

Map Accuracy Assessment plots: N=31; 25-1326, 25-1327, 25-1329, 25-1330, 25-1331, 25-1332, 25-1333, 25-1334, 25-1335, 25-1336, 25-1337, 25-1338, 25-1339, 25-1340, 25-1341, 25-1342, 25-1343, 25-1344, 25-1345, 25-1346, 25-1347b, 25-1348, 25-1349, 25-1350, 25-1351, 25-1352, 25-1354, 25-1355, 25-1720, 50-0536, 50-0806.

## Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Tree** | | | | | | | | | |
| | *Yucca brevifolia* | 36 | 0.3 | 0.2 | 2.0 | | | | |
| **Shrub** | | | | | | | | | |
| | ***Acacia greggii*** | **100** | **5.5** | **2.0** | **13.2** | **X** | **X** | **X** | **X** |
| | ***Prunus fasciculata*** | **79** | **2.1** | **0.2** | **6.0** | | **X** | | **X** |
| | *Eriogonum fasciculatum* | 71 | 0.7 | 0.2 | 3.0 | | | | X |
| | *Ambrosia salsola* | 64 | 1.7 | 0.2 | 6.0 | | | | X |
| | *Salazaria mexicana* | 64 | 1.6 | 0.4 | 8.2 | | | | X |
| | *Yucca schidigera* | 57 | 0.3 | 0.2 | 1.2 | | | | X |
| | *Simmondsia chinensis* | 50 | 0.4 | 0.2 | 2.0 | | | | X |
| | *Cylindropuntia echinocarpa* | 57 | 0.2 | 0.2 | 0.4 | | | | X |
| | *Lycium andersonii* | 43 | 0.1 | 0.2 | 0.4 | | | | |
| | *Larrea tridentata* | 36 | 0.5 | 0.2 | 4.0 | | | | |
| | *Ephedra nevadensis* | 36 | 0.3 | 0.2 | 3.0 | | | | |
| | *Phoradendron californicum* | 36 | 0.2 | 0.2 | 2.0 | | | | |
| | *Viguiera parishii* | 36 | 0.1 | 0.2 | 1.0 | | | | |
| **Herb** | | | | | | | | | |
| | *Bromus rubens* | 50 | 3.8 | 0.2 | 38.0 | | | | X |
| | *Erodium cicutarium* | 50 | 0.2 | 0.2 | 1.0 | | | | X |
| | *Mirabilis laevis* var. *villosa* | 43 | 0.1 | 0.2 | 0.4 | | | | |

## *Ephedra californica* Shrubland Alliance

**California Joint Fir Shrubland Alliance (Mapping code 24020, not mapped)**

*Ephedra californica* is a widespread shrub of the Mojave/Sonoran Desert of California, ranging up to the central Coast Ranges to Merced and Santa Clara counties (CalFlora 2000). Stands of *Ephedra californica* alliance are scattered throughout the Mojave, Sonoran, and Colorado Desert sections of California, and into the inner central Coast Ranges including the Carrizo Plain National Monument (Sawyer et al. 2009). The species is also a component of several alliances including: *Psorothamnus spinosus, Larrea tridentata – Ambrosia dumosa, Atriplex canescens, Atriplex polycarpa, Fouquieria splendens,* and *Yucca schidigera.* Conservation rank: G3, S3.

Stands of *Ephedra californica* Shrubland Alliance are most commonly associated with washes. In washes, the *Ephedra californica* alliance occupies a similar ecological zone to *Ambrosia salsola* alliance, but is often found in slightly less disturbed micro sites as along low terraces and banks of washes (Evens 2000 and personal observation, T. Keeler-Wolf personal observation). Diversity is typically low in the active portions of washes. Some stands are associated with sand sheets, dunes, and other sandy and austere substrates. On these non-alluvial substrates, the stands often associate with perennial grasses such as *Pleuraphis rigida, Poa secunda, Achnatherum hymenoides,* and *Achnatherum speciosum* as well as various annual herbs. The isolated stands of *Ephedra californica* found in the inner coast range, called Monvero Dunes community by Holland (1986), are found on ancient, stabilized, diatomaceous dunes and old silty alluvium associated with *Ambrosia salsola* or *Ericameria linearifolia – Isomeris arborea* shrubland alliances. It is interesting to note that *Isomeris arborea* is often a characteristic associated with species with this alliance from the isolated coast range stands to the eastern Mojave Desert wash stands (Sawyer et al. 2009, Evens 2000).

The *Ephedra californica* alliance is indicative of low-gradient wash sites within the mid and lower elevations of the Mojave Desert; these washes range from 10 to 100 m in width and have variable slope and aspect. Large, continuous stands are found along some washes in the eastern Mojave Desert, but many are small stands less than 100 square meters. Stands on sand sheets tend to stabilize and form mounds. *Ephedra californica* is a clonal species and may spread by underground rhizomes, making it well adapted to shifting sand and alluvial substrates.

This alliance is represented in Joshua Tree National Park by one association, the *Ephedra californica – Ambrosia salsola* Shrubland Association.

## *Ephedra californica – Ambrosia salsola* Association

**California Joint Fir – Cheesebush Association (Mapping code 24021, not mapped)**

### Range

Globally: This association is known from California in the central Mojave Desert (Evens 2000) and southern Mojave Desert including Joshua Tree National Park.

JOTR: Stands of the *Ephedra californica – Ambrosia salsola* Association were sampled in the Park within the Cadiz Valley Southwest, Indian Cove, and Malapai Hill 7.5-minute topographic quadrangles.

### Environmental Description

Globally: This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of *Ephedra californica – Ambrosia salsola* Shrubland Association are found at mid elevations (2,100–3,700 ft.; 600–1,100 m) on gentle (2 degrees) slopes in drainages/washes, on convex, undulating, and linear slopes of rocky highlands and are northwest facing. Soils are usually coarse sand formed from granitic, parent material. Ground cover consists of 0 percent bedrock, 0 percent boulder, 0–5 percent stone, 5–15 percent cobble, 4–36 percent gravel, and 32–79 percent fines. Litter ranges from 2–34 percent cover. These sites generally experience low- to high-disturbance levels from exotics species.

### Vegetation Description

Globally: This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of the *Ephedra californica – Ambrosia salsola* Shrubland Association form an open shrubland with 0 percent cover for the tree/tall stratum, 7–35 percent cover for the shrub/medium stratum, and 0–40 percent cover for the herb/low stratum. Total vegetative cover ranges from 13–25 percent. Exotic species cover is generally low but might be moderate or high in some stands.

This association characteristically contains the shrub species *Ambrosia dumosa, Ambrosia salsola, Cylindropuntia echinocarpa*, *Cylindropuntia ramosissima, Echinocereus engelmannii, Ephedra californica, Krameria grayi, Larrea tridentata, Lycium andersonii, Salazaria mexicana, Senna armata,* and *Yucca schidigera*. *Ambrosia salsola, Ephedra californica,* and *Larrea tridentata* have the highest average cover and constancy of these shrubs.

Cryptobiotic crust and *Schismus* are abundant in the understory. Shrubs that are often present in this association are *Acacia greggii, Cleome isomeris, Eriogonum*

*fasciculatum, Lycium cooperi, Simmondsia chinensis,* and *Viguiera parishii*. Herbaceous species that often occur are *Amaranthus, Erodium cicutarium, Mirabilis laevis* var. *villosa,* and *Pleuraphis rigida*.

**Other Noteworthy Species**
N/A

**Conservation Rank:** Rare

**Rank Justification**
Currently, this association is known only from the central and southern portions of the Mojave Desert.

**Comments**
Globally: Other stands of this association or similar ones have been seen in Anza-Borrego Desert State Park and in the eastern Mojave Desert of California (Keeler-Wolf personal observation, 2002).

JOTR: N/A

Plots Used for This Description: N=4; JOTRA: 14-27-1, 22-26-5, 56-22-2; Long: VMAL97-33; Watts n=2.

Map Accuracy Assessment plots: N=0.

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Shrub** | | | | | | | | | |
| | ***Ephedra californica*** | **100** | **4.5** | **2.0** | **8.0** | | **X** | | **X** |
| | *Larrea tridentata* | 100 | 3.5 | 1.0 | 8.0 | | X | | X |
| | ***Ambrosia salsola*** | **100** | **2.7** | **0.4** | **8.0** | | **X** | | **X** |
| | *Senna armata* | 75 | 2.1 | 1.0 | 5.0 | | X | | X |
| | *Salazaria mexicana* | 75 | 1.8 | 1.0 | 3.0 | | X | | X |
| | *Ambrosia dumosa* | 75 | 1.0 | 0.4 | 3.0 | | X | | X |
| | *Yucca schidigera* | 75 | 1.0 | 0.2 | 3.2 | | X | | X |
| | *Cylindropuntia ramosissima* | 75 | 0.4 | 0.2 | 1.0 | | X | | X |
| | *Cylindropuntia echinocarpa* | 75 | 0.3 | 0.2 | 0.4 | | X | | X |
| | *Echinocereus engelmannii* | 75 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Krameria grayi* | 75 | 0.2 | 0.2 | 0.4 | | X | | X |
| | *Lycium andersonii* | 75 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Eriogonum fasciculatum* | 50 | 0.8 | 0.2 | 3.0 | | | | X |
| | *Viguiera parishii* | 50 | 0.6 | 0.2 | 2.2 | | | | X |
| | *Lycium cooperi* | 50 | 0.3 | 0.2 | 1.0 | | | | X |
| | *Acacia greggii* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Cleome isomeris* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Simmondsia chinensis* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| **Herb** | | | | | | | | | |
| | *Schismus* | 50 | 1.0 | 2.0 | 2.0 | | | X | X |
| | *Pleuraphis rigida* | 50 | 0.9 | 0.4 | 3.0 | | | | X |
| | *Erodium cicutarium* | 50 | 0.8 | 0.2 | 3.0 | | | | X |
| | *Amaranthus* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Mirabilis laevis* var. *villosa* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| **Nonvascular** | | | | | | | | | |
| | Cryptogammic crust | 50 | 2.9 | 1.4 | 10.2 | | | X | X |

## *Ericameria paniculata (= Chrysothamnus paniculatus)* Shrubland Alliance

**Black-Stem Rabbitbrush Shrubland Alliance (Mapping code 28120, not mapped)**

The *Ericameria paniculata* Shrubland Alliance occurs in the southern deserts of California and Grand Canyon-Parshant Nation Monument in Arizona, and it is also reported from Nevada (NatureServe 2011). Conservation rank: G4, S3

*Ericameria paniculata* is commonly known as Black-Stemmed Rabbitbrush from a rust that causes distinct black bands around the young stems. Stands of this alliance are widespread, though localized, in arroyos and washes throughout the hot deserts of California and other western states. Most stands are in medium to large washes where flooding events occur every few years. Stands typically occupy wash bottoms in broad, braided-channel washes and terraces in narrower, higher-energy washes, suggesting that high rates of scour and flooding intensities are not conducive to high-density establishment. Many stands are monospecific, intermittent to dense and lacking an understory (Sawyer et al. 2009).

As with other "rabbitbrush" species (*Chrysothamnus, sensu lato,* or *Ericameria*), *E. paniculata* is relatively short lived and well adapted to disturbance. Seeding is prolific in the fall, and the windblown seeds lodge in gravels and irregularities in wash bottoms, becoming further dispersed and activating germination when flooding occurs. *E. paniculata* grows quickly in favorable sites and may reach 4 m in height. It is an excellent colonizer after disturbances including fire. However, fire is not likely an important agent of disturbance, since moderate to severe fires likely kill shrubs (Tesky 1993b).

Large flooding events may destroy and eliminate all shrubs in the main watercourse, but seedling recruitment from adjacent individuals in protected microsites may be rapid. *E. paniculata* does not occur at high elevations or further north in the Great Basin as with several other *Ericameria* spp. It may be relatively frost sensitive. In the warm deserts of California, it is limited to sites with higher moisture than surrounding modal environments; thus, it occurs in washes only.

Short-lived communities, such as this alliance, are relatively unscathed by human interactions except for OHV impacts and gravel mining. Further information on the ecological relationships between similar, short-lived, shrubby, wash vegetation alliances should be investigated.

This alliance has been sampled once during the classification phase for Joshua Tree National Park (JOTRA: 32-08-2; see Stand Table on the next page), and more survey and classification work are needed to fully characterize this type in the park.

## Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Shrub** | | | | | | | | | |
| | ***Ericameria paniculata*** | **100** | **9.0** | **9.0** | **9.0** | **X** | **X** | **X** | **X** |
| | *Salazaria mexicana* | 100 | 2.2 | 2.2 | 2.2 | | X | | X |
| | *Acacia greggii* | 100 | 1.2 | 1.2 | 1.2 | | X | | X |
| | *Phoradendron californicum* | 100 | 1.0 | 1.0 | 1.0 | | X | | X |
| | *Bebbia juncea* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Bernardia myricifolia* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Cylindropuntia echinocarpa* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Eriogonum fasciculatum* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Larrea tridentata* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Lycium andersonii* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Nolina bigelovii* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Petalonyx thurberi* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Tetracoccus hallii* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| **Herb** | | | | | | | | | |
| | *Erodium cicutarium* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Mirabilis laevis var. villosa* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Phacelia campanularia* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Salvia columbariae* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Schismus* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |

## *Encelia virginensis* Shrubland Alliance

### Virgin River Brittlebush Shrubland Alliance (Mapping code 28500, not mapped)

The *Encelia virginensis* Shrubland Alliance has been described from washes in the Mojave Desert in California and Nevada (NatureServe 2011), and may occur in adjacent Utah, Arizona, and Sonora and Baja California, Mexico. In California, it is known from the Mojave Desert, the Mono Section, southeastern Great Basin, and southern mountains and valleys (Sawyer et al. 2009). Small seral stands of this alliance also occur in Anza-Borrego Desert State Park. Conservation rank: G4, S3.

*Encelia virginensis,* including *E. virginensis* ssp. *actonii*, is a short-lived, drought-deciduous shrub that grows to 1.5 m tall. Plants reproduce by seeds that are well adapted to wind dispersal. The species seeds in well after wet years, and it is an early colonizer of disturbed sites such as washes, road cuts, recently cleared land, fire, or other disturbances. *Encelia virginensis* depends on off-site seed sources to reestablish after disturbances (Sawyer et al. 2009).

In general, populations increase with increasing disturbance and are replaced in areas lacking recurring disturbance. It is common on rocky uplands and in gravelly or cobbled washes with slow internal drainage or where the water table is near the soil surface. The soils can be encrusted with salt. This species is closely related to *E. frutescens* and has been considered a variety (Esser 1993a).

*Encelia virginensis* as an associate occurs commonly on uplands in several alliances at middle and upper elevations in California's hot deserts. The alliance is locally common in washes where irregular flooding occurs, particularly on cobbled calcareous substrates. Stands in the late spring and summer have spectacular shows of their full golden flowers, lining the washes as they radiate from the mountain ranges.

The *Encelia virginensis* Shrubland Alliance is primarily disturbed by fluvial processes rather than fire. Most stands are opens and rocky; however, fire could affect them in years where introduced or native annuals form dense cover and sufficient flashy fuels (Sawyer et al. 2009).

In Joshua Tree National Park, this alliance is represented by the *Encelia virginensis* ssp. *actoni* Association.

### *Encelia virginensis ssp. actoni* Shrubland Association

**Acton's Brittlebush Association (Mapping code 28501, not mapped)**

#### Range

Globally: This association is known from the Mojave Desert of California and Nevada (NatureServe 2011). Stands in the eastern Mojave Desert of California have been described by Evens (2000).

JOTR: Stands of the *Encelia virginensis* ssp. *actoni* Shrubland Association were sampled in the western portion of the park within the East Deception Canyon and Indian Cove 7.5-minute topographic quadrangles.

#### Environmental Description

Globally: Stands of this association occurs in disturbed sites, including calcareous washes and post-burn granitic slopes in the Mojave and Sonoran Deserts. In the Mojave, this species has been surveyed in arroyos at elevations ranging from 1,225–1,375 meters in cobbly/gravelly soils derived from limestone. Aspects ranged from west to south-southwest (Evens 2000).

JOTR: Stands of *Encelia virginensis* ssp. *actoni* Shrubland Association are found at high elevations (4,300–5,000 ft.; 1,300–1,500 m) on variable slope aspects, and occur from lower slopes up to ridgetops in areas recovering from past fire. Slopes are somewhat steep to steep (15–40 degrees) with concave or undulating topographies. Soils range from coarse sands to medium silts derived from gneissose or granitic parent materials. Ground cover in this association consists of 0–20 percent bedrock, 3–10 percent boulder, 10–15 percent stone, 15–30 percent cobble, 5–20 percent gravel, and 20–50 percent fines cover. Litter consists of <1–10 percent cover. Disturbance from exotic plant species has not been reported for this association.

#### Vegetation Description

Globally: This association is dominated by *Encelia virginensis* ssp. *actonii* in the shrub layer. The herbaceous layer is usually sparse.

JOTR: Stands of the *Encelia virginensis* ssp. *actoni* Shrubland Association form an open shrubland with <1 percent cover in the tree/tall stratum, 7–32 percent cover in the shrub/mid stratum, and 1–60 percent cover in the herb/low stratum. Total vegetation cover ranges from 10–70 percent.

This association is dominated by *Encelia virginensis* ssp. *actonii* in the shrub layer and *Achnatherum speciosum* in the herb layer. Characteristic species are *Sphaeralcea ambigua* and *Yucca schidigera; Juniperus californica* is typically abundant. Other often occurring species include *Ambrosia salsola, Ephedra*

*nevadensis, Ericameria linearifolia, Eriogonum fasciculatum, Nolina parryi, Opuntia basilaris, Mirabilis laevis* var. *villosa, Pleuraphis rigida,* and *Xylorhiza tortifolia.*

**Other Noteworthy Species**
N/A

**Conservation Rank:** Rare

**Rank Justification**
Stands are localized in calcareous washes and other disturbed sites in the Mojave Desert.

**Comments**
Globally: N/A

JOTR: N/A

Plots used for this description: N=3, JOTR: JOTR110, JOTR81, JOTR83.

Map Accuracy Assessment plots: N=0.

## Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Tree** | | | | | | | | | |
| | *Juniperus californica* | 67 | 0.4 | 0.2 | 1.0 | | | X | X |
| | *Yucca brevifolia* | 33 | 0.1 | 0.2 | 0.2 | | | | |
| | *Quercus cornelius-mulleri* | 33 | 0.3 | 1.0 | 1.0 | | | | |
| **Shrub** | | | | | | | | | |
| | ***Encelia actonii*** | **100** | **9.0** | **3.0** | **20.0** | **X** | **X** | **X** | **X** |
| | *Sphaeralcea ambigua* | 100 | 1.1 | 0.2 | 3.0 | | X | | X |
| | *Yucca schidigera* | 100 | 0.5 | 0.2 | 1.0 | | X | | X |
| | *Ephedra nevadensis* | 67 | 1.4 | 0.2 | 4.0 | | | | X |
| | *Ericameria linearifolia* | 67 | 1.1 | 0.2 | 3.0 | | | | X |
| | *Nolina parryi* | 67 | 0.4 | 0.2 | 1.0 | | | | X |
| | *Eriogonum fasciculatum* | 67 | 0.4 | 0.2 | 1.0 | | | | X |
| | *Ambrosia salsola* | 67 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Opuntia basilaris* | 67 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Salazaria mexicana* | 33 | 0.7 | 2.0 | 2.0 | | | | |
| | *Lepidium fremontii* | 33 | 0.3 | 1.0 | 1.0 | | | | |
| | *Viguiera parishii* | 33 | 0.1 | 0.2 | 0.2 | | | | |
| | *Coleogyne ramosissima* | 33 | 0.1 | 0.2 | 0.2 | | | | |
| | *Purshia tridentata* | 33 | 0.1 | 0.2 | 0.2 | | | | |
| | *Ericameria laricifolia* | 33 | 0.1 | 0.2 | 0.2 | | | | |
| | *Salvia mohavensis* | 33 | 0.1 | 0.2 | 0.2 | | | | |
| **Herb** | | | | | | | | | |
| | *Achnatherum speciosum* | 100 | 2.1 | 0.2 | 5.0 | X | X | X | X |
| | *Xylorhiza tortifolia* | 67 | 0.4 | 0.2 | 1.0 | | | | X |
| | *Mirabilis laevis* var. *villosa* | 67 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Pleuraphis rigida* | 67 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Physalis crassifolia* | 33 | 0.1 | 0.2 | 0.2 | | | | |
| | *Erigeron parishii* | 33 | 0.1 | 0.2 | 0.2 | | | | |
| | *Mirabilis laevis* var. *retrorsa* | 33 | 0.1 | 0.2 | 0.2 | | | | |
| | *Stephanomeria pauciflora* | 33 | 0.1 | 0.2 | 0.2 | | | | |

## *Prunus fasciculata* Shrubland Alliance

### Desert Almond Shrubland Alliance (Mapping code 32010)

The *Prunus fasciculata* Intermittently Flooded Shrubland Alliance occurs in the Mojave Desert region of California and in Arizona (NatureServe 2011). Rare occurrences of this alliance occur into the inner central Coast Range of California in the Carrizo Plain National Monument (J. Evens, personal observation, 2010). Conservation rank: G4, S3.

This alliance often occurs in desert washes, arroyos and canyon bottoms, yet they are also found on upland sites such as alluvial terraces, bajadas and lower canyon slopes throughout the Mojave Desert. Soils are generally alluvial. Disturbance from intermittent flooding or upland disturbance from grazing animals and ORVs occurs on many sites and may be important to the maintenance of this alliance (NatureServe 2011).

In California, *Prunus fasciculata* is a common, large shrub of higher elevation wash margins and boulder slopes above drainages in the Mojave Desert. Thomas et al. (2004) have identified it as the highest elevation component of the wash continuum in the Mojave Desert. Thus, this alliance receives higher precipitation and cooler temperatures than other wash vegetation. It is characterized by the dominance of *Prunus fasciculata* but is most frequently mixed with several other shrubs including *Ambrosia eriocentra, A. salsola, Ephedra nevadensis, Eriogonum fasciculatum, Purshia* spp., *Rhus trilobata,* and *Salazaria mexicana*.

The life history attributes of *Prunus fasciculata* are not well known. More information is needed on the role these stands play in the upper Mojave Desert.

This alliance is well-represented in Joshua Tree National Park by one association, the *Prunus fasciculata* Shrubland Association. The following samples taken in Joshua Tree National Park suggest further variation as another association than what is defined below:

*Prunus fasciculata – Rhus trilobata* Association (Watts: n=3)

## *Prunus fasciculata* Association

**Desert Almond Association (Mapping code 32013)**

### Range

Globally: This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of the *Prunus fasciculata* Association occur primarily in broad, sandy washes in the Coxcomb, Eagle, and Hexie Mountains and are most abundant in the western Pinto Mountains and the northwest portion of the Little San Bernardino Mountains. Stands were sampled within the Cottonwood Spring, East Deception Canyon, Joshua Tree South, Malapai hill, Porcupine Wash, Queen Mountain, and Rockhouse Canyon 7.5-minute topographic quadrangles.

### Environmental Description

Globally: This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of *Prunus fasciculata* Association are found at mid to high elevations (2,900–5,000 ft.; 900–1,500 m) on flat to gentle slopes (0-3 degrees). They occur in drainages of canyon bottoms, washes and adjacent bajadas that have fluvial disturbance, and also rocky hills that have had fire disturbance. Microtopography varies and may be convex, linear, concave, or undulating. Soil textures typically are sandy and soils are derived from granitic parent material. Ground cover is comprised of 0–35 percent bedrock, 0–20 percent boulder, 0–20 percent stone, 0–20 percent cobble, 0–62 percent gravel, and 9–94 percent fines cover. Litter cover is 0–25 percent. These sites experience low to high levels of disturbance from competition from exotics.

### Vegetation Description

Globally: This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of the *Prunus fasciculata* Intermittently Flooded Shrubland Association form an open to intermittent shrubland with 0–4 percent cover for the tree/tall stratum, 1–35 percent cover for the shrub/medium stratum, and 0–24 percent cover for the herb/low stratum. Total vegetative cover ranges from1–36 percent.

This association is dominated by the shrub *Prunus fasciculata,* and herb species *Achnatherum speciosum*. *Yucca brevifolia* often occurs at low cover in the tree layer. Shrub species often present are *Ambrosia salsola, Ephedra nevadensis, Eriogonum fasciculatum, Lycium cooperi, Salazaria mexicana,* and *Yucca schidigera*. The exotic species *Bromus rubens* is often present in the herbaceous layer.

**Other Noteworthy Species**
N/A

**Conservation Rank:** Rare

**Rank Justification**
Stands occur scattered in higher elevation washes, arroyos, and adjacent bajadas and slopes that experience disturbance in Mojave Desert Joshua Tree National Park.

**Comments**
Globally: N/A

JOTR: *Lycium cooperi* was co-dominant with *Prunus fasciculatum* in five plots with evidence of fire that were localized in the Joshua Tree South topographic quadrangle. This variation with *Lycium* could be considered as a phase of the *Prunus fasciculatum* Assocation.

Plots used for this description: N=12; JOTRA: 08A-02-3, 18-24-1, 18-27-3, 21-14-1; JOTR: JOTR02, JOTR03, JOTR04, JOTR05, JOTR84; MDEI: 128-1-6; Long: VCOT97-2, VMAL97-39; Watts n=2.

Map Accuracy Assessment plots: N=7; 50-1024, 50-1031, 50-1036, 50-1039, 50-1043, 50-1045, 50-1048.

## Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Tree** | | | | | | | | | |
| | *Yucca brevifolia* | 67 | 0.6 | 0.2 | 3.0 | | | X | X |
| | *Juniperus californica* | 42 | 0.4 | 0.2 | 3.4 | | | | |
| **Shrub** | | | | | | | | | |
| | ***Prunus fasciculata*** | **100** | **6.6** | **1.2** | **15.0** | **X** | **X** | **X** | **X** |
| | *Eriogonum fasciculatum* | 67 | 0.6 | 0.2 | 3.0 | | | | X |
| | *Ephedra nevadensis* | 67 | 0.5 | 0.2 | 3.0 | | | | X |
| | *Ambrosia salsola* | 58 | 1.3 | 0.2 | 5.2 | | | | X |
| | *Salazaria mexicana* | 58 | 1.2 | 0.2 | 7.0 | | | | X |
| | *Lycium cooperi* | 50 | 2.8 | 0.2 | 20.0 | | | | X |
| | *Yucca schidigera* | 50 | 0.7 | 0.2 | 3.0 | | | | X |
| | *Acacia greggii* | 42 | 0.9 | 0.2 | 3.2 | | | | |
| | *Gutierrezia microcephala* | 42 | 0.3 | 0.2 | 2.0 | | | | |
| | *Sphaeralcea ambigua* | 42 | 0.2 | 0.2 | 1.0 | | | | |
| | *Phoradendron californicum* | 42 | 0.2 | 0.2 | 1.0 | | | | |
| | *Larrea tridentata* | 33 | 0.6 | 0.2 | 3.0 | | | | |
| | *Purshia tridentata* | 33 | 0.6 | 0.2 | 5.0 | | | | |
| | *Cylindropuntia echinocarpa* | 33 | 0.2 | 0.4 | 1.2 | | | | |
| **Herb** | | | | | | | | | |
| | *Achnatherum speciosum* | 83 | 1.3 | 0.2 | 4.0 | X | X | X | X |
| | *Bromus rubens* | 50 | 2.9 | 0.2 | 15.0 | | | | X |
| | *Erodium cicutarium* | 33 | 0.4 | 0.2 | 3.0 | | | | |

## 3.B.1. Cool Semi-Desert Scrub & Grassland Formation

## 3.B.1.a. Western North American Cool Semi-Desert Scrub & Grassland Division

## M071. Great Basin & Intermountain Semi-Desert Shrubland & Steppe Macrogroup

## Intermountain Semi-Desert Shrubland & Steppe Group

### *Ericameria nauseosa* Shrubland Alliance

**Rubber Rabbitbrush Shrubland Alliance (Mapping code 28210)**

The *Ericameria nauseosa* Shrubland Alliance includes shrublands from localized areas across the northern Great Plains and throughout the western U.S. in Idaho, Montana, North and South Dakota, Wyoming, Nevada, Utah, Colorado, and Arizona (NatureServe 2011). In California it is found in the Central Coast Ranges, Klamath Mountains, Modoc Plateau, Mojave Desert, southeastern Great Basin, eastern Sierra Nevada, and in Anza-Borrego State Park (Sawyer et al. 2009). Conservation rank: G5, S5.

*Ericameria nauseosa* is a fast-growing, early-seral shrub that establishes after disturbance. It blooms in late summer and fruits in fall; wind-dispersed seeds germinate in the early spring. The ecology of *E. nauseosa* varies by subspecies and ecotype. It has numerous adaptations to arid environments including deep taproots and narrow leaves with trichomes that give it a silvery appearance (Tirmenstein 1999c). California has eight of the 26 subspecies of *E. nauseosa*; some subspecies are local while others have extensive ranges. We do not know which subspecies are sufficiently common to characterize California's vegetation, since few ecologists make subspecies determinations when describing vegetation.

Stands of this alliance exist throughout the semiarid regions in the state. They typically grow in disturbed and fluvial areas, whether naturally disturbed by intermittent flooding or disturbed by overgrazing, road cuts, clearings, or old mine tailings. Plants colonize and persist for at least 10 years, including after changes in grazing regimes or after fires (Tirmenstein 1999c), and plantings of *E. nauseosa* have been successful for remediating severely disturbed sites in restoration projects.

*Ericameria nauseosa* has resinous foliage that burns readily even with high moisture content. This fire-adapted species vigorously sprouts after fire, and wind-dispersed seed readily colonizes areas after fire from neighboring plants (Tirmenstein 1999c). Stands in northeastern California and higher elevations of the Mojave Desert develop into stands of the *Artemisia tridentata, A. arbuscula, Purshia tridentata*, *Pinus monophylla* and *Yucca brevifolia* alliances after 10 to 50 years.

Stands in Joshua Tree National Park include *Ericameria nauseosa* as the dominant shrub with *Prunus fasciculata, Purshia tridentata*, *Gutierrezia microcephala, Ambrosia eriocentra, Artemisia tridentata,* and *Salvia dorii.* They occur in flat to gently sloping, sandy washes in upper elevations (1400–1500 m).

This alliance is described in Joshua Tree National Park from two samples, with variation denoted by the following (and see Stand Table on next page). A map accuracy assessment plot was also conducted in this type. More inventory and sampling is needed in the Park to define this association:

*Ericameria nauseosa* desert wash (JOTRA 8A-04-2; MDEI 04-25-02; MapAA: 25-1386)

### Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Shrub** | | | | | | | | | |
| | ***Ericameria nauseosa*** | **100** | **5.9** | **3.2** | **8.5** | **X** | **X** | **X** | **X** |
| | *Prunus fasciculata* | 100 | 0.7 | 0.4 | 1.0 | | X | | X |
| | *Purshia tridentata* | 100 | 0.6 | 0.2 | 1.0 | | X | | X |
| | *Gutierrezia microcephala* | 100 | 0.5 | 0.4 | 0.5 | | X | | X |
| | *Ambrosia eriocentra* | 50 | 2.3 | 4.5 | 4.5 | | | | X |
| | *Artemisia tridentata* | 50 | 0.5 | 1.0 | 1.0 | | | | X |
| | *Salvia dorrii* | 50 | 0.5 | 1.0 | 1.0 | | | | X |
| | *Ericameria linearifolia* | 50 | 0.3 | 0.5 | 0.5 | | | | X |
| | *Thamnosma montana* | 50 | 0.3 | 0.5 | 0.5 | | | | X |
| | *Eriogonum fasciculatum* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| **Herb** | | | | | | | | | |
| | *Bromus rubens* | 100 | 0.4 | 0.2 | 0.5 | | X | | X |
| | *Elymus elymoides* | 100 | 0.4 | 0.2 | 0.5 | | X | | X |
| | *Carex douglasii* | 50 | 0.5 | 1.0 | 1.0 | | | | X |
| | *Artemisia dracunculus* | 50 | 0.2 | 0.4 | 0.4 | | | | X |
| | *Eriogonum* | 50 | 0.2 | 0.4 | 0.4 | | | | X |
| | *Achnatherum speciosum* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Bromus tectorum* | 50 | 0.1 | 0.2 | 0.2 | | | | X |

## *Ericameria teretifolia* Shrubland Alliance

**Round-Leaved Rabbitbrush Shrubland Alliance (Mapping code 28220, not mapped)**

The *Ericameria teretifolia* Shrubland Alliance occurs in the Mojave Desert, the Mono Region, southeastern Great Basin, eastern Sierra Nevada in Death Valley, and southern California mountains and Valley in Anza-Borrego State Park. In Joshua Tree National Park, it is restricted to upper elevations in the vicinity of *Juniperus californica* and *Viguiera parishii* stands. Conservation status: G4, S4.

*Ericameria teretifolia* blooms in the late summer and sets fruit in the fall; seeds are wind-dispersed and germinate in early spring. This relatively short-lived shrub establishes abundantly after disturbance. It is deep-rooted, providing an advantage in long-term drought situations, but necessitates higher rainfall before initial moisture reaches the relatively deep root system. *Ericameria teretifolia* nearly always shares the shrub canopy with other species. Stands are typically disturbed areas, including burns, washes, road cuts, and heavily grazed sites (Sawyer et al. 2009).

In the Mojave Desert and Peninsular Range/Colorado Desert borderland, the *E. teretifolia* alliance is one of several mid-elevation, xeromorphic, upland scrub alliances above the broad belt of *Larrea tridentata – Ambrosia dumosa* but below the high-elevation scrubs with *Artemisia tridentata* and the *Pinus monophylla* belt. Stands of *Ericameria teretifolia* are typically found adjacent to those of the *Atriplex confertifolia*, *Coleogyne ramosissima*, *Grayia spinosa*, *Juniperus californica*, and *Juniperus osteosperma* alliances.

This seral type replaces other long-persistent alliances following fire or perhaps other disturbance, such as intensive grazing or mechanical soil disturbance. For example, *Ericameria teretifolia* stands established in place of *Juniperus californica* stands burned 25 years ago in Anza-Borrego Desert State Park (Keeler-Wolf et al. 1998). However, research on fire regime is lacking for this alliance.

This alliance is a seral type that should be considered as part of the natural spatio-temporal matrix of mid-to-upper desert vegetation. Stands ideally should be small. Large stands are indicative of some disturbance process that is out of synchrony with historic disturbance events (fire, road development, perhaps intensive grazing).

This alliance is denoted in Joshua Tree National Park from two alliance-level samples:

*Ericameria teretifolia* (Watts: N=2)

## Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Tree** | | | | | | | | | |
| | *Pinus monophylla* | 50 | 0.1 | 0.3 | 0.3 | | | X | X |
| | *Quercus cornelius-mulleri* | 50 | 0.1 | 0.1 | 0.1 | | | | X |
| **Shrub** | | | | | | | | | |
| | ***Ericameria teretifolia*** | **100** | **3.8** | **1.2** | **6.4** | | **X** | | **X** |
| | *Cleome isomeris* | 100 | 1.9 | 0.2 | 3.6 | | X | | X |
| | *Eriogonum plumatella* | 50 | 4.4 | 8.9 | 8.9 | | | X | X |
| | *Ephedra nevadensis* | 50 | 2.7 | 5.4 | 5.4 | | | | X |
| | *Coleogyne ramosissima* | 50 | 0.8 | 1.6 | 1.6 | | | | X |
| | *Cylindropuntia echinocarpa* | 50 | 0.3 | 0.6 | 0.6 | | | | X |
| | *Gutierrezia microcephala* | 50 | 0.2 | 0.5 | 0.5 | | | | X |
| | *Krameria grayi* | 50 | 0.2 | 0.4 | 0.4 | | | | X |
| | *Acacia greggii* | 50 | 0.2 | 0.4 | 0.4 | | | | X |
| | *Echinocereus engelmannii* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Escobaria vivipara* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Phoradendron californicum* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Salvia mohavensis* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Thamnosma montana* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| **Herb** | | | | | | | | | |
| | *Stephanomeria exigua* | 100 | 7.6 | 0.1 | 15.0 | X | X | X | X |
| | *Heteropogon contortus* | 50 | 1.0 | 2.0 | 2.0 | | | X | X |
| | *Eriastrum* | 50 | 0.4 | 0.8 | 0.8 | | | | X |
| | *Xylorhiza tortifolia* | 50 | 0.2 | 0.4 | 0.4 | | | | X |
| | *Adenophyllum porophylloides* | 50 | 0.1 | 0.3 | 0.3 | | | | X |
| | *Pleuraphis rigida* | 50 | 0.1 | 0.3 | 0.3 | | | | X |
| | *Nama californicum* | 50 | 0.1 | 0.2 | 0.2 | | | | X |

## M169. Great Basin & Intermountain Tall Sagebrush Shrubland & Steppe Macrogroup

## Intermountain Mesic Tall Sagebrush Shrubland & Steppe Group

### *Purshia tridentata* Shrubland Alliance

**Antelope Bush Shrubland Alliance (Mapping code 24030, not mapped)**

The *Purshia tridentata* Shrubland Alliance is widespread in many western states including Oregon, Washington, Idaho, Wyoming, Colorado, and California. The core of its range is the Columbia Basin and Plateau, Owyhee Uplands, Snake River Plains, and the Colorado Rockies (NatureServe 2011). In California, it occurs in the northern and eastern portions of southern California mountains and valleys, the Mojave Desert, the Mono Section, the southeastern Great Basin, and the northwestern basin and range regions (Sawyer et al. 2009). Conservation rank: G4, S3.

In *The Jepson Manual* (Hickman 1993), *Purshia tridentata* includes two varieties that are treated as separate species in many manuals. *Purshia tridentata* var. *glandulosa* and *Purshia tridentata* var. *tridentata* are generally differentiated by range, but both grow in the southeastern Great Basin. Both varieties are currently included in this alliance.

*Purshia tridentata* var. *tridentata* is a long-lived (125+ years), deep-rooted shrub that varies greatly in habit and local ecotypic response. An erect form tends to grow at lower elevations and a more common decumbent form at moister, higher elevations. It establishes easily on disturbed sites that have some plant cover.

Cleaned and cached seeds can be dispersed by ants, birds, and rodents up to 1,000 feet (350 m) from source shrubs. Seedling establishment is sporadic and episodic, occurring in years of heavy seed crop, moderate rodent populations, sufficiently cold winters to promote seed ripening, and favorable spring and summer moisture and temperature conditions. For this reason, this alliance often occurs as even-aged stands of cohorts.

*Purshia tridentata* var. *tridentata* is an important browse for livestock in the spring and wildlife in the winter. It is susceptible to fire, where it often killed by summer or fall fire. It may regenerate after fire by resprouting or by seedlings from cached seed. The erect form resprouts from buds just above the root collar; the decumbent form resprouts from buds just above the root collar or buds along layered branches. Young shrubs less than five-years old and those over 60 years do not resprout as well as mid-aged, vigorously growing ones. Fires that reduce duff, litter, and competitive plants in years of favorable conditions are associated with high seedling recruitment. Invasion by *Bromus tectorum* has increased the fine fuels in this and related alliances, and antelope bush is not adapted to frequent, high severity fires resulting from increased fuel loads (Zlatnik 1999).

The conspecific *Purshia tridentata* var. *glandulosa* is a long-lived, deep-rooted shrub, varying in habit and in local ecotypic response. This subspecies establishes easily on disturbed sites that have some plant cover. This variety generally grows in drier environments than *Purshia tridentata* var. *tridentata*. *Purshia tridentata* var. *glandulosa* is important browse for mule deer, especially in the winter. It is not easily killed by fire, readily resprouts after fire, and can persist with recurring fire. It regenerates after fire by resprouting or by seedlings from cached seed. It resprouts from buds just about the root collar, along upright and layered branches, or from roots. Historically, fire in bitterbrush habitats probably was infrequent, since fuel loads in this and related alliances tend to be light (Zlatnik 1999).

This alliance is generally considered to be on the decline in much of its California range due to altered fire regimes. Intervals have become too frequent and stands have been converted to *Bromus tectorum, Ericameria nauseosa*, or *Taeniatherum caput-medusae*. Long-term, intensive grazing has also reduced the vigor and reproductive capacity of some stands. Stands of this alliance are extremely important rangelands for livestock and for deer, due to the palatability of *Purshia tridentata.* Thus, proper management is economically and ecologically important.

The *Purshia tridentata* Shrubland Alliance is represented by two sampled plots with *Purshia tridentata* var. *glandulosa* and is classified as the *Purshia tridentata – Quercus cornelius-mulleri* association (Long: VCOT98-1, VMAL98-42) (see Stand Table on next page).

## Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Tree** | | | | | | | | | |
| | *Quercus cornelius-mulleri* | 100 | 38.5 | 37.0 | 40.0 | X | X | X | X |
| | *Juniperus californica* | 50 | 2.6 | 5.2 | 5.2 | | | | X |
| | *Yucca brevifolia* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| **Shrub** | | | | | | | | | |
| | *Petalonyx thurberi* | 100 | 29.0 | 19.0 | 39.0 | X | X | X | X |
| | ***Purshia tridentata*** | **100** | **19.5** | **14.0** | **25.0** | | **X** | | **X** |
| | *Grayia spinosa* | 100 | 3.1 | 0.2 | 6.0 | | X | | X |
| | *Phoradendron californicum* | 100 | 2.5 | 1.0 | 4.0 | | X | | X |
| | *Psorothamnus fremontii* | 100 | 2.1 | 0.2 | 4.0 | | X | | X |
| | *Eriogonum fasciculatum* | 100 | 0.6 | 0.2 | 1.0 | | X | | X |
| | *Lycium cooperi* | 100 | 0.6 | 0.2 | 1.0 | | X | | X |
| | *Psorothamnus emoryi* | 100 | 0.6 | 0.2 | 1.0 | | X | | X |
| | *Opuntia polyacantha var.* | 50 | 5.0 | 10.0 | 10.0 | | | | X |
| | *Encelia frutescens* | 50 | 1.0 | 2.0 | 2.0 | | | | X |
| | *Ambrosia salsola* | 50 | 0.5 | 1.0 | 1.0 | | | | X |
| | *Cylindropuntia ramosissima* | 50 | 0.5 | 1.0 | 1.0 | | | | X |
| | *Ephedra californica* | 50 | 0.5 | 1.0 | 1.0 | | | | X |
| | *Ferocactus cylindraceus* | 50 | 0.5 | 1.0 | 1.0 | | | | X |
| | *Galium stellatum* | 50 | 0.5 | 1.0 | 1.0 | | | | X |
| | *Nolina parryi* | 50 | 0.5 | 1.0 | 1.0 | | | | X |
| | *Prunus fasciculata* | 50 | 0.5 | 1.0 | 1.0 | | | | X |
| | *Psorothamnus arborescens* | 50 | 0.5 | 1.0 | 1.0 | | | | X |
| | *Tetradymia canescens* | 50 | 0.5 | 1.0 | 1.0 | | | | X |
| | *Cleome isomeris* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Ephedra viridis* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Ericameria cuneata* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Krameria grayi* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Simmondsia chinensis* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Stanleya pinnata* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Tetradymia spinosa* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Yucca schidigera* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| **Herb** | | | | | | | | | |
| | *Heteropogon contortus* | 50 | 1.5 | 3.0 | 3.0 | | | X | X |
| | *Phacelia* | 50 | 1.0 | 2.0 | 2.0 | | | | X |
| | *Achnatherum speciosum* | 50 | 0.5 | 1.0 | 1.0 | | | | X |
| | *Erigeron parishii* | 50 | 0.5 | 1.0 | 1.0 | | | | X |
| | *Lotus* | 50 | 0.5 | 1.0 | 1.0 | | | | X |
| | *Cucurbita palmata* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Dudleya saxosa* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Leptochloa fusca* | 50 | 0.1 | 0.2 | 0.2 | | | | X |

## Intermountain Semi-Desert Grassland Group

### *Achnatherum speciosum* Herbaceous Alliance

**Desert Needlegrass Herbaceous Alliance (Mapping code 59020, not mapped)**

The *Achnatherum speciosum* Herbaceous Alliance is defined from the Colorado Plateau in Utah and the Mojave Desert in California. This alliance was once widespread throughout the Mojave Desert but has been reduced to scattered stands by overgrazing (NatureServe 2011). Conservation rank: G4, S2.

*Achnatherum speciosum* is a native, cool-season, perennial bunchgrass that grows in large, dense clumps that have persistent leaf bases. The species reproduces asexually with tiller growth and sexually by seed. Seed crop size is closely tied to adequate moisture and temperature conditions. The grass has persistent seed and seedling banks, and seeds are self-planting (Pavek 1993). It is often referred to as *Stipa speciosa* in botanical literature.

*Achnatherum speciosum* occurs as a species in a wider range than does the alliance. In California, for example, *A. speciosum* occurs west of the desert in the dry, interior Coast Ranges in Fresno Co. However, the alliance is known from relatively few and scattered stands in transmontane California, and a few stand in the lower elevations of the Tehachapi Mountains. Known stands are in upper-desert settings, adjacent to stands dominated by *Coleogyne ramosissima, Ericameria teretifolia, Eriogonum fasciculatum, Grayia spinosa, Juniperus californica*, or *Yucca brevifolia*. Its rarity is likely a function of the natural disturbance regimes necessary for its development. However, its rarity is also likely a function of the invasion of non-native annual grasses that have altered fire frequencies.

Stands appear associated with disturbances, such as past burns that occur in the late summer or fall. The stands occupy areas where fire frequencies are moderate to relatively high, including in borderlands between desert and chaparral types. Individuals of *Achnatherum speciosum* survive fires, sprout rapidly, set seed, and colonize burned areas more rapidly than the formerly dominant shrubs (Humphrey 1974). However, the presence of *Bromus rubens*, *Schismu*s spp., and other non-natives increases fire frequencies, and the invasive qualities of these species impose a decline on the importance of this bunchgrass.

This alliance is represented in Joshua Tree National Park by the *Achnatherum speciosum – Sphaeralcea ambigua* Herbaceous Alliance.

### *Achnatherum speciosum – Sphaeralcea ambigua* Association

**Desert Needlegrass – Desert Globemallow Association (Mapping code 59022, not mapped)**

#### Range

Globally: This association is known only from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of the *Achnatherum speciosum – Sphaeralcea ambigua* Association were sampled in the Cadiz Valley SW, East Deception Canyon, and Malapai Hill 7.5-minute topographic quadrangles.

#### Environmental Description

Globally: This association is known only from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: Stands of the *Achnatherum speciosum – Sphaeralcea ambigua* Association are found at high elevations (4,300–4,900 ft.; 1,300–1,500 m) on flat or undulating surfaces. Soils are sands derived from granitic parent materials. Ground cover in this association consists of 0 percent bedrock, 0 percent boulder, 0 percent stone, 0–<1 percent cobble, 7–34 percent gravel, and 45–91 percent fines cover. Litter cover is 1–13 percent. Disturbance from exotic species is not reported for this association. Stands are associated with past burns, including in the Covington Flats area. Another potential past impact is historic grazing. These sites also experience low to high levels of disturbance from exotic species.

#### Vegetation Description

Globally: This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR: The *Achnatherum speciosum – Sphaeralcea ambigua* Association forms sparse stands having <1 percent cover in the tree/tall stratum, 2–3 percent cover in the shrub/mid strata, and 4–6 percent cover in the herb/low strata. Total vegetation cover is 8–9 percent.

Stands of the *Achnatherum speciosum – Sphaeralcea ambigua* Association are dominated by *Sphaeralcea ambigua* and *Achnatherum speciosum* in the herbaceous layer and *Yucca brevifolia* in the emergent tree layer. Characteristic species in this association are *Ephedra nevadensis* and *Lycium cooperi. Salazaria mexicana* is also often present. These burned stands were previously *Yucca brevifolia* alliance stands with *Juniperus californica, Ephedra nevadensis,* and *Coleogyne ramosissima* as associates. Nonnative plants in stands include *Bromus rubens* and *B. tectorum.*

**Other Noteworthy Species**
N/A

**Conservation Rank:** Rare

**Rank Justification**
This association currently is known only form Joshua Tree National Park, though other stands have been observed in post-burn areas of the Mojave National Preserve.

**Comments**
Globally : N/A

JOTR: N/A

Plots used for this description: N=3; JOTRA: 08A-04-3; JOTR: JOTR85, JOTR86.

Map Accuracy Assessment plots: N=0.

**Stand Table**

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Tree** | | | | | | | | | |
| | *Yucca brevifolia* | 100 | 0.2 | 0.2 | 0.2 | X | X | X | X |
| **Shrub** | | | | | | | | | |
| | ***Sphaeralcea ambigua*** | **100** | **1.4** | **0.2** | **2.0** | **X** | **X** | **X** | **X** |
| | *Lycium cooperi* | 100 | 0.2 | 0.2 | 0.2 | | X | | X |
| | *Ephedra nevadensis* | 100 | 0.5 | 0.2 | 1.0 | | X | | X |
| | *Salazaria mexicana* | 67 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Atriplex canescens* | 33 | 0.3 | 1.0 | 1.0 | | | | |
| | *Coleogyne ramosissima* | 33 | 0.3 | 1.0 | 1.0 | | | | |
| | *Purshia tridentata* | 33 | 0.3 | 1.0 | 1.0 | | | | |
| | *Ambrosia salsola* | 33 | 0.1 | 0.2 | 0.2 | | | | |
| | *Encelia actonii* | 33 | 0.1 | 0.2 | 0.2 | | | | |
| | *Ericameria teretifolia* | 33 | 0.1 | 0.2 | 0.2 | | | | |
| | *Gutierrezia microcephala* | 33 | 0.1 | 0.2 | 0.2 | | | | |
| | *Gutierrezia sarothrae* | 33 | 0.1 | 0.2 | 0.2 | | | | |
| | *Lycium andersonii* | 33 | 0.1 | 0.2 | 0.2 | | | | |
| | *Opuntia basilaris* | 33 | 0.1 | 0.2 | 0.2 | | | | |
| | *Prunus fasciculata* | 33 | 0.1 | 0.2 | 0.2 | | | | |
| | *Tetradymia spinosa* | 33 | 0.1 | 0.2 | 0.2 | | | | |
| **Herb** | | | | | | | | | |
| | ***Achnatherum speciosum*** | **100** | **4.1** | **4.0** | **4.2** | **X** | **X** | **X** | **X** |
| | *Bromus rubens* | 33 | 0.7 | 2.0 | 2.0 | | | | |
| | *Bromus tectorum* | 33 | 0.7 | 2.0 | 2.0 | | | | |
| | *Eriogonum* | 33 | 0.1 | 0.2 | 0.2 | | | | |
| **Nonvascular** | | | | | | | | | |
| | Cryptogammic crust | 33 | 0.1 | 0.2 | 0.2 | | | | |

## M093. Great Basin Saltbrush Scrub Macrogroup

## Intermountain Shadscale-Saltbush Scrub Group

### *Atriplex canescens* Shrubland Alliance

**Fourwing Saltbush Shrubland Alliance (Mapping code 28080)**

The *Atriplex canescens* Shrubland Alliance occurs primarily in arid and semi-arid areas of the southwestern U.S. from western Texas to southern and eastern California and into Chihuahua, Mexico. It is also found in the western Great Plains to the Great Basin from western Kansas, Colorado, and Wyoming to Utah, Nevada and eastern Oregon (NatureServe 2011). In California it occurs in the Central Coast Ranges, Colorado Desert, San Joaquin Valley, Mojave and Sonoran deserts, northwestern Basin and Range, southeastern Great Basin, and western Riverside County (Sawyer et al. 2009). Conservation rank: G5, S4.

This alliance is often considered part of the chenopod, or saltbush, scrub group; most stands of this group are dominated by one or more perennial species of *Atriplex*. These scrubs are better thought of as a collection of alliances consisting of *Atriplex polycarpa, Atriplex spinescens, Atriplex lentiformis, Atriplex hymenelytra,* and/or *Atriplex confertifolia* alliances.

The physiology and form of *Atriplex canescens* is as variable as the ecological settings in which it is found. They include sandy dune aprons and low dunes in Death Valley and Saline Valley, and moderately alkaline playas such as Silver Dry Lake and Superior Dry Lake. In the hot deserts of California, *Atriplex canescens* appears to have more of an affinity for windblown sand than other *Atriplex* shrubs and frequently forms part of the dune margin matrix with stands of *Prosopis glandulosa, Pleuraphis rigida,* and *Larrea tridentata-Ambrosia* alliances. It also mixes regularly with other species of *Atriplex* to form mixed stands in washes (*Atriplex canescens – Atriplex polycarpa*) and on playa and playa edges (*Atriplex canescens – Atriplex confertifolia*).

Plants are long-lived and resistant to salt, cold, and drought; they tolerate saline, alkaline, boron, and gypsum soils. This tolerance range is at least partially explained by chromosomal differences in populations. Different ploidy levels of *Atriplex canescens* appear to occupy different ecoregions. These include hot desert and cold desert ecotypes (Howard 2003). The species has been considered as the most rapidly evolving shrub in North America (Sawyer et al. 2009).

Associated alliances range from alkaline wetland types, such as *Scirpus americanus, Distichlis spicata, Pluchea sericea,* and *Juncus balticus;* to playa types such as *Suaeda moquinii, Allenrolfea occidentalis,* and *Atriplex polycarpa;* to upland types such as *Atriplex confertifolia, Grayia spinosa,* and *Coleogyne ramosissima.*

*Atriplex canescens* colonizes readily from seed and does not appear to require mycorrhizal associations to grow vigorously. It has been used extensively for rehabilitation of mine excavations in Wyoming and Montana. Tolerant of grazing, the species is also resistant to fire

because of moist and non-volatile leaf composition, and it sprouts prolifically if top-killed by fire (Sawyer et al. 2009). Natural disturbance processes probably did not involve fire to any great degree in most California stands, except the cismontane ones. Fire may have more considerable impacts currently as a result of invasion of *Bromus* spp. in understory and because of increased human-caused ignitions.

In general, this alliance is in stable throughout its range. Its ability to tolerate alkaline soils and grazing, fire, and other disturbance bodes well for its persistence, although sensitivity to high levels of grazing and fire at certain times of year should be investigated (Howard 2003).

This alliance is represented in Joshua Tree National Park by the *Atriplex canescens* Association.

## *Atriplex canescens* Association

**Four-Wing Saltbush Association (Mapping code 28083)**

### Range

Globally: The wide ranging *Atriplex canescens* Association is known from the Great Basin north into the southern Columbia Basin and east into Wyoming and the Colorado Plateau in Wyoming, Colorado, Utah, Arizona, Nevada, and California (NatureServe 2011).

JOTR: A significant stand exists in Pleasant Valley, and all stands sampled have been in the Malapai Hill 7.5-minute topographic quadrangle in this valley. However, other small un-mapped stands occur elsewhere in the central portion of the park.

### Environmental Description

Globally: The *Atriplex canescens* Association is common at middle elevations along low-lying playas and edges of alkaline wetlands, in sandy areas, on alluvial fans and toeslopes in deep, sandy soils including sandy areas around cinder cones, and at lower elevations along alluvial benches where soils are often finer-textured and seemingly saline/alkaline (Evens and Hartman 2007, NatureServe 2011).

JOTR: This association is found at mid elevations (3,300–3,400 ft.; 1,000 m) on relatively flat surfaces with variable slope aspect. Slopes are nearly flat (0–1 degree). Soils range from medium to very fine sandy loams to moderately fine silty clay loams derived from sandy alluvium. Ground cover in this association consists of 0 percent bedrock, 0 percent boulder, 0 percent stone, 0–<1 percent cobble, <1–95 percent gravel. Litter cover ranges from 4–80 percent.

### Vegetation Description

Globally*:* *Atriplex canescens* occurs as short or medium shrubs in relatively sparse to intermittent cover (1% to > 20% cover) as the dominant or sometimes co-dominant. *Larrea tridentata* or other shrubs may be present and sometimes similar in cover as a co-dominant. Non-native species, including *Bromus rubens* and *Erodium cicutarium,* can create an herbaceous layer that is denser than the shrub layer on disturbed sites (Evens and Hartman 2007).

JOTR: Stands of the *Atriplex canescens* Shrubland Association form sparse to open shrublands with 0 percent cover in the tree/tall stratum, <1–14 percent cover in the shrub/mid stratum, and 2–52 percent cover in the herb/low stratum.

This association is dominated by *Atriplex canescens* in the shrub layer and the non-natives *Bromus rubens* and *Erodium cicutarium* in the herb layer*.* Stands experience low to high levels of disturbance from exotic plant species.

**Other Noteworthy Species**
N/A

**Conservation Rank:** N/A

**Rank Justification**
N/A

**Comments**
Globally: N/A

JOTR: N/A

Plots used for this description: N=5; Long: VMAL97-1, VMAL97-1M, VMAL97-3, VMAL97-4M, VMAL97-5M; Watts n=2.

Map Accuracy Assessment plots: N=13; 25-1453, 25-1454, 25-1455, 25-1456, 25-1457, 25-1458, 50-0115, 50-0119, 50-0121, 50-0124, 50-0128, 50-0132, 50-0133.

**Stand Table**

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Shrub** | | | | | | | | | |
| | ***Atriplex canescens*** | **100** | **4.1** | **0.4** | **8.0** | **X** | **X** | **X** | **X** |
| | *Larrea tridentata* | 40 | 0.2 | 0.2 | 1.0 | | | | |
| **Herb** | | | | | | | | | |
| | *Erodium cicutarium* | 100 | 4.0 | 0.2 | 6.0 | X | X | X | X |
| | *Bromus rubens* | 80 | 15.8 | 1.0 | 50.0 | X | X | X | X |
| | *Pleuraphis rigida* | 40 | 0.1 | 0.2 | 0.4 | | | | |

## *Grayia spinosa* Shrubland Alliance

**Spiny Hop-Sage Shrubland Alliance (Mapping code 36020, not mapped)**

The *Grayia spinosa* Shrubland Alliance occurs throughout the Great Basin, Columbia Plateau, and eastern Mojave regions of Colorado, Utah, Nevada, Oregon, and Washington (NatureServe 20110. In California, it occurs in the Mojave Desert, Mono Section, northwestern Basin and Range, Sierra Nevada, and the southeastern Great Basin. It is most extensive in the southwestern portion of the Great Basin (Sawyer et al. 2009). Conservation rank: G5, S3.

*Grayia spinosa* is a diffusely branched shrub that reaches 1.5 m in height. Shrubs are relatively long lived. Stands are small but widespread in the Mojave Desert and southwestern Great Basin where they exist in a distinct and relatively narrow transition zone between the lower *Larrea tridentata* and upper *Artemisia tridentata* and *Coleogyne ramosissima* zones (Beatley 1965, 1975, Keeler-Wolf et al. 2007). Shrub density and importance tend to increase with stand age (Webb et al. 1987). In the Panamint Mountains, *G. spinosa* replaces the early colonizing *Atriplex* spp. and *Chrysothamnus viscidiflorus* shrubs, allowing *C. ramosissima* to increase in dominance as *G. spinosa* stands age. Pure stands exist on deep sandy soils.

Wind, gravity, and water disperse dry fruits with persistent bracts, which developed into seed banks. Seedlings establish in the cool season when moisture is available, and subsequent germination is improved with cold stratification (Sawyer et al. 2009, Tirmenstein 1999).

Little is known about the disturbance patterns of this alliance. Shrubs are top-killed and appear to sprout weakly from the base after fires (CNPS Desert Workshop 2000, Tirmenstein 1999c). *Grayia spinosa* sprouts readily after trampling or light burning, but it does not colonize by seed immediately following disturbance (Webb et al. 1988). Plants tolerate browsing and are important for livestock in the Great Basin, but they are not considered good forage because of their spines. In restoration projects, living shrubs of *G. spinosa* have been transplanted successfully along roadsides in eastern California (Tirmenstein 1999).

The alliance in Joshua Tree National Park is denoted by four samples with limited data (see Stand Table on next page):

*Grayia spinosa* (Watts n=4)

## Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Shrub** | | | | | | | | | |
| | ***Grayia spinosa*** | **100** | **4.0** | **2.3** | **5.7** | | **X** | | **X** |
| | *Grusonia parishii* | 75 | 1.2 | 0.2 | 4.2 | | X | | X |
| | *Simmondsia chinensis* | 75 | 0.4 | 0.2 | 0.8 | | X | | X |
| | *Ephedra californica* | 75 | 0.3 | 0.2 | 0.7 | | X | | X |
| | *Lycium andersonii* | 75 | 0.2 | 0.2 | 0.6 | | X | | X |
| | *Ambrosia salsola* | 75 | 0.2 | 0.1 | 0.6 | | X | | X |
| | *Rhus trilobata* | 75 | 0.1 | 0.1 | 0.2 | | X | | X |
| | *Cleome isomeris* | 50 | 6.8 | 5.1 | 22.0 | | | | X |
| | *Acacia greggii* | 50 | 3.5 | 0.2 | 13.6 | | | | X |
| | *Encelia farinosa* | 50 | 3.2 | 0.9 | 11.7 | | | | X |
| | *Salvia mohavensis* | 50 | 0.4 | 0.2 | 1.5 | | | | X |
| | *Thamnosma montana* | 50 | 0.4 | 0.4 | 1.2 | | | | X |
| | *Coleogyne ramosissima* | 50 | 0.3 | 0.2 | 1.0 | | | | X |
| | *Tetradymia spinosa* | 50 | 0.1 | 0.2 | 0.3 | | | | X |
| | *Escobaria vivipara* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| **Herb** | | | | | | | | | |
| | *Adenophyllum porophylloides* | 100 | 2.8 | 0.2 | 7.1 | | X | | X |
| | *Adenophyllum cooperi* | 75 | 3.2 | 0.2 | 10.4 | | X | | X |
| | *Pleuraphis rigida* | 75 | 0.5 | 0.2 | 1.8 | | X | | X |
| | *Dudleya saxosa* | 75 | 0.5 | 0.2 | 1.3 | | X | | X |
| | *Lotus rigidus* | 50 | 1.6 | 1.5 | 5.1 | | | | X |
| | *Heteropogon contortus* | 50 | 0.4 | 0.4 | 1.2 | | | | X |
| | *Eriastrum* | 50 | 0.1 | 0.1 | 0.2 | | | | X |

## 6. Nonvascular & Sparse Vascular Rock Vegetation Class

## 6.C.1. Warm Semi-Desert Cliff, Scree, & Rock Vegetation Formation

## 6.C.1.a. North American Warm Semi-Desert Cliff, Scree & Rock Vegetation Division

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

## North American Warm Semi-Desert Cliff, Scree & Pavement Group

### *Atriplex hymenelytra* Shrubland Alliance

**Desert Holly Shrubland Alliance (Mapping code 28070, not mapped)**

The *Atriplex hymenelytra* Shrubland Alliance occurs in the Mojave Desert, Sonoran Desert, Colorado Desert, and southeastern Great Basin regions of California; and in the Mojave Desert of Nevada. It may also occur in deserts in Arizona, Utah, and northern Mexico (NatureServe 2011). Conservation rank: G5, S4.

Stands of the *Atriplex hymenelytra* Shrubland Alliance occur on alluvial fans; along washes; and on steep colluvium, recent lava flows, cinder cones, and in heavy alkaline lake sediments. It is also commonly found along drainages that dissect west-facing bajadas and on western slopes of mountains (NatureServe 2011). Soils are derived from alluvium; colluvium; and residuum from metamorphic, igneous, and other sedimentary rocks. Parent materials may be carbonate, alkaline, or saline with desert pavements. The alliance also occurs in wetland habitats such as intermittently flooded wash bottoms. Elevations range from -240 to 4,500 feet (-73 to 1,400 m).

Where *Atriplex hymenelytra* occurs in washes, it generally occupies the rocky, gravelly bottoms that have little or no organic buildup in the substrate. These washes may not receive water for several successive years. Surrounding upland vegetation may include *Larrea tridentata – Ambrosia dumosa, Larrea tridentata – Encelia farinosa,* or desert annuals. Tolerance of bare mineral substrate with low nutritional value and no apparent mycorrhizal associations confers an advantage for *Atriplex hymenelytra* in colonizing low-elevation washes as well as road cuts and other unnatural disturbances. *Tidestromia oblongifolia*, one of the most common associates of this alliance, is commonly found in disturbed sites (OHV areas, roadsides). It is possible that severe degradation of upland *Atriplex hymenelytra* stands can result in *Tidestromia oblongifolia* alliance, but this has not yet been described.

This alliance is often considered part of either creosote bush scrub or saltbush scrubs; which are better thought of as a collection of alliances. Species common to this alliance are also common to the *Larrea tridentata, Larrea tridentata – Ambrosia dumosa* and *Larrea tridentata – Encelia farinosa* shrubland alliances. In general, shrub density in the *Atriplex hymenelytra* alliance is very low. This is the most xeric shrub alliance in the Mojave Desert, where it persists in extremely hot, dry locations where virtually no other perennial shrub is able to flourish.

The *Atriplex hymenelytra* alliance has relatively simple seral relationships. *Atriplex hymenelytra* can be both an invader and a long-lived, stable component of the landscape. Studies at the Zzyzx Desert Studies Center (A. Romspert, personal communication 2000) indicate individuals are long lived and may undergo sex change based on age and environmental conditions. Recruitment at Trona Pinnacles is episodic; the last major event was 21 years ago, suggesting long viable seed in soil (G. Harris, personal communication 2000).

Natural disturbance in the harsh upland environments comes mostly as shifts in moisture availability. A series of wetter years will shift *Atriplex hymenelytra* toward other desert alliances such as *Larrea tridentata, Larrea tridentata – Ambrosia dumosa,* or *Larrea tridentata – Encelia farinosa.* A series of drier years will eliminate individual *Atriplex hymenelytra* and other component species and leave only annual, ephemeral herb species, such as *Geraea canescens* and *Chorizanthe rigida*, in the seed bank.

This alliance is rare in the study area, and most stands with *A. hymenelytra* have been classified into the *Larrea tridentata / Atriplex hymenelytra* Shrubland Association within the *Larrea tridentata* Shrubland Alliance.

## *Chorizanthe rigida – Geraea canescens* Desert Pavement Annual Herbaceous Alliance
### Desert Gold – Spiny Herb Desert Pavement Annual Herbaceous Alliance (Mapping code 90100)

The *Chorizanthe rigida – Geraea canescens* Herbaceous Alliance occurs in the Mojave Desert and Sonoran Deserts in California, including from Joshua Tree National Park. It is likely to occur more widely in the Mojave of Arizona and Nevada, and in the Colorado and Sonoran Deserts of California. Typical sites are bajadas, lower hillslopes, and desert pavement. Conservation status: G4, S4?

*Chorizanthe rigida* and *Geraea canescens* are native, warm-season annual plants that develop in the late winter and flower in the spring. The number and timing of germinating plants are related to the amount of fall/winter precipitation and temperature. Colorful spring displays of flowering plants occur in El Nino years, while plants are sparse in dry years. Thus, annual plant cover may vary from 1% to >20% depending on the year. The suite of annual plants indicative this alliance include *Geraea canescens, Chorizanthe rigida, C. brevicornu, Camissonia* spp., *Chaenactis* spp., *Cryptantha* spp., *Eriogonum* spp., *Langloisia setosissima, Loeseliastrum schottii, Mentzelia* spp., *Pectocarya* spp., *Phacelia* spp., *Plantago ovata,* as well as non-natives *Bromus rubens, Erodium cicutarium,* and *Schismus* spp. Shrub cover is typically <1% cover, and may include *Atriplex hymenelytra, Encelia farinosa, Larrea tridentata,* and *Opuntia basilaris.*

Stands occur on desert pavement, broad alluvial fans, and lower slopes in the desert. The ground surface is usually mixed alluvium, with various rocks and gravel along with interstitial fine sediments. These environments are not typically disturbed by fire, except where non-native grasses have invaded and can carry fire. Other impacts can be OHV activity and livestock grazing.

In Joshua Tree National Park, this alliance is mapped as areas of desert pavement, which are found in the central and eastern portions at low to moderate elevations. Stands have sparse (<2%) cover of shrubs, including *Ambrosia dumosa, Cylindropuntia echinocarpa, Encelia farinosa, Krameria grayi,* and *Larrea tridentata.* The cover of herbs is variable, and they may be seasonally abundant and include natives *Allionia incarnata, Chamaesyce* spp., *Plantago ovata,* and *Pleuraphis rigida,* and non-natives *Brassica tournefortii.* The cover of non-vascular cryptogammic crust may also vary in cover (<2 to 50%).

More inventory and sampling of this type is needed in the Park to define associations, and plots sampled are at the alliance/group level:

*Chorizanthe rigida – Geraea canescens* Alliance (JOTRA: 37B-17-2, 38-28-3, 56-06-2, 62-02-2; JOTR: JOTR87, JOTR90, JOTR94, JOTR95; MapAA: 50-0053, 50-0056, 50-0059, 50-0060, 50-0061, 50-0062, 50-0063, 50-0064, 50-0065, 50-0066, 50-0070, 50-0077, 50-0078, 50-0079, 50-0080, 50-0081, 50-0123, 50-0130, 50-0551, 50-1952, 50-1954, 50-1955, 50-1956, 50-1957, 50-1959, 50-1960)

## *Peucephyllum schottii* Provisional Shrubland Alliance

**Schott's Pygmycedar Provisional Shrubland Alliance (Mapping code 28400, not mapped)**

The *Peucephyllum schottii* Provisional Shrubland Alliance has been described from the Mojave Desert in southern Nevada and California (NatureServe 2011), including in Joshua Tree National Park. The vegetation is characterized by an open, xeromorphic shrub layer dominated by *Peucephyllum schottii*; *Gutierrezia microcephala* is co-dominant is some stands (NatureServe2011).

Stands of *Peucephyllum schottii* are found at low to high elevation (1,500–4,400 ft.; 500–1,300 m) on neutral or north-facing aspects. Slopes are gentle to steep (1–24 degrees) with convex topography. Typical habitats include rocky ridge tops, rocky washes or edges of washes, and the lower to middle third of slopes. Soils are coarse sands derived from granitic parent materials or soils are barely developed with plants growing out of rock crevices. Ground cover is comprised of 20 percent bedrock, 50 percent boulder, 25 percent stone, 3 percent cobble, 1 percent gravel, and 1 percent files. Litter is typically <1 percent cover. Stands are often found in or adjacent to washes or on rocky walls just above them; or they are on bouldery north-facing mountainsides.

Stands of *Peucephyllum schottii* form a sparse to intermittent shrubland with 0–47 percent cover in the tree/tall stratum, 8–27 percent cover in the shrub/mid stratum, and 0–<1 percent cover in the herb/low stratum. Total vegetation cover ranges from 9–75 percent.

Species characteristic to these stands include *Peucephyllum schottii* with *Ambrosia dumosa, Krameria grayi, Erigeron parishii,* and *Nama californicum.* Other species often present are *Cleome isomeris, Cylindropuntia ramosissima, Echinocereus mojavensis, Encelia farinosa, Eucnide urens, Gutierrezia microcephala, Larrea tridentata, Lycium andersonii, Pleurocoronis pluriseta, Salvia mohavensis,* and *Eriastrum* spp.

This alliance is represented in Joshua Tree National Park by two associations with limited data and sample sizes; thus, the species Stand Table on the next page represents the variation for the alliance without association descriptions being written:

> *Peucephyllum schottii – Gutierrezia microcephala* Provisional Association (Watts n=3)
> *Peucephyllum schottii – Pleurocoronis pluriseta – Eucnide urens* Provisional Association (JOTR15)

## Stand Table

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Shrub** | | | | | | | | | |
| | ***Peucephyllum schottii*** | **100** | **7.8** | **1.8** | **22.8** | | **X** | | **X** |
| | *Krameria grayi* | 75 | 3.9 | 1.2 | 10.0 | | X | | X |
| | *Ambrosia dumosa* | 75 | 0.6 | 0.2 | 1.4 | | X | | X |
| | *Salvia mohavensis* | 50 | 4.7 | 0.3 | 18.4 | | | | X |
| | *Gutierrezia microcephala* | 50 | 2.7 | 4.4 | 6.5 | | | | X |
| | *Cleome isomeris* | 50 | 1.2 | 0.2 | 4.7 | | | | X |
| | *Cylindropuntia ramosissima* | 50 | 0.8 | 1.4 | 1.9 | | | | X |
| | *Lycium andersonii* | 50 | 0.6 | 0.2 | 2.1 | | | | X |
| | *Echinocereus mojavensis* | 50 | 0.4 | 0.4 | 1.3 | | | | X |
| | *Encelia farinosa* | 50 | 0.2 | 0.2 | 0.7 | | | | X |
| | *Larrea tridentata* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| **Herb** | | | | | | | | | |
| | *Erigeron parishii* | 75 | 0.9 | 0.3 | 1.9 | | X | | X |
| | *Nama californicum* | 75 | 0.5 | 0.2 | 1.5 | | X | | X |
| | *Eriastrum* | 50 | 0.2 | 0.2 | 0.4 | | | | X |

## North American Warm Desert Dunes & Sand Flats Group

### *Dicoria canescens – Abronia villosa* Sparsely Vegetated Alliance (Desert Dunes & Sand Flats)

**Desert Twinbugs – Desert Sand Verbena Sparsely Vegetated Alliance (Desert Dunes & Sand Flats) (Mapping code 60020)**

The *Dicoria canescens – Abronia villosa* Sparsely Vegetated Alliance occurs in the Mojave Desert and Sonoran Deserts in California, including from Joshua Tree National Park. It is likely to occur more widely in the Mojave of Arizona and Nevada, and in the Colorado and Sonoran Deserts of California. Typical sites are bajadas, lower hillslopes, and desert pavement. Conservation status: G3, S2.

*Abronia villosa* and *Dicoria canescens* are native, warm-season annual plants*; A. villosa* develops and blooms in the spring while *D. canesens* is active in the summer. The number and timing of germinating plants are related to the amount of fall/winter precipitation and temperature as well as summer precipitation. Thus, the cover of plants can vary from <1% to >20% depending on the year. The suite of annual plants indicative of this alliance include *Abronia villosa, Dicoria canescens, Achnatherum hymenoides, Argemone corymbosa, A. munita, Astragalus lentiginosus, Camissonia claviformis, Cleome sparsifolia, Coldenia plicata, Croton californicus, Eriogonum spp. Geraea canescens, Gilia latifolia, Oenothera deltoides, Palafoxia arida, Panicum urvilleanum, Petalonyx thurberi, Pleuraphis rigida,* and *Rumex hymenosepalus,* and the non-natives *Brassica tournefortii, Salsola tragus,* and *Schismus* spp*.* Emergent shrubs may be present and include *Ambrosia dumosa, Atriplex* spp., *Larrea tridentata,* and *Peucephyllum schottii.*

Stands occur on active dunes, partially stabilized dunes, stabilized dunes, sand fields. Soils are fine to moderately coarse sand. The occurrence of sand sheets and sand dunes is the most reliable feature of this alliance since the presence (or absence) of plants can vary. Depending on the site, different uncommon and rare plant taxa may occur such as *Oenothera californica* ssp. *eurekensis* and *Petalonyx thurberi* ssp. *gilmanii* in Death Valley in the Mojave Desert; and *Astragalus magdalenae* var. *peirsonii, Eriogonum deserticola* and *Pholisma sonorae* at the Aglodones Dunes in the Colorado Desert, and *Astragalus insularis* var. *harwoodii, Cryptantha costata, Eriogonum deserticola,* at the Chuckwalla Valley dunes in the Sonoran Desert. These environments are not typically disturbed by fire. Impacts and threats to this alliance are from OHV activity and competition with non-native plants.

Stands in Joshua Tree National Park are scattered throughout the park, and they are variable in species composition and cover. Some are very small and associated with other types on sandy substrates, and these stands may be mapped within *Larrea tridentata / Pleuraphis rigida* Shrubland Association. Two stands in the Park have been sampled with classification plot data, and they include the following herbaceous species at low (<4%) cover: *Oenothera deltoides, Palafoxia arida, Petalonyx thurberi, Plantago ovata,* and *Pleuraphis rigida* as natives and *Brassica tournefortii* as non-native*.* Shrubs are emergent and sparse (<2% cover), and include

*Ambrosia dumosa* and *Larrea tridentata.* The ground surface is primarily sand (98–99% cover). Other observed stands include a variety of herbs including *Abronia villosa, Astragalus lentiginosus,* and *Dicoria canescens*. More inventory and sampling of this type is needed in the Park to define associations, and two plots sampled of this type are classified at the alliance level:

*Dicoria canescens – Abronia villosa* Alliance (JOTRA: 49A-14-2, 56-06-3)

**STAND TABLE**

| Lifeform | Species Name | Con | Avg | Min | Max | D | Ch | Ab | Oft |
|---|---|---|---|---|---|---|---|---|---|
| **Tree** | | | | | | | | | |
| | *Chilopsis linearis* | 50 | 0.1 | 0.2 | 0.2 | | | X | X |
| **Shrub** | | | | | | | | | |
| | *Ambrosia dumosa* | 100 | 0.7 | 0.2 | 1.2 | X | X | X | X |
| | *Larrea tridentata* | 100 | 0.3 | 0.2 | 0.4 | | X | | X |
| | *Ambrosia salsola* | 50 | 0.2 | 0.4 | 0.4 | | | | X |
| | *Encelia frutescens* | 50 | 0.2 | 0.4 | 0.4 | | | | X |
| | *Psorothamnus emoryi* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| **Herb** | | | | | | | | | |
| | *Petalonyx thurberi* | 50 | 1.6 | 3.2 | 3.2 | | | | X |
| | *Datura wrightii* | 50 | 0.2 | 0.4 | 0.4 | | | | X |
| | *Palafoxia arida* | 50 | 0.2 | 0.4 | 0.4 | | | | X |
| | *Brassica tournefortii* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Oenothera deltoides* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Pectis papposa* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Plantago ovata* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| | *Pleuraphis rigida* | 50 | 0.1 | 0.2 | 0.2 | | | | X |
| **Nonvascular** | | | | | | | | | |
| | Cryptogammic crust | 50 | 0.1 | 0.2 | 0.2 | | | X | X |

## Glossary of Terms

**Abundant:** For a plant to be considered abundant, relative cover must be ≥ 30% and constancy/frequency ≥50% but <75%.

**Alliance**: Plant communities based on dominant/diagnostic species of uppermost or dominant stratum. Part of the USNVC hierarchy. Species separated by "-" are within the same stratum; species separated by "/" are in different strata. The number at the end of some plant community names is the Mapping Code used for labeling plant community polygons for the associated GIS-based plant community map.

**Association:** The most botanically detailed plant community designation based on dominant species and multiple co- or subdominant indicator species from any strata. Part of the USNVC system. Species separated by "-" are within the same stratum; species separated by "/" are in different strata. The number at the end of some plant community names is the Mapping Code used for labeling plant community polygons for the associated GIS-based plant community map.

**Aspect:**

| | |
|---|---|
| N | 338–22 |
| NE | 23–67 |
| E | 68–112 |
| SE | 113–157 |
| S | 158–202 |
| SW | 203–247 |
| W | 248–292 |
| NW | 293–337 |

**Characteristic:** For a plant to be considered characteristic, constancy/frequency must be ≥75%.

**Cover:**

**Absolute cover -** The actual percentage of the surface area of the plot that is covered by a species or physiognomic group (trees, shrubs, herbaceous), as in "creosote bush covers 10 percent of the plot." Absolute cover of all species or physiognomic groups, when added together, may total greater than 100 percent, because this is not a proportional number and plants can overlap each other. For example, a plot could have 25 percent tree cover, 40 percent shrub cover, and 50 percent herbaceous cover.

**Relative cover -** The percentage of the surface area of the plot that is covered by one species or physiognomic group (trees, shrubs, herbaceous) as compared or relative to the amount of surface of the plot covered by all species or groups.

Thus, 50 percent relative cover means that half of the total proportion of cover of all species or physiognomic groups is composed of the single species or group in question. Relative cover values are a proportional number that, when added together, total 100 percent for each plot. For example, a Creosote bush–burro bush vegetation plot with 5 percent cover creosote bush and 5 percent cover burro bush estimated using absolute cover would translate to 50 percent relative cover of creosote bush and 50 percent relative cover of burro bush.

**Conservation rank:** Listed by the state Nature Conservancy Heritage Programs, these are the "Global" and "State" ranks, as seen below.

G1 and S1 - Fewer than six viable occurrences worldwide and/or 2,000 acres
G2 and S2 - six–20 viable occurrences worldwide and/or 2,000–10,000 acres
G3 and S3 - 21–100 viable occurrences worldwide and/or 10,000–50,000 acres
G4 and S4: Greater than 100 viable occurrences worldwide and/or greater than 50,000 acres

**Cover class values:**

Class 1 = <1%
Class 2 = 1–5%
Class 3 = >5–25%
Class 4 = >25–50%
Class 5 = >50–75%
Class 6 = >75%

**Diagnostic species:** A species typically found in the dominant stratum of a vegetation association and lending its name to that association.

**Dominance:**

**Codominant - Each species has 30 percent–60 percent relative cover.** Codominance refers to two or more species in a stand with near equal cover. In general, codominance can occur among species that have between 30 and 60 percent relative cover each.

**Dominance by layer -** Tree, shrub, and herbaceous layers are considered physiognomically distinct. A vegetation type is considered to belong to a certain physiognomic group if it is dominated by one layer. Layers are prioritized in order of height. The tallest layer, if it meets a criterion in the "characterized" definitions (see below) is said to dominate, and the type is usually named at the alliance level by the characteristic species of the tallest layer.

**Dominant - >50 percent relative cover.** Dominance refers to the preponderance of vegetation cover in a stand of uniform composition and site history. It may refer to cover of an individual species (as in "dominated by

Douglas-fir", or it may refer to dominance by a physiognomic group, as in "dominated by shrubs." Dominance refers to the relative cover of one species or physiognomic group as compared to another species or physiognomic group. Anything more than 50 percent relative cover is said to dominate a stand, however, see "dominance by layer", below.

In the descriptions, an additional criterion used for denoting dominance is a plant's constancy/frequency. For a plant to be dominant, constancy needs to be ≥75%.

**Strongly dominant - ≥60 percent relative cover.** A species in the dominant life form has 60 percent or greater relative cover.

**Elevation:**

High - 4,000+ ft
Mid - 2,000–4,000 ft
Low < 2,000 ft

**Exotic Species:** A species introduced into an area where it does not normally occur. The percent of exotic species in a stand is relative to the total cover of vegetation.

Low - <5%
Moderate - >5–15%
High = >15%

**Important:** A species is considered important if it has greater than 1 percent absolute cover. This term is contrasted with dominant to mean that the species is always present in greater than 1 percent cover but not always dominant.

**Mapping code:** A unique numeric code ascribed to each alliance or association for mapping purposes.

**Minimum sample size for description:** n=3. Descriptions of associations with fewer than three samples were attempted if (a) the association was sampled and described by previous authors, or (b) the vegetation was confirmed as distinctive and repeatable based on field reconnaissance or by photo interpretation signature.

**Physiognomy:** The apparent characteristics, outward features, or appearance of a species.

**Herbaceous plant -** Any species of plant that has no main woody stem development and includes grasses, forbs, and perennial species that die back seasonally.

**Shrub -** Normally a multistemmed woody, plant that is between 0.2 meters and five meters tall. Definitions are blurred at low and the high ends of the height scales.

**Subshrub -** A multistemmed plant with noticeably woody stems less than 0.5 meters tall.

**Tree -** A single-stemmed, woody plant that normally grows to be greater than five meters tall.

**Woody plant -** Any species of plant that has noticeably woody stems and have a constancy rate of 30 percent or greater. It does not include herbaceous species with woody, underground portions such as tubers, roots, or rhizomes.

**Often/usually occurring:** For a plant to be considered as often/usually occurring, relative cover must be < 30% and constancy/frequency ≥50%.

**Rare and endangered plants:** Listed as per CNPS (2011) Online Inventory of Rare and Endangered Plants.

**Sample(s):** Listed by their survey numbers from the vegetation databases and indicated using the following: Relevé samples begin with the alpha code "JOTR" for the 300 plots collected specifically for this project, "MDEI" for the 74 plots collected by the Mojave Desert Ecosystem Initiative crews in 1998, "Long" for the Bret Long crew's 74 plots collected in 1997, and "Watts" for the 115 plots collected by the Watts team in the Malapai Hill Quadrangle in 1996.

**Steepness:**

| Designation | degrees | percent |
|---|---|---|
| Flat | 0 | 0% |
| Gentle | 0–5 | 1–9% |
| Moderate | 6–14 | 10–25% |
| Somewhat steep | 15–26 | 26–49% |
| Steep | 27–45 | 50–100% |
| Very steep | 46–69 | 101–275% |
| Abrupt | 70–100 | 276–300% |
| Overhanging/sheltered | >100 | >300% |

**Soils (coarse to fine):**

| | |
|---|---|
| COSA | coarse sand |
| MESN | medium sand |
| FISN | fine sand |
| COLS | coarse loamy sand |
| MELS | medium to very fine loam sand |
| MCSL/MCLS | moderately coarse, sandy loam |
| MESAL/MESA | medium to very fine sandy loam |

| | |
|---|---|
| MELO | medium loam |
| MESIL/MESL | medium silt loam |
| MESI | medium silt |
| MFCL | moderately fine clay loam |
| MFSA | moderately fine sandy clay loam |
| MFSL | moderately fine silty clay loam |
| FISA | fine sandy clay |
| FISC | fine silty clay |
| FICL | fine clay |
| SAND | sand |
| LOAM | loam |
| CLAY | clay |
| UNKN | unknown |
| PEAT | peat |
| MUCK | muck |

**Stand:** The basic physical unit of vegetation in a landscape. It has no set size. Some vegetation stands, such as wetland seeps, are very small, and some, such as desert or forest types, may be several square kilometers in size. A stand is defined by two main unifying characteristics:

a. It has *compositional* integrity. Throughout the site, the combination of species is similar. The stand is differentiated from adjacent stands by a discernible boundary that may be abrupt or gradual.

b. It has structural integrity. It has a similar history or environmental setting, affording relatively similar horizontal and vertical spacing of plant species. For example, a hillside forest formerly dominated by the same species but that has burned on the upper part of the slope and not the lower is divided into two stands. Likewise, a sparse woodland occupying a slope with shallow rocky soils is considered a different stand from an adjacent slope of a denser woodland/forest with deep, moister soil and the same species.

The structural and compositional features of a stand are often combined into a term called homogeneity. For an area of vegetated ground to meet the requirements of a stand, it must be homogeneous at the scale being considered. The associated plant community mapping project had a Minimum Mapping Unit (MMU) of 0.5 hectares.

**Stand characteristics:**

| Descriptor | Relative cover |
|---|---|
| Sparse/emergent (taller) | <10% |
| Open | 10–33% |
| Intermittent | 33–66% |
| Continuous | >66% |

**Stand Table Codes:**

Constancy (Con), Average (Avg), Minimum (Min), Maximum (Max), Dominant (D), Characteristic (Ch), Abundant (Ab), Often (Oft)

**Vegetation Characteristics:**

**Herbaceous -** Herbs are evenly distributed throughout the stand, providing a consistent (even if sparse) structural component, and play an important role in ecological processes within the stand.

**Non-vascular -** Nonvascular organisms provide a consistent (even if sparse) structural component and play an important role in ecological processes within the stand.

**Shrubland -** Shrubs (including dwarf-shrubs) are evenly distributed throughout the stand, providing a consistent (even if sparse) structural component, and one or both of the following criteria are met: (1) Shrubs influence the distribution or population dynamics of other plant species; (2) Shrubs play an important role in ecological processes within the stand.

**Sparse -** Neither vascular plants nor nonvascular organisms provide a consistent structural component or play an important role in ecological processes on the site.

**Sparsely wooded -** Refers to stands with conspicuous trees (generally at least 10 percent absolute cover), but less than 25 percent cover may occur over shrubs as the dominant canopy (sparsely wooded shrubland) or herbaceous (sparsely wooded) cover.

**Tree -** Trees are evenly distributed throughout the stand, with typically $\geq$10 percent cover, providing a consistent (even if sparse) structural component, and one or both of the following criteria are met: (1) Trees influence the distribution or population dynamics of other plant species; (2) Trees play an important role in ecological processes within the stand.

**Forest -** In the National Vegetation Classification, a forest is defined as a tree-dominated stand of vegetation with 60 percent or greater cover of trees.

**Woodland -** Under the National Vegetation Classification, a woodland is defined as a tree-dominated stand of vegetation with between 25 and 60 percent cover of trees.

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**CLASSIFICATION OF JOSHUA TREE NATIONAL PARK VEGETATION**
**Final Draft February 2012**

Class 1. Forest & Woodland

Formation 1.C.2. Cool Temperate Forest.

Division 1.C.2.c. Western North American Cool Temperate Woodland & Scrub

Macrogroup M026. Intermountain Singleleaf Pinyon–Western Juniper Woodland

Group - Great Basin Pinyon - Juniper Woodland.

**Single-leaf Pinyon Pine (*Pinus monophylla*) Woodland Alliance** 10160

**Single-leaf Pinyon Pine / Muller's Oak (*Pinus monophylla / Quercus cornelius-mulleri)* Woodland Association** 10161

Formation 1.C.3. Temperate Flooded & Swamp Forest

Division 1.C.3.d. Western North American Warm Temperate Flooded & Swamp Forest

Macrogroup M036. Warm Mediterranean & Desert Riparian, Flooded & Swamp Forest

Group - Southwestern North American Warm Desert Riparian Group

**Fremont Cottonwood (*Populus fremontii*) Forest Alliance** 15040
(No associations defined for this project**,** only one large stand in the park in Smith Water Canyon, otherwise occurs in small stands or singly in wet canyons.)

**Black Willow (*Salix gooddingii*) Woodland Alliance** 15030

**Black Willow — Red Willow (*Salix gooddingii — Salix laevigata*) Association** 15031
(Not mapped, more plot data needed.)

**California Fan Palm *(Washingtonia filifera)* Woodland Alliance** 15110

**California Fan Palm / Narrowleaved Willow / Deer Grass (*Washington filifera / Salix exigua / Muhlenbergia rigens*) Provisional Association** 15112
(Not mapped in park, more data needed.)

Macrogroup M298. Western North American Warm Temperate Ruderal Flooded & Swamp Forest

Group - Southwestern North American Ruderal Riparian Scrub

**Tamarisk *(Tamarix* spp.*)* Semi-natural Shrubland Stands** 22040
(Not mapped, but may be present in small isolated stands, smaller than the MMU. Large stand near Coxcombs has been treated; check Invasive Species Program for most current information.)

Class 2. Shrubland & Grassland
Formation 2.B.1. Mediterranean Scrub
Division 2.B.1.a. California Scrub
Macrogroup M043. California Chaparral

Group - California Mesic North-Slope Chaparral

**Muller Oak (*Quercus cornelius-mulleri*) Shrubland Alliance** 21230

**Muller Oak — California buckwheat — Narrowleaf goldenbush (*Quercus cornelius-mulleri — Eriogonum fasciculatum — Ericameria linearifolia*) Association** 21234

Group - California Xeric Chaparral

**Bigberry Manzanita *(Arctostaphylos glauca)* Shrubland Alliance** 21210
(Not mapped, more data needed.)

Formation 2.B.2. Mediterranean Grassland & Forb Meadow.
Division 2.B.2.a. California Grassland & Meadow.
Macrogroup M045. California Annual & Perennial Grassland
Group - California Annual Forb / Grass Vegetation

**Fiddlenecks *(Amsinckia menziesii, A. tessellata*) Herbaceous Alliance** 60030
(Not mapped, more data needed.)

Group - Mediterranean California Naturalized Annual & Perennial Grassland

**Red brome — Mediterranean grass (*Bromus rubens — Schismus* (*arabicus, barbatus*)) Semi-Natural Herbaceous Stands** 60010

Formation 2.C.1. Temperate Grassland, Meadow & Shrubland
Division2.C.1.a. Vancouverian & Rocky Mountain Grassland & Shrubland
Macrogroup M048. Western North American Temperate Grassland & Meadow

Group- Vancouverian and Rocky Mountain Naturalized Annual Grassland

**Cheatgrass *(Bromus tectorum)* Semi-Natural Herbaceous Stands 60120**
(not mapped, more data needed)

Formation 2.C.5. Temperate & Boreal Freshwater Wet Meadow & Marsh
Division 2.C.5.c. Western North American Warm Desert Freshwater Marsh.
Macrogroup M076. Warm Desert Freshwater Shrubland, Marsh & Meadow

Group – North American Warm Desert Riparian Low Bosque & Shrubland

**Narrowleaved Willow *(Salix exigua)* Shrubland Alliance 15020**
(Not mapped in park, but may be present in small isolated stands smaller than the MMU.)

**Narrowleaved Willow — Broom Baccharis *(Salix exigua — Baccharis sergiloides)* Association 15021**
(Not mapped, more data needed.)

**Broom Baccharis *(Baccharis sergiloides)* Shrubland Alliance** 22030
(Not mapped, more data needed.)

**Broom Baccharis / Deer grass (*Baccharis sergiloides / Muhlenbergia rigens*) Association** 22031
(Not mapped, more data needed.)

Class 3. Xeromorphic Scrub & Herb Vegetation (Semi-Desert)
Formation 3.A.1. Warm Desert Scrub & Grassland
Division 3.A.2.a. North American Warm Desert Scrub & Grassland
Macrogroup M088. Mojave–Sonoran Semi-Desert Scrub

Group - Mojave Mid-Elevation Mixed Desert Scrub

**Blackbush *(Coleogyne ramosissima)* Shrubland Alliance** 28020

**Blackbush (*Coleogyne ramosissima)* Association** 28021
(Not mapped, more data needed.)

**Blackbush — Nevada Ephedra (*Coleogyne ramosissima — Ephedra nevadensis)* Association** 28023

**Nevada Joint fir (*Ephedra nevadensis)* Shrubland Alliance** 24010
(Not mapped, more data needed.)

**California buckwheat — Desert Sunflower (*Eriogonum fasciculatum — Viguiera parishii)* Shrubland Alliance** 28130

**California buckwheat (*Eriogonum fasciculatum*) Rock Outcrop Shrubland Association** 28131
(Not mapped, more data needed)

**Desert Sunflower (*Viguiera parishii)* Association** 28132
(Not mapped, more data needed)

**Desert sunflower — White Bursage— Jojoba (*Viguiera parishii — Ambrosia dumosa — Simmondsia chinensis)* Association** 28134

**Desert sunflower — California Buckwheat — Jojoba (*Viguiera parishii — Eriogonum fasciculatum — Simmondsia chinensis)* Association** 28133

**California Juniper *(Juniperus californica)* Woodland Alliance** 10020

**California Juniper / Blackbush (*Juniperus californica / Coleogyne ramosissima)* Association** 10025

**California Juniper / Muller Oak — Blackbush (*Juniperus californica / Quercus cornelius-mulleri — Coleogyne ramosissima*) Woodland Association** 10032

**California Juniper / Mojave Yucca / Big Galleta (*Juniperus californica / Yucca schidigera / Pleuraphis rigida)* Woodland Association** 10031

**Anderson's Boxthorn (*Lycium andersonii*) Shrubland Alliance** 28190
(Not mapped, more data needed.)

**Anderson's Boxthorn — Jojoba / Big Galleta (*Lycium andersonii — Simmondsia chinensis / Pleuraphis rigida*) Association** 28192
(Not mapped, more data needed.)

**Big Galletta Grass (*Pleuraphis rigida*) Herbaceous Alliance** 59010

**Big Galleta Grass / White Bursage *(Pleuraphis rigida / Ambrosia dumosa)* Association** 59011

**Big Galleta Grass / Four-Wing Saltbush *(Pleuraphis rigida / Atriplex canescens)* Association** 59012

**Bladder-Sage (*Salazaria mexicana*) Shrubland Alliance** 28140
(Not mapped, more data needed.)

**Hall's Tetracoccus *(Tetracoccus hallii)* Provisional Shrubland Alliance** 28180

**Hall's Tetracoccus *(Tetracoccus hallii)* Provisional Association** 28181

**Joshua Tree (*Yucca brevifolia*) Woodland Alliance** 13010

**Joshua Tree / Blackbush *(Yucca brevifolia / Coleogyne ramosissima)* Woodland Association** 13012

**Joshua Tree — California Juniper / Nevada Ephedra (*Yucca brevifolia — Juniperus californica / Ephedra nevadensis)* Woodland Association** 13015

**Joshua Tree / Creosote Bush — Mojave Yucca / Big Galleta Grass (*Yucca brevifolia / Larrea tridentata — Yucca schidigera / Pleuraphis rigida)* Woodland Association** 13016

**Joshua Tree / Big Galleta Grass (*Yucca brevifolia / Pleuraphis rigida)* Woodland Association** 13021

**Joshua Tree / Desert Almond (*Yucca brevifolia / Prunus fasciculata*) Association** 13014

**Mojave Yucca (*Yucca schidigera)* Shrubland Alliance** 29030

**Mojave Yucca — Blackbush *(Yucca schidigera — Coleogyne ramosissima)* Association** 29032

**Mojave Yucca — Creosote Bush — White Bursage *(Yucca schidigera — Larrea tridentata — Ambrosia dumosa)* Association** 29033

**Mojave Yucca / Big Galleta Grass (*Yucca schidigera / Pleuraphis rigida)* Association** 29034

Group - Sonoran-Mojave Creosotebush - White Bursage Desert Scrub

**White Bursage (*Ambrosia dumosa)* Shrubland Alliance** 28300
(Not mapped, more data needed.)

**White Bursage (*Ambrosia dumosa)* Association** 28301
(Not mapped, more data needed.)

**Cheesebush (*Ambrosia salsola)* Shrubland Alliance** 28110

**Cheesebush (*Ambrosia salsola)* Shrubland Association** 28111
(Not mapped, more data needed.)

**Cheesebush — Desert Senna (*Ambrosia salsola — Senna armata)* Shrubland Association** 28112
(Not mapped, more data needed.)

**Teddy-Bear cholla (*Cylindropuntia bigelovii)* Shrubland Alliance** 29050

**Teddy-Bear cholla *(Cylindropuntia bigelovii)* Shrubland Association** 29051

**Brittlebush (*Encelia farinosa)* Shrubland Alliance** 28030

**Brittlebush *(Encelia farinosa)* Association** 28031
(Not mapped, more data needed.)

**Brittlebush —White Bursage *(Encelia farinosa — Ambrosia dumosa)* Association** 28033

**Creosote bush (*Larrea tridentata)* Shrubland Alliance** 27010

**Creosote Bush (*Larrea tridentata)* Association** 27019

**Creosote Bush — Cheesebush (*Larrea tridentata — Ambrosia salsola)* Shrubland Association** 27013
(Not mapped, more data needed.)

**Creosote Bush — Desert Holly (*Larrea tridentata — Atriplex hymenelytra*) Shrubland Association** 27023

**Creosote Bush / Big Galleta Grass (*Larrea tridentata / Pleuraphis rigida*) Association** 27021

**Creosote Bush —White Bursage *(Larrea tridentata — Ambrosia dumosa)* Shrubland Alliance** 27030

**Creosote Bush — White Bursage (*Larrea tridentata — Ambrosia dumosa)* Association** 27031

**Creosote Bush — White Bursage — Ocotillo *(Larrea tridentata — Ambrosia dumosa — Fouquieria splendens)* Association** 27049

**Creosote Bush — White Bursage — White Rhatany (*Larrea tridentata — Ambrosia dumosa — Krameria grayi)* Association** 27034

**Creosote Bush — White Bursage / Big Galleta Grass (*Larrea tridentata — Ambrosia dumosa / Pleuraphis rigida*) Association** 27048 (not mapped)

**Creosotebush — White Bursage — Indigo Bush *(Larrea tridentata — Ambrosia dumosa — Psorothamnus arborescens)* Association** 27044

**Creosote Bush — White Bursage — Desert Senna (*Larrea tridentata — Ambrosia dumosa — Senna armata)* Association** 27047

**Creosote Bush — White Bursage — Jojoba (*Larrea tridentata — Ambrosia dumosa — Simmondsia chinensis)* Association** 27046

**Creosote Bush — White Bursage — Mojave Yucca (*Larrea tridentata — Ambrosia dumosa — Yucca schidigera)* Association** 27045

**Creosote Bush — Brittlebush (*Larrea tridentata — Encelia farinosa)* Shrubland Alliance** 27050

**Creosote Bush — Brittlebush (*Larrea tridentata — Encelia farinosa)* Shrubland Association** 27051
(not mapped, more data needed)

**Creosote Bush — Brittlebush — White Bursage (*Larrea tridentata — Encelia farinosa — Ambrosia dumosa)* Shrubland Association** 27057

**Creosote Bush — Brittlebush — Ocotillo *(Larrea tridentata — Encelia farinosa — Fouquieria splendens)* Association** 27056

**Creosote Bush — Brittlebush — Arrowleaf (*Larrea tridentata — Encelia farinosa — Pleurocoronis pluriseta*) Association** 27059

Macrogroup M092. North American Warm-Desert Xero-Riparian Group - Sonoran-Coloradan Semi-Desert Wash Woodland / Scrub

**Desert Willow (*Chilopsis linearis*) Woodland Alliance** 15010

**Desert Willow (*Chilopsis linearis*) Association** 15013

**Desert Willow / Cheesebush (*Chilopsis linearis / Ambrosia salsola* ) Association** 15014
(Not mapped, more data needed.)

**Desert Lavender *(Hyptis emoryi)* Shrubland Alliance** 28200

**Desert Lavender *(Hyptis emoryi)* Association** 28203

**Chuparosa *(Justicia californica)* Provisional Shrubland Alliance** 28171

**Blue Palo Verde — Ironwood (*Parkinsonia florida — Olneya tesota)* Woodland Alliance** 16010

**Ironwood** (***Olneya tesota)*** **Association** 16016

**Blue Palo Verde / Desert Lavender (*Parkinsonia florida / Hyptis emoryi*) Association** 16015

**Blue Palo Verde / Creosote Bush — Desert Fir (*Parkinsonia florida / Larrea tridentata — Peucephyllum schottii)* Association** 16013

**Blue Palo Verde — Ironwood / Cholla (*Parkinsonia florida — Olneya tesota / Cylindropuntia* sp.) Association** 16024

**Blue Palo Verde — Ironwood / Desert Lavender (*Parkinsonia florida — Olneya tesota / Hyptis emoryi*) Association** 16025

**Honey Mesquite (*Prosopis glandulosa)* Woodland Alliance** 16040

**Honey Mesquite *(Prosopis glandulosa)* Association** 16041

**Honey Mesquite / Saltbush — Bush Seepweed *(Prosopis glandulosa / Atriplex* spp. *— Suaeda moquinii)* Association** 16043

**Smoketree *(Psorothamnus spinosus)* Woodland Alliance** 16030

**Smoketree / California Joint Fir — Cheesebush (*Psorothamnus spinosus / Ephedra californica — Ambrosia salsola* Association) Association** 16036
(Not mapped, more data needed)

**Smoketree / Desert Lavender — Catclaw *(Psorothamnus spinosus / Hyptis emoryi — Acacia greggii)* Association** 16035

**Lotebush *(Ziziphus obtusifolia*) Shrubland Special Stands** 15060
(Not mapped, more data needed.)

Group - Warm Semi-Desert Shrub & Herb Wash-Arroyo

**Catclaw Acacia (*Acacia greggii)* Shrubland Alliance** 36010

**Catclaw Acacia — (Sweetbush — Desert Lavender) (*Acacia greggii — (Bebbia juncea — Hyptis emoryi*)) Association** 36015

**Catclaw Acacia — California buckwheat (*Acacia greggii — Eriogonum fasciculatum*) Association** 36018

**Catclaw Acacia — Desert Almond (*Acacia greggii — Prunus fasciculata*) Association** 36016

**California joint fir *(Ephedra californica)* Shrubland Alliance** 24020
(Not mapped, more data needed.)

**California joint fir — Cheesebush *(Ephedra californica — Ambrosia salsola)* Association** 24021
(Not mapped, more data needed.)

**Black-stem Rabbitbrush *(Ericameria paniculata)* Shrubland Alliance** 28120
(Not mapped, more data needed.)

**Virgin River Brittlebush *(Encelia virginensis)* Shrubland Alliance** 28500
(Not mapped, more data needed.)

**Acton's Brittlebush *(Encelia virginensis* ssp. *actoni)* Association** 28501
(Not mapped, more data needed)

**Desert Almond** (***Prunus fasciculata)* Shrubland Alliance** 32010

**Desert Almond *(Prunus fasciculata)* Association** 32013

**Desert Almond** — **Skunkbush Sumac (*Prunus fasciculata — Rhus trilobata*) Association** 32014
(not mapped, more data needed)

Formation 3.B.1. Cool Semi-Desert Scrub & Grassland

Division 3.B.1.a. Western North American Cool Semi-Desert Scrub & Grassland

Macrogroup M071. Great Basin and Intermountain Semi-Desert Shrubland & Steppe

Group - Intermountain Semi-Desert Shrubland & Steppe

**Rubber Rabbitbrush** (***Ericameria nauseosa***) **Shrubland Alliance** 28210

**Round-leaved Rabbitbrush** ***(Ericameria teretifolia)*** **Shrubland Alliance** 28220
(Not mapped, more data needed.)

Macrogroup M169. Great Basin & Intermountain Tall Sagebrush Shrubland & Steppe

Group – Intermountain Mesic Tall Sagebrush Shrubland & Steppe

**Antelope Bush** ***(Purshia tridentata)*** **Shrubland Alliance** 24030
(Not mapped, more data needed)

Group - Intermountain Semi-Desert Grassland

**Desert Needlegrass (*Achnatherum speciosum)* Herbaceous Alliance** 59020
(Not mapped, more data needed)

**Desert Needlegrass — Desert Globemallow (*Achnatherum speciosum — Sphaeralcea ambigua)* Association** 59022
(Not mapped, more data needed.)

Macrogroup M093. Great Basin Saltbrush Scrub

Group - Intermountain Shadscale – Saltbush Scrub

**Four-Wing Saltbush** ***(Atriplex canescens)*** **Shrubland Alliance** 28080

**Four-Wing Saltbush (*Atriplex canescens*) Association** 28083

**Spiny Hop-sage (*Grayia spinosa)* Shrubland Alliance** 36020
(Not mapped, more data needed)

Class 6. Nonvascular & Sparse Vascular Rock Vegetation
Formation 6.C.1 Warm Semi-Desert Cliff, Scree & Rock Vegetation
Division 6.C.1.a North American Warm Semi-Desert Cliff, Scree & Rock Vegetation
Macrogroup M117. North American Warm Semi-Desert Cliff, Scree & Rock Vegetation

Group - North American Warm Semi-Desert Cliff, Scree & Pavement

**Desert Holly (*Atriplex hymenelytra*) Shrubland Alliance** 28070
(Not mapped, more data needed.)

**Desert Gold — Spiny Herb** (***Geraea canescens — Chorizanthe rigida)*** **Desert Pavement Annual Herbaceous Alliance** 90100

**Schott's Pygmycedar (*Peucephyllum schottii*) Provisional Shrubland Alliance** 28400
(Not mapped, more data needed.)

> **Schott's Pygmycedar — Threadleaf Snakeweed *(Peucephyllum schottii — Gutierrezia microcephala)* Provisional Association** 28401
> (Not mapped, more data needed.)
>
> **Schott's Pygmycedar — Arrowleaf — Desert Stingbush *(Peucephyllum schottii — Pleurocoronis pluriseta — Eucnide urens*) Provisional Association** 28402
> (Not mapped, more data needed.)

Group - North American Warm Desert Dunes & Sand Flats

**Desert Twinbugs — Desert Sand Verbena *(Dicoria canescens — Abronia villosa)* Sparsely Vegetated Alliance (Desert Dunes & Sand Flats)** 60020

**Non-vegetated habitats (less than 2% absolute cover)** 90000

90200= Rock Outcrops
90300= Dunes
90400= Playa
90600= Disturbed/built-up
90700= Recent burns (Not mapped)
90900= Water

# KEY TO VEGETATION OF JOSHUA TREE NATIONAL PARK, CALIFORNIA

Written by Todd Keeler-Wolf and Tasha La Doux
November, 2012

This key is constructed in a traditional dichotomous style, with couplets of opposing choices. It is considered an artificial key, although it attempts to follow the new national vegetation classification hierarchy promoted by the Ecological Society of America's Vegetation Panel and the Federal Geographic Data Committee in order to underscore the ecological relationships of different vegetation in the Park. The hierarchical units used for this report include (from highest to lowest): 1. Class, 2. Subclass, 3. Formation, 4. Division, 5. Macrogroup, 6. Group, 7. Alliance, and 8. Association. The full hierarchy is shown in the document titled, "Appendix B: Final Classification 2012", however in an attempt to keep this key field-friendly we have left out these higher taxonomic units. A complete expandible and explorable browser format reference for the National Vegetation Classification can be found at: http://usnvc.org/explore-classification/.

**1.** Vegetation not evenly distributed, generally <5% total cover and not composed of evenly spaced trees, shrubs, or herbaceous perennials. Following seasons of exceptional precipitation, herbaceous annual species may be abundant and evenly distributed. (If woody vegetation, e.g., *Larrea tridentata, Atriplex hymeneleytra, Encelia farinosa*, is <5% but is evenly distributed, go to 1')

**2**. Landscape characterized by open dunes, or sand flats/ramps, perennial vegetation generally <2% cover; annual blooms in favorable years 2-10% cover.

**3.** Fine, shifting sand habitat, may have low cover (<2%) of *Larrea tridentata, Hilaria rigida (Pleuraphis rigida), Achnatherum hymenoides*, or *Ambrosia dumosa* with a variable herbaceous cover (2-10%) including *Dicoria canescens, Abronia villosa, Palafoxia arida*; other local annual species may vary (e.g., *Cryptantha angustifolia, Camissonia claviformis, Oenothera deltoides*):

**Desert Twinbugs — Desert Sand Verbena *(Dicoria canescens — Abronia villosa)* Sparsely Vegetated Alliance (Desert Dunes & Sand Flats)** 60020

**3'.** Other non-vegetated dune habitats (<2% absolute cover):

**North American Warm Desert Dunes & Sand Flats** 90300

**2'**. Landscape characterized by desert pavement, pediment, playa margins, coarse sand, or rocky outcrops with <5% cover of woody perennial plant species. *Larrea, Atriplex, Encelia,* and other warm desert shrubs may be present, but <5% total cover and not evenly distributed in the stand. During exceptional years there may be significant annual or ephemeral species cover. Species are not always present, but can include *Plantago ovata, Cryptantha angustifolia, Chorizanthe rigida,* and *Geraea canescens,* etc.

**4.** Desert pavement, defined as a flat, smooth land surface densely covered (>65%) with varnished rocks and coarse gravel (Wood 2000); generally with <2% absolute cover, however small islands of woody perennials (e.g., *Larrea tridentata*) may exist, especially where pavements are intertwined with more densely vegetated rivulets.

**Desert Gold — Spiny Herb (*Geraea canescens — Chorizanthe rigida)* Desert Pavement Annual Herbaceous Alliance** 90100
(Not mapped, more data needed. As of 2012, no samples have been taken at the proper time to define stands by their ephemeral component. However, several recent plots (jotr87, jotr90, jotr94, jotr95) with very low cover of *Ambrosia dumosa, Encelia farinosa*, or *Larrea tridentata* and no *Atriplex hymenelytra* suggest they will be categorized in this Alliance if re-sampled in a good rainfall year.)

**4'.** Other non-vegetated habitats (<2% absolute cover), but large enough to meet the minimum mapping unit (MMU=0.5 hectare):

90000 = **Non-vegetated Habitat**
Generic placeholder for areas that could not be placed into a more specific category; most likely Dune, Playa, or Desert Pavement, but will need further data
90200 = **Rock Outcrops**
Large boulder fields, cliffs, or rock piles
90400 = **Playa**
Flat, dry basin or lake bed; areas with hard pan sandy substrate
90600 = **Disturbed/built-up**
Campgrounds, Parking lots, Park facilities, etc.
90700 = **Recent burns (<1 year prior)**
Areas burned within the last year, where the ground is still black and devoid of vegetation due to fire. (not mapped)
90900 = **Water**
Small body of water, artificial or not.

**1'**. Vegetation ≥5% total cover (sometimes as low as 2% if evenly distributed) and characterized by trees, shrubs, and or herbs that are evenly distributed across the stand.

**5.** Vegetation characterized by trees or taller shrubs (typically larger than the average *Larrea tridentata*, e.g., >3 m tall) of arroyos, washes, canyon bottoms, springs, seeps, or other areas that receive and retain more moisture than ambient settings in Joshua Tree National Park. Characteristic species of the dominant layer are winter-deciduous, or evergreen, and do not exhibit xeromorphic characteristics such as thorns, drought-deciduousness, succulent stems or microphyllous leaves/leaflets. Not typically occurring in dry washes, but in areas where moisture is present at least under the surface in the warmer months. (for 5', go to pg 5)

**6. *Washingtonia filifera*** present and evenly distributed in the stand (not as isolated individuals) comprising >3% absolute cover throughout the stand. *Populus fremontii* and tree-size willows may be co-dominant.

**California Fan Palm *(Washingtonia filifera)* Woodland Alliance** 15110

**California Fan Palm / Narrowleaved Willow / Deer Grass (*Washingtonia filifera / Salix exigua / Muhlenbergia rigens*) Provisional Association** 15112 (not mapped in Park, more data needed)

**6'.** Other riparian trees/shrubs (***Populus fremontii, Salix gooddingii, S. laevigata, S. exigua, Prosopis glandulosa, Baccharis sergiloides, Tamarix ramosissima)*** >50% relative cover in the tree/shrub canopy; *Washingtonia filifera* absent or if present not evenly distributed throughout the stand.

**7. *Populus fremontii*** >50% relative cover in the tree layer, though sometimes >30% relative cover if *Salix* species are co-dominant. ***P. fremontii*** must have >5% absolute cover.

**Fremont Cottonwood (*Populus fremontii*) Forest Alliance** 15040
(no associations defined for this project**,** only one large stand in the Park in Smith Water Canyon, otherwise occurs in small stands or singly in wet canyons)

**7'.** *Populus fremontii* not dominant or co-dominant in tree layer, ***Salix spp.*** or other moisture-loving shrubs (e.g., ***Prosopis glandulosa, Baccharis sergiloides, Tamarix ramosissima)*** are the dominant or co-dominant species.

**8.** Tree willows **(*Salix gooddingii*** and/or ***S. laevigata)*** dominant or co-dominant in the tree canopy and evenly distributed. ***S. gooddingii*** >50% relative cover; if other willows present, willows may co-dominate and ***S. gooddingii*** >30% relative cover in canopy. Mixed stands of these two tree willows, plus ***S. exigua***, found in moist canyons and near springs, occasional throughout the Park.

**Black Willow (*Salix gooddingii*) Woodland Alliance** 15030

**Black Willow — Red Willow (*Salix gooddingii — Salix laevigata*) Association** 15031
(not mapped, more plot data needed)

**8'.** Tree willows absent or <10% relative cover and/or not evenly distributed. ***Salix exigua, Prosopis glandulosa, Baccharis sergiloides, Tamarix ramosissima*** dominant or co-dominant, >50% relative cover in canopy and evenly distributed.

**9. *Salix exigua*** or ***Prosopis glandulosa*** present, other riparian trees <10% cover, or not evenly distributed in the stand.

**10**. ***Salix exigua*** dominant or co-dominant in shrub canopy; ≥5% absolute cover and dominant, or >50% relative cover. Found in small isolated stands in temporarily flooded canyons or near springs throughout

Park, however stands typically smaller than MMU (0.5 ha).

**Narrowleaved Willow *(Salix exigua)* Shrubland Alliance** 15020 (Not mapped in Park, more data needed)

**Narrowleaved Willow — Broom Baccharis *(Salix exigua — Baccharis sergiloides)* Association** 15021 (Not mapped, more data needed)

**10'. *Prosopis glandulosa*** >3% absolute cover as the dominant (including shrubs and trees together), not exceeded in cover by any other species of microphyllous tall shrub or tree; or ≥2% absolute cover and >50% relative cover in the tree or tall shrub canopy; other woody shrubs and cacti may occur at not more than equal cover.

**Honey Mesquite (*Prosopis glandulosa)* Woodland Alliance** 16040

**a.** Open stands with low vegetative cover, typically present at edges of playas on alkaline soils; *Atriplex spp.* and *Suaeda moquinii* present at varying cover. Occurs on low elevation sandy flats near western edge of Palen Dry Lake (along southeastern edge of Coxcomb Mountains).

**Honey Mesquite / Saltbush — Bush Seepweed *(Prosopis glandulosa / Atriplex spp. — Suaeda moquinii)* Association** 16043

**b.** Found in small localized stands in washes and canyon bottoms where permanent underground water is available. Many stands smaller than MMU exist in Park. Stands are dense in cover; other characteristic species include *Acacia greggii, Lycium andersonii,* and *Baccharis sergiloides*.

**Honey Mesquite *(Prosopis glandulosa)* Association** 16041

**9**'. *Salix exigua* or *Prosopis glandulosa* usually not present, ***Baccharis sergiloides*** or the non-native ***Tamarix ramosissima*** dominant or co-dominant in the shrub canopy.

**11**. ***Baccharis sergiloides*** dominant or co-dominant in the shrub canopy; >3% absolute cover and >50% relative cover in overstory as the dominant shrub. Characteristic in canyon bottoms with relatively high subsurface moisture. Found in isolated stands throughout the Park in upper elevation arroyos, washes, or bordering springs and seeps; stands are smaller than MMU.

**Broom Baccharis *(Baccharis sergiloides)* Shrubland Alliance** 22030 (not mapped, more data needed)

**Broom Baccharis / Deer grass *(Baccharis sergiloides / Muhlenbergia rigens)* Shrubland Association** 22031 (not mapped, more data needed)

**11'. *Tamarix sp.*** dominant in the shrub (or tree) layer. Currently not mapped and not included in the Vegetation Classification, but of significance because of its highly invasive characteristics. Note: All ***Tamarix spp.*** stands are being monitored and treated by the Invasive Species Program at the Park; current status of these stands can be obtained from Park staff. ***T. aphylla*** is very rare in the Park, while ***T. ramosissima*** generally occurs in small isolated stands or individually in temporarily flooded canyons, near springs or water sources throughout Park. However, several larger stands of the latter species are being monitored in the Coxcomb Mountains.

**Tamarisk *(Tamarix* spp.*)* Semi-natural Shrubland Stands** 22040 (not mapped, more data needed)

**5'**. Vegetation characterized by trees, shrubs and/or herbs not of wetland or moist low lying areas, although they may grow in washes, arroyos, playas and other intermittently flooded situations. If taller shrubs or trees characteristic, these lacking large winter-deciduous or evergreen leaves and often possessing thorns, or other drought related adaptations, or they are coniferous with scales or needles present instead of broad leaves.

**12.** Presence of ***Atriplex spp.*** on sparsely vegetated pavements, playas, intermittently flooded depressions, or near margins of dry lakebeds. No tree layer present and perennial vegetation cover is generally low.

**13.** Open to intermittent shrub canopy with >2% absolute cover and >50% relative cover of ***Atriplex canescens.*** Habitat can vary, but generally found on sandy playas or alluvial fans, or lake margins with silty, alkaline soils. In

JOTR, this Alliance has only been mapped in the Pleasant Valley region, and is represented by only one Association in the Park.

**Four-Wing Saltbush (*Atriplex canescens*) Shrubland Alliance** 28080

**Four-Wing Saltbush (*Atriplex canescens*) Association** 28083

**13'.** Very low vegetative cover on open alluvial fans, often associated with alkaline soils on playas or margins of dry lakebeds. ***Atriplex hymenelytra*** is the dominant shrub species, but *Larrea tridentata* may also be present with less cover. The southeast corner of JOTR captures a small stand of ATHY, however these polygons are labeled as *Larrea tridentata — Atriplex hymenelytra* Shrubland Association. Not currently mapped because stands are smaller than MMU.

**Desert Holly (*Atriplex hymenelytra*) Shrubland Alliance** 28070 (not mapped)

**12'**. *Atriplex spp*. not present, vegetation of mid- to higher elevations with significant tree layer of ***Yucca brevifolia, Pinus monophylla,*** or ***Juniperus californica***.

**14.** Conifers (with needles or scales and pine cones or berry like cones) ***Pinus monophylla*** or ***Juniperus californica*** present in tree canopy and evenly distributed; stands are at mid- to higher elevation areas of the Park.

**15.** Stands with ***Juniperus californica*** evenly distributed (though may be widely spaced) and dominant or co-dominant in the tree or tall shrub layer.

**California Juniper *(Juniperus californica)* Woodland Alliance** 10020

**16**. Stand with evenly distributed ***Yucca brevifolia*** or ***Yucca schidigera;*** *Coleogyne ramosissima* absent as characteristic shrub**.**

**17.** Open stands of ***Juniperus californica*** with evenly distributed ***Yucca brevifolia*** as dominant or co-dominant in tree/tall shrub layer, YUBR >2x the relative cover of JUNCAL; open shrub layer with ***Coleogyne ramosissima***, ***Ephedra nevadensis,*** and ***Yucca schidigera*** present.

**Joshua Tree — California Juniper / Nevada Ephedra (*Yucca brevifolia — Juniperus californica / Ephedra nevadensis)* Woodland Association** 13015
(Appears twice in key; 2nd time is under YUBR Alliance)

**17'.** Stands characterized by evenly spaced ***Juniperus californica*** with ***Yucca schidigera*** and usually the perennial grass ***Hilaria rigida (Pleuraphis rigida)*** conspicuous, typically on fans and well drained porous slopes, not rocky uplands. Areas near Eagle Mountains may include equal amounts of the shrub *Tetracoccus hallii*.

**California Juniper / Mojave Yucca / Big Galleta (*Juniperus californica / Yucca schidigera / Hilaria rigida)* Woodland Association** 10031

**16'.** ***Coleogyne ramosissima*** dominant cover in shrub layer and no significant *Yucca schidigera* or *Yucca brevifolia*.

**18.** Stands contain evenly spaced ***Juniperus californica*** over a ***Coleogyne ramosissima*** shrub layer, which may occur in substantially higher cover than JUNCAL. Stands are usually not on deep porous or gravelly soil, but shallow, rocky uplands. Other rocky upland species such as *Encelia actonii*, *Yucca schidigera*, *Bahiopsis parishii (Viguiera parishii)*, and/or *Stipa speciosa (Achnatherum speciosum)* may be relatively high in cover.

**California Juniper / Blackbush (*Juniperus californica / Coleogyne ramosissima)* Association** 10025

**18'.** Stands of the ***Juniperus californica*** and ***Quercus cornelius-mulleri (Quercus john-tuckeri*** may also be mixed in) in tree/tall shrub layer with dominant ***Coleogyne ramosissima*** in the shrub layer (≥2%). Often found on upper fans and relatively linear hillslopes of the upper elevations in the western part of the Park (e.g., Covington Flats/Little San Bernardino Mountains). Note: If *Quercus john-tuckeri* is present, you may want to combine the cover of the two *Quercus spp.*

**California Juniper / Muller Oak — Blackbush (*Juniperus californica / Quercus cornelius-mulleri — Coleogyne ramosissima*) Woodland Association** 10032 Note: Appears twice in key, see also couplet 59'.

**15'.** ***Pinus monophylla*** with ≥1% absolute cover in tree canopy and evenly distributed, shorter shrubs may be higher in cover; *Juniperus californica* and/or *Quercus spp.* may be present at similar or greater cover. ***Pinus monophylla*** occurs over a sparse to relatively dense cover of shrubs and is restricted to cool, relatively moist sites of the upper elevations in the Little San Bernardino Mountains and isolated stands in the Coxcomb Mountains.

**Single-leaf Pinyon Pine (*Pinus monophylla*) Woodland Alliance** 10160

One association represented in the Park with sparse to moderately closed stands of ***Pinus monophylla*** with ***Quercus cornelius-mulleri*** (and occasionally ***Q. john-tuckeri***) and/or ***Juniperus californica.*** JUNCAL cover does not exceed that of PIMO. Quercus spp. cover can exceed that of PIMO but not JUNCAL. Other associated species may include *Stipa speciosa, Ericameria spp, Yucca brevifolia, and Nolina parryi*.

**Single-leaf Pinyon Pine / Muller's Oak (*Pinus monophylla / Quercus cornelius-mulleri)* Woodland Association** 10161

**14'.** Non-conifer trees, shrubs, or herbaceous species dominant and characteristic.

**19.** Small to moderately sized ***Yucca brevifolia*** present and evenly distributed throughout stand, often with only 1- 5% cover, and with substantially higher cover of shorter shrubs or perennial grasses beneath the well spaced emergent trees.

**Joshua Tree *(Yucca brevifolia)* Woodland Alliance** 13010

**20.** ***Yucca brevifolia*** and ***Coleogyne ramosissima*** co-occur, sometimes with other woody perennials, but *Larrea tridentata* and *Hilaria rigida (Pleuraphis rigida)* generally absent or unimportant.

**21.** ***Yucca brevifolia*** and ***Juniperus californica*** co-occur in tall shrub/short tree layer with ***Coleogyne ramosissima, Yucca schidigera, Ephedra nevadensis*** and other woody perennials present.

**Joshua Tree — California Juniper / Nevada Ephedra (*Yucca brevifolia — Juniperus californica / Ephedra nevadensis)* Woodland Association** 13015 (Appears 2x in key; see also JUNCAL Alliance)

**21'.** *Juniperus californica* is generally absent and ***Coleogyne ramosissima*** is strongly dominant beneath the ***Yucca brevifolia***.

**Joshua Tree / Blackbush *(Yucca brevifolia / Coleogyne ramosissima)* Woodland Association** 13012

**20'.** ***Yucca brevifolia*** evenly scattered over shrubs or grasses without (or <1% cover) *Juniperus* and/or *Coleogyne* in the stand, and one of the following is conspicuous: ***Larrea tridentata***, ***Hilaria rigida (Pleuraphis rigida)*****,** or ***Prunus fasciculata*****.**

**22.** ***Larrea tridentata*** conspicuous in a diverse shrub layer with ***Yucca schidigera*** generally present. Understory herb layer may have ***Hilaria rigida***. Typically found in the Little San Bernardinos on flat to undulating toeslopes.

**Joshua Tree / Creosote Bush — Mojave Yucca / Big Galleta *(Yucca brevifolia / Larrea tridentata — Yucca schidigera / Hilaria rigida))* Woodland Association** 13016

**22'.** ***Hilaria rigida*** or ***Prunus fasciculata*** conspicuous in the herb or shrub layer, *Larrea tridentata* absent or less than 1% cover.

**23.** ***Hilaria rigida*** dominant in herbaceous layer with emergent ***Yucca brevifolia*** in tree layer, generally occurs on open alluvial fans and basins with sandy loam. The sparse to open shrub layer may include a variety of other woody species such as *Ambrosia salsola, Ephedra nevadensis, Opuntia echinocarpa,* and *Scutellaria mexicana (Salazaria mexicana)*.

**Joshua Tree / Big Galleta (*Yucca brevifolia / Hilaria rigida* Woodland Association** 13021

**23'.** ***Prunus fasciculata*** present without significant *Larrea tridentata* or *Hilaria rigida* cover**.** Open shrublands in the higher elevation valleys, generally along wash edges. Other

characteristic species may include *Cylindropuntia echinocarpa, Lycium cooperi,* and *Stipa speciosa (Achnatherum speciosum)*.

**Joshua Tree / Desert Almond (*Yucca brevifolia / Prunus fasciculata* Association** 13014

**19'. *Yucca brevifolia*** absent or not evenly distributed. Trees, if present, not as above, but may be thorny, xeromorphic species of washes, and slopes. (Go to 24, left justified for spacing purposes).

**24.** Diagnostic species are typically larger shrubs or small trees, many with thorns, or spines and thin, often small leaves or leaflets. Stands characteristic of intermittently flooded washes, arroyos, canyons, and gullies from the mid- to lower elevations of the Park, but may occur in rocky uplands. Diagnostic species are one of the following: ***Chilopsis linearis***, ***Hyptis emoryi***, ***Justicia californica, Parkinsonia florida, Olneya tesota, Prosopis glandulosa, Psorothamnus spinosus, Ambrosia salsola (Hymenoclea salsola), Ziziphus obtusifolia, Acacia greggii, Ericameria paniculata, Ericameria nauseosa, Prunus fasciculata,*** or ***Ephedra californica***. (for 24' go to page 19)

**25.** Stands with one or more of the following small thorny and/or facultatively-deciduous trees or shrubs present and evenly distributed: ***Chilopsis linearis***, ***Hyptis emoryi***, ***Justicia californica, Parkinsonia florida, Olneya tesota, Prosopis glandulosa, Psorothamnus spinosus, Ambrosia salsola (Hymenoclea salsola),*** or ***Ziziphus obtusifolia***. Stands occur primarily in washes, arroyos, rills, channels, or on fans and bajadas of the lower elevation portions of the Park with warmer winters, but may occur in rocky uplands. Stands may contain higher cover of shorter shrubs or herbs. (for 25' go to page 16)

**26.** Stands are dominated and or characterized by taller shrubs and short trees including ***Chilopsis linearis, Parkinsonia florida, Olneya tesota,*** and ***Psorothamnus spinosus.*** Typical of the warmer low to mid-elevation washes and bajadas of the Park, except in the case of *Chilopsis linearis*, which occurs at higher elevations. To be defined, these species need only have >1% cover evenly distributed in a stand. (for 26' go to page 13)

**27. *Chilopsis linearis*** is higher cover (>2% absolute cover, >50% relative cover) than any other large shrub/small tree. Often occurs in localized stands, driven by fluvial processes, along intermittently flooded wash corridors in higher elevations of Park (replaced by *Parkinsonia florida — Olneya tesota* Alliance in lower elevations). Diagnostic species can be irregularly distributed in portions of the wash corridor.

**Desert Willow *(Chilopsis linearis)* Woodland Alliance** 15010

**28.** Sandy to gravelly washes with relatively wide flood path, or along wash benches. No other species with equally high cover, although *Ambrosia salsola* can be present at low cover. Generally found in

localized stands where fluvial processes are the primary disturbance, but most large-stature stands are on small terraces above the active wash channels

**Desert Willow (*Chilopsis linearis*) Association** 15013

**28'.** ***Ambrosia salsola*** dominant in shrub layer, often found in localized stands within active channel of sandy or gravelly washes with relatively wide flood paths across pediments and in natural "narrows" in valleys.

**Desert Willow / Cheesebush (*Chilopsis linearis / Ambrosia salsola*) Association** 15014 (not mapped)

**27'.** *Chilopsis linearis* not dominant. Stands dominated in the tree layer by one of the following: ***Olneya tesota, Parkinsonia florida,*** or ***Psorothamnus spinosus.***

**29.** ***Olneya tesota*** and/or ***Parkinsonia florida*** occur as emergent tall shrubs or short trees over desert scrub. Stands can occur as a mixture of both species or with one absent. Found on fan or bajada settings with or without strong wash geomorphology, but generally typically found in south-facing washes/canyons along the southeastern boundary of the Park. Other species may be similar in cover, particularly *Ambrosia salsola*, *Larrea tridentata*, and *Chilopsis linearis*, but presence of a consistent tree layer in the stand defines these types.

**Blue Palo Verde — Ironwood (*Parkinsonia florida — Olneya tesota)* Woodland Alliance** 16010

**30.** Low elevation, flat to undulating bajadas with stands of ***Olneya tesota*** forming sparse to open woodlands, stands lack *Parkinsonia florida*.

**Ironwood (*Olneya tesota*) Association** 16016

**30'.** Stands with ***Parkinsonia florida***, in wash corridors, benches, or on open bajadas.

**31.** A wash type that may have ***Olneya, Parkinsonia*** or both together; trees very sparse to openly spaced with the constant presence of ***Hyptis emoryi*** (≥1% cover). *Chilopsis linearis*, *Psorothamnus spinosus*, and *Ambrosia salsola* may be higher in cover. Diagnostic

species are irregularly distributed in portions of the wash corridor.

**32.** Generally in active wash channels, *Olneya tesota* without significant presence.

**Blue Palo Verde / Desert Lavender (*Parkinsonia florida / Hyptis emoryi*) Association** 16015

**32'.** Generally in fluvial floodplains, where wash widens; ***Olneya tesota*** becomes more prominent.

**Blue Palo Verde — Ironwood / Desert Lavender (*Parkinsonia florida — Olneya tesota / Hyptis emoryi)* Association** 16025

**31'.** Stands on slopes or bajadas laced with small rivulets, where *Hyptis emoryi* is generally <1% (not in large active washes).

***33. Larrea tridentata*** occurs with other, non-wash species in rocky uplands, including ***Peucephyllum schottii*** and ***Encelia farinosa;*** usually has ***Parkinsonia florida*** dominant with less or no cover of *Olneya tesota.*

**Blue Palo Verde / Creosote Bush — Desert Fir (*Parkinsonia florida / Larrea tridentata — Peucephyllum schotti*) Association** 16013

**33'.** Both ***Olneya*** and ***Parkinsonia*** may be present on hillslopes, small tributaries, fans, and terraces above large washes that do not flood regularly. May have ***Cylindropuntia* spp.,** *Fouquieria splendens,* and *Ambrosia salsola* in relatively high cover.

**Blue Palo Verde — Ironwood / Cholla (*Parkinsonia florida — Olneya tesota / Cylindropuntia sp.*) Association** 16024

**29'. *Psorothamnus spinosus*** consistently distributed in low energy washes (normally at >1%, but occasionally lower). No other species with greater or equal cover. Of low-elevation, active washes, mostly in southern and central portion of the Park. *Chilopsis linearis* may occur in some stands.

**Smoketree *(Psorothamnus spinosus)* Woodland Alliance** 16030

**34.** Gently sloping sandy or gravelly surfaces or washes with significant cover of ***Ephedra californica*** and ***Ambrosia salsola***. Ground cover <2% cobble.

**Smoketree / California Joint Fir — Cheesebush *(Psorothamnus spinosus / Ephedra californica — Ambrosia salsola)* Association** 16036 (not mapped)

**34'.** Gently sloping washes with flat, hummocky, or swaley topographies; ***Hyptis emoryi*** and ***Acacia greggii*** with significant cover. Ground cover generally >2% cobble.

**Smoketree / Desert Lavender — Catclaw *(Psorothamnus spinosus / Hyptis emory — Acacia greggii)* Association** 16035

**26'.** The larger desert trees and shrubs mentioned in couplet 26 generally absent from stands. Instead, mid-size shrubs such as ***Hyptis emoryi***, ***Justicia californica, Prosopis glandulosa, Ambrosia salsola (Hymenoclea salsola),*** and/or ***Ziziphus obtusifolia*** are important and constant in stands.

**35.** Vegetation characterized (≥2%) by ***Hyptis emoryi***. Other shrub species are not in high cover, but may include *Acacia greggii, Larrea tridentata,* and *Sarcostemma hirtellum.* In rocky washes of upper bajadas and low-elevation canyons (sometimes on slopes) throughout the Park.

**Desert Lavender *(Hyptis emoryi)* Shrubland Alliance** 28200

This alliance is represented in the Park by one broadly defined association. Stands are common in narrow and steep, high energy, rocky washes throughout the mountain ranges in the eastern portions of the Park.

**Desert Lavender *(Hyptis emoryi)* Association** 28203

**35'.** *Hyptis emoryi* absent or not evenly distributed, instead ***Justicia californica, Prosopis glandulosa, Ambrosia salsola (Hymenoclea salsola),*** and/or ***Ziziphus obtusifolia*** are the main indicators. In washes or low-lying

areas such as margins of playas or dunes at lower elevations, except in the case of *Prosopis glandulosa*, which can occur in isolated stands in canyons at higher elevations in the Park.

**36. *Justicia californica*** as a characteristic species with highest average cover (<1 to 14% absolute cover). Other shrubs such as *Encelia farinosa, Larrea tridentata*, and *Hyptis emoryi* also characteristically occur at low cover (<1 to 3% absolute cover). Emergent trees include characteristic presence of *Parkinsonia florida* and *Fouquieria splendens* (<1 to 3% absolute cover). Occasional stands associated with low-elevation washes along southeastern edge of Park. Questionably distinct from other wash types, need more data.

**Chuparosa *(Justicia californica)* Provisional Shrubland Alliance** 28171

**36'.** Stands lacking *Justicia californica*, instead ***Prosopis glandulosa, Ambrosia salsola,*** and/or ***Ziziphus obtusifolia*** are dominant or evenly distributed.

**37. *Prosopis glandulosa*** dominant and conspicuous as sprawling large green shrubs.

**Honey Mesquite (*Prosopis glandulosa)* Woodland Alliance** 16040

**38**. Alkaline soils, generally on dry lake margins with fine sediment; ***Suaeda moquinii*** and ***Atriplex hymenelytra*** significant in stand. Only stands known in Park are along southeast side of Coxcombs on western edge of Palen Lake basin.

**Honey Mesquite / Saltbush — Bush Seepweed (*Prosopis glandulosa / Atriplex spp. — Suaeda moquinii)* Association** 16043

**38'**. Stands primarily occur in sandy washes or on loamy benches in canyons or washes in higher elevations of Park. Other species may include *Acacia greggii*, *Lycium andersonii*, and *Baccharis sergiloides*.

**Honey Mesquite (*Prosopis glandulosa)* Association** 16041

**37'. *Ambrosia salsola,*** and/or ***Ziziphus obtusifolia*** are dominant or evenly distributed (≥2% cover) along washes or

sandy drainages. *Larrea tridentata*, if present, not co-dominant and at lower cover than the dominant species.

**39. *Ziziphus obtusifolia*** is dominant in the shrub canopy, stands in the Park generally with *Atriplex canescens* and/or *Salix exigua*. Only known from a few washes in the southern portions of the Park near Cottonwood Springs.

**Lotebush (*Ziziphus obtusifolia*) Shrubland Special Stands** 15060 (not mapped)

**39'. *Ambrosia salsola (Hymenoclea salsola)*** dominant, no other shrubs with greater cover. Generally associated with areas of high disturbance, for example, flooding, fire, grazing, or roadsides. Stands in uplands are uncommon in the Park and are usually associated with unnatural disturbance. Whereas most natural stands are associated with washes in mid and lower elevations. (This Alliance appears twice in key; see also couplet 60')

**Cheesebush (*Ambrosia salsola)* Shrubland Alliance** 28110

**40.** Stands characteristic of sandy or gravelly washes in lower elevations. ***Ambrosia salsola*** much higher in cover than other characteristic species, which may include: *Psorothamnus arborescens, Mirabilis laevis* var. *villosa, Krameria bicolor (Krameria grayi), Eriogonum fasciculatum,* and *Senna armata.* Most stands are below MMU so have been incorporated into other polygons named for larger more diagnostic species such as *Hyptis emoryi, Psorothamnus spinosus, Chilopsis linearis,* and others.

**Cheesebush (*Ambrosia salsola)* Shrubland Association** 28111 (not mapped)

**40'. *Ambrosia salsola*** and ***Senna armata*** dominant cover in sparse to open shrublands on undulating or flat slopes. Generally slightly above wash corridors, with coarse sand to fine sandy loam. Other shrub species characteristic of this association include: *Lycium andersonii*, *Ephedra californica, Cylindropuntia*

*ramosissima, Larrea tridentata,* and *Scutellaria mexicana (Salazaria mexicana).*

**Cheesebush — Desert Senna (*Ambrosia salsola — Senna armata)* Shrubland Association** 28112 (not mapped)

**25'.** Stands with one of the following large shrubs present and evenly distributed: ***Acacia greggii, Ericameria paniculata, Ericameria nauseosa, Prunus fasciculata,*** or ***Ephedra californica.*** Stands mostly occur in washes, arroyos, rills, channels, or on fans and bajadas of the mid-elevation portions of the Park, but sometimes occur on rocky slopes, or repeatedly burned flats, where the dominants may increase due to their resprouting abilities. All of these stands may contain higher cover of shorter shrubs or herbs, but presence of one of these species as an evenly distributed dominant or co-dominant should be considered an indicator for their respective Alliance.

**41.** ***Acacia greggii*** with ≥2% absolute cover, commonly of washes, arroyos, and lower canyons, but may be on rocky slopes and valleys away from fluvial disturbance.

**Catclaw (*Acacia greggii)* Shrubland Alliance** 36010

**42.** ***Acacia greggii*** dominates stand with significant presence or co-dominance of ***Hyptis emoryi, Bebbia juncea*****,** or ***Prunus fasciculata***. Typically found in washes, arroyos, or canyon drainages.

**43.** ***Acacia greggii*** co-occurs with lower elevation wash shrubs such as ***Hyptis emoryi*** and/or ***Bebbia juncea.*** *Larrea tridentata* and *Ambrosia salsola* are also common. Generally in alluvial drainages with noticeable groundcover of cobble and gravel.

**Catclaw acacia — (Sweetbush — Desert lavender) (*Acacia greggii — (Bebbia juncea — Hyptis emoryi)* Association** 36015

**43'.** ***Acacia greggii*** co-occurs with ***Prunus fasciculata*** and often with similar cover of *Lycium cooperi, Larrea tridentata*, *Ambrosia salsola, Hilaria rigida (Pleuraphis rigida),* generally along banks of mid-elevation washes, or in recently burned flats of mid elevations, where it indicates a recovery transition from burned *Yucca brevifolia* stands.

**Catclaw acacia — Desert almond (*Acacia greggii — Prunus fasciculata)* Association** 36016

**42'.** ***Acacia greggii*** dominates with ***Eriogonum fasciculatum*** characteristic in stand; occurs on rocky, bouldery slopes above washes with mixed upland

shrubs such as *Bahiopsis parishii (Viguiera parishii), Simmondsia chinensis, Keckiella antirrhinoides, Prunus fasciculata, Scutellaria mexicana (Salazaria mexicana), Sphaeralcea ambigua,* and *Yucca schidigera.*

**Catclaw Acacia — California Buckwheat (*Acacia greggii — Eriogonum fasciculatum*) Association** 36018

**41'.** *Acacia greggii* not the dominant or co-dominant shrub. Instead, one or more of the following shrubs dominant or co-dominant: ***Ericameria paniculata, Ericameria nauseosa, Prunus fasciculata,*** or ***Ephedra californica.***

**44. *Ephedra californica*** is the dominant or characteristic (co-dominant) shrub. Stands occur in broad, active washes of mid to upper bajadas and fans. Ranges somewhat locally throughout the southwestern, central, and eastern portions of the Park. Other species common in this alliance include: *Ambrosia salsola, Bahiopsis parishii (Viguiera parishii),* and *Hilaria rigida (Pleuraphis rigida).*

**California joint fir *(Ephedra californica*) Shrubland Alliance** 24020

One association defined for Park; typically found on coarse sand in drainages and washes at mid elevations (2,100-3,700 ft) of rocky highlands. Other common species include: *Krameria bicolor* (*Krameria grayi), Larrea tridentata, Lycium andersonii, Scutellaria mexicana (Salazaria mexicana),* and *Senna armata.*

**California joint fir — Cheesebush *(Ephedra californica — Ambrosia salsola*) Shrubland Association** 24021 (not mapped)

**44'. *Ephedra californica*** not dominant or co-dominant.

**45.** Stands dominated by either ***Ericameria nauseosa*** or ***E. paniculata***.

**46. *Ericameria paniculata*** ≥2% absolute cover and must be ≥25% of relative cover. Occasional throughout broad elevation range in Park; found in relatively large, active washes. Stands in Park are typically below MMU and are not mapped. This alliance is not defined at the association level locally.

**Black-stem Rabbitbrush *(Ericameria paniculata)* Shrubland Alliance** 28120 (not mapped)

**46'. *Ericameria nauseosa*** is dominant, other species present might include *Prunus fasciculata, Purshia tridentata*, or *Gutierrezia microcephala*. Occurs in flat to gently sloping, sandy washes in upper elevations (1400-1500 m) and often

associated with disturbance, particularly in fluvial areas. Stands in Park are typically smaller than the MMU.

**Rubber Rabbitbrush (*Ericameria nauseosa*) Shrubland Alliance** 28210
Note: Alliance appears twice in key (see couplet 59), it may be seral to stands of *YUBR, JUNCAL,* and *PIMO* Alliance after disturbance (e.g., fire).

**45'**. ***Prunus fasciculata*** ≥2% cover and must be ≥25% of relative cover. *Gutierrezia sarothrae* and *Lycium cooperi* may have higher cover (up to 2x). If *Prunus fasciculata* co-occurs with other tall shrubs, such as *Acacia greggii*, it must have twice the cover of other species to make the Alliance definition. Typically of washes and arroyos at the mid and upper elevations of the Park, but may occur on wash terraces and in valleys. Cover may be high following resprouting from fire. The following species are common associates: *Scutellaria mexicana (Salazaria mexicana)*, *Ericameria teretifolia, Lycium cooperi, Yucca schidigera*, *Rhus aromatica (Rhus trilobata)*, and *Purshia tridentata*.

**Desert Almond (*Prunus fasciculata)* Shrubland Alliance** 32010

**47. *Prunus fasciculata*** dominates with both ***Lycium cooperi*** and ***Stipa speciosa (Achnatherum speciosum)*** characteristic in stand. Generally occurs in drainages of canyon bottoms, wash margins, and adjacent bajadas that have fluvial disturbance, but also can proliferate on well-drained terraces and slopes following fire or other disturbance at mid and upper elevations. Other shrub species often present are *Ambrosia salsola, Ephedra nevadensis, Eriogonum fasciculatum, Lycium cooperi, Scutellaria mexicana (Salazaria mexicana),* and *Yucca schidigera*.

**Desert Almond *(Prunus fasciculata)* Shrubland Association** 32013

**47'. *Rhus aromatica*** co-dominates in stand with ***Prunus fasciculata***, but can be patchy along wash corridor.

**Desert Almond — Skunkbush Sumac *(Prunus fasciculata — Rhus aromatica)* Association** 32014 (not mapped)

**24'.** Diagnostic species not characteristic of washes or arroyos, but may be widespread in uplands. Stands not dominated or characterized by xeromorphic trees or large shrubs, with thorns and/or seasonal leaves. Composed of smaller shrubs or herbs of various characteristics including sclerophyllous leaves, succulent stems (cacti), drought-deciduous or evergreen foliage, or annual life histories. These include the widest variety of vegetation types in the Park ranging from Mediterranean scrub and grassland (chaparral, coastal scrub, and Californian grasslands), warm interior chaparrals, cool semi-desert scrub and grasslands of the higher elevations, to warm semi-desert scrub and grasslands (typical Mojave or Sonoran desert scrub).

**48**. Scrubs and grasslands of mostly mesic (e.g., sheltered and northerly-facing) mid- and upper elevations in the Park, characterized by predominant winter precipitation similar to the higher rainfall (or snowfall) of the Mediterranean climate regime of most of cismontane California or other temperate (non-desert) conditions. Conifers not dominant, but may be scattered in low cover, indicator genera are ***Arctostaphylos, Quercus*, *Eriogonum, Achnatherum (Stipa), Sphaeralcea, Amsinckia***, ***Bromus,*** or ***Schismus.*** (for 48' go to pg 21)

**49.** Scrub dominated or characterized by shrubs (sometimes considered short trees) with thickened evergreen (sclerophyll) or facultatively drought deciduous fasciculate leaves in the genera ***Arctostaphylos, Quercus*,** or ***Eriogonum.*** Generally of higher elevations.

**50.** Vegetation dominated, co-dominated or characterized by ***Arctostaphylos glauca*** or ***Quercus cornelius-mulleri***.

**51.** ***Arctostaphylos glauca*** is the dominant or co-dominant overstory shrub, conifers *(Pinus, Juniperus)* absent or in very low cover. Stands are rare or currently non-detectable (perhaps due to fire history) in the Park, but occur in isolated stands in the Little San Bernardino Mountains region of the Park.

**Bigberry Manzanita (*Arctostaphylos glauca)* Shrubland Alliance** 21210 (not mapped)

**51'** Stands characterized by ***Quercus cornelius-mulleri*** at ≥2% cover and not exceeded by any other tree in cover *(Quercus john-tuckeri* may also be mixed in), however ***Juniperus californica*** can co-dominate.

**Muller Oak (*Quercus cornelius-mulleri*) Shrubland Alliance** 21230

**52.** ***Quercus cornelius-mulleri*** occurs with a mixture of shrubs including ***Eriogonum fasciculatum, Ericameria linearifolia, Yucca schidigera,*** and ***E. teretifolia*.**

**Muller Oak — California buckwheat — Narrowleaf goldenbush (*Quercus cornelius-mulleri* —**

***Eriogonum fasciculatum — Ericameria linearifolia)*** **Shrubland Association** 21234

**52'.** ***Juniperus californica*** and ***Quercus cornelius-mulleri*** may be co-dominant, typically contains some ***Coleogyne ramosissima*** and ***Stipa speciosa (Achnatherum speciosum)***. Note: Technically a member of the *Juniperus californica* Alliance, but placed in the key here to assist in identifying stands with co-dominant *Quercus*. See also couplet 18'.

**California Juniper / Muller Oak — Blackbush (*Juniperus californica / Quercus cornelius-mulleri — Coleogyne ramosissima*) Woodland Association** 10032

**50'.** Scrub dominated or characterized by shrubs with facultatively deciduous fasciculate leaves, poorly developed in the Park and characterized by the dominance or co-dominance of ***Eriogonum fasciculatum.*** Stands are generally found on rocky substrates at mid-elevations and can have a high diversity of perennial species. Note: Technically this vegetation type is a member of the *Eriogonum fasciculatum — Viquiera parishii* Shrubland Alliance, but the lack of *Viquiera parishii* in this particular association justifies its placement here. See couplet 75' for the other associations.

**California Buckwheat *(Eriogonum fasciculatum)*** Rock Outcrop Shrubland Association 28131

**49'.** Vegetation dominated by forbs and grasses (>10% cover), with shrubs not evenly distributed or well under 10% cover. Stands are ephemeral and successional following fires in the montane zone of the Park where shrubs are temporarily reduced in cover for several years.

**53.** The perennial bunchgrass ***Stipa speciosa* (*Achnatherum speciosum*)** dominates the stand with ***Sphaeralcea ambigua*** present seasonally. *Yucca brevifolia* may be in the emergent tree layer and *Ephedra nevadensis, Scutellaria mexicana (Salazaria mexicana),* and *Lycium cooperi* are often present in low cover. In the Park, these burned stands were previously characterized by *Yucca brevifolia*, *Juniperus californica, Ephedra nevadensis*, and *Coleogyne ramosissima*.

**Desert Needlegrass (*Stipa speciosa*) Herbacous Alliance** 59020 (not mapped)

**Desert Needlegrass — Desert Globemallow (*Stipa speciosa — Sphaeralcea ambigua*) Association** 59022 (not mapped)

**53'.** Stands dominated by annual plants: ***Amsinckia spp***., ***Bromus spp.,*** and/or ***Schismus spp.*** Emergent shrub layer can be present, but at low cover.

**54.** ***Amsinckia spp*****.** ***(menziesii, tessellata)*** ≥10% relative cover in herbaceous layer seasonally. Other annual species may co-dominate including *Cryptantha spp., Pectocarya spp., Lotus spp*., or *Bromus madritensis ssp. rubens*. Generally of upland slopes or broad valleys with well-drained loamy soils. Currently not represented by samples in the Park but expected to occur following fires in upper elevations.

***Amsinckia (menziesii, tessellata)*** **Herbacous Alliance** 60030 (not mapped)

**54'.** ***Bromus spp.*** and/or ***Schismus spp*****.** are the only dominant annual grasses or herbs with no other species co-dominant.

**55.** ***Bromus madritensis*** **ssp.** ***rubens*** >80% relative cover in herbaceous layer or ***Schismus*** **(*arabicus, barbatus*)** >80% relative cover. Returning scrub may contain *Quercus, Eriogonum, Yucca,* or other species. Currently not represented by samples in the Park, but mapped based on field recon in 2000 following fires in Covington Flat and other upper elevation areas, as well as data collected during the AA process in 2007-2008.

***Bromus rubens — Schismus (arabicus, barbatus*****) Semi-Natural Herbaceous Stands** 60010

**55'.** ***Bromus tectorum*** dominates the community with greater than 80-90% total vegetative cover; occurring post-fire or in areas of high disturbance (grazing). Although there is sample data supporting this type in the Park it is not mapped, partly due to the patchiness and size of the stands (often less than the MMU (0.5 ha)).

***Bromus tectorum*** **Semi-Natural Herbaceous Stands** 60120 (not mapped)

**48'** Scrubs and grasslands of dry desert conditions either in mid or lower elevations, if at higher elevations, usually not in cooler (e.g., north-facing) exposures or settings. Indicator taxa include: ***Ericameria (Chrysothamnus), Scutellaria (Salazaria), Ambrosia*** (including ***Hymenoclea), Senna, Coleogyne, Ephedra, Purshia, Encelia*****,** ***Grayia*****,** ***Larrea, Hilaria (Pleuraphis), Atriplex canescens, Tetracoccus hallii, Lycium andersonii, Bahiopsis (Viguiera), Peucephyllum, Yucca schidigera,*** and/or ***Cylindropuntia bigelovii.***

**56.** Vegetation usually characterized by open scrub habitats or perennial grasslands, generally found in the drier, mid to upper elevation areas of the Park. Although widespread in much of the California deserts, most of these Alliances are poorly developed in the Park. Indicator species include: ***Ericameria teretifolia*** (***Chrysothamnus teretifolius***)**,** ***E. nauseosa*** (***C. nauseosus***), ***Scutellaria mexicana (Salazaria mexicana)***, ***Ambrosia salsola*** (***Hymenoclea salsola***), ***Senna armata, Coleogyne ramosissima, Ephedra nevadensis, Purshia tridentata, Encelia virginensis,*** or ***Grayia spinosa.*** (for 56' go to page 25, left justified)

**57**. Dominant plants are relatively short-lived plants that colonize uplands following natural or unnatural disturbance such as clearing or fire. Indicator species include ***Ericameria teretifolia, E. nauseosa***, ***Scutellaria mexicana***, ***Ambrosia salsola,*** and/or ***Senna armata***.

**58.** Stands dominated by species in the genus ***Ericameria***.

**59.** ***Ericameria nauseosa*** is dominant as a seral stage following major disturbance. Mostly known from small (<0.5 ha) upper elevation disturbed areas in sandy washes of the Little San Bernardino Mountains, however one site near Covington Flat may be seral to stands of *YUBR, JUNCAL,* or *PIMO* Alliances. (Alliance appears twice in key, see couplet 46')

**Rubber Rabbitbrush (*Ericameria nauseosa*) Shrubland Alliance** 28210

**59'**. ***Ericameria teretifolia*** is the dominant shrub, usually small (<MMU) post-fire stands associated with *Juniperus californica* or other upland Alliances. Not documented in the Park and no associations sampled. This species can become abundant on steep rocky slopes and canyons and is not necessarily associated with disturbance. However, because the expression of this Alliance is not very clear in the Park, it is only listed here.

***Ericameria teretifolia* Shrubland Alliance** 28220 (not mapped)

**58'.** Stands not dominated by species in the genus *Ericameria*.

**60**. ***Scutellaria mexicana*** forms small stands, which can be disturbance related (fire, clearing); not clearly defined for the Park. Expected in the mid and upper elevations associated with *Yucca brevifolia* woodlands.

**Bladder-Sage (*Scutellaria mexicana*) Shrubland Alliance** 28140 (not mapped)

**60'.** ***Ambrosia salsola (Hymenoclea salsola)*** dominant, no other shrubs with greater cover. Generally associated with areas of high disturbance, for example, flooding, fire, grazing, or roadsides. Stands in uplands are uncommon in the Park and are usually associated with unnatural disturbance. Whereas most natural stands are associated with washes in mid and lower elevations. (This Alliance appears 2x in key, see also couplet 39')

**Cheesebush (*Ambrosia salsola)* Shrubland Alliance** 28110

**61.** Stands characteristic of sandy or gravelly washes in lower elevations. ***Ambrosia salsola*** much higher in cover than other characteristic species, which may include: *Psorothamnus arborescens, Mirabilis laevis* var. *villosa, Krameria bicolor (Krameria grayi), Eriogonum fasciculatum,* and *Senna armata.* Most stands are below MMU so have been incorporated into other polygons named for larger more diagnostic species such as *Hyptis emoryi, Psorothamnus spinosus, Chilopsis linearis,* and others.

**Cheesebush (*Ambrosia salsola)* Shrubland Association** 28111 (not mapped)

**61'.** ***Ambrosia salsola*** and ***Senna armata*** dominant cover in sparse to open shrublands on undulating or flat slopes. Generally slightly above wash corridors, with coarse sand to fine sandy loam. Other shrub species characteristic of this association include: *Lycium andersonii*, *Ephedra californica, Cylindropuntia ramosissima, Larrea tridentata,* and *Scutellaria mexicana.*

**Cheesebush — Desert Senna (*Ambrosia salsola — Senna armata)* Shrubland Association** 28112 (not mapped)

**57'.** Scrubs composed of longer-lived species that tend to persist without frequent disturbance. Indicator species include: ***Coleogyne ramosissima, Ephedra nevadensis, Purshia tridentata, Encelia virginensis,*** or ***Grayia spinosa.***

**62.** ***Coleogyne ramosissima*** is the dominant or co-dominant shrub, typically with no *Yucca, Juniper*, or other taller shrub at >33% of the total relative cover of *Coleogyne*, though other smaller shrubs such as *Ephedra nevadensis* may equal it in cover.

**Blackbush *(Coleogyne ramosissima)* Shrubland Alliance** 28020

**63.** Open shrubland at mid to high elevations (3,400-5,000 ft) and generally with <25% total vegetation cover. ***Coleogyne ramosissima*** is the dominant (≥2% absolute cover), with ***Ephedra nevadensis*** consistent throughout the stand (may exceed CORA but not more than 2x).

**Blackbush — Nevada Ephedra *(Coleogyne ramosissima — Ephedra nevadensis*) Association** 28023

**63'.** Dense stands of ***Coleogyne ramosissima*** with no other species co-dominant or consistent in stand. The expression of this in the Park is not very well documented.

**Blackbush (*Coleogyne ramosissima*) Association** 28021 (not mapped)

**62'.** *Coleogyne ramosissima* not dominant or co-dominant, other shrubs of the high desert including ***Ephedra nevadensis, Purshia tridentata, Grayia spinosa,*** or ***Encelia virginensis*** are present and conspicuous**.** Several shrub Alliances in this intermontane desert group are predicted to occur in greater abundance in the Park then currently known, however at this time the data supporting these groups is insufficient for mapping.

**a. *Purshia tridentata*** ≥5% absolute cover, (and ≥50% relative cover), stands can have emergent trees or tall shrubs, especially *Quercus cornelius-mulleri*. Generally on well-drained soils.

***Purshia tridentata* Shrubland Alliance** 24030 (not mapped)

**b. *Ephedra nevadensis*** ≥2% absolute cover, usually a strong dominant with >2x the cover of other species in the stand. Generally dry, open slopes with well-drained soils.

***Ephedra nevadensis* Shrubland Alliance** 24010 (not mapped)

**c. *Grayia spinosa*** ≥2% absolute cover in shrub canopy; no other shrub with greater cover except *Ericameria cooperi* or *Lycium andersonii*. Stands generally occur on mountain slopes or bajadas with deep alluvial soils.

***Grayia spinosa* Shrubland Alliance** 36020 (not mapped)

**d. *Encelia virginensis*** ≥2% absolute cover in shrub canopy; no other shrub with greater cover, but *Stipa speciosa* can dominate the herbaceous layer. Stands occur in higher elevations on mountain slopes or ridge tops with cobbley/gravelly soils.

**Virgin River Brittlebush (*Encelia virginensis)* Shrubland Alliance** 28500 (not mapped)

**Acton's Brittlebush (*Encelia virginensis* ssp. *actoni)* Association** 28501 (not mapped)

**56'.** Vegetation is defined by scrubs and occasional grasslands within the warm desert belt of the Park. Principal indicator species are adapted to very hot dry summers, and not particularly cold winters, characteristic of the majority of the mid and lower elevations of the Mojave and the Sonoran (Colorado) deserts. Indicator taxa include: ***Ambrosia dumosa, Encelia farinosa, Larrea, Hilaria rigida (Pleuraphis rigida), Atriplex canescens, Tetracoccus hallii, Lycium andersonii, Bahiopsis parishii (Viguiera parishii), Eriogonum fasciculatum, Peucephyllum schottii, Yucca schidigera,*** and/or ***Cylindropuntia bigelovii***.

**64.** Vegetation of the lower slopes, fans and small sandy washes of the warm desert parts of the Park. Dominated by small to moderate sized shrubs (or perennial grasses) of ***Ambrosia dumosa, Encelia farinosa,*** and/or ***Larrea tridentata.*** (If *Yucca schidigera*, *Peucephyllum schottii, Tetracoccus hallii, Senna armata, Psorothamnus, Hilaria rigida (Pleuraphis rigida), Krameria spp., Cylindropuntia bigelovii,* or *Bahiopsis parishii (Viguiera parishii)* occur with ≥2% absolute cover in shrub canopy, consider the 64' couplet). (for 64' go to pg 30)

**65.** Stands lacking significant cover of *Larrea tridentata* but containing ***Ambrosia dumosa*** and/or ***Encelia farinosa*** or other low elevation hot desert upland shrubs.

**66**. ***Ambrosia dumosa*** must have greater cover than any other shrub species, and if *Larrea tridentata* is present, then AMDU should have >2x as much absolute cover as LATR. Generally found on uplands with relatively fine textured soil or on terraces above active washes.

**White Bursage (*Ambrosia dumosa)* Shrubland Alliance** 28300 (not mapped)

Occurs on north-facing slopes in low to mid elevation sites, often on alluvial fans or rocky hills.

**White Bursage (*Ambrosia dumosa)* Shrubland Association** 28301 (not mapped)

**66'. *Encelia farinosa*** is dominant (at least >1% absolute cover), and no other species has higher cover. *Ambrosia dumosa* can be characteristic and may even co-dominate. Occasional on hot, rocky slopes at lower elevations in the Park.

**Brittlebush (*Encelia farinosa)* Shrubland Alliance** 28030

**67. *Encelia farinosa*** is the dominant (>50% relative cover), no other species have equal or higher cover.

**Brittlebush *(Encelia farinosa)* Shrubland Association** 28031
(not mapped)

**67'. *Encelia farinosa*** is the dominant (>30% relative cover), and ***Ambrosia dumosa*** is characteristic and may even co-dominate.

**Brittlebush — White Bursage *(Encelia farinosa — Ambrosia dumosa)* Shrubland Association** 28033

**65'**. ***Larrea tridentata*** either dominant, co-dominant, or characteristic in stand. ***Ambrosia dumosa*** or ***Encelia farinosa*** may be characteristic or co-dominant.

Note: Stands with clonal rings of *Larrea tridentata* should be keyed out according to the species that are present in the stand. *Larrea tridentata* clones are not considered a distinct vegetation type, but are of interest to Park managers so locality information should be recorded. Known clones can be viewed on the map layer called "Park Specials."

**68. *Larrea tridentata*** and ***Encelia farinosa*** both evenly distributed across the stand (≥1% absolute cover) with no other woody shrubs greatly exceeding their cover. *Ambrosia dumosa* may be present but will be less than or equal to ENFA. Usually in rocky/bouldery uplands or on well-drained bajadas.

**Creosote Bush — Brittlebush (*Larrea tridentata — Encelia farinosa)* Shrubland Alliance** 27050

The four associations that occur in the Park are listed below with distinguishing characteristics:

**a. *Larrea tridentata*** dominates stand with ***Ambrosia dumosa*** and ***Encelia farinosa*** as subdominants to co-dominants. Stands widely distributed on lower and warmer slopes. *Bebbia juncea* is often present.

**Creosote Bush — Brittlebush — Burro Bush (*Larrea tridentata — Encelia farinosa — Ambrosia dumosa)* Association** 27057

**b.** Sparse to open shrublands at low to mid elevation rocky/bouldery uplands. Stands with ***Larrea tridentata*** and ***Encelia farinosa*** as co-dominants and ***Pleurocoronis pluriseta*** with variable cover (<1 to 8%). Other emergent shrubs include: *Ambrosia dumosa, Bahiopsis parishii, Trixis californica,* and *Simmondsia chinensis*.

**Creosote Bush — Brittlebush — Arrowleaf (*Larrea tridentata — Encelia farinosa — Pleurocoronis pluriseta*) Association** 27059

**c. *Fouquieria splendens*** evenly spaced emergent shrub, with ***Larrea tridentata*** and ***Encelia farinosa*** consistent in stand. Restricted to lower slopes and fans in the far southern portion of the Park. Note: The isolated stand of *F. splendens* in Pinto Basin ("Ocotillo Patch") is mapped separately as code 27049 because it lacks *E. farinosa.*

**Creosote Bush — Brittlebush — Ocotillo *(Larrea tridentata — Encelia farinosa — Fouquieria splendens)* Association** 27056

**d. *Larrea tridentata*** and ***Encelia farinosa*** co-dominate the stand with very low cover of any other shrub species. Occurs on rocky or steep, south-facing slopes of the southern portions of the Park.

**Creosote Bush — Brittlebush *(Larrea tridentata — Encelia farinosa)* Association** 27051 (not mapped)

**68'**. ***Larrea tridentata*** is the sole dominant or co-dominant with ***Ambrosia dumosa.*** If *Encelia farinosa* present it is less cover than either AMDU or LATR.

**69. *Larrea tridentata*** exceeds other shrubs in cover, and is typically the sole dominant or co-dominant with a shrub other than *Ambrosia dumosa* or *Encelia farinose*. Occurs in sandy soils of lower slopes, playa edges, or rivulets through desert pavement.

**Creosote Bush *(Larrea tridentata)* Shrubland Alliance** 27019

Four associations with these general characteristics occur in the Park and are listed below:

**a. *Larrea tridentata*** dominant, without significant cover of any other perennial shrub or herb; stands occur adjacent to playa-like flats or at the bases of large alluvial fans where soil texture is fine; ground cover dominated by annuals in good years. Note: When *Larrea* is present on sand, but very sparse consider sparsely vegetated types 60020 or 90300 listed under couplet 2.

**Creosote Bush (*Larrea tridentata)* Association** 27019

**b.** Distinguished by having low to moderate cover of the perennial grass ***Hilaria rigida***, along with ***Larrea tridentata***

consistently across the stand. *Ambrosia dumosa* is usually present but in lower cover (<1%). Sparse to intermittent stands on hummocky sand dune deposits or open bajadas.

**Creosote Bush / Big Galleta (*Larrea tridentata* / *Hilaria rigida)* Shrubland Association** 27021

**c.** Very sparsely vegetated stands of ***Larrea tridentata*** and low cover of ***Atriplex hymenelytra,*** and little to no cover of other shrub species. Occurs in alkaline soils in the extreme southeastern portion of the Park near Palen Dry Lake.

**Creosote Bush — Desert Holly (*Larrea tridentata — Atriplex hymenelytra*) Shrubland Association** 27023

**d.** Open shrubland with ***Larrea tridentata*** as dominant to co-dominant with ***Ambrosia salsola (Hymenoclea salsola),*** no other shrub species are common or characteristic. Often in low gradient washes with gravelly benches.

**Creosote Bush — Cheesebush (*Larrea tridentata — Ambrosia salsola)* Shrubland Association** 27013
(not mapped)

**69'.** ***Ambrosia dumosa*** conspicuously present (≥1% cover), may have higher cover than ***Larrea tridentata.*** Both species generally with >2x the cover of other shrub species. If *Encelia farinosa* present it is <1% cover. Widespread on all but the hottest and most rocky, sandy, or alkaline areas of the middle and lower elevations.

**Creosote Bush — Burrobush (*Larrea tridentata — Ambrosia dumosa)* Shrubland Alliance** 27030

Eight associations are known from the Park and are listed below with their distinguishing characteristics:

**a**. Stands simple, with co-dominance of ***Larrea tridentata*** and ***Ambrosia dumosa*** and few or no other species in significant cover. Occurs on open fans and slopes of upland alluvial deposits, typically not on sandy substrates. *Hilaria rigida* is absent or not conspicuous.

***Larrea tridentata — Ambrosia dumosa* Shrubland Association** 27031

**b**. Stands occur in narrow rivulets incised into well-developed desert pavement on the distal portions of bajadas and fans.

***Krameria bicolor (Krameria grayi)*** is conspicuous and often co-dominant with ***Larrea tridentata*** and ***Ambrosia dumosa.***

> **Creosote Bush — Burro Bush — White Rhatany (*Larrea tridentata — Ambrosia dumosa — Krameria bicolor)* Shrubland Association** 27034

**c**. ***Fouquieria splendens*** consistent in stand with ***Larrea tridentata*** as the dominant or co-dominant with ***Ambrosia dumosa.*** These stands are distinguished from 27056 by the lack of *Encelia farinosa*, and likely represent the northern edge of the distribution for *F. splendens*. The "Ocotillo Patch" is the only area mapped as this association in the Park, though there may be other isolated stands of *F. splendens* that qualify as this type.

> **Creosote Bush — Burro Bush — Ocotillo (*Larrea tridentata — Ambrosia dumosa — Fouquieria splendens)* Association** 27049

**d**. Stands dominated by ***Larrea tridentata*** with both ***Ambrosia dumosa*** and ***Senna armata*** characteristic. Found on gravelly surfaces in shallow washes, wash margins, or slightly higher up the bajada; associated with low energy washes or sheet flow. Other commonly encountered species include *Cylindropuntia echinocarpa, C. ramosissima*, and *Ambrosia salsola*.

> **Creosote Bush — Burro Bush — Desert Senna (*Larrea tridentata —Ambrosia dumosa — Senna armata)* Association** 27047

**e.** Stands are restricted to granitic pediments in the northcentral and northeastern portion of the Park where ***Larrea tridentata, Ambrosia dumosa,*** and ***Psorothamnus arborescens*** co-dominate; generally each of these species has >2% cover. Other common species include: *Senna armata, Encelia farinosa*, and *Bebbia juncea.*

> **Creosote Bush — White Bursage — Indigo Bush *(Larrea tridentata— Ambrosia dumosa — Psorothamnus arborescens)* Association** 27044

**f**. Stands with ***Larrea tridentata*** and ***Hilaria rigida*** present throughout, may not have significant cover of ***Ambrosia dumosa.*** Typically of marginal sandy substrates, and not associated with desert pavements.

**Creosote Bush — Burro Bush / Big Galleta (*Larrea tridentata — Ambrosia dumosa / Hilaria rigida)* Association** 27048 (not mapped)

**g**. Open shrublands on coarse sand to gravelly upland bajadas. ***Larrea tridentata*** and ***Ambrosia dumosa*** co-dominate with ***Yucca schidigera*** characteristic throughout the stand, but often not over 2% cover. Stands may occur in recently burned sites at mid elevations that may have contained *Juniperus californicus* and/or *Yucca brevifolia* prior to fire; may include substantial *Tetracoccus hallii* in south central portion of Park.

**Creosote Bush — Burro Bush — Mojave Yucca (*Larrea tridentata — Ambrosia dumosa — Yucca schidigera*) Association** 27045

**h**. Stands with ***Simmondsia chinensis*** conspicuous (≥2% cover) or co-dominant with ***Larrea tridentata*** and/or ***Ambrosia dumosa.*** Distributed at lower and mid elevations on rocky or bouldery uplands. Other common species: *Encelia farinosa, Pleurocoronis pleuriseta*, and *Bahiopsis parishii (Viguiera parishii)*.

**Creosote Bush — White Bursage — Jojoba (*Larrea tridentata — Ambrosia dumosa — Simmondsia chinensis)* Association** 27046

**64'.** Warm desert scrub which includes one of the following species as co-dominants or dominants: ***Hilaria rigida (Pleuraphis rigida), Atriplex canescens, Tetracoccus hallii, Lycium andersonii, Bahiopsis parishii (Viguiera parishii), Eriogonum fasciculatum, Peucephyllum schottii,*** or ***Yucca schidigera,*** and ***Cylindropuntia bigelovii***. Stands may also include *Larrea, Ambrosia,* and/or *Encelia*, but these are overridden in consideration if any of the species listed here are present and evenly distributed at ≥2% absolute cover and no other species is co-dominant to dominant.

**70. *Cylindropuntia bigelovii*** >50% relative cover in shrub layer. Generally on well-drained, upper bajadas or rocky slopes. *Larrea, Ambrosia*, or *Encelia* may be characteristic or co-dominate. Isolated stands are restricted to a few locations in the southern portions of the Park and one area in Pinto Basin.

**Teddy-bear cholla (*Cylindropuntia bigelovii*) Shrubland Alliance** 29050

**Teddy-bear Cholla *(Cylindropuntia bigelovii)* Shrubland Association** 29051

**70'.** Stands with one of the following species evenly distributed and ≥2% absolute cover: ***Hilaria rigida (Pleuraphis rigida), Atriplex canescens, Tetracoccus hallii, Lycium andersonii, Bahiopsis parishii (Viguiera parishii), Eriogonum fasciculatum, Peucephyllum schottii,*** or ***Yucca schidigera.***

**71.** ***Hilaria rigida*** ≥2% absolute cover in herbaceous layer (often exceeding 10%). Scattered shrubs are typically emergent (<10% absolute cover) over a continuous ground layer of this perennial grass; shrub or tree layer cannot exceed ***Hilaria rigida*** in cover.

**Big Galleta (*Hilaria rigida)* Herbaceous Alliance** 59010

**72.** ***Atriplex canescen***s is sub-dominant but consistently present in stands. Generally flat basins or playas with fine-textured soils. Most stands are associated with the Pleasant Valley Playa. Note: For pure *Atriplex canescens* stands, see couplet 13.

**Big Galleta / Four-wing Saltbush *(Hilaria rigida / Atriplex canescens)* Association** 59012

**72'.** Sparse to open shrublands on rocky, erosional surfaces or the upper third of slopes. ***Hilaria rigida*** and ***Ambrosia dumosa*** co-dominant in stand, ≥2% absolute cover.

**Big Galleta / White Bursage *(Hilaria rigida / Ambrosia dumosa)* Association** 59011

**71'.** Stands with one of the following species evenly distributed and ≥2% absolute cover: ***Tetracoccus hallii, Lycium andersonii, Bahiopsis parishii (Viguiera parishii), Eriogonum fasciculatum, Peucephyllum schottii,*** or ***Yucca schidigera.***

**73.** ***Tetracoccus hallii*** is dominant (over 50% relative cover) in the shrub layer with mixed shrubs and succulents. Stands are centered in the southern-central portion of the Park from low-elevation wash margins near Eagle Mine to rocky uplands in the vicinity of Cottonwood Springs. Other common species include: *Nolina bigelovii, Ephedra nevadensis,* and *Simmondsia chinensis*.

**Hall's Tetracoccus *(Tetracoccus hallii)* Provisional Alliance** 28180

**Hall's Tetracoccus *(Tetracoccus hallii)* Provisional Association** 28181

**73'.** Stands with one of the following species evenly distributed and ≥2% absolute cover: ***Lycium andersonii, Bahiopsis parishii, Eriogonum fasciculatum, Peucephyllum schottii,*** or ***Yucca schidigera.***

**74.** Stands with ***Lycium andersonii, Bahiopsis parishii (Viguiera parishii),*** or ***Eriogonum fasciculatum*** evenly distributed and ≥2% absolute cover.

**75.** ***Lycium andersonii*** >50% relative cover in shrub canopy. Occurs on rocky highlands or along rocky intermittently flooded washes. One association defined for the Park.

**Anderson's Boxthorn (*Lycium andersonii)*** Shrubland Alliance 28190 (not mapped)

**Anderson's Boxthorn — Jojoba / Big Galleta (*Lycium andersonii — Simmondsia chinensis / Hilaria rigida*) Association** 28192 (not mapped)

**75'.** ***Bahiopsis parishii (Viguiera parishii)*** with ≥2% absolute cover, and no other species with greater or equal cover except ***Eriogonum fasciculatum***. Usually on rocky slopes in areas with cobbles, boulders, and/or outcrops at low to mid elevations just above the *Larrea tridentata —Ambrosia dumosa* zone or, rarely, in washes. Stands are often highly diverse shrublands with *Acacia greggii, Ambrosia dumosa, Simmondsia chinensis, Hilaria rigida, Lotus rigidus,* or *Encelia actoni*. Note: Four associations known to Park, however one association lacks VIPA and is therefore found at couplet 50'.

**California buckwheat — Desert Sunflower (*Eriogonum fasciculatum — Viguiera parishii)* Shrubland Alliance** 28130

The three associations with VIPA defined in the Park include:

**a. *Bahiopsis parishii (Viguiera parishii)*** is usually co-dominant with ***Eriogonum fasciculatum***, but also may include moderate cover of ***Simmondsia chinensis,*** *Ephedra nevadensis, Encelia actonii, Pleurocoronis pluriseta,* and/or *Nolina bigelovii*. Other common shrubs at low to moderate cover include *Hyptis emoryi* and *Encelia farinosa.*

**Desert sunflower — California buckwheat — Jojoba (*Viguiera parishii — Eriogonum fasciculatum — Simmondsia chinensis)* Association** 28133

**b. *Ambrosia dumosa*** often present and may be co-dominant with ***Bahiopsis parishii***. Generally on gravelly or cobbly (not bouldery) slopes of mid to lower elevations.

**Desert sunflower — Burrobush — Jojoba (*Viguiera parishii — Ambrosia dumosa — Simmondsia chinensis*) Association** 28134

**c. *Bahiopsis parishii*** the sole dominant on well-drained bouldery alluvium.

**Desert sunflower *(Viguiera parishii)* Association** 28133 (not mapped)

**74'.** Stands either dominated by the rocky slope, warm desert species ***Peucephyllum schottii***, or by the mid- to upper elevation shrub ***Yucca schidigera*.**

**76.** Stands on low elevation, hot rocky cliffs and slopes. ***Peucephyllum schottii*** is the conspicuous shrub. May have *Pleurocoronis pluriseta, Gutierrezia microcephala,* and/or *Trixis californica* in similar cover. Generally scarce in the Park, but isolated stands occur in the Coxcomb and Eagle Mountains.

**Schott's Pygmycedar (*Peucephyllum schottii*) Provisional Alliance** 28400 (not mapped)

**77. *Peucephyllum schottii*** and ***Gutierrezia microcephala*** co-dominant along rocky washes or canyons.

**Schott's Pygmycedar — Threadleaf Snakeweed (*Peucephyllum schottii — Gutierrezia microcephala*) Provisional Association** 28401 (not mapped)

**77'. *Peucephyllum schottii*** and ***Pleurocoronis pluriseta*** co-dominant on rocky ridgetops and canyon walls. Note: *Eucnide urens* does not occur in the Park; this species is not required to qualify for this vegetation type.

**Schott's Pygmycedar — Arrowleaf — Desert Stingbush (*Peucephyllum schottii — Pleurocoronis pluriseta — Eucnide urens*) Provisional Alliance** 28402 (not mapped)

**76'.** Stands with ≥2% absolute cover of ***Yucca schidigera***; may have *Larrea tridentata*, *Ambrosia dumosa, Simmondsia chinensis***,** or other shrubs at equal or even higher cover. *Yucca schidigera* is considered an indicator species, it rarely dominates. Often found on shallow soils and in highly diverse shrub stands.

**Mojave Yucca (*Yucca schidigera)* Shrubland Alliance** 29030

Three associations have been defined in the Park:

**a. *Yucca schidigera*** ≥2% cover with ***Larrea tridentata*** and ***Ambrosia dumosa*** often as co-dominants. *Tetracoccus hallii* may be co-dominant in some areas of the Park and *Simmondsia chinensis* may also be in significant cover (≥2%). *Juniperus* may be present (<2% cover). Common on bajadas and gentle hillslopes at mid-elevations. (If *Juniperus* is ≥2x the cover of *Yucca schidigera,* then consider *Juniperus californica* Woodland Alliance.)

**Mojave Yucca — Creosote Bush — White Bursage *(Yucca schidigera — Larrea tridentata — Ambrosia dumosa)* Association** 29033

**b. *Yucca schidigera*** ≥2% cover with mixed shrub layer, annuals, and ***Hilaria rigida*** dominant in herbaceous layer. Usually on rocky upper hillslopes and bajadas. *Yucca brevifolia* is often scattered in tree layer (<1%).

**Mojave Yucca / Big Galleta (*Yucca schidigera / Hilaria rigida)* Association** 29034

**c. *Yucca schidigera*** ≥2% absolute cover with ***Coleogyne ramosissima*** dominant in the shrub layer. On pediments and hillslopes near the upper elevational range of the Alliance.

**Mojave Yucca — Blackbush *(Yucca schidigera — Coleogyne ramosissima)* Association** 29032

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# Appendix D: Map and Classification Crosswalk, 2005 to 2012.

| Appendix D-a: Crosswalk between 2005 version of JOTR Vegetation Classification map and 2012 version of the map. (Arranged numerically by the 2005 PI code.) | | | |
|---|---|---|---|
| **v1 (2005) PI code** | **v1 (2005) Alliance or Association name** | **v2 (2012) PI code** | **v2 (2012) Alliance or Association name** |
| 10020 | California Juniper Woodland Alliance | 10020 | California Juniper *(Juniperus californica)* Woodland Alliance |
| 10020 | California Juniper Woodland Alliance | 21234 | Muller Oak — California buckwheat — Narrowleaf goldenbush (*Quercus cornelius-mulleri — Eriogonum fasciculatum — Ericameria linearifolia*) Association |
| 10021 | Juniperus californica / Coleogyne ramosissima - Yucca schidigera | 10025 | California Juniper / Blackbush (*Juniperus californica / Coleogyne ramosissima)* Association |
| 10025 | Juniperus californica / Coleogyne ramosissima | 10025 | California Juniper / Blackbush (*Juniperus californica / Coleogyne ramosissima)* Association |
| 10029 | Juniperus californica / Tetracoccus hallii | 10025 | California Juniper / Blackbush (*Juniperus californica / Coleogyne ramosissima)* Association |
| 10029 | Juniperus californica / Tetracoccus hallii | 10031 | California Juniper / Mojave Yucca / Big Galleta (*Juniperus californica / Yucca schidigera / Pleuraphis rigida)* Woodland Association |
| 10029 | Juniperus californica / Tetracoccus hallii | 27045 | Creosote Bush — White Bursage — Mojave Yucca (*Larrea tridentata — Ambrosia dumosa — Yucca schidigera)* Association |
| 10030 | Juniperus californica / Viguiera parishii - (Nolina bigelovii) | 10025 | California Juniper / Blackbush (*Juniperus californica / Coleogyne ramosissima)* Association |
| 10031 | Juniperus californica / Yucca schidigera - (Tetracoccus hallii) | 10031 | California Juniper / Mojave Yucca / Big Galleta (*Juniperus californica / Yucca schidigera / Pleuraphis rigida)* Woodland Association |
| 10033 | Juniperus californica / (Coleogyne ramosissima - Yucca schidigera) Super Association | 10025 | California Juniper / Blackbush (*Juniperus californica / Coleogyne ramosissima)* Association |
| 10034 | Juniperus californica / (Eriogonum fasciculatum / Achnatherum speciosum) Super Association | 10025 | California Juniper / Blackbush (*Juniperus californica / Coleogyne ramosissima)* Association |
| 10160 | Pinus monophylla Woodland Alliance | 10160 | Single-leaf Pinyon Pine (*Pinus monophylla*) Woodland Alliance |
| 10161 | Singleleaf Pinyon Pine/Muller's Oak (Pinus monophylla/Quercus cornelius-mulleri) Woodland Association | 10161 | Single-leaf Pinyon Pine / Muller's Oak (*Pinus monophylla / Quercus cornelius-mulleri)* Woodland Association |
| 10162 | Pinus monophylla-(Juniperus californica) / Achnatherum speciosum Woodland Association | 10161 | Single-leaf Pinyon Pine / Muller's Oak (*Pinus monophylla / Quercus cornelius-mulleri)* Woodland Association |
| 13010 | Joshua Tree (*Yucca brevifolia*) Wooded Shrubland Alliance | 13010 | Joshua Tree (*Yucca brevifolia*) Woodland Alliance |
| 13010 | Joshua Tree (*Yucca brevifolia*) Wooded Shrubland Alliance | 13012 | Joshua Tree / Blackbush *(Yucca brevifolia / Coleogyne ramosissima)* Woodland Association |
| 13010 | Joshua Tree (*Yucca brevifolia*) Wooded Shrubland Alliance | 13014 | Joshua Tree / Desert Almond (*Yucca brevifolia / Prunus fasciculata*) Association |
| 13010 | Joshua Tree (*Yucca brevifolia*) Wooded Shrubland Alliance | 21234 | Muller Oak — California buckwheat — Narrowleaf goldenbush (*Quercus cornelius-mulleri — Eriogonum fasciculatum — Ericameria linearifolia*) Association |

| v1 (2005) PI code | v1 (2005) Alliance or Association name | v2 (2012) PI code | v2 (2012) Alliance or Association name |
|---|---|---|---|
| 13010 | Joshua Tree (*Yucca brevifolia*) Wooded Shrubland Alliance | 32013 | Desert Almond *(Prunus fasciculata)* Association |
| 13010 | Joshua Tree (*Yucca brevifolia*) Wooded Shrubland Alliance | 36018 | Catclaw Acacia — California buckwheat (*Acacia greggii — Eriogonum fasciculatum*) Association |
| 13012 | Yucca brevifolia / Coleogyne ramosissima | 13012 | Joshua Tree / Blackbush *(Yucca brevifolia / Coleogyne ramosissima)* Woodland Association |
| 13015 | Yucca brevifolia - Juniperus californica / (Coleogyne ramosissima - Yucca schidigera - Ephedra nevadensis) Super Association | 13015 | Joshua Tree — California Juniper / Nevada Ephedra (*Yucca brevifolia — Juniperus californica / Ephedra nevadensis)* Woodland Association |
| 13016 | Yucca brevifolia / Larrea tridentata - (Yucca schidigera / Pleuraphis rigida) Super Association | 13016 | Joshua Tree / Creosote Bush — Mojave Yucca / Big Galleta Grass (*Yucca brevifolia / Larrea tridentata — Yucca schidigera / Pleuraphis rigida)* Woodland Association |
| 13021 | Yucca brevifolia / (Ephedra nevadensis - Grayia spinosa - Lycium spp.) / Pleuraphis rigida Super Association | 13021 | Joshua Tree / Big Galleta Grass (*Yucca brevifolia / Pleuraphis rigida)* Woodland Association |
| 15012 | Chilopsis linearis - Psorothamnus spinosus - (Cercidium floridum / Acacia greggii) MAMU | 15013 | Desert Willow (*Chilopsis linearis*) Association |
| 15012 | Chilopsis linearis - Psorothamnus spinosus - (Cercidium floridum / Acacia greggii) MAMU | 16013 | Blue Palo Verde / Creosote Bush — Desert Fir (*Parkinsonia florida / Larrea tridentata — Peucephyllum schottii)* Association |
| 15012 | Chilopsis linearis - Psorothamnus spinosus - (Cercidium floridum / Acacia greggii) MAMU | 16015 | Blue Palo Verde / Desert Lavender (*Parkinsonia florida / Hyptis emoryi*) Association |
| 15012 | Chilopsis linearis - Psorothamnus spinosus - (Cercidium floridum / Acacia greggii) MAMU | 16025 | Blue Palo Verde — Ironwood / Desert Lavender (*Parkinsonia florida — Olneya tesota / Hyptis emoryi*) Association |
| 15012 | Chilopsis linearis - Psorothamnus spinosus - (Cercidium floridum / Acacia greggii) MAMU | 16035 | Smoketree / Desert Lavender — Catclaw *(Psorothamnus spinosus / Hyptis emoryi — Acacia greggii)* Association |
| 15012 | Chilopsis linearis - Psorothamnus spinosus - (Cercidium floridum / Acacia greggii) MAMU | 27047 | Creosote Bush — White Bursage — Desert Senna (*Larrea tridentata — Ambrosia dumosa — Senna armata)* Association |
| 15012 | Chilopsis linearis - Psorothamnus spinosus - (Cercidium floridum / Acacia greggii) MAMU | 28110 | Cheesebush (*Ambrosia salsola)* Shrubland Alliance |
| 15012 | Chilopsis linearis - Psorothamnus spinosus - (Cercidium floridum / Acacia greggii) MAMU | 36016 | Catclaw Acacia — Desert Almond (*Acacia greggii — Prunus fasciculata*) Association |
| 15013 | Chilopsis linearis / (Prunus fasciculata- Acacia gregii) Super Association | 15013 | Desert Willow (*Chilopsis linearis*) Association |
| 15013 | Chilopsis linearis / (Prunus fasciculata- Acacia gregii) Super Association | 16015 | Blue Palo Verde / Desert Lavender (*Parkinsonia florida / Hyptis emoryi*) Association |
| 15030 | Salix laevigata Woodland Alliance | 15030 | Black Willow (*Salix gooddingii*) Woodland Alliance |
| 15040 | Fremont cottonwood | 15040 | Fremont Cottonwood (*Populus fremontii*) Forest Alliance |
| 15112 | Washington filifera / Salix exigua / Muhlenbergia rigens | 15110 | California Fan Palm *(Washingtonia filifera)* Woodland Alliance |
| 16010 | Blue Palo Verde | 16013 | Blue Palo Verde / Creosote Bush — Desert Fir (*Parkinsonia florida / Larrea tridentata — Peucephyllum schottii)* Association |

| v1 (2005) PI code | v1 (2005) Alliance or Association name | v2 (2012) PI code | v2 (2012) Alliance or Association name |
|---|---|---|---|
| 16013 | Cercidium floridum / Larrea tridentata | 16013 | Blue Palo Verde / Creosote Bush — Desert Fir (*Parkinsonia florida / Larrea tridentata — Peucephyllum schottii)* Association |
| 16015 | Cercidium floridum / Hyptis emoryi | 16015 | Blue Palo Verde / Desert Lavender (*Parkinsonia florida / Hyptis emoryi*) Association |
| 16015 | Cercidium floridum / Hyptis emoryi | 16016 | Ironwood (*Olneya tesota)* Association |
| 16024 | Olneya tesota / (Larrea tridentata - Encelia farinosa) Fan Type | 16024 | Blue Palo Verde — Ironwood / Cholla (*Parkinsonia florida — Olneya tesota / Cylindropuntia sp.*) Association |
| 16025 | Olneya tesota - (Cercidium floridum / Hyptis emoryi) Wash Type | 16025 | Blue Palo Verde — Ironwood / Desert Lavender (*Parkinsonia florida — Olneya tesota / Hyptis emoryi*) Association |
| 16034 | Psorothamnus spinosus/ (Ephedra californica - Hymenoclea salsola) broad low energy sandy wash type | 16035 | Smoketree / Desert Lavender — Catclaw *(Psorothamnus spinosus / Hyptis emoryi — Acacia greggii)* Association |
| 16035 | Smoketree - (Desert-Lavender) - Catclaw Association (Psorothamnus spinosus/ (Hyptis emoryi) - Acacia greggii) Association | 16035 | Smoketree / Desert Lavender — Catclaw *(Psorothamnus spinosus / Hyptis emoryi — Acacia greggii)* Association |
| 16040 | Prosopis glandulosa/Suaeda moquinii | 16041 | Honey Mesquite *(Prosopis glandulosa)* Association |
| 16040 | Prosopis glandulosa/Suaeda moquinii | 16043 | Honey Mesquite / Saltbush — Bush Seepweed *(Prosopis glandulosa / Atriplex* spp. *— Suaeda moquinii)* Association |
| 21233 | Quercus cornelius-mulleri - (Juniperus californica / Coleogyne ramosissima) MAMU | 10032 | California Juniper / Muller Oak — Blackbush (*Juniperus californica / Quercus cornelius-mulleri — Coleogyne ramosissima*) Woodland Association |
| 21234 | Quercus cornelius-mulleri - (Juniperus californica) MAMU | 21234 | Muller Oak — California buckwheat — Narrowleaf goldenbush (*Quercus cornelius-mulleri — Eriogonum fasciculatum — Ericameria linearifolia*) Association |
| 24001 | (Ephedra nevadensis - Pleurocoronis pluriseta - Encelia farinosa - Trixis californica - Bebbia juncea - Eriogonum fasiculatum - Lycium andersonii - Acacia greggii) low elevation rocky mountain type | 27059 | Creosote Bush — Brittlebush — Arrowleaf (*Larrea tridentata — Encelia farinosa — Pleurocoronis pluriseta*) Association |
| 27001 | (Salazaria mexicana - Krameria spp. - Encelia farinosa - Hyptis emoryi - Eriogonum fasiculatum - Hymenoclea salsola - Acacia greggii - Tetracoccus hallii) rivulets within desert pavement | 27034 | Creosote Bush — White Bursage — White Rhatany (*Larrea tridentata — Ambrosia dumosa — Krameria grayi)* Association |
| 27010 | Creosote bush Alliance | 27031 | Creosote Bush — White Bursage (*Larrea tridentata — Ambrosia dumosa)* Association |
| 27011 | Larrea tridentata - (Ambrosia dumosa) - Hymenoclea salsola Low Energy Wash Type | 27047 | Creosote Bush — White Bursage — Desert Senna (*Larrea tridentata — Ambrosia dumosa — Senna armata)* Association |
| 27019 | Larrea tridentata Undifferentiated Playa and Sandy Dune Top Type | 27019 | Creosote Bush (*Larrea tridentata)* Association |
| 27019 | Larrea tridentata Undifferentiated Playa and Sandy Dune Top Type | 27021 | Creosote Bush / Big Galleta Grass (*Larrea tridentata / Pleuraphis rigida*) Association |
| 27019 | Larrea tridentata Undifferentiated Playa and Sandy Dune Top Type | 27031 | Creosote Bush — White Bursage (*Larrea tridentata — Ambrosia dumosa)* Association |

| v1 (2005) PI code | v1 (2005) Alliance or Association name | v2 (2012) PI code | v2 (2012) Alliance or Association name |
|---|---|---|---|
| 27019 | Larrea tridentata Undifferentiated Playa and Sandy Dune Top Type | 27045 | Creosote Bush — White Bursage — Mojave Yucca (*Larrea tridentata — Ambrosia dumosa — Yucca schidigera)* Association |
| 27019 | Larrea tridentata Undifferentiated Playa and Sandy Dune Top Type | 27047 | Creosote Bush — White Bursage — Desert Senna (*Larrea tridentata — Ambrosia dumosa — Senna armata)* Association |
| 27019 | Larrea tridentata Undifferentiated Playa and Sandy Dune Top Type | 60020 | Desert Twinbugs — Desert Sand Verbena *(Dicoria canescens — Abronia villosa)* Sparsely Vegetated Alliance (Desert Dunes & Sand Flats) |
| 27021 | Larrea tridentata - (Ambrosia dumosa) / Pleuraphis rigida Sandy Type | 27021 | Creosote Bush / Big Galleta Grass (*Larrea tridentata / Pleuraphis rigida*) Association |
| 27021 | Larrea tridentata - (Ambrosia dumosa) / Pleuraphis rigida Sandy Type | 60020 | Desert Twinbugs — Desert Sand Verbena *(Dicoria canescens — Abronia villosa)* Sparsely Vegetated Alliance (Desert Dunes & Sand Flats) |
| 27022 | Larrea tridentata Clones | 60020 | Desert Twinbugs — Desert Sand Verbena *(Dicoria canescens — Abronia villosa)* Sparsely Vegetated Alliance (Desert Dunes & Sand Flats) |
| 27031 | Larrea tridentata - Ambrosia dumosa Generic - Fans & Slopes | 27031 | Creosote Bush — White Bursage (*Larrea tridentata — Ambrosia dumosa)* Association |
| 27031 | Larrea tridentata - Ambrosia dumosa Generic - Fans & Slopes | 27049 | Creosote Bush — White Bursage — Ocotillo *(Larrea tridentata — Ambrosia dumosa — Fouquieria splendens)* Association |
| 27043 | Larrea tridentata - (Ambrosia dumosa) - Tetracoccus hallii - (Yucca schidigera) | 27045 | Creosote Bush — White Bursage — Mojave Yucca (*Larrea tridentata — Ambrosia dumosa — Yucca schidigera)* Association |
| 27045 | Larrea tridentata - Ambrosia dumosa - Yucca schidigera - (Senna armata) Toe-slopes & Steeper Fans Type | 27045 | Creosote Bush — White Bursage — Mojave Yucca (*Larrea tridentata — Ambrosia dumosa — Yucca schidigera)* Association |
| 27046 | Larrea tridentata - (Ambrosia dumosa - Viguiera parishii) Higher Elevation Type | 27046 | Creosote Bush — White Bursage — Jojoba (*Larrea tridentata — Ambrosia dumosa — Simmondsia chinensis)* Association |
| 27047 | Creosote Bush - Burro Bush - (Spiny Senna - Indigo Bush) (Larrea tridentata - Ambrosia dumosa (Senna armata, Psorothamnus schottii) Shrubland Association | 27047 | Creosote Bush — White Bursage — Desert Senna (*Larrea tridentata — Ambrosia dumosa — Senna armata)* Association |
| 27056 | Larrea tridentata - Encelia farinosa - Fouquieria splendens | 27056 | Creosote Bush — Brittlebush — Ocotillo *(Larrea tridentata — Encelia farinosa — Fouquieria splendens)* Association |
| 27056 | Larrea tridentata - Encelia farinosa - Fouquieria splendens | 29051 | Teddy-Bear cholla *(Cylindropuntia bigelovii)* Shrubland Association |
| 27057 | Larrea tridentata - Encelia farinosa - (Ambrosia dumosa - mixed shrub) Super Alliance | 27057 | Creosote Bush — Brittlebush — White Bursage (*Larrea tridentata — Encelia farinosa — Ambrosia dumosa)* Shrubland Association |
| 28023 | Coleogyne ramosissima - (mixed shrub) Super Association | 10025 | California Juniper / Blackbush (*Juniperus californica / Coleogyne ramosissima)* Association |
| 28023 | Coleogyne ramosissima - (mixed shrub) Super Association | 13012 | Joshua Tree / Blackbush *(Yucca brevifolia / Coleogyne ramosissima)* Woodland Association |

| v1 (2005) PI code | v1 (2005) Alliance or Association name | v2 (2012) PI code | v2 (2012) Alliance or Association name |
|---|---|---|---|
| 28023 | Coleogyne ramosissima - (mixed shrub) Super Association | 13016 | Joshua Tree / Creosote Bush — Mojave Yucca / Big Galleta Grass (*Yucca brevifolia / Larrea tridentata — Yucca schidigera / Pleuraphis rigida)* Woodland Association |
| 28023 | Coleogyne ramosissima - (mixed shrub) Super Association | 27046 | Creosote Bush — White Bursage — Jojoba (*Larrea tridentata — Ambrosia dumosa — Simmondsia chinensis)* Association |
| 28023 | Coleogyne ramosissima - (mixed shrub) Super Association | 27057 | Creosote Bush — Brittlebush — White Bursage (*Larrea tridentata — Encelia farinosa — Ambrosia dumosa)* Shrubland Association |
| 28023 | Coleogyne ramosissima - (mixed shrub) Super Association | 28023 | Blackbush — Nevada Ephedra (*Coleogyne ramosissima — Ephedra nevadensis)* Association |
| 28023 | Coleogyne ramosissima - (mixed shrub) Super Association | 28133 | Desert sunflower — California Buckwheat — Jojoba (*Viguiera parishii — Eriogonum fasciculatum — Simmondsia chinensis)* Association |
| 28023 | Coleogyne ramosissima - (mixed shrub) Super Association | 28134 | Desert sunflower — White Bursage— Jojoba (*Viguiera parishii — Ambrosia dumosa — Simmondsia chinensis)* Association |
| 28023 | Coleogyne ramosissima - (mixed shrub) Super Association | 29033 | Mojave Yucca — Creosote Bush — White Bursage *(Yucca schidigera — Larrea tridentata — Ambrosia dumosa)* Association |
| 28033 | Encelia farinosa Assoiciation | 28033 | Brittlebush —White Bursage *(Encelia farinosa — Ambrosia dumosa)* Association |
| 28070 | Desert holly | 27023 | Creosote Bush — Desert Holly (*Larrea tridentata — Atriplex hymenelytra*) Shrubland Association |
| 28080 | Fourwing saltbush | 28083 | Four-Wing Saltbush (*Atriplex canescens*) Association |
| 28133 | Viguiera parishii - (Ephedra nevadensis - Eriogonum fasiculatum - Nolina bigelovii) high elevation rocky eastern mountains type | 28133 | Desert sunflower — California Buckwheat — Jojoba (*Viguiera parishii — Eriogonum fasciculatum — Simmondsia chinensis)* Association |
| 28171 | Justicia californica - Hyptis emoryi | 28171 | Chuparosa *(Justicia californica)* Provisional Shrubland Alliance |
| 28180 | Tetracoccus hallii | 28181 | Hall's Tetracoccus *(Tetracoccus hallii)* Provisional Association |
| 28203 | Hyptis emoryi Association | 28203 | Desert Lavender *(Hyptis emoryi)* Association |
| 28220 | Round-leaved Rabbitbrush | 28210 | Rubber Rabbitbrush (*Ericameria nauseosa*) Shrubland Alliance |
| 29032 | Yucca schidigera - Coleogyne ramosissima | 29032 | Mojave Yucca — Blackbush *(Yucca schidigera — Coleogyne ramosissima)* Association |
| 29033 | Yucca schidigera - Larrea tridentata - (Ambrosia dumosa) | 29033 | Mojave Yucca — Creosote Bush — White Bursage *(Yucca schidigera — Larrea tridentata — Ambrosia dumosa)* Association |
| 29034 | Yucca schidigera / Pleuraphis rigida (Post Fire) | 29034 | Mojave Yucca / Big Galleta Grass (*Yucca schidigera / Pleuraphis rigida)* Association |
| 29035 | Yucca schidigera - Tetracoccus hallii | 29033 | Mojave Yucca — Creosote Bush — White Bursage *(Yucca schidigera — Larrea tridentata — Ambrosia dumosa)* Association |
| 29050 | Teddy-bear cholla | 29051 | Teddy-Bear cholla *(Cylindropuntia bigelovii)* Shrubland Association |

| v1 (2005) PI code | v1 (2005) Alliance or Association name | v2 (2012) PI code | v2 (2012) Alliance or Association name |
|---|---|---|---|
| 36015 | Acacia greggii - (Hymenoclea salsola - Larrea tridentata - Peucephyllum schottii - Bebbia juncea - Ephedra californica) Low elevation wash type | 36015 | Catclaw Acacia — (Sweetbush — Desert Lavender) (*Acacia greggii — (Bebbia juncea — Hyptis emoryi*)) Association |
| 36016 | Acacia greggii - (Lycium cooperi - Prunus fasiculatum) High elevation wash type | 36016 | Catclaw Acacia — Desert Almond (*Acacia greggii — Prunus fasciculata*) Association |
| 36017 | Acacia greggii - (Viguiera parishii - Eriogonum fasiculatum) Upland slopes type | 27059 | Creosote Bush — Brittlebush — Arrowleaf (*Larrea tridentata — Encelia farinosa — Pleurocoronis pluriseta*) Association |
| 43013 | Ambrosia dumosa - Senna armata - (Psorothamnus schottii) Eastern pediment type | 27044 | Creosotebush — White Bursage — Indigo Bush *(Larrea tridentata — Ambrosia dumosa — Psorothamnus arborescens)* Association |
| 43014 | Ambrosia dumosa - (Eriogonum fasiculatum - Lycium andersonii / Pleuraphis rigida) Western mountain type | 28133 | Desert sunflower — California Buckwheat — Jojoba (*Viguiera parishii — Eriogonum fasciculatum — Simmondsia chinensis)* Association |
| 43014 | Ambrosia dumosa - (Eriogonum fasiculatum - Lycium andersonii / Pleuraphis rigida) Western mountain type | 28134 | Desert sunflower — White Bursage— Jojoba (*Viguiera parishii — Ambrosia dumosa — Simmondsia chinensis)* Association |
| 59010 | Big galleta | 59011 | Big Galleta Grass / White Bursage *(Pleuraphis rigida / Ambrosia dumosa)* Association |
| 59010 | Big galleta | 59012 | Big Galleta Grass / Four-Wing Saltbush *(Pleuraphis rigida / Atriplex canescens)* Association |
| 60000 | Annual grassland | 27019 | Creosote Bush (*Larrea tridentata)* Association |
| 60000 | Annual grassland | 27031 | Creosote Bush — White Bursage (*Larrea tridentata — Ambrosia dumosa)* Association |
| 60000 | Annual grassland | 28083 | Four-Wing Saltbush (*Atriplex canescens*) Association |
| 60000 | Annual grassland | 28134 | Desert sunflower — White Bursage— Jojoba (*Viguiera parishii — Ambrosia dumosa — Simmondsia chinensis)* Association |
| 60000 | Annual grassland | 90000 | Non-vegetated habitats (less than 2% absolute cover) |
| 60000 | Annual grassland | 90100 | Desert Gold — Spiny Herb (*Geraea canescens — Chorizanthe rigida)* Desert Pavement Annual Herbaceous Alliance |
| 60000 | Annual grassland | 90300 | Dunes |
| 60000 | Annual grassland | 90400 | Playa |
| 60001 | Bromus tectorum fire plot | 60010 | Red brome — Mediterranean grass (*Bromus rubens — Schismus* (*arabicus, barbatus*)) Semi-Natural Herbaceous Stands |
| 90100 | Desert pavement | 90100 | Desert Gold — Spiny Herb (*Geraea canescens — Chorizanthe rigida)* Desert Pavement Annual Herbaceous Alliance |
| 90200 | Rock Outcrops | 90200 | Rock Outcrops |
| 90400 | Dunes | 90400 | Playa |
| 90600 | Disturbed / Built-up | 90600 | Disturbed / Built-up |

| Appendix D-b: Crosswalk between 2005 version of JOTR Vegetation Classification map and 2012 version of the map. (Arranged numerically by the 2012 PI code.) | | | |
|---|---|---|---|
| **v1 (2005) PI code** | **v1 (2005) Alliance or Association name** | **v2 (2012) PI code** | **v2 (2012) Alliance or Association name** |
| 10020 | California Juniper Woodland Alliance | 10020 | California Juniper *(Juniperus californica)* Woodland Alliance |
| 10021 | Juniperus californica / Coleogyne ramosissima - Yucca schidigera | 10025 | California Juniper / Blackbush (*Juniperus californica / Coleogyne ramosissima)* Association |
| 10025 | Juniperus californica / Coleogyne ramosissima | 10025 | California Juniper / Blackbush (*Juniperus californica / Coleogyne ramosissima)* Association |
| 10029 | Juniperus californica / Tetracoccus hallii | 10025 | California Juniper / Blackbush (*Juniperus californica / Coleogyne ramosissima)* Association |
| 10030 | Juniperus californica / Viguiera parishii - (Nolina bigelovii) | 10025 | California Juniper / Blackbush (*Juniperus californica / Coleogyne ramosissima)* Association |
| 10033 | Juniperus californica / (Coleogyne ramosissima - Yucca schidigera) Super Association | 10025 | California Juniper / Blackbush (*Juniperus californica / Coleogyne ramosissima)* Association |
| 10034 | Juniperus californica / (Eriogonum fasciculatum / Achnatherum speciosum) Super Association | 10025 | California Juniper / Blackbush (*Juniperus californica / Coleogyne ramosissima)* Association |
| 28023 | Coleogyne ramosissima - (mixed shrub) Super Association | 10025 | California Juniper / Blackbush (*Juniperus californica / Coleogyne ramosissima)* Association |
| 10029 | Juniperus californica / Tetracoccus hallii | 10031 | California Juniper / Mojave Yucca / Big Galleta (*Juniperus californica / Yucca schidigera / Pleuraphis rigida)* Woodland Association |
| 10031 | Juniperus californica / Yucca schidigera - (Tetracoccus hallii) | 10031 | California Juniper / Mojave Yucca / Big Galleta (*Juniperus californica / Yucca schidigera / Pleuraphis rigida)* Woodland Association |
| 21233 | Quercus cornelius-mulleri - (Juniperus californica / Coleogyne ramosissima) MAMU | 10032 | California Juniper / Muller Oak — Blackbush (*Juniperus californica / Quercus cornelius-mulleri — Coleogyne ramosissima*) Woodland Association |
| 10160 | Pinus monophylla Woodland Alliance | 10160 | Single-leaf Pinyon Pine (*Pinus monophylla*) Woodland Alliance |
| 10161 | Singleleaf Pinyon Pine/Muller's Oak (Pinus monophylla/Quercus cornelius-mulleri) Woodland Association | 10161 | Single-leaf Pinyon Pine / Muller's Oak (*Pinus monophylla / Quercus cornelius-mulleri)* Woodland Association |
| 10162 | Pinus monophylla-(Juniperus californica) / Achnatherum speciosum Woodland Association | 10161 | Single-leaf Pinyon Pine / Muller's Oak (*Pinus monophylla / Quercus cornelius-mulleri)* Woodland Association |
| 13010 | Joshua Tree (*Yucca brevifolia*) Wooded Shrubland Alliance | 13010 | Joshua Tree (*Yucca brevifolia*) Woodland Alliance |
| 13010 | Joshua Tree (*Yucca brevifolia*) Wooded Shrubland Alliance | 13012 | Joshua Tree / Blackbush *(Yucca brevifolia / Coleogyne ramosissima)* Woodland Association |
| 13012 | Yucca brevifolia / Coleogyne ramosissima | 13012 | Joshua Tree / Blackbush *(Yucca brevifolia / Coleogyne ramosissima)* Woodland Association |
| 28023 | Coleogyne ramosissima - (mixed shrub) Super Association | 13012 | Joshua Tree / Blackbush *(Yucca brevifolia / Coleogyne ramosissima)* Woodland Association |

| v1 (2005) PI code | v1 (2005) Alliance or Association name | v2 (2012) PI code | v2 (2012) Alliance or Association name |
|---|---|---|---|
| 13010 | Joshua Tree (*Yucca brevifolia*) Wooded Shrubland Alliance | 13014 | Joshua Tree / Desert Almond (*Yucca brevifolia / Prunus fasciculata*) Association |
| 13015 | Yucca brevifolia - Juniperus californica / (Coleogyne ramosissima - Yucca schidigera - Ephedra nevadensis) Super Association | 13015 | Joshua Tree — California Juniper / Nevada Ephedra (*Yucca brevifolia — Juniperus californica / Ephedra nevadensis)* Woodland Association |
| 13016 | Yucca brevifolia / Larrea tridentata - (Yucca schidigera / Pleuraphis rigida) Super Association | 13016 | Joshua Tree / Creosote Bush — Mojave Yucca / Big Galleta Grass (*Yucca brevifolia / Larrea tridentata — Yucca schidigera / Pleuraphis rigida)* Woodland Association |
| 28023 | Coleogyne ramosissima - (mixed shrub) Super Association | 13016 | Joshua Tree / Creosote Bush — Mojave Yucca / Big Galleta Grass (*Yucca brevifolia / Larrea tridentata — Yucca schidigera / Pleuraphis rigida)* Woodland Association |
| 13021 | Yucca brevifolia / (Ephedra nevadensis - Grayia spinosa - Lycium spp.) / Pleuraphis rigida Super Association | 13021 | Joshua Tree / Big Galleta Grass (*Yucca brevifolia / Pleuraphis rigida)* Woodland Association |
| 15012 | Chilopsis linearis - Psorothamnus spinosus - (Cercidium floridum / Acacia greggii) MAMU | 15013 | Desert Willow (*Chilopsis linearis*) Association |
| 15013 | Chilopsis linearis / (Prunus fasciculata- Acacia gregii) Super Association | 15013 | Desert Willow (*Chilopsis linearis*) Association |
| 15030 | Salix laevigata Woodland Alliance | 15030 | Black Willow (*Salix gooddingii*) Woodland Alliance |
| 15040 | Fremont cottonwood | 15040 | Fremont Cottonwood (*Populus fremontii*) Forest Alliance |
| 15112 | Washington filifera / Salix exigua / Muhlenbergia rigens | 15110 | California Fan Palm *(Washingtonia filifera)* Woodland Alliance |
| 15012 | Chilopsis linearis - Psorothamnus spinosus - (Cercidium floridum / Acacia greggii) MAMU | 16013 | Blue Palo Verde / Creosote Bush — Desert Fir (*Parkinsonia florida / Larrea tridentata — Peucephyllum schottii)* Association |
| 16010 | Blue Palo Verde | 16013 | Blue Palo Verde / Creosote Bush — Desert Fir (*Parkinsonia florida / Larrea tridentata — Peucephyllum schottii)* Association |
| 16013 | Cercidium floridum / Larrea tridentata | 16013 | Blue Palo Verde / Creosote Bush — Desert Fir (*Parkinsonia florida / Larrea tridentata — Peucephyllum schottii)* Association |
| 15012 | Chilopsis linearis - Psorothamnus spinosus - (Cercidium floridum / Acacia greggii) MAMU | 16015 | Blue Palo Verde / Desert Lavender (*Parkinsonia florida / Hyptis emoryi*) Association |
| 15013 | Chilopsis linearis / (Prunus fasciculata- Acacia gregii) Super Association | 16015 | Blue Palo Verde / Desert Lavender (*Parkinsonia florida / Hyptis emoryi*) Association |
| 16015 | Cercidium floridum / Hyptis emoryi | 16015 | Blue Palo Verde / Desert Lavender (*Parkinsonia florida / Hyptis emoryi*) Association |
| 16015 | Cercidium floridum / Hyptis emoryi | 16016 | Ironwood (*Olneya tesota)* Association |
| 16024 | Olneya tesota / (Larrea tridentata - Encelia farinosa) Fan Type | 16024 | Blue Palo Verde — Ironwood / Cholla (*Parkinsonia florida — Olneya tesota / Cylindropuntia sp.*) Association |
| 15012 | Chilopsis linearis - Psorothamnus spinosus - (Cercidium floridum / Acacia greggii) MAMU | 16025 | Blue Palo Verde — Ironwood / Desert Lavender (*Parkinsonia florida — Olneya tesota / Hyptis emoryi*) Association |
| 16025 | Olneya tesota - (Cercidium floridum / Hyptis emoryi) Wash Type | 16025 | Blue Palo Verde — Ironwood / Desert Lavender (*Parkinsonia florida — Olneya tesota / Hyptis emoryi*) Association |

| v1 (2005) PI code | v1 (2005) Alliance or Association name | v2 (2012) PI code | v2 (2012) Alliance or Association name |
|---|---|---|---|
| 15012 | Chilopsis linearis - Psorothamnus spinosus - (Cercidium floridum / Acacia greggii) MAMU | 16035 | Smoketree / Desert Lavender — Catclaw *(Psorothamnus spinosus / Hyptis emoryi — Acacia greggii)* Association |
| 16034 | Psorothamnus spinosus/ (Ephedra californica - Hymenoclea salsola) broad low energy sandy wash type | 16035 | Smoketree / Desert Lavender — Catclaw *(Psorothamnus spinosus / Hyptis emoryi — Acacia greggii)* Association |
| 16035 | Smoketree - (Desert-Lavender) - Catclaw Association (Psorothamnus spinosus/ (Hyptis emoryi) - Acacia greggii) Association | 16035 | Smoketree / Desert Lavender — Catclaw *(Psorothamnus spinosus / Hyptis emoryi — Acacia greggii)* Association |
| 16040 | Prosopis glandulosa/Suaeda moquinii | 16041 | Honey Mesquite *(Prosopis glandulosa)* Association |
| 16040 | Prosopis glandulosa/Suaeda moquinii | 16043 | Honey Mesquite / Saltbush — Bush Seepweed *(Prosopis glandulosa / Atriplex* spp. *— Suaeda moquinii)* Association |
| 10020 | California Juniper Woodland Alliance | 21234 | Muller Oak — California buckwheat — Narrowleaf goldenbush (*Quercus cornelius-mulleri — Eriogonum fasciculatum — Ericameria linearifolia*) Association |
| 13010 | Joshua Tree (*Yucca brevifolia*) Wooded Shrubland Alliance | 21234 | Muller Oak — California buckwheat — Narrowleaf goldenbush (*Quercus cornelius-mulleri — Eriogonum fasciculatum — Ericameria linearifolia*) Association |
| 21234 | Quercus cornelius-mulleri - (Juniperus californica) MAMU | 21234 | Muller Oak — California buckwheat — Narrowleaf goldenbush (*Quercus cornelius-mulleri — Eriogonum fasciculatum — Ericameria linearifolia*) Association |
| 27019 | Larrea tridentata Undifferentiated Playa and Sandy Dune Top Type | 27019 | Creosote Bush (*Larrea tridentata)* Association |
| 60000 | Annual grassland | 27019 | Creosote Bush (*Larrea tridentata)* Association |
| 27019 | Larrea tridentata Undifferentiated Playa and Sandy Dune Top Type | 27021 | Creosote Bush / Big Galleta Grass (*Larrea tridentata / Pleuraphis rigida*) Association |
| 27021 | Larrea tridentata - (Ambrosia dumosa) / Pleuraphis rigida Sandy Type | 27021 | Creosote Bush / Big Galleta Grass (*Larrea tridentata / Pleuraphis rigida*) Association |
| 28070 | Desert holly | 27023 | Creosote Bush — Desert Holly (*Larrea tridentata — Atriplex hymenelytra*) Shrubland Association |
| 27010 | Creosote bush Alliance | 27031 | Creosote Bush — White Bursage (*Larrea tridentata — Ambrosia dumosa)* Association |
| 27019 | Larrea tridentata Undifferentiated Playa and Sandy Dune Top Type | 27031 | Creosote Bush — White Bursage (*Larrea tridentata — Ambrosia dumosa)* Association |
| 27031 | Larrea tridentata - Ambrosia dumosa Generic - Fans & Slopes | 27031 | Creosote Bush — White Bursage (*Larrea tridentata — Ambrosia dumosa)* Association |
| 60000 | Annual grassland | 27031 | Creosote Bush — White Bursage (*Larrea tridentata — Ambrosia dumosa)* Association |
| 27001 | (Salazaria mexicana - Krameria spp. - Encelia farinosa - Hyptis emoryi - Eriogonum fasiculatum - Hymenoclea salsola - Acacia greggii - Tetracoccus hallii) rivulets within desert pavement | 27034 | Creosote Bush — White Bursage — White Rhatany (*Larrea tridentata — Ambrosia dumosa — Krameria grayi)* Association |

| v1 (2005) PI code | v1 (2005) Alliance or Association name | v2 (2012) PI code | v2 (2012) Alliance or Association name |
|---|---|---|---|
| 43013 | Ambrosia dumosa - Senna armata - (Psorothamnus schottii) Eastern pediment type | 27044 | Creosotebush — White Bursage — Indigo Bush *(Larrea tridentata — Ambrosia dumosa — Psorothamnus arborescens)* Association |
| 10029 | Juniperus californica / Tetracoccus hallii | 27045 | Creosote Bush — White Bursage — Mojave Yucca (*Larrea tridentata — Ambrosia dumosa — Yucca schidigera)* Association |
| 27019 | Larrea tridentata Undifferentiated Playa and Sandy Dune Top Type | 27045 | Creosote Bush — White Bursage — Mojave Yucca (*Larrea tridentata — Ambrosia dumosa — Yucca schidigera)* Association |
| 27043 | Larrea tridentata - (Ambrosia dumosa) - Tetracoccus hallii - (Yucca schidigera) | 27045 | Creosote Bush — White Bursage — Mojave Yucca (*Larrea tridentata — Ambrosia dumosa — Yucca schidigera)* Association |
| 27045 | Larrea tridentata - Ambrosia dumosa - Yucca schidigera - (Senna armata) Toe-slopes & Steeper Fans Type | 27045 | Creosote Bush — White Bursage — Mojave Yucca (*Larrea tridentata — Ambrosia dumosa — Yucca schidigera)* Association |
| 27046 | Larrea tridentata - (Ambrosia dumosa - Viguiera parishii) Higher Elevation Type | 27046 | Creosote Bush — White Bursage — Jojoba (*Larrea tridentata — Ambrosia dumosa — Simmondsia chinensis)* Association |
| 28023 | Coleogyne ramosissima - (mixed shrub) Super Association | 27046 | Creosote Bush — White Bursage — Jojoba (*Larrea tridentata — Ambrosia dumosa — Simmondsia chinensis)* Association |
| 15012 | Chilopsis linearis - Psorothamnus spinosus - (Cercidium floridum / Acacia greggii) MAMU | 27047 | Creosote Bush — White Bursage — Desert Senna (*Larrea tridentata — Ambrosia dumosa — Senna armata)* Association |
| 27011 | Larrea tridentata - (Ambrosia dumosa) - Hymenoclea salsola Low Energy Wash Type | 27047 | Creosote Bush — White Bursage — Desert Senna (*Larrea tridentata — Ambrosia dumosa — Senna armata)* Association |
| 27019 | Larrea tridentata Undifferentiated Playa and Sandy Dune Top Type | 27047 | Creosote Bush — White Bursage — Desert Senna (*Larrea tridentata — Ambrosia dumosa — Senna armata)* Association |
| 27047 | Creosote Bush - Burro Bush - (Spiny Senna - Indigo Bush) (Larrea tridentata - Ambrosia dumosa (Senna armata, Psorothamnus schottii) Shrubland Association | 27047 | Creosote Bush — White Bursage — Desert Senna (*Larrea tridentata — Ambrosia dumosa — Senna armata)* Association |
| 27031 | Larrea tridentata - Ambrosia dumosa Generic - Fans & Slopes | 27049 | Creosote Bush — White Bursage — Ocotillo *(Larrea tridentata — Ambrosia dumosa — Fouquieria splendens)* Association |
| 27056 | Larrea tridentata - Encelia farinosa - Fouquieria splendens | 27056 | Creosote Bush — Brittlebush — Ocotillo *(Larrea tridentata — Encelia farinosa — Fouquieria splendens)* Association |
| 27057 | Larrea tridentata - Encelia farinosa - (Ambrosia dumosa - mixed shrub) Super Alliance | 27057 | Creosote Bush — Brittlebush — White Bursage (*Larrea tridentata — Encelia farinosa — Ambrosia dumosa)* Shrubland Association |
| 28023 | Coleogyne ramosissima - (mixed shrub) Super Association | 27057 | Creosote Bush — Brittlebush — White Bursage (*Larrea tridentata — Encelia farinosa — Ambrosia dumosa)* Shrubland Association |
| 24001 | (Ephedra nevadensis - Pleurocoronis pluriseta - Encelia farinosa - Trixis californica - Bebbia juncea - Eriogonum fasiculatum - Lycium andersonii - Acacia greggii) low elevation rocky mountain type | 27059 | Creosote Bush — Brittlebush — Arrowleaf (*Larrea tridentata — Encelia farinosa — Pleurocoronis pluriseta*) Association |
| 36017 | Acacia greggii - (Viguiera parishii - Eriogonum fasiculatum) Upland slopes type | 27059 | Creosote Bush — Brittlebush — Arrowleaf (*Larrea tridentata — Encelia farinosa — Pleurocoronis pluriseta*) Association |
| 28023 | Coleogyne ramosissima - (mixed shrub) Super Association | 28023 | Blackbush — Nevada Ephedra (*Coleogyne ramosissima — Ephedra nevadensis)* Association |

| v1 (2005) PI code | v1 (2005) Alliance or Association name | v2 (2012) PI code | v2 (2012) Alliance or Association name |
|---|---|---|---|
| 28033 | Encelia farinosa Assoiciation | 28033 | Brittlebush —White Bursage *(Encelia farinosa — Ambrosia dumosa)* Association |
| 28080 | Fourwing saltbush | 28083 | Four-Wing Saltbush (*Atriplex canescens*) Association |
| 60000 | Annual grassland | 28083 | Four-Wing Saltbush (*Atriplex canescens*) Association |
| 15012 | Chilopsis linearis - Psorothamnus spinosus - (Cercidium floridum / Acacia greggii) MAMU | 28110 | Cheesebush (*Ambrosia salsola)* Shrubland Alliance |
| 28023 | Coleogyne ramosissima - (mixed shrub) Super Association | 28133 | Desert sunflower — California Buckwheat — Jojoba (*Viguiera parishii — Eriogonum fasciculatum — Simmondsia chinensis)* Association |
| 28133 | Viguiera parishii - (Ephedra nevadensis - Eriogonum fasiculatum - Nolina bigelovii) high elevation rocky eastern mountains type | 28133 | Desert sunflower — California Buckwheat — Jojoba (*Viguiera parishii — Eriogonum fasciculatum — Simmondsia chinensis)* Association |
| 43014 | Ambrosia dumosa - (Eriogonum fasiculatum - Lycium andersonii / Pleuraphis rigida) Western mountain type | 28133 | Desert sunflower — California Buckwheat — Jojoba (*Viguiera parishii — Eriogonum fasciculatum — Simmondsia chinensis)* Association |
| 28023 | Coleogyne ramosissima - (mixed shrub) Super Association | 28134 | Desert sunflower — White Bursage— Jojoba (*Viguiera parishii — Ambrosia dumosa — Simmondsia chinensis)* Association |
| 43014 | Ambrosia dumosa - (Eriogonum fasiculatum - Lycium andersonii / Pleuraphis rigida) Western mountain type | 28134 | Desert sunflower — White Bursage— Jojoba (*Viguiera parishii — Ambrosia dumosa — Simmondsia chinensis)* Association |
| 60000 | Annual grassland | 28134 | Desert sunflower — White Bursage— Jojoba (*Viguiera parishii — Ambrosia dumosa — Simmondsia chinensis)* Association |
| 28171 | Justicia californica - Hyptis emoryi | 28171 | Chuparosa *(Justicia californica)* Provisional Shrubland Alliance |
| 28180 | Tetracoccus hallii | 28181 | Hall's Tetracoccus *(Tetracoccus hallii)* Provisional Association |
| 28203 | Hyptis emoryi Association | 28203 | Desert Lavender *(Hyptis emoryi)* Association |
| 28220 | Round-leaved Rabbitbrush | 28210 | Rubber Rabbitbrush (*Ericameria nauseosa*) Shrubland Alliance |
| 29032 | Yucca schidigera - Coleogyne ramosissima | 29032 | Mojave Yucca — Blackbush *(Yucca schidigera — Coleogyne ramosissima)* Association |
| 28023 | Coleogyne ramosissima - (mixed shrub) Super Association | 29033 | Mojave Yucca — Creosote Bush — White Bursage *(Yucca schidigera — Larrea tridentata — Ambrosia dumosa)* Association |
| 29033 | Yucca schidigera - Larrea tridentata - (Ambrosia dumosa) | 29033 | Mojave Yucca — Creosote Bush — White Bursage *(Yucca schidigera — Larrea tridentata — Ambrosia dumosa)* Association |
| 29035 | Yucca schidigera - Tetracoccus hallii | 29033 | Mojave Yucca — Creosote Bush — White Bursage *(Yucca schidigera — Larrea tridentata — Ambrosia dumosa)* Association |
| 29034 | Yucca schidigera / Pleuraphis rigida (Post Fire) | 29034 | Mojave Yucca / Big Galleta Grass (*Yucca schidigera / Pleuraphis rigida)* Association |
| 27056 | Larrea tridentata - Encelia farinosa - Fouquieria splendens | 29051 | Teddy-Bear cholla *(Cylindropuntia bigelovii)* Shrubland Association |
| 29050 | Teddy-bear cholla | 29051 | Teddy-Bear cholla *(Cylindropuntia bigelovii)* Shrubland Association |
| 13010 | Joshua Tree (*Yucca brevifolia*) Wooded Shrubland Alliance | 32013 | Desert Almond *(Prunus fasciculata)* Association |

| v1 (2005) PI code | v1 (2005) Alliance or Association name | v2 (2012) PI code | v2 (2012) Alliance or Association name |
|---|---|---|---|
| 36015 | Acacia greggii - (Hymenoclea salsola - Larrea tridentata - Peucephyllum schottii - Bebbia juncea - Ephedra californica) Low elevation wash type | 36015 | Catclaw Acacia — (Sweetbush — Desert Lavender) (*Acacia greggii — (Bebbia juncea — Hyptis emoryi*)) Association |
| 15012 | Chilopsis linearis - Psorothamnus spinosus - (Cercidium floridum / Acacia greggii) MAMU | 36016 | Catclaw Acacia — Desert Almond (*Acacia greggii — Prunus fasciculata*) Association |
| 36016 | Acacia greggii - (Lycium cooperi - Prunus fasiculatum) High elevation wash type | 36016 | Catclaw Acacia — Desert Almond (*Acacia greggii — Prunus fasciculata*) Association |
| 13010 | Joshua Tree (*Yucca brevifolia*) Wooded Shrubland Alliance | 36018 | Catclaw Acacia — California buckwheat (*Acacia greggii — Eriogonum fasciculatum*) Association |
| 59010 | Big galleta | 59011 | Big Galleta Grass / White Bursage *(Pleuraphis rigida / Ambrosia dumosa)* Association |
| 59010 | Big galleta | 59012 | Big Galleta Grass / Four-Wing Saltbush *(Pleuraphis rigida / Atriplex canescens)* Association |
| 60001 | Bromus tectorum fire plot | 60010 | Red brome — Mediterranean grass (*Bromus rubens — Schismus* (*arabicus, barbatus*)) Semi-Natural Herbaceous Stands |
| 27019 | Larrea tridentata Undifferentiated Playa and Sandy Dune Top Type | 60020 | Desert Twinbugs — Desert Sand Verbena *(Dicoria canescens — Abronia villosa)* Sparsely Vegetated Alliance (Desert Dunes & Sand Flats) |
| 27021 | Larrea tridentata - (Ambrosia dumosa) / Pleuraphis rigida Sandy Type | 60020 | Desert Twinbugs — Desert Sand Verbena *(Dicoria canescens — Abronia villosa)* Sparsely Vegetated Alliance (Desert Dunes & Sand Flats) |
| 27022 | Larrea tridentata Clones | 60020 | Desert Twinbugs — Desert Sand Verbena *(Dicoria canescens — Abronia villosa)* Sparsely Vegetated Alliance (Desert Dunes & Sand Flats) |
| 60000 | Annual grassland | 90000 | Non-vegetated habitats (less than 2% absolute cover) |
| 60000 | Annual grassland | 90100 | Desert Gold — Spiny Herb (*Geraea canescens — Chorizanthe rigida)* Desert Pavement Annual Herbaceous Alliance |
| 90100 | Desert pavement | 90100 | Desert Gold — Spiny Herb (*Geraea canescens — Chorizanthe rigida)* Desert Pavement Annual Herbaceous Alliance |
| 90200 | Rock Outcrops | 90200 | Rock Outcrops |
| 60000 | Annual grassland | 90300 | Dunes |
| 60000 | Annual grassland | 90400 | Playa |
| 90400 | Dunes | 90400 | Playa |
| 90600 | Disturbed / Built-up | 90600 | Disturbed / Built-up |

# Vegetation Classification of Joshua Tree National Park, Riverside and San Bernardino Counties, California

A report submitted to

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March 2005

# Table of Contents

**Section** **Page**

**INTRODUCTION** ..... **1**
Background and Standards ..... 1
Study Area ..... 3
Timeline ..... 3

**METHODS** ..... **4**
Vegetation Sampling and Classification ..... 4
Development of the Preliminary Classification ..... 4
Integration of Existing Data Sets ..... 4
Summary ..... 7
Sample Allocation and the Development of the GRADSECT ..... 7
Field Data Collection ..... 9
Archiving and Analysis of Data ..... 10
Classification ..... 18
Developing the Key ..... 18
Description Writing ..... 18
Lessons Learned ..... 20

**CLASSIFICATION OF VEGETATION ASSOCIATIONS FROM JOSHUA TREE NATIONAL PARK, CALIFORNIA** ..... **22**

**KEY TO THE VEGETATION TYPES OF JOSHUA TREE NATIONAL PARK** ..... **28**
How to Use the Key ..... 28
Key to Main Vegetation Divisions ..... 31
Division A: Tree Vegetation ..... 31
Division B: Shrub Vegetation ..... 36
Division C: Herbaceous Vegetation ..... 47

**VEGETATION DESCRIPTIONS** ..... **49**
Montane Woodland and Scrub ..... 49
California Juniper *(Juniperus californica)* Wooded Shrubland Alliance ..... 49
Singleleaf Pinyon Pine (*Pinus monophylla)* Woodland Alliance ..... 63
Bigberry Manzanita *(Arctostaphylos glauca)* Shrubland Alliance ..... 68
Muller's Oak *(Quercus cornelius-mulleri)* Shrubland Alliance ..... 70
Rubber Rabbitbrush *(Ericameria nauseosa =Chrysothamnus nauseosus)* Shrubland Alliance ..... 76
Round-Leaved Rabbitbrush *(Ericameria teretifolia = Chrysothamnus teretifolius)* Shrubland Alliance ..... 78

**Section** **Page**

Desert False Willow (*Baccharis sergiloides*) Intermittently Flooded Shrubland Alliance ..... 80
Antelope Bush *(Purshia tridentata)* Shrubland Alliance ..... 82
Parry Nolina (*Nolina parryi)* Shrubland Alliance ..... 85
Cheatgrass (*Bromus tectorum)* Annual Grassland Alliance ..... 88

Mojavean Upper Bajada Scrub ..... **90**
Joshua Tree (*Yucca brevifolia)* Wooded Shrubland Alliance ..... 90
Joshua Tree (*Yucca brevifolia)* Wooded Herbaceous Alliance ..... 106
Blackbush (*Coleogyne ramosissima)* Shrubland Alliance ..... 108
California Buckwheat (*Eriogonum fasciculatum*) Shrubland Alliance ..... 111
Desert Willow (*Chilopsis linearis)* Shrubland Alliance ..... 114
Nevada Ephedra *(Ephedra nevadensis)* Shrubland Alliance ..... 116
California Ephedra (*Ephedra californica*) Intermittently Flooded Shrubland Alliance ..... 119
Paper-Bag Bush (*Salazaria mexicana)* Shrubland Alliance ..... 122
Mojave Yucca *(Yucca schidigera)* Shrubland Alliance ..... 124
Desert Almond *(Prunus fasciculata)* Intermittently Flooded Shrubland Alliance ..... 135

Lower Mojave Scrub ..... **138**
Creosote Bush *(Larrea tridentata)* Shrubland Alliance ..... 138
Creosote Bush - Burro Bush *(Larrea tridentata - Ambrosia dumosa)* Shrubland Alliance (Mapping Code: 27030) ..... 145
Hall's Tetracoccus *(Tetracoccus hallii)* Unique Stands ..... 164
Four-wing Saltbush *(Atriplex canescens)* Shrubland Alliance ..... 165
Cheesebush (*Hymenoclea salsola*) Shrubland Alliance ..... 167
Paniculate Rabbitbrush *(Ericameria paniculata = Chrysothamnus paniculatus)* Shrubland Alliance ..... 170
Parish Viguiera *(Viguiera parishii)* Shrubland Alliance ..... 173
Anderson's Box-Thorn *(Lycium andersonii)* Shrubland Alliance ..... 176
Catclaw *(Acacia greggii)* Shrubland Alliance ..... 178
Burro Bush *(Ambrosia dumosa)* Dwarf Shrubland Alliance ..... 186
Big Galleta *(Pleuraphis rigida)* Grassland Alliance ..... 190
Common Mediterranean Grass *(Schismus barbatus)* Unique Stands ..... 193

Sonoran Desert Wash Woodland and Scrub ..... **194**
Desert Willow (*Chilopsis linearis)* Shrubland Alliance ..... 194
Blue Palo Verde (*Cercidium floridum = Parkinsonia floridum*) Woodland Alliance ..... 196
Ironwood *(Olneya tesota)* Woodland Alliance ..... 202
Blue Palo verde-Ironwood [*Cercidium floridum (=Parkinsonia florida)-Olneya tesota]* Extremely Xeromorphic Deciduous Woodland Alliance ..... 205

**Section** **Page**

Smoketree (*Psorothamnus spinosus)* Intermittently Flooded Shrubland Alliance ..... 207
Creosote Bush – Brittlebush *(Larrea tridentata - Encelia farinosa)* Shrubland Alliance ..... 216
Brittlebush *(Encelia farinosa)* Shrubland Alliance ..... 224
Desert Holly *(Atriplex hymenelytra)* Shrubland Alliance ..... 227
Desert Lavender *(Hyptis emoryi)* Intermittently Flooded Shrubland Alliance ..... 230
Chuparosa *(Justicia californica)* Unique Stands ..... 234
Teddy-Bear Cholla *(Opuntia bigelovii)* Shrubland Alliance ..... 234
Lotebush (*Ziziphus obtusifolia)* Unique Stands ..... 236

Freshwater Wetland Vegetation ..... **237**
Red Willow *(Salix laevigata)* Temporarily Flooded Alliance ..... 237
Fremont Cottonwood *(Populus fremontii)* Temporarily Flooded Woodland Alliance ..... 239
California Fan Palm *(Washingtonia filifera)* Seasonally Flooded Woodland Alliance ..... 241

**Literature Cited** ..... **244**

**Appendix** 1—Crosswalk Between Vegetation Classification, Mapping Classification, Leary (1977) and Hogan (1977) ..... **A-1**
**Appendix 2—**Relevé Field Form and Codes ..... **B-1**
**Appendix 3—**USGS—NPS Vegetation Mapping Program Joshua Tree National Park—Final Mapping Classification ..... **C-1**

# INTRODUCTION

The U.S. Geological Survey (USGS) and National Park Service (NPS) formed a partnership in 1994 to map the vegetation of United States national park system units using The Nature Conservancy's National Vegetation Classification, a standard for reporting vegetation information among federal agencies (Grossman *et al.* 1998). Goals of the projects include providing baseline ecological information to resource managers in the parks; putting the data into regional and national contexts; and providing opportunities for future inventory, monitoring, and research activities. Each park developing a vegetation map follows a standardized field sampling and vegetation classification protocol to document the various vegetation types found in that park. This information is used by photointerpreters to delineate polygons of vegetation communities, which are subsequently subjected to an accuracy assessment process (USGS 1997). The final products consist of a vegetation map, descriptions of each vegetation type, a key to each type, and all related data and metadata files (original field forms, plot database, accuracy assessment points, etc.). This report presents the work at Joshua Tree National Park and environs conducted from 1997 to 2004.

## Background and Standards

The vegetation classification applied throughout this report, the U.S. National Vegetation Classification (USNVC), was developed by NatureServe (formerly The Nature Conservancy) in partnership with the network of State Natural Heritage Programs. Additional support was provided by federal agencies and the Ecological Society of America. A first edition of the classification has been released that provides a thorough introduction to the classification, its structure, and the list of vegetation units known in the United States as of April 1997 (Grossman et al. 1998). Refinements to the classification occurred in the application process, leading to ongoing proposed revisions that are reviewed both locally and nationally. These refinements are best seen using the NatureServe Web site at http://www.natureserve.org/explorer/.

Vegetation mapping in national parks has been done under the auspices of the NPS Inventory and Monitoring program, in close cooperation with the USGS Biological Resources Division. The mapping is done in accordance with standards established by the Federal Geographic Data Committee (FGDC) for vegetation mapping on federal lands. The FGDC Web site, http://biology.usgs.gov/fgdc.veg/standards/vegstd.htm, explains the development of the classification standards currently used for mapping and classifying vegetation in national parks. The USGS Biological Resources Division—NPS Vegetation Mapping project Web site, http://biology.usgs.gov/npsveg/standards.html, has additional information on vegetation mapping in national parks.

The development of a vegetation classification and concomitant map is a complex project. Not all vegetation types are equally mappable at a certain scale. Coordination between the vegetation classification team and the aerial photointerpreters is needed to resolve the best way to map the types, whether directly at the finest association level, at the higher classification levels (such as at the alliance), or as a mosaic or complex. Thus, not all types described in this report are

necessarily mapped directly. A separate report documents the link between the mapping and the field-based vegetation classification (AIS 2004).

Several parks representing different regions, environmental conditions, and vegetation types were chosen by USGS-NPS to be part of the prototype phase of the program. The initial goal of the prototype phase is to "develop, test, refine, and finalize the standards and protocols" to be used during the production phase of the project. The program includes the development of a standardized vegetation classification system for each park and the establishment of photointerpretation, field sampling, and accuracy assessment procedures. This report outlines and describes the project timeline, vegetation classification methodologies, sampling criteria, and data analysis procedures implemented in creating the final vegetation layer for Joshua Tree National Park. It describes the result of this classification process in terms of a formal classification list, key, and description of all vegetation types identified during this process.

The Joshua Tree classification and mapping project was initiated in 1996 when NatureServe and the private companies ESRI and Aerial Information Systems (AIS), NPS, and USGS met to discuss the use of Joshua Tree as a pilot for the recently formed NPS mapping program. Joshua Tree was to become the first desert national park to be mapped. These documents (online at http://biology.usgs.gov/npsveg/standards.html) detail the basis for the mapping concepts used in the project.

The principal issues at hand for this park mapping project were the following:

- To implement a GIS-based, gradient-directed transect (GRADSECT) approach for sampling

- To integrate the vegetation sampling process with the photointerpretation process so a seamless, mutually beneficial feedback loop would develop with the field crews providing information to the mappers while, at the same time, the mappers would be supporting decisions by the field crews about where and what to sample

- To integrate any existing or concomitant vegetation data that had been collected or was being collected with the necessary field data to be collected during this project into a unified vegetation classification that would be used for the final products

- To work within the peculiar confines of a sparse vegetation desert environment and develop the best methods for detailed classification and mapping of its vegetation

The purpose of developing the classification for the area to be mapped was to integrate a large amount of new information into the California vegetation classification and the USNVC. This report provides the basis to achieve that goal. By standardizing the reporting structure of each new classification unit, NatureServe will be able to integrate this information into the classification.

## Study Area

In 1936, approximately 825,000 acres of desert habitat in California was set aside as Joshua Tree National Monument. The monument was elevated to park status in October 1994 as part of the Desert Protection Bill. Joshua Tree National Park (JOTR) straddles the gradational boundary between the higher elevation Mojave Desert ecosystem and the warmer Colorado Desert ecosystem. Currently, Joshua Tree National Park contains 794,000 acres of land including 585,000 acres of wilderness.

## Timeline

Meetings were held in May 1996 at Joshua Tree National Park to bring together the project team members from the National Biological Service (NBS), USGS, ESRI, AIS, and NatureServe. These meetings focused primarily on discussing the Vegetation Inventory and Mapping Program, existing park data, logistics, and park specific issues. The following year-by-year timeline depicts major activities for the duration of this project.

**1996**—Initial project planning meeting and AIS field reconnaissance trip for Malapai Hill area. Vegetation sampling by Joe Watts and his team from the U.S. Army Corps of Engineers (see below).

**1997**—Pilot area mapping—Malapai Hill quadrangle. Field data collection by Brent Long and his crew from Joshua Tree National Park using large relevés.

**1998**—New color infrared (CIR) aerial photographs acquired (June–November) and vegetation field sampling by Mojave Desert Ecosystem Initiative crews (see below).

**1999**—Review and evaluation of park vegetation classification. Preliminary photointerpretation performed to aid field sampling. Vertical vegetation monitoring of climbing areas completed.

**2000**—AIS conducts vegetation field sampling (300 plots) using gradient directed sample stratification.

**2001**—Vegetation classification for JOTR developed. Aerial photointerpretation initiated.

**2002**—Vegetation photointerpretation completed.

**2003**—Data automation and rectification commences.

**2004**—Final vegetation coverage and photointerpretation report completed and vegetation classification report written.

# METHODS

## Vegetation Sampling and Classification

### Development of the Preliminary Classification

Before any work began on the map, the California ecologists for the project (NatureServe/California Heritage) developed a preliminary classification. This was needed to drive the field sampling effort (the approximate number of field samples that were to be collected) and to determine the effort needed for the photointerpretation of the vegetation polygons (the number of mapping units that should be used and whether or not they were directly interpretable from the vegetation classification).

In 1997, a preliminary classification for the mapping area was developed using the existing California vegetation classification (Sawyer and Keeler–Wolf 1995) in conjunction with the local knowledge of vegetation ecologists at the park that went beyond the recent summary of California's vegetation. The classification was refined to comply with the National Vegetation Classification standards. The working preliminary classification was used to prioritize plot collection and identify preliminary mapping units. Much of this initial work was supported by a concomitant project throughout much of the California Mojave Desert (Thomas *et al.* 2004).

In addition to this work, two earlier studies of the vegetation of Joshua Tree National Park were consulted. These were "The Ecology of the Joshua Tree in Joshua Tree National Monument," a master's thesis by James Hogan of the University of Nevada, Las Vegas (cited as Hogan 1977), and a National Park Department technical report by Patrick Leary entitled "Investigation of the Vegetational Communities of Joshua Tree National Monument" (cited as Leary 1977). Both of these studies included a relatively detailed quantitative vegetation classification as a foundation. Hogan (1977) classified vegetation of the western upper elevation zone of the park including all habitat for the Joshua tree (*Yucca brevifolia*), while Leary (1977) provided quantitative vegetation analysis and sampling of most portions of the park. Both efforts produced classification lists, which were compared with the new classification developed for this project in a crosswalk (Appendix A). Those familiar with these classification systems may use this table to orient themselves to the new classification as well as to the vegetation mapping classification derived from the data analyzed and described in this report (AIS 2004). Both the Hogan (1977) and Leary (1977) classification systems tended to underrepresent the floristic variation of the park's vegetation at the stand level.

### Integration of Existing Data Sets

Although the Hogan (1977) and Leary (1977) data had already been collected, the data sets collected for these reports were unavailable for further analysis. Thus, it was not possible for individual samples to be reanalyzed using current standard methods as described in the methods section of this report.

However, several overlapping projects were being conducted simultaneously at JOTR during the timeframe of this project, each of which contributed to the overall knowledge of the vegetation patterns in the park. These included three separate sets collected specifically for vegetation, using somewhat different methods.

One of the principal goals of the national park mapping and classification pilot projects was to determine how well the existing data could be integrated into the classification. To better understand the amount of field effort needed to round out the classification, the number of existing data plots likely to represent different vegetation types needed to be determined. Thus, much time was spent evaluating these data sets and analyzing them within the classification process. The following briefly describes the data sets.

**Watts Data:** This data was collected in the 1996 field season by a team led by Joe Watts of the Army Corps of Engineers, Topographic Engineering Center (TEC) squad. A total of 108 plots, each 100 $m^2$,were sampled for density, cover, species composition, and basic environmental variables. The plots were chosen using a random, stratified approach from a predetermined grid system throughout the Malapai Hill 7.5-minute topographic quadrangle. This quadrangle was selected as a pilot area because it represented many of the vegetation and topographic features of the park and had the advantage of being relatively accessible by roads. A quantitative classification was developed using this data and was analyzed by the NatureServe regional ecologist Rex Crawford in 1997. A report describing the classification was written (Crawford 1997). Although this product was useful in defining the potential range of variability of vegetation in this portion of the park, the plot size was generally too small to capture the natural spacing of many species in the desert vegetation stands. This was particularly true for larger plants such as California Juniper, Joshua Tree, Muller Oak, and Single-Leaf Pinyon. The classification of these small plots also tended to under-represent certain vegetation types in the area because of the random selection of grid locations to be sampled. The resulting classification and raw plot data were used in this final report as ancillary data to confirm and validate vegetation sampling. However, this data was not taken verbatim as grounds for independently describing vegetation associations.

**Long Data:** In 1997, following a successful implementation of desert vegetation sampling using large (2,100 $m^2$) relevé sampling in Anza-Borrego Desert State Park (Keeler-Wolf *et al.* 1998), Brent Long, an ecologist at Joshua Tree National Park, and his team implemented a sampling scheme to monitor vegetation with reference to restoration and desert tortoise habitat within the park. A total of 74 plots were sampled using the protocol described in Keeler-Wolf *et al.* (1998), mostly in the central portion of the park (including the following quadrangles: Conejo Wells, Cottonwood Springs, Indian Cove, Joshua Tree South, Keys View, Malapai Hill, Pinto Wells, and Yucca Valley South).

The majority of samples (74%) were taken in the Malapai Hill quadrangle and thus served as a resampling of many of the Watts samples. This data was analyzed, along with the remainder of the data in 2001, and is among the plots that form the basis of the defined vegetation types described in this report.

**MDEI Data:** In 1997, a cooperative project between the USGS Biological Resources Division, San Diego State University, and the California Department of Fish and Game was funded by the U.S. Department of Defense Mojave Desert Ecosystem Initiative Program (MDEI) to sample, classify, and map the vegetation of the majority of the California Mojave Desert (Thomas *et al.* 2004). As with the preceding Long data, 74 relevé samples were collected using a standardized 1,000-$m^2$ plot size, essentially the same as the protocol used below for collecting the majority of the vegetation samples for the classification and mapping. This technique is described in detail by Thomas *et al.* (2004). This protocol utilized a gradient-directed sampling technique that selected representative combinations of biophysical units throughout the Mojave Desert (Franklin *et al.* 2002).

At the outset of this project, the portion of Joshua Tree National Park that lies within the Mojave Desert was included and field crews sampled the area including plots within these quadrangles: Clarks Pass, Conejo Wells, Coxcomb Mountains, East Deception Canyon, Fountain Peak, Fried Liver Wash, Indian Cove, Joshua Tree South, Malapai Hill, New Dale, Porcupine Wash, Queen Mountain, Seven Palms Valley, Washington Wash, and Yucca Valley South. Following the initiation of the Joshua Tree National Park mapping project in late 1997, no further MDEI plots were collected in the park.

As with the Long data, this data was analyzed, along with the remainder of the data in 2001, and is among the plots that form the basis of the defined vegetation types described in this report. This data was considered completely classifiable using the same approach as was used for the main data set.

**Main Data Set (JOTR):** In 2000, for a period of approximately four months, 300 plots were sampled using the stratified random sampling design described below. These plots formed the basis of the park classification and were used to describe the majority of the vegetation types described in this report. The protocol used was the California Native Plant Society (CNPS) Relevé protocol (CNPS 2004), essentially identical to the sampling technique used in the MDEI study mentioned above. Among the advantages of this data set were the parkwide distribution, including the only series of samples taken in the lowest portions of the Colorado Desert area of the park, and many more samples in other areas of the park that were underrepresented in the previous sampling efforts.

**Vertical Vegetation Monitoring Data:** An additional data set of 15 pared plots (30 plots total) was collected to monitor and clarify the effects of climbing and access to climbing sites on certain popular bouldering and climbing areas of the park (Joshua Tree National Park 1999). Plots were set up on rock faces and were inventoried for vegetation cover and impacts. A Modified-Whittaker multiscale sampling plot (Stohlgren *et al.* 1995) was used, which is better suited for capturing vegetation cover, species richness, frequency, and so forth (Stohlgren *et al.* 1998), and cryptobiotic crusts (Stohlgren *et al.* 1997) than small area plots and transect methods (Stohlgren *et al.* 1998). The Modified-Whittaker plot measures 20 m by 50 m. It contains 10, 1-$m^2$ subplots; two 10-$m^2$ subplots; and one 100-$m^2$ subplot. Within each 1-$m^2$ subplot, each plant species is identified and percent cover (to the nearest%) for each species and four different soil

categories are recorded. In the remaining subplots and the entire 1,000-$m^2$ plot, species presence is recorded.

Because this data was collected in a different manner from the other data sets, they were not interpreted directly for vegetation classification. However, they are mentioned here as a resource to others interested in the rupicolous (rock loving) vegetation of the park. The original study is on file at park headquarters and is available on the Web at http://www.cnps.org/programs/conservation/files/Vertical.pdf.

Summary

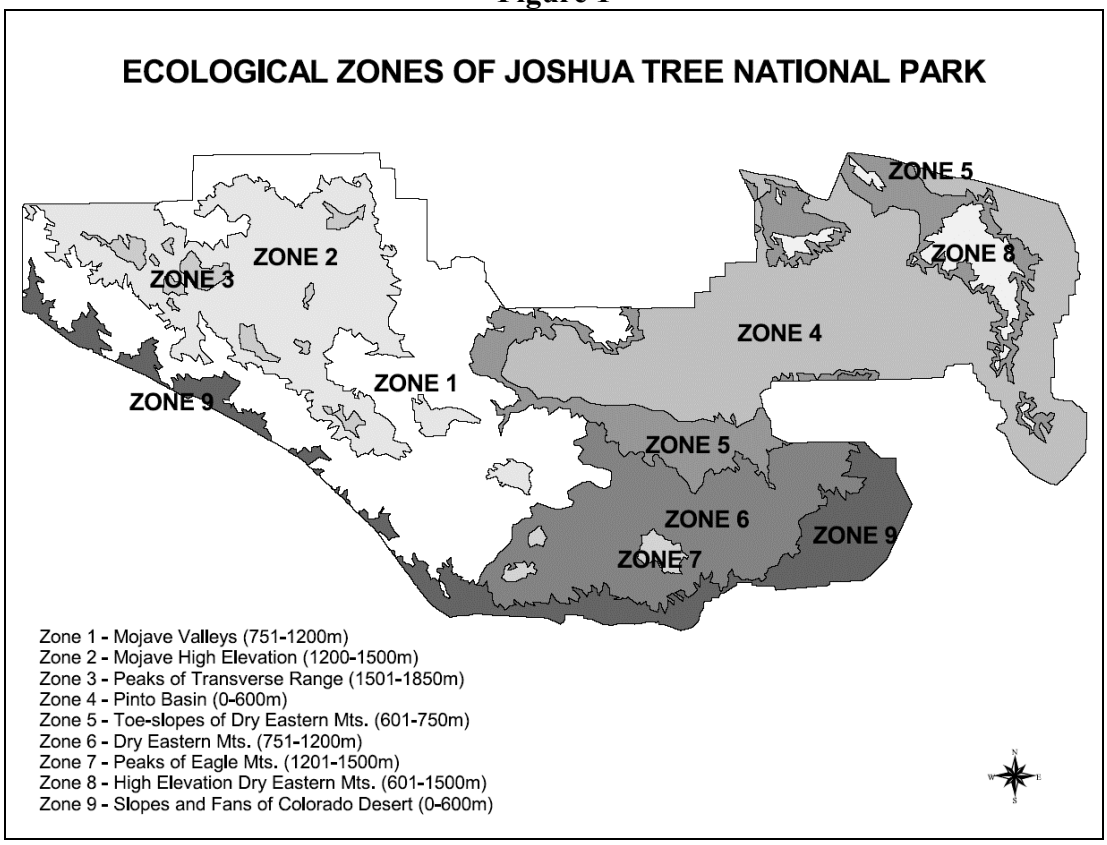
In total, 556 plots were either directly analyzed or summarized to develop the classification for this project. These included 300 JOTR, 74 Long, 74 MDEI, and 108 Watts samples.

Sample Allocation and the Development of the GRADSECT

One of the most important mandates of the Inventory and Monitoring Program is the consistent capture and classification of vegetation types. This project included partial coverage of vegetation samples collected using three different techniques, which amounted to a total of 263 individual samples (combining Watts, Long, and MDEI data). However, there were distinct gaps in this data, with much of the lower elevation eastern and southern portions of the park not represented. In addition, a single quadrangle in the west central portion of the park (Malapai Hill) was overrepresented relative to all other quadrangles. It was determined by the Heritage ecologist and the collaborative Joshua Tree National Park and AIS photointerpretation team that a strategy for more complete representation of the array of vegetation in the park was needed to capture multiple examples of most vegetation found in the park.

The sampling approach relied on the representation of biophysical controls on vegetation by selecting a set of GIS data including elevation, slope, aspect, and the relative acreages of each of these combinations into a GIS grid. The objective was to provide a method for defining ecological zones and biophysical units (BPUs), which can then be applied to generate vegetation plot locations. BPUs were described by a combination of elevational and landform characteristics driven using a climatic model of the park. Thus, nine different climatic zones were established in the park (Figure 1).

**Figure 1**




The photointerpreters and the vegetation sampling team developed a stratified sampling system to provide an array of sampling points throughout the park based on the matrix of the air photo array they would be using for photointerpretation of the vegetation. The following information has been summarized from Appendix II of the photointerpretation report (AIS 2004).

All GIS layers were projected into UTM Zone 11, NAD27. All layers were either originally created at 30-m resolution or resampled to 30-m resolution. Thus, the grid cell of unique biophysical units as a combination of elevation, slope, and aspect was 30 m x 30 m.

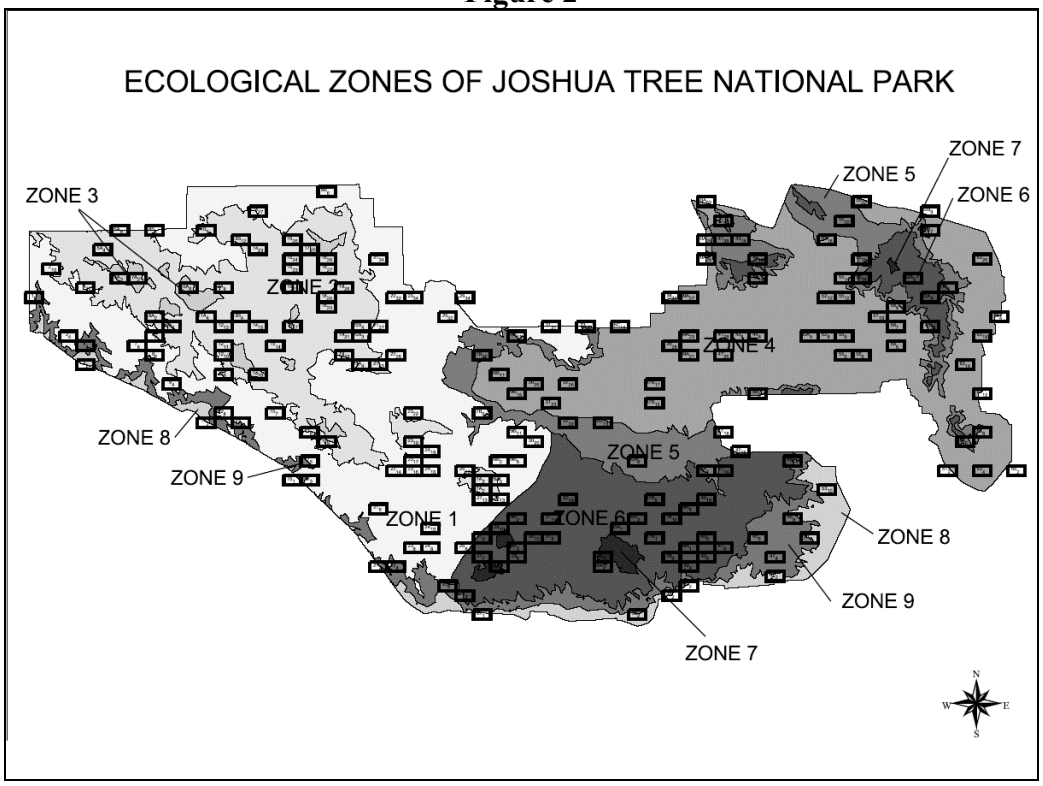
Selecting Photos

1. Calculated the distance from road to each photo.
2. Calculated the number of BPUs in each zone.
3. Calculated the number of existing plots in each BPU.
4. Tallied the number of unsampled BPUs in each zone.
5. Selected BPUs that had been sampled and set them equal to no data.
6. Used BPUs that had not been sampled as a mask and produced a map showing only those BPUs that had no samples.
7. Calculated the number of unique (unsampled) BPUs in each photo.

8. Constructed a map showing the richness of unsampled BPUs within each photo.
9. Determined the number of photos to select from each zone based on (a) the land area occupied by unsampled BPUs and (b) the number of unsampled BPUs. Calculated percentages of each and then took the average.
10. Ordered photos within each zone from the highest number of BPUs to the lowest number of BPUs and selected those that were within 3 km of the nearest road.
11. Determined how many BPUs would not be sampled via this strategy in each zone and then added photos (regardless of distance from road) to each zone until all BPUs were sampled.

Following this process, 250 areas were selected for sampling that represented the center portion of 250 of the aerial photos covering the entire park (Figure 2).

**Figure 2**




These photos were visited, and one to three samples were taken at each area, depending upon the variation of vegetation and the number of samples already collected for various types of vegetation. The photointerpreter/vegetation sampling team also collected an array of reconnaissance samples for field validation using this stratified technique.

Field Data Collection

A standardized field data collection protocol used in the Mojave Desert Ecosystem Initiative project (Thomas *et al.* 2004) was used to collect the majority of the plots for this project. This

protocol was relevé based. Covers of trees, shrubs, and herbaceous species were estimated in plots of variable sizes based on the physiognomy of the vegetation. In general, scrub and riparian plots were 400 $m^2$, and large stands of desert vegetation were sampled with 1,000 $m^2$ plots. A standard set of environmental variables was collected as part of each field sample. All plots were permanently located with markers using global positioning system receivers. A detailed description of the field sampling protocol, the field data sheets, and code lists are provided in Appendix 3.

The field crews who performed the data collection for the 2000–2001 field season were trained in fall 2000. Throughout the months of October, November, and December of 2000 and January, February, and March of 2001, they collected data from 300 field plots.

The members of the 2000–2001 field crew were Kumi Rattenbury, Renee (Vargo) Huron, Marci Long, and John Menke.

Archiving and Analysis of Data

A Microsoft Access database was created by the photointerpretation/field sampling team in 2000 and was used to enter and archive all field data collected in the 2000–2001 sampling season. This database was developed specifically for the JOTR projects, and data entry mirrored the field forms used in the project. Data was entered and quality controlled by the field crew in 2001.

The analysis of plot data collected in 2000–2001 was undertaken using the PC-ORD software suite of ordination and classification tools (McCune and Mefford 1997). PC-ORD allows disparate types of data to be fed directly into classification programs, such as TWINSPAN (Hill 1979) or Cluster Analysis (McCune and Mefford 1997), whether entered in various spreadsheet, database, or condensed formats.

Classification and ordination analyses were performed in a complementary approach to objectively classify the samples and create order out of complex vegetation patterns in the data. Main groups were defined by similarities in species composition and abundance. When these analyses show similar results, they substantiate each other and provide a consistent, strong analysis (Gauch 1982, Parker 1991). Through this process, a classification of the different natural communities or vegetation types can be scientifically made, based mainly on floristics and secondarily on environmental factors.

The classification of the data sets followed a standard process. Data was screened for outliers (extreme values of sample units or species), which were removed to reduce heterogeneity and increase normality in the data set. Samples that were more than three standard deviations from the mean were removed (using outlier analysis in PC-ORD), and species that were in fewer than three samples were removed. The classifications included all resulting sample-by-species information, which were subjected to two basic cluster analysis runs. The first was based on presence/absence of species with no additional cover data considered. This provided a general impression of the relationships between all the groups based solely on species membership. The second cluster analysis was based on the standard default run where cover values are converted

to seven different classes using the following modified Braun-Blanquet (1965) cover categories: 1=<1 percent, 2=1–5 percent, 3=>5–15 percent, 4=>15–25 percent, 5=>25–50 percent, 6=>50–75 percent, 7=>75 percent. The first four cover classes comprise the majority of the species values. This second run demonstrated the modifications that cover values can make on the group memberships.

Since plant community data sets are inherently heterogeneous and more than one underlying gradient usually determines the heterogeneity in plant patterns, a hierarchical agglomerative cluster analysis was employed (McCune and Grace 2002) with Sorenson distance and flexible beta linkage method at -0.25. A cluster analysis dendrogram is produced using this technique, whereby samples are grouped together hierarchically into clusters of groups (from many nested subgroups to two main groups). Since the intent of this study was to display the natural groupings at the finest level of classification (the association) rather than the alliance level, the dendrogram was divided at the relatively fine level of 14 groups.

After the Cluster Analysis runs, Indicator Species Analysis (ISA) was employed to objectively decide at what group level to "cut" the dendrogram and explicitly interpret the groups. Furthermore, ISA was used to designate species that indicate the different groups. ISA produced indicator values for each species in each of the groups within the dendrogram, and these species were tested for statistical significance using a Monte Carlo technique (Dufrene and Legendre 1997). ISA was repeated at successive group levels from the two main groups of the dendrogram up to 14 groups (*i.e.,* the maximum number of groups allowable, where all groups have at least two samples per group). At each group level, the analysis was evaluated to obtain the total number of significant indicator species (p-value $\leq 0.5$) within each group level and the mean p-value for all species.

The group level that had the highest number of significant indicators and lowest overall mean p-value was selected for the final evaluations of the community classification (McCune and Grace 2002). At this grouping level, plant community names were applied to the samples of the different groups. Naming conventions followed the floristic units of "associations," as defined by the National Vegetation Classification System (Grossman *et al.* 1998) and the California Native Plant Society (Sawyer and Keeler-Wolf 1995). An association is defined by a group of samples that have similar dominant and characteristic species in the overstory and other important and indicator species, whereby these species are distinctive for a particular environmental setting. Further, significant indicator species were drawn from the analysis and applied to the associations.

Following each of these analyses, the consistent groupings were identified and compared between Cluster Analysis and TWINSPAN. Cluster Analysis with Sorenson distance measure was compared to TWINSPAN using Euclidean distance measure (McCune and Mefford 1997), which provides a divisive view of grouping as opposed to the agglomerative grouping in Cluster Analysis. Congruence of groupings between TWINSPAN and Cluster Analysis was generally close. Disparities were resolved by reviewing the species composition of individual samples. Most of these uncertain plots either represented transitional forms of vegetation that could be thought of as borderline misclassified plots or plots with no other similar samples in the data set.

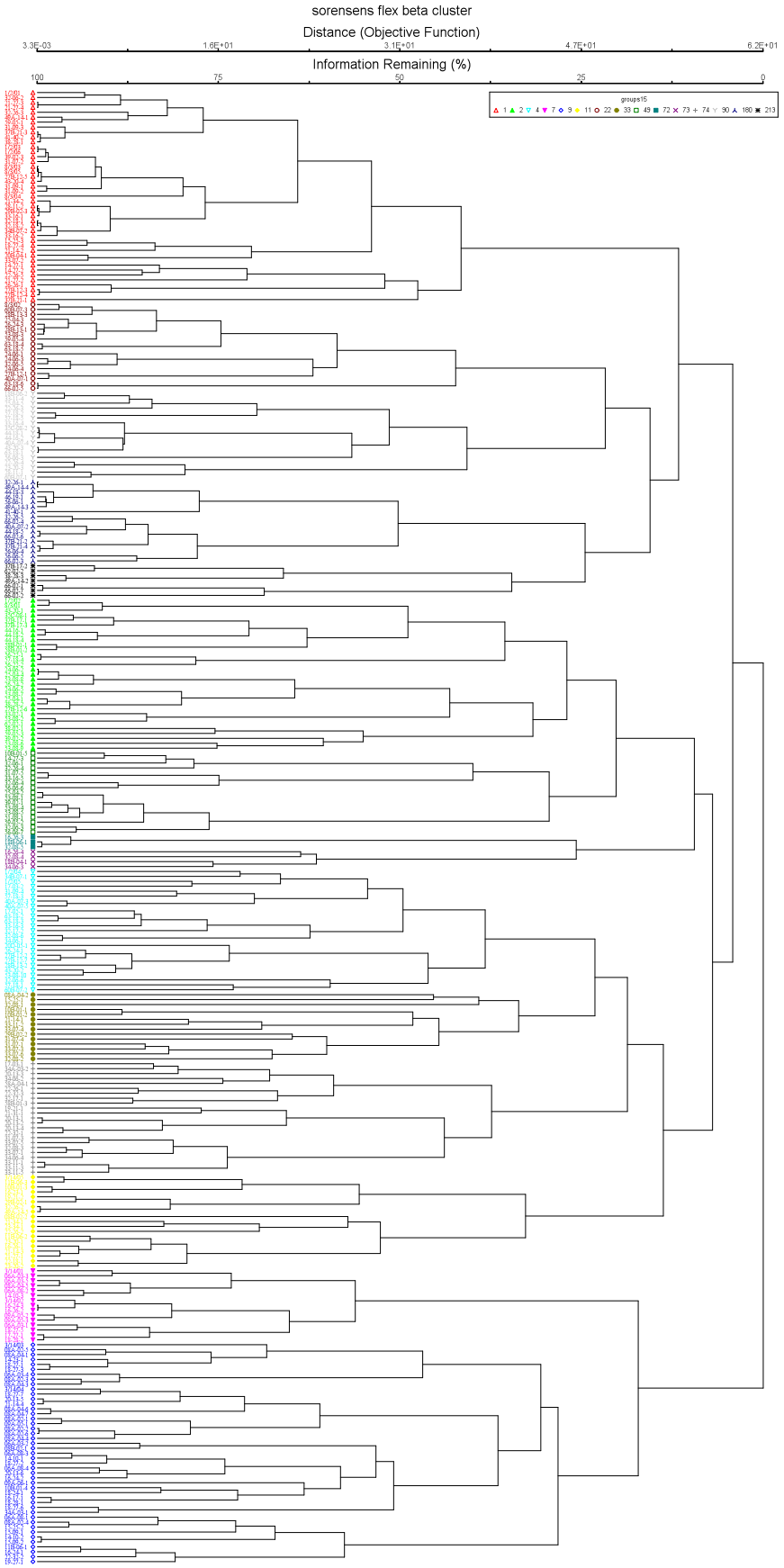
Each sample was revisited within the context of the cluster to which it had been assigned to quantitatively define membership rules for each association. The membership rules were defined by species constancy, indicator species, and species cover values. Upon revisiting each sample, the few samples that had been misclassified in earlier fusions of the cluster analysis were reclassified based on the membership rules. The set of data collected throughout the study area was used as the principal means for defining the association composition and membership rules; however, preexisting classifications and floras were consulted to locate analogous/similar classifications or descriptions of vegetation.

A summary of the analysis process is provided in the following steps:

a. Screen all sample-by-species data for outliers. Samples that were more than three standard deviations from the mean were removed, and species that were in fewer than three samples were removed.
b. Run presence–absence Cluster Analysis to determine general arrangement of samples.
c. Run cover category Cluster Analysis to display a more specific arrangement of samples based on species presence and abundance.
d. Run Indicator Species Analysis at each of the successive group levels in the Cluster Analysis output, from two groups to the maximum number of groups (all groups have at least two samples).
e. Settle on the final representative grouping level of each Cluster Analysis to use in the preliminary labeling.
f. Preliminarily label alliance and association for each of the samples, and denote indicator species from the ISA.
g. Run TWINSPAN to test congruence with the subsetted TWINSPAN divisions, comparing the general arrangement of samples.
h. Develop decision rules for each association and alliance based on most conservative group membership possibilities based on plot-by-plot review of species cover.
i. Relabel final alliance labels for each sample and arrange in database table.
j. Use decision rules developed in the new data to assign alliance and association names to all analyzed data and all outlier samples removed from data set.

The full array of JOTR 300 plots was classified and formed the basis of the quantitative classification. A diagram showing 15 broader cluster units is shown in Figure 3. The larger clusters of similar plots are identified by the most characteristic indicator species as identified in the indicator species analysis (Dufrene and Legendre 1997). Each of these main clusters was further analyzed in a step-down manner. A more detailed examination of the cluster showing the names and relationships of the individual associations, following complete analysis, is shown in Figure 4. The MDEI and LONG data sets were analyzed separately in conjunction with the MDEI report so each type was classified first by Thomas *et al*. (2004) but then scrutinized based on the 300 plot array analyzed as the core JOTR data set. In some cases, adjustments were made to the first classification of the Long and MDEI samples.

## Figure 3




*Larrea tridentata* alliance (low-diversity Larrea dominant) →

Upland Sonoran Desert (*Encelia farinosa-Fouquieria splendens*) →

*Larrea-Ambrosia-Echinocactus polycephalus* →

Sandy (*Brassica tournefortii, Psorothamnus emoryi*) →

Sink (*Atriplex hymenelytra-S. moquinii*) →

Low elevation washes (*Psorothamnus spinosus, Hymenoclea, Encelia frutescens*) →

Sonoran washes (*Cercidium, Chilopsis, Brandegea*) →

Mesquite (*Prosopis glandulosa*) →
Permanent fresh $H_2O$ *Populus, Salix,* →

Low elevation rocky uplands (*Hyptis, Bebbia, Pleurocoronis*) →

Upper elevation washes (*Prunus fasciculata, Acacia greggii, Artemisia dracunculus*) →

Mid-elevation rocky upland scrub (*Ephedra nevadensis, Eriogonum fasciculatum, Viguiera parishii, Xylorhiza teretifolia*) →

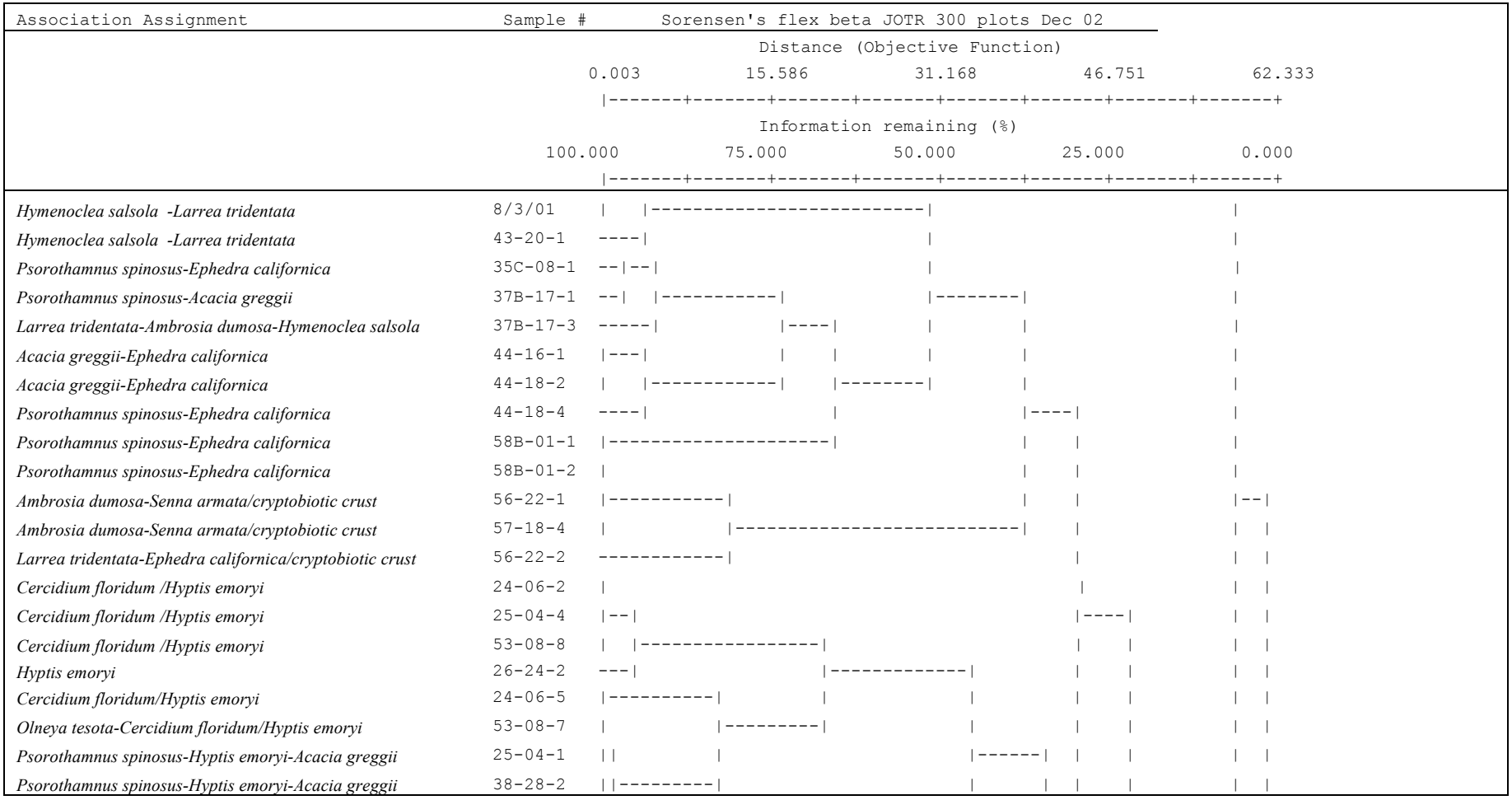
Mid-elevation upper bajadas and alluvial deposits (*Pleuraphis rigida, Ericameria cooperi, Acamptopappus sphaerocephalus*) →

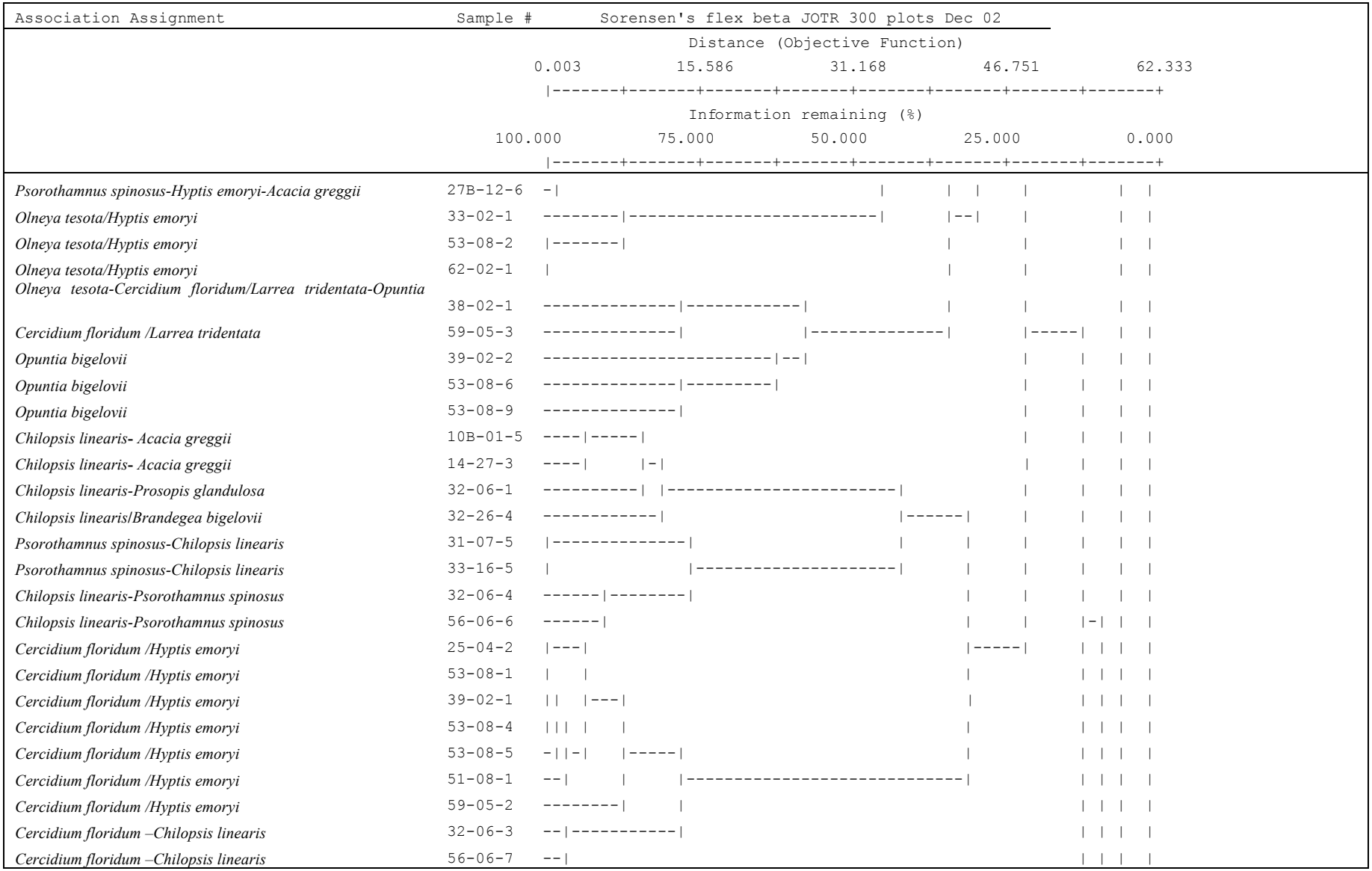
Upper elevation woodland and scrub (*Pinus monophylla, Quercus Cornelius-mulleri, Ericameria linearifolia, Arctostaphylos glauca*) →

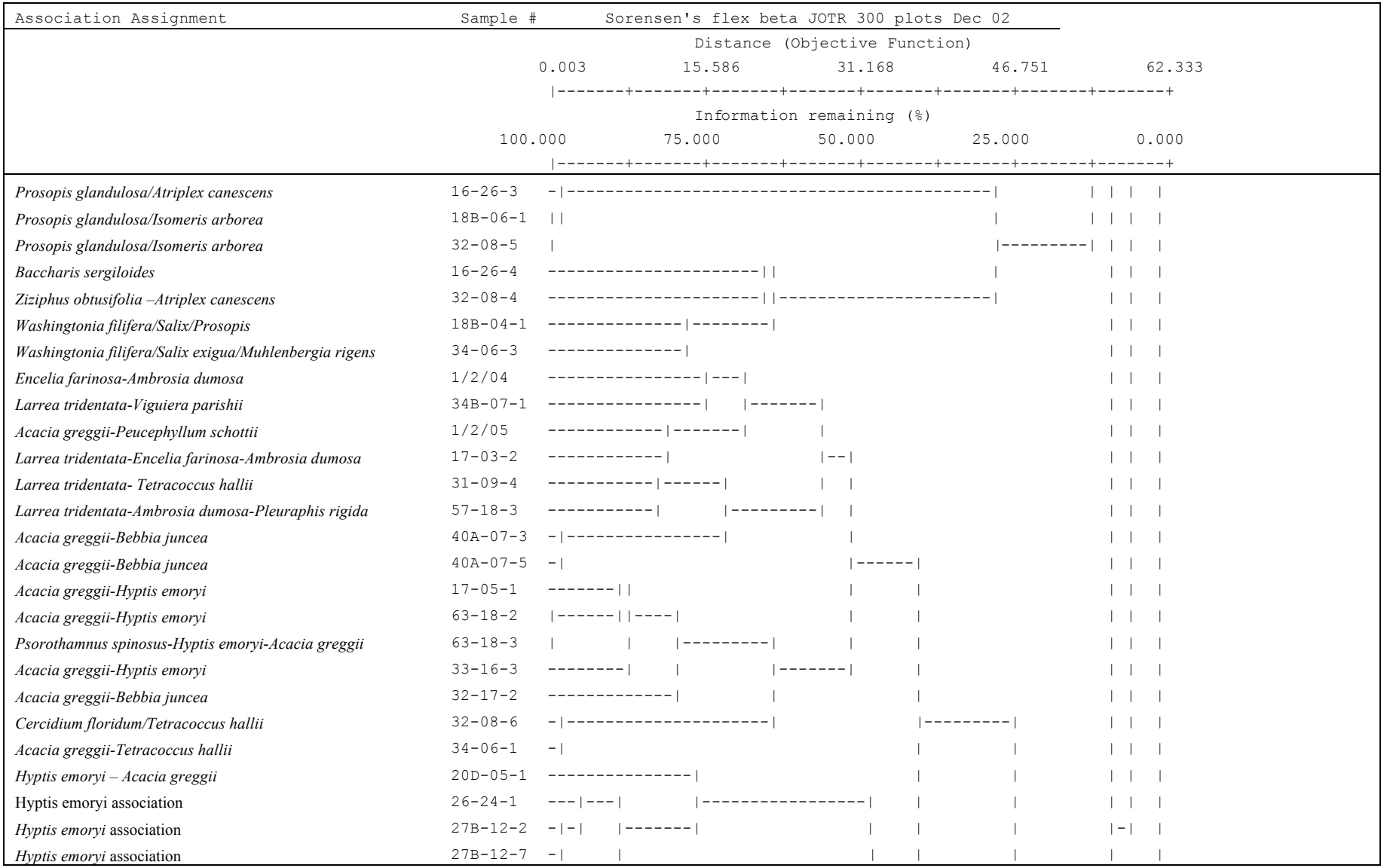
Upper Mojavean transitional scrub (*Achnatherum speciosum, Juniperus californica, Coleogyne ramosissima, Yucca brevifolia*) →

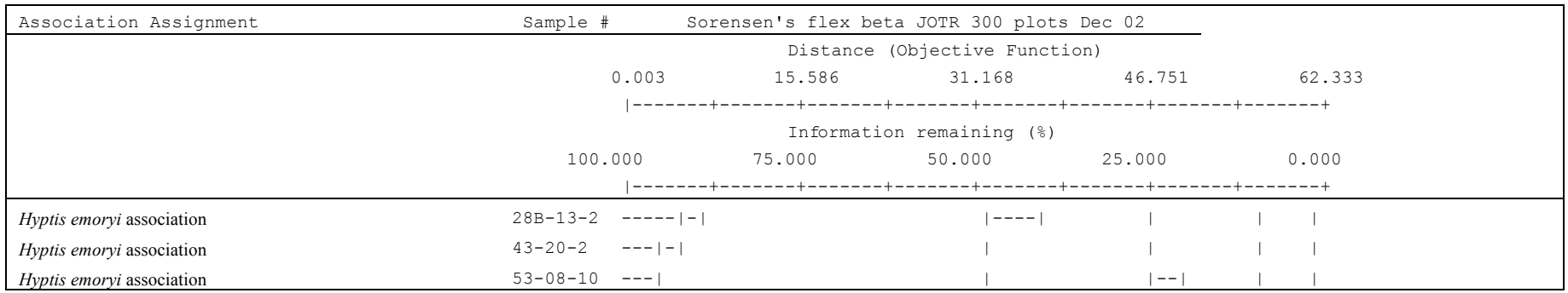
**Figure 4**
**Detail of Cluster Analysis for Part of the Data Shown Highlighted in Gray in Figure 3.**

Plots with shorter breaks on left side of diagram are more closely related (following two pages).




Association Assignment
Sample #
Sorensen's flex beta JOTR 300 plots Dec 02
Distance (Objective Function)
0.003
15.586
31.168
46.751
62.333
Information remaining (%)
100.000
75.000
50.000
25.000
0.000
Psorothamnus spinosus-Hyptis emoryi-Acacia greggii 27B-12-6
Olneya tesota/Hyptis emoryi 33-02-1
Olneya tesota/Hyptis emoryi 53-08-2
Olneya tesota/Hyptis emoryi 62-02-1
Olneya tesota-Cercidium floridum/Larrea tridentata-Opuntia 38-02-1
Cercidium floridum /Larrea tridentata 59-05-3
Opuntia bigelovii 39-02-2
Opuntia bigelovii 53-08-6
Opuntia bigelovii 53-08-9
Chilopsis linearis- Acacia greggii 10B-01-5
Chilopsis linearis- Acacia greggii 14-27-3
Chilopsis linearis-Prosopis glandulosa 32-06-1
Chilopsis linearis/Brandegea bigelovii 32-26-4
Psorothamnus spinosus-Chilopsis linearis 31-07-5
Psorothamnus spinosus-Chilopsis linearis 33-16-5
Chilopsis linearis-Psorothamnus spinosus 32-06-4
Chilopsis linearis-Psorothamnus spinosus 56-06-6
Cercidium floridum /Hyptis emoryi 25-04-2
Cercidium floridum /Hyptis emoryi 53-08-1
Cercidium floridum /Hyptis emoryi 39-02-1
Cercidium floridum /Hyptis emoryi 53-08-4
Cercidium floridum /Hyptis emoryi 53-08-5
Cercidium floridum /Hyptis emoryi 51-08-1
Cercidium floridum /Hyptis emoryi 59-05-2
Cercidium floridum –Chilopsis linearis 32-06-3
Cercidium floridum –Chilopsis linearis 56-06-7


Association Assignment
Sample #
Sorensen's flex beta JOTR 300 plots Dec 02
Distance (Objective Function)
0.003
15.586
31.168
46.751
62.333
Information remaining (%)
100.000
75.000
50.000
25.000
0.000
Prosopis glandulosa/Atriplex canescens 16-26-3
Prosopis glandulosa/Isomeris arborea 18B-06-1
Prosopis glandulosa/Isomeris arborea 32-08-5
Baccharis sergiloides 16-26-4
Ziziphus obtusifolia –Atriplex canescens 32-08-4
Washingtonia filifera/Salix/Prosopis 18B-04-1
Washingtonia filifera/Salix exigua/Muhlenbergia rigens 34-06-3
Encelia farinosa-Ambrosia dumosa 1/2/04
Larrea tridentata-Viguiera parishii 34B-07-1
Acacia greggii-Peucephyllum schottii 1/2/05
Larrea tridentata-Encelia farinosa-Ambrosia dumosa 17-03-2
Larrea tridentata- Tetracoccus hallii 31-09-4
Larrea tridentata-Ambrosia dumosa-Pleuraphis rigida 57-18-3
Acacia greggii-Bebbia juncea 40A-07-3
Acacia greggii-Bebbia juncea 40A-07-5
Acacia greggii-Hyptis emoryi 17-05-1
Acacia greggii-Hyptis emoryi 63-18-2
Psorothamnus spinosus-Hyptis emoryi-Acacia greggii 63-18-3
Acacia greggii-Hyptis emoryi 33-16-3
Acacia greggii-Bebbia juncea 32-17-2
Cercidium floridum/Tetracoccus hallii 32-08-6
Acacia greggii-Tetracoccus hallii 34-06-1
Hyptis emoryi – Acacia greggii 20D-05-1
Hyptis emoryi association 26-24-1
Hyptis emoryi association 27B-12-2
Hyptis emoryi association 27B-12-7


Association Assignment
Sample #
Sorensen's flex beta JOTR 300 plots Dec 02
Distance (Objective Function)
0.003
15.586
31.168
46.751
62.333
Information remaining (%)
100.000
75.000
50.000
25.000
0.000
Hyptis emoryi association
28B-13-2
Hyptis emoryi association
43-20-2
Hyptis emoryi association
53-08-10

## Classification

A classification and key were produced to identify all vegetation types detected in the fieldwork for this project based on consistent patterns of species composition, abundance, and habitat/environmental factors. The classification follows a standard floristic hierarchy of the U.S. National Vegetation Classification System (Grossman *et al*. 1998) and A Manual of California Vegetation (Sawyer and Keeler-Wolf 1995), which have naming conventions for alliances and associations. An alliance is the generic unit in the floristic classification. It is based on the dominant (or diagnostic) species of the stand, which are usually of the uppermost and/or dominant height stratum. An association is the most basic, fundamental unit of classification. Associations are subdivisions of alliances based on constant patterns of additional species within an overall pattern of alliance dominance. Associations are typically geographically more specific than alliances, and they tend to be locally distributed and indicative of a certain environment or ecosystem in a local setting.

In the naming of alliances and associations, species in the uppermost stratum are listed first and species differing in strata are separated with a slash (*e.g., Yucca brevifolia/Pleuraphis rigida*), while species in the same stratum are separated with a dash (*e.g., Larrea tridentata–Ambrosia dumosa)*. Because the levels above alliance and association currently are being reevaluated, a conservative approach was taken for the formation and other upper levels of the classification and in keeping with current revisions of the national hierarchy.

## Developing the Key

The key provides general choices and information on the physiognomy of the vegetation and the different environments based on species composition and ecological setting. This approach in the key was chosen (1) to reduce the length and redundancy common to dichotomous keys and (2) because such a guide can be easily used by nonbotanists/plant ecologists. It can be used as a stand-alone product, allowing anyone with some basic ecology background and knowledge of the main characteristic plant species to identify the vegetation. The vegetation key is written from two perspectives: (1) a field team attempting to identify vegetation and (2) an office team attempting to place field samples into the proper category. Thus, heavy reliance is placed on correct identification of characteristic plant species and of estimation of cover of these species.

The key is first broken into major units based on dominant plant life form—trees, shrubs, and herbs. Trees are categorized into three sections: coniferous, broadleaf evergreen and deciduous, and microphyllous. Shrubs are also categorized into three sections: shrublands of wet to moist localities, moderately tall shrublands of drier localities, and dwarf shrublands. Herbs are categorized into perennial grass and annual grass-dominated types. Since the vast majority of vegetation in this project area is shrubby, the shrubland sections are the most complicated.

## Description Writing

Following the analysis of field data and development of the classification and key, brief alliance-level descriptions were written and based on available literature. Association-level descriptions

were written in two formats, depending on the sample size: (1) Associations with only one sample are described in a brief description of species and environmental composition, with comparison to existing references; (2) ssociations represented by two or more samples are described using the currently available template provided by NatureServe. The two primary writers were Sau San and Diana Hickson (California Department of Fish and Game). Todd Keeler-Wolf (California Department of Fish and Game) edited all the descriptions. When writing the descriptions, the following standards were set:

1. Dominant or codominant species: Must be in at least 80 percent of the samples, with at least 30 percent relative cover in all samples.
2. Characteristic/Diagnostic species: Must be present in at least 80 percent of the samples, with no restriction on cover.
3. Abundant species: Must be present in at least 50 percent of the samples, with an average of at least 30 percent relative cover in all samples.
4. Often/Usually occurring species: Must be present in at least 50 percent of the samples, with no restriction on cover.
5. Minimum sample size for description: n=3. Descriptions of associations with fewer than three samples were attempted if (a) the association was sampled and described by previous authors, or (b) the vegetation was confirmed as distinctive and repeatable based on field reconnaissance or by photointerpretation signature.
6. Open: Used to describe individual layers of vegetation (tree, shrub, herb, or subdivisions of them) where the cover is generally less than 33 percent absolute cover.
7. Intermittent: Used to describe individual layers of vegetation (tree, shrub, herb, or subdivisions of them) where there is 33–66 percent absolute cover.
8. Continuous: Used to describe individual layers of vegetation (tree, shrub, herb, or subdivisions of them) where there is greater than 66 percent absolute cover.
9. Relative cover: Refers to the amount of the surface of the plot or stand sampled that is covered by one species (or physiognomic group) as compared to (relative to) the amount of surface of the plot or stand covered by all species (in that group). Thus, 50 percent relative cover means that half of the total cover of all species or physiognomic groups is composed of the single species or group in question. Relative cover values are proportional numbers and, if added, total 100 percent for each stand (sample).
10. Absolute cover: Refers to the actual percentage of the ground (surface of the plot or stand) that is covered by a species or group of species. For example, *Pinus monophylla* covers between five and 10 percent of the stand. Absolute cover of all species or groups in a stand or plot, if added, may total greater or less than 100 percent, because it is not a proportional number.
11. Stand: The basic physical unit of vegetation in a landscape. It has no set size. Some vegetation stands, such as wetland seeps, are very small, and some, such as desert or forest types, may be several square kilometers in size. A stand is defined by two main unifying characteristics:
    a. It has *compositional* integrity. Throughout the site, the combination of species is similar. The stand is differentiated from adjacent stands by a discernible boundary that may be abrupt or gradual.

   b. It has *structural* integrity. It has a similar history or environmental setting, affording relatively similar horizontal and vertical spacing of plant species. For example, a hillside forest formerly dominated by the same species but that has burned on the upper part of the slope and not the lower is divided into two stands. Likewise, a sparse woodland occupying a slope with shallow rocky soils is considered a different stand from an adjacent slope of a denser woodland/forest with deep, moister soil and the same species.
12. Woody plant: Any species of plant that has noticeably woody stems. It does not include herbaceous species with woody, underground portions such as tubers, roots, or rhizomes.
13. Tree: A single-stemmed, woody plant that normally grows to be greater than five meters tall.
14. Shrub: Normally a multistemmed woody, plant that is between 0.2 meters and five meters tall. Definitions are blurred at low and the high ends of the height scales.
15. Herbaceous plant: Any species of plant that has no main woody stem development and includes grasses, forbs, and perennial species that die back seasonally.
16. Forest: In the National Vegetation Classification, a forest is defined as a tree-dominated stand of vegetation with 60 percent or greater cover of trees.
17. Woodland: In the National Vegetation Classification, a woodland is defined as a tree-dominated stand of vegetation with between 25 and 60 percent cover of trees.
18. Sparsely wooded: Refers to stands with conspicuous trees (generally at least 10 percent absolute cover), but less than 25 percent cover may occur over shrubs as the dominant canopy (sparsely wooded shrubland) or herbaceous (sparsely wooded) cover.
19. Rare and endangered plants: Listed as per CNPS (2003) Online Inventory of Rare and Endangered Plants.
20. Conservation rank: Listed by the state Nature Conservancy Heritage Programs, these are the "Global" and "State" ranks, as seen below.
    a. G1 and S1: Fewer than six viable occurrences worldwide and/or 2,000 acres
    b. G2 and S2: six–20 viable occurrences worldwide and/or 2,000–10,000 acres
    c. G3 and S3: 21–100 viable occurrences worldwide and/or 10,000–50,000 acres
    d. G4 and S4: Greater than 100 viable occurrences worldwide and/or greater than 50,000 acres
21. Sample(s): Listed by their survey numbers from the vegetation databases and indicated using the following: Relevé samples begin with the alpha code "JOTR" for the 300 plots collected specifically for this project, "MDEI" for the 74 plots collected by the Mojave Desert Ecosystem Initiative crews in 1998, "Long" for the Bret Long crew's 74 plots collected in 1997, and "Watts" for the 115 plots collected by the Watts team in the Malapai Hill Quadrangle in 1996.

Lessons Learned

This National Park Service vegetation project was the first in California to utilize an overlapping crew of photointerpreters and field data collectors. There were clear, positive benefits to this in that the photointerpretation/field sampling team gleaned a detailed and intimate understanding of the vegetation and corresponding environmental cues. This was very useful in interpreting the often subtle and indistinct vegetation patterns that show up in the aerial photographs.

This project also made use of several data sets that were collected sequentially in support of other mapping or overlapping data needs. The value of the Long and MDEI data on a plot-by-plot basis was equivalent to the larger JOTR data set. However, the Watts data was less useful, primarily as a result of the small plot size and the relatively inflexible random plot selection process. Clearly, the JOTR data set was the most useful because of its full allocation across the entire park, relying as it did on an environmentally driven, randomly stratified sample allocation.

Several new types of vegetation were described in this project. The sampling of the Colorado Desert portion of the park was particularly useful. Due to the paucity of previous data analysis of vegetation from the eastern California portion of the Colorado Desert, many new types were described in this area. This data will provide valuable perspective when new field data collected from the Bureau of Land Management (BLM) Northern and Eastern Colorado Desert Plan (NECO 2003) become analyzed later this year, as planned by the California Native Plant Society (Julie Evens, personal communication, February 2005).

One final point of interest is the relationship of the Joshua Tree (*Yucca brevifolia*) in the current National Vegetation Classification System. Presently, there is a sparsely wooded shrubland alliance defined by *Yucca brevifolia* and a wooded herbaceous alliance defined by *Yucca brevifolia*. Some evidence from the data in this study suggests that there may, indeed, be Joshua Tree alliance; however, there is also likely to be a series of associations within the Blackbush (*Coleogyne ramosissima*) and the Creosote Bush (*Larrea tridentata*) alliances that are defined by Joshua Tree. In other words, despite the fact that the Joshua Tree is taller, it may be less significant than the shrubs with which it occurs, and further analysis may determine that the so-named *Yucca brevifolia/Coleogyne ramosissima* association and other similar situations may be better thought of as Joshua Tree associations of a shrub alliance (e.g., *Coleogyne ramosissima/Yucca brevifolia* association).

CLASSIFICATION OF VEGETATION ASSOCIATIONS FROM JOSHUA TREE NATIONAL PARK, CALIFORNIA

## I. Forest

Trees Usually Over 5 m Tall With Their Crowns Interlocking (Generally Forming 60–100 percent Cover).

### I.B. Deciduous Forest

I.B.2.N.d.38 *Populus fremontii* Temporarily Flooded Forest Alliance

## II. Woodland

Open Stands of Trees Usually Over 5 m Tall with Crowns Not Usually Touching (Generally Forming 25–60 percent Cover).

### II.A. Evergreen Woodland

**II.A.2.N.b—Seasonally flooded temperate broad-leaved evergreen woodland**

II.A.2.N.b.1. *Washingtonia filifera* Seasonally Flooded Woodland Alliance

**II.A.4.N.a—Rounded-crowned temperate or subpolar needle-leaved evergreen woodland**

II.A.4.N.a.45 *Pinus monophylla—(Juniperus osteosperma)* Woodland Alliance

**II.A.5.N.a—Sclerophyllous extremely xeromorphic evergreen woodland**

*Parkinsonia florida* (*Cercidium floridum* in California taxonomy) Shrubland Alliance

*Cercidium floridum/Hyptis emoryi* Association
*Cercidium floridum/Chilopsis linearis* Association
*Olneya tesota* Woodland Alliance
*Olneya tesota/Hyptis emoryi* Association

### II.B. Deciduous Woodland

**II.B.2.N.b—Temporarily flooded cold-deciduous woodland**

II.B.2.N.b.12 *Populus fremontii* Temporarily Flooded Woodland Alliance

**II.B.3.N.a—Thorn extremely xeromorphic deciduous woodland**

II.B.3.N.a.2 *Prosopis (glandulosa, velutina)* Woodland Alliance

## III. Shrubland

Shrubs or Trees Usually 0.5 To 5 m Tall with Individuals or Clumps Not Touching to Interlocking (Generally Forming >25 percent Canopy Cover)

### III.A. Evergreen Shrubland

**III.A.2.N.c—Sclerophyllous temperate broad-leaved evergreen shrubland**

III. A.2.N.c. xxx *Arctostaphylos glauca* Shrubland Alliance

III.A.2.N.c.400 *Quercus cornelius-mulleri* Shrubland Alliance

*Quercus cornelius-mulleri/Eriogonum fasciculatum-Ericameria linearifolia* Shrubland Association

*Quercus cornelius-mulleri/Coleogyne ramosissima* Shrubland Association

**III.A.4.N.a—Lowland microphyllous evergreen shrubland**

III.A.4.N.a.13 *Purshia tridentata* Shrubland Alliance

III.A.4.N.a.23 *Ericameria nauseosa* Shrubland Alliance

**III.A.4.N.b—Intermittently flooded microphyllous shrubland**

III.A.4.N.b. *Baccharis sergiloides* Intermittently Flooded Shrubland Alliance

**III.A.4.N.c—Temporarily flooded microphyllous shrubland**

III.A.4.N.c.1 *Tamarix* spp. Seminatural Temporarily Flooded Shrubland Alliance

**III.A.5.N.a—Broad-leaved and microphyllous evergreen extremely xeromorphic subdesert shrubland**

III.A.5.N.a. *Larrea tridentata - Ambrosia dumosa* Shrubland Alliance

*Larrea tridentata-Ambrosia dumosa* Shrubland Association

*Larrea tridentata-Ambrosia dumosa-Krameria grayi* Shrubland Association

*Larrea tridentata-Ambrosia dumosa-Psorothamnus schottii* Shrubland Association

*Larrea tridentata-Ambrosia dumosa-Pleuraphis rigida* Shrubland Association

*Larrea tridentata-Ambrosia dumosa-Senna armata* Shrubland Association

*Larrea tridentata-Ambrosia dumosa-Yucca schidigera* Shrubland Association

*Larrea tridentata-Ambrosia dumosa-Encelia farinosa* Shrubland Association

*Larrea tridentata-Encelia farinosa-Ambrosia dumosa* Shrubland Association

III.A.5.N.a.5 *Larrea tridentata* Shrubland Alliance
*Larrea tridentata* (Undifferentiated) Shrubland Association
*Larrea tridentata/Pleuraphis rigida* Shrubland Association
*Larrea tridentata-Hymenoclea salsola* Shrubland Association
III.A.5.N.a.11 *Ephedra nevadensis* Shrubland Alliance
III.A.5.N.a.14 *Encelia virginensis* Shrubland Alliance

**III.A.5.N.b—Facultatively deciduous extremely xeromorphic subdesert shrubland**

III.A.5.N.b.x *Larrea tridentata - Encelia farinosa* Shrubland Alliance
*Larrea tridentata-Encelia farinosa* Shrubland Association
*Larrea tridentata-Encelia farinose - Fouquieria splendens* Shrubland Association
III.A.5.N.b.4 *Encelia farinosa* Shrubland Alliance
III.A.5.N.b.5 *Eriogonum fasciculatum* Shrubland Alliance
III.A.5.N.b.6 *Atriplex canescens* Shrubland Alliance
III.A.5.N.b.9 *Atriplex hymenelytra* Shrubland Alliance
*Atriplex hymenelytra-Larrea tridentata-Ambrosia dumosa* Shrubland Association
III.A.5.N.b.11 *Coleogyne ramosissima* Shrubland Alliance
III.A.5.N.b.x *Viguiera parishii* Shrubland Alliance
*Viguiera parishii/Eriogonum fasciculatum* Shrubland Association

**III.A.5.N.c—Succulent extremely xeromorphic evergreen shrubland**

III.A.5.N.c.x *Nolina parryi* Shrubland Alliance
III.A.5.N.c.3 *Opuntia bigelovii* Shrubland Alliance
*Opuntia bigelovii* Shrubland Association
III.A.5.N.c.7 *Yucca schidigera* Shrubland Alliance
*Yucca schidigera-Coleogyne ramosissima* Shrubland Association
*Yucca schidigera-Larrea tridentata* Shrubland Association
*Yucca schidigera-Larrea tridentata-Ambrosia dumosa* Shrubland Association
*Yucca schidigera/Pleuraphis rigida* Shrubland Association

**III.A.5.N.e—Extremely xeromorphic evergreen shrubland with a sparse tree layer**

III.A.5.N.e.x *Pinus monophylla* Wooded Shrubland Alliance
*Pinus monophylla/Quercus cornelius-mulleri* Wooded shrubland Association
*Pinus monophylla/Juniperus californica/Achnatherum speciosum* Wooded Shrubland Association
III.A.5.N.e *Juniperus californica* Wooded Shrubland Alliance
*Juniperus californica-Quercus cornelius-mulleri/Coleogyne ramosissima* Woodland Association

*Juniperus californica/Coleogyne ramosissima-Yucca schidigera* Woodland Association
*Juniperus californica-(Yucca schidigera)/Pleuraphis rigida* Woodland Association
*Juniperus californica/Coleogyne ramosissima* Woodland Association
*Juniperus californica/Nolina parryi* Woodland Association

III.A.5.N.e.1 *Yucca brevifolia* Wooded Shrubland Alliance
*Yucca brevifolia/Coleogyne ramosissima* Wooded Shrubland Association
*Yucca brevifolia/Juniperus californica/Coleogyne ramosissima* Wooded Shrubland Association
*Yucca brevifolia/Juniperus californica/Ephedra nevadensis* Wooded Shrubland Association
*Yucca brevifolia/Larrea tridentata-Yucca schidigera* Wooded Shrubland Association
*Yucca brevifolia/Larrea tridentata-Pleuraphis rigida* Wooded Herbaceous Association
*Yucca brevifolia/Pleuraphis rigida* Wooded Herbaceous Association
*Yucca brevifolia/Prunus fasciculata* Wooded Shrubland Association

## III.B. Deciduous Shrubland

### III.B.2.N.d—Temporarily flooded cold-deciduous shrubland

III.B.2.N.d.6 *Salix (exigua, interior)* Temporarily Flooded Shrubland Alliance

### III.B.3.N.a—Extremely xeromorphic deciduous subdesert shrubland without succulents

III.B.3.N.a.x *Salazaria mexicana* Shrubland Alliance
III.B.3.N.a.4 *Prosopis glandulosa* Shrubland Alliance
III.B.3.N.a.9 *Acacia greggii* Shrubland Alliance
*Acacia greggii-Prunus fasciculata* Shrubland Association
*Acacia greggii-Bebbia juncea* Shrubland Association
*Acacia greggii-Hyptis emoryi* Shrubland Association
III.B.3.N.a.11 *Grayia spinosa* Shrubland Alliance
III.B.3.N.a.x *Hymenoclea salsola* Shrubland Alliance

### III.B.3.N.b—Intermittently flooded extremely xeromorphic deciduous subdesert shrubland

III.B.3.N.b.x *Ephedra californica* Intermittently Flooded Shrubland Alliance
*Ephedra californica* Shrubland Association

III.B.3.N.b.x *Hyptis emoryi* Intermittently Flooded Shrubland Alliance
*Hyptis emoryi* Shrubland Association
III.B.3.N.b.x *Ericameria paniculata* Intermittently Flooded Shrubland Alliance
III.B.3.N.b.x *Prunus fasciculata* Intermittently Flooded Shrubland Alliance
*Prunus fasciculata* Intermittently Flooded Shrubland Association
III.B.3.N.b.x *Psorothamnus spinosus* Intermittently Flooded Shrubland Alliance
*Psorothamnus spinosus-Hyptis emoryi-Acacia greggii* Association
*Psorothamnus spinosus-Ephedra californica* Association
III.B.3.N.b.1 *Chilopsis linearis* Intermittently Flooded Shrubland Alliance
*Chilopsis linearis* Shrubland Association
III.B.3.N.b.2 *Grayia spinosa* Intermittently Flooded Shrubland Alliance

**III.C. Mixed Evergreen-Deciduous Shrubland**

**III.C.3.N.a—Extremely xeromorphic deciduous subdesert shrubland with succulents**
III.C.3.N.a.x *Ericameria teretifolia* Shrubland Alliance

**III.C.3.N.b—Mixed evergreen - deciduous subdesert shrubland**
*Lycium andersonii* Shrubland (provisional) Alliance
*Lycium andersonii–Simmondsia chinensis–Pleuraphis rigida* Shrubland Association

**IV. Dwarf-Shrubland**
Low-growing shrubs and/or trees usually under 0.5 m tall, individuals or clumps not touching to interlocking (generally forming >25 percent cover).

**IV.A.2.N.a—Extremely xeromorphic evergreen subdesert dwarf-shrubland**
IV.A.2.N.a.6 *Ambrosia dumosa* Dwarf-Shrubland Alliance
*Ambrosia dumosa-Pleuraphis rigida* Dwarf-Shrubland Association

**V. Herbaceous Vegetation**
Graminoids and/or forbs (including ferns) (generally forming >10 percent cover with woody cover usually <10%).

**V.A.5.N.d—Medium-tall bunch temperate or subpolar grassland**
V.A.5.N.d.3 *Pleuraphis rigida* Herbaceous Alliance (= *Hilaria rigida*)
*Pleuraphis rigida-Atriplex canescens* Grassland Association

**V.A.5.N.f—Short bunch temperate or subpolar grassland**

V.A.5.N.f.2 *Achnatherum speciosum* Herbaceous Alliance (= *Stipa speciosa*)

**V.D.2.N—Natural/Seminatural temperate or subpolar annual grasslands or forb vegetation**

*Bromus tectorum* Seminatural Herbaceous Alliance

**Probable but Not Verified:**

VII.A.1.N.a.x Rock Outcrop Sparse Vegetation Alliance
VII.A.1.N.a.x Rock Outcrop/Butte Sparse Vegetation Alliance
VII.A.2.N.a.4 Open Pavement Sparse Vegetation Alliance
VII.B.2.N.b.x Gravel Wash Sparse Vegetation Alliance
VII.C.1.N.a.x Herbaceous Dunes Sparse Vegetation Alliance
III.B.3.N.b.x *Bebbia juncea* Intermittently Flooded Shrubland Alliance
V.A.5.N.k.10 *Eleocharis (montevidensis, palustris, quinqueflora)* Seasonally Flooded Herbaceous Alliance
V.A.5.N.k.13 *Juncus balticus* Seasonally Flooded Herbaceous Alliance
V.A.5.N.l.9 *Typha (angustifolia, latifolia) – (Schoenoplectus* spp.) Semipermanently Flooded Herbaceous Alliance

## KEY TO THE VEGETATION TYPES OF JOSHUA TREE NATIONAL PARK

How to Use the Key

This is not a dichotomous key; there are often more than two choices for each section. Read all options in each list to choose the best match for your vegetation stand. The key will direct you first to the life forms: tree, shrub, and herbaceous, then lead you through more specific lists based on dominant/characteristic or presence/absence of significant species.

Due to the high diversity of the vegetation communities in the area, this is a complex key. You will need to collect plant composition data that includes not only those species that are dominant but also those "indicator," or characteristic species, whose presence may cause the plot to key to another vegetation type.

**If there is a species present in high cover for which no type exists in the key,** there are two options. First, the plot can key to another species that is present in high cover. For example, a plot with 35 percent cover toyon and 30 percent holly-leaved cherry would key to holly-leaved cherry, since there is no toyon type defined in the study area. If this is not a reasonable option, the plot can be designated "unable to key." Plots that are unable to key may be candidates for new vegetation types.

**Estimating cover using actual percentages, rather than cover classes,** is preferable, because it gives the fullest picture of the vegetation present. It enables later review of the data to confirm choice of plant community and may help to describe new vegetation types and answer future management or research questions. If a less rigorous and faster approach is needed, for example, if the project is not primarily a vegetation project, the following cover classes are compatible with the key and may be used:

**1. <1 percent**
**2. 1–5 percent**
**3a. 6–15 percent**
**3b. 16–25 percent**
**4. 26–50 percent**
**5. 51–75 percent**
**6. 76–100 percent**

### *Using percent Cover Data to Arrive at a Plant Vegetation Type*

All references to percent cover in the key are to absolute cover unless specified in a particular section as relative cover.

**Absolute cover:** The actual percentage of the surface area of the plot that is covered by a species or physiognomic group (trees, shrubs, herbaceous), as in "creosote bush covers 10 percent of the plot." Absolute cover of all species or physiognomic groups, when added

together, may total greater than 100 percen, because this is not a proportional number and plants can overlap each other. For example, a plot could have 25 percent tree cover, 40 percent shrub cover, and 50 percent herbaceous cover.

**Relative cover:** The percentage of the surface area of the plot that is covered by one species or physiognomic group (trees, shrubs, herbaceous) as compared or relative to the amount of surface of the plot covered by all species or groups. Thus, 50 percent relative cover means that half of the total proportion of cover of all species or physiognomic groups is composed of the single species or group in question. Relative cover values are a proportional number that, when added together, total 100 percent for each plot. For example, a Creosote bush–burro bush vegetation plot with 5 percent cover creosote bush and 5 percent cover burro bush estimated using absolute cover would translate to 50 percent relative cover of creosote bush and 50 percent relative cover of burro bush.

Terms and Concepts Used Throughout the Key

Dominance

**Dominance by layer:** Tree, shrub, and herbaceous layers are considered physiognomically distinct. A vegetation type is considered to belong to a certain physiognomic group if it is dominated by one layer. Layers are prioritized in order of height. The tallest layer, if it meets a criterion in the "characterized" definitions (see below) is said to dominate, and the type is usually named at the alliance level by the characteristic species of the tallest layer.

**Dominant: >50 percent relative cover.** Dominance refers to the preponderance of vegetation cover in a stand of uniform composition and site history. It may refer to cover of an individual species (as in "dominated by Douglas-fir", or it may refer to dominance by a physiognomic group, as in "dominated by shrubs." Dominance refers to the relative cover of one species or physiognomic group as compared to another species or physiognomic group. Anything more than 50 percent relative cover is said to dominate a stand, however, see "dominance by layer", below.

**Strongly dominant: 60 percent+ relative cover.** A species in the dominant life form has 60 percent or greater relative cover.

**Codominant: Each species has 30 percent–60 percent relative cover.** Codominance refers to two or more species in a stand with near equal cover . In general, codominance can occur among species that have between 30 and 60 percent relative cover each.

**Significant: 1 percent–5 percent absolute cover.** A species has 1 to 5 percent absolute cover.

**Important: >1 percent absolute cover.** A species is considered important if it has greater than 1 percent absolute cover. This term is contrasted with dominant to mean that the species is always present in greater than 1 percent cover but not always dominant.

**Tree-characterized vegetation:** Trees are evenly distributed throughout the stand, with typically ≥10 percent cover, providing a consistent (even if sparse) structural component, and one or both of the following criteria are met: (1) Trees influence the distribution or population dynamics of other plant species; (2) Trees play an important role in ecological processes within the stand.

**Shrub-characterized vegetation:** Shrubs (including dwarf-shrubs) are evenly distributed throughout the stand, providing a consistent (even if sparse) structural component, and one or both of the following criteria are met: (1) Shrubs influence the distribution or population dynamics of other plant species; (2) Shrubs play an important role in ecological processes within the stand.

**Herb-characterized vegetation:** Herbs are evenly distributed throughout the stand, providing a consistent (even if sparse) structural component, and play an important role in ecological processes within the stand.

**Nonvascular vegetation:** Nonvascular organisms provide a consistent (even if sparse) structural component and play an important role in ecological processes within the stand.

**Sparse vegetation:** Neither vascular plants nor nonvascular organisms provide a consistent structural component or play an important role in ecological processes on the site.

*Other Important Terms*

**Alliance**: Plant communities based on dominant/diagnostic species of uppermost or dominant stratum. Part of the USNVC hierarchy.

**Association:** The most botanically detailed plant community designation based on dominant species and multiple co- or subdominant indicator species from any strata. Part of the USNVC system.

**Diagnostic species:** A species typically found in the dominant stratum of a vegetation association and lending its name to that association.

**Shrub:** A multistemmed plant with noticeably woody stems that is between 0.2 and 5 meters tall.

**Subshrub:** A multistemmed plant with noticeably woody stems less than 0.5 meters tall.

**Plant community nomenclature:** Species separated by "-" are within the same stratum; species separated by "/" are in different strata. The number at the end of some plant community names is the Mapping Code used for labeling plant community polygons for the associated GIS-based plant community map.

**Stand:** The basic physical unit of plant communities in a landscape. It has no set size. Some vegetation stands are very small, such as certain wetland types, and some may be several square kilometers in size, such as certain forest types. A stand is defined by two main unifying characteristics:

1. It has compositional integrity. Throughout the stand, the combination of species is similar. The stand is differentiated from adjacent stands by a discernible boundary that may be abrupt or occur indistinctly along an ecological gradient.

2. It has structural integrity. It has a similar history or environmental setting that affords relatively similar horizontal and vertical spacing of plant species. For example, a hillside forest originally dominated by the same species that burned on the upper part of the slopes but not the lower would be divided into two stands. Likewise, a sparse woodland occupying a slope with very shallow rocky soils would be considered a different stand from an adjacent slope with deeper, moister soil and a denser woodland or forest of the same species.

The structural and compositional features of a stand are often combined into a term called homogeneity. For an area of vegetated ground to meet the requirements of a stand, it must be homogeneous at the scale being considered. The associated plant community mapping project had a Minimum Mapping Unit (MMU) of 0.5 hectares.

Key to Main Vegetation Divisions

**I.** Vegetation characterized by trees (at least 3 m tall). Trees are evenly distributed throughout the stand but may form a sparse cover over denser subcanopies of shrub and herbaceous species.

**Division A: Tree Vegetation**

**II.** Vegetation dominated by shrubs or subshrubs. Trees, if present, are rare and not evenly distributed across the stand and generally form less than 1 percent cover.

**Division B: Shrub Vegetation**

**III.** Vegetation characterized by herbaceous species including grasses, grass-like plants, and broad-leaved, herbaceous species.

**Division C: Herbaceous Vegetation**

**Division A: Tree Vegetation**

Tree species are present. Trees are defined as woody perennials that are regularly over 3 m in height including shrub species often taller than 3 m such as *Chilopsis linearis*, *Prosopis glandulosa, Tamarix* spp. and *Juniperus californica*. The tree layer is visibly uniform in the stand, although it may be low in cover.

Three sections are included: (1) coniferous trees, (2) broadleaf evergreen and deciduous trees, and (3) microphyllous trees.

**Section I**

**I.** Stands characterized by coniferous evergreen trees including *Pinus monophylla* and *Juniperus californica*.
**Needle-Leaved Evergreen Woodland**

**IA.** *Pinus monophylla* >=1 percent and generally less than 25 percent cover. *Juniperus californica* may be present. *Pinus monophylla* occurs over a sparse to relatively dense cover of shrubs. Restricted to cool, relatively moist sites of the upper elevations mostly in Little San Bernardino Mountains, but isolated stands in Coxcomb Mountains.
**Single-Leaf Pinyon *(Pinus monophylla)* Wooded Shrubland Alliance**

Two associations have been described from JOTR.

> **IA.1.** The scattered tree layer is dominated by *Pinus monophylla* with *Quercus cornelius-mulleri* as dominant in the shrub layer, respectively.
> **Singleleaf Pinyon Pine/Muller's Oak (*Pinus monophylla/Quercus cornelius-mulleri)* Woodland Association**
>
> **IA.2**. The scattered tree layer has *Juniperus californica* mixed with *Pinus monophylla* and does not have a regular presence of the shrub *Quercus cornelius-mulleri.* Desert Needlegrass (*Achnatherum speciosum*) is characteristic of the understory.
> **Singleleaf Pinyon Pine/California Juniper/Desert Needlegrass *(Pinus monophylla/Juniperus californica/Achnatherum speciosum)* Woodland Association**

**IB.** The short tree (or large shrub) layer is characterized by California Juniper (*Juniperus californica*) with no other tree species equaling or exceeding cover of *J. californica*, though other species (*Pinus monophylla, Yucca brevifolia*) may be present in small amounts (usually <1 percent cover).
**California Juniper *(Juniperus californica)* Woodland Alliance**

This alliance is represented by five different associations in JOTR.

> **IB.1.** *J. californica* is the characteristic short tree or tall shrub, mixing with the scrub oak *Quercus cornelius-mulleri*. The small shrub *Coleogyne ramosissima* is characteristic in the understory.
> **California Juniper - Muller Oak - Blackbush *(Juniperus californica - Quercus cornelius-mulleri/Coleogyne ramosissima)* Woodland Association**
>
> **IB.2.** *J. californica* occurs as a tall shrub or low tree with the shrubby Mojave Yucca, and the short shrub *Coleogyne ramosissima* is characteristic in the understory.

**California Juniper /Blackbush - Mojave Yucca *(Juniperus californica/Coleogyne ramosissima - Yucca schidigera)* Woodland Association**

**IB.3.** *J. californica* occurs with *Yucca schidigera. Coleogyne* is absent or very low cover and the medium tall bunch grass *Pleuraphis rigida* is characteristic of the understory
**California Juniper - Mojave Yucca/Big Galleta *(Juniperus californica - (Yucca schidigera)/Pleuraphis rigida)* Woodland Association**

**IB.4.** *J. californica* is the principal tall shrub or small tree over a relatively simple understory characterized by the low shrub *Coleogyne ramosissima.*
**California Juniper/Blackbush *(Juniperus californica/Coleogyne ramosissima)* Woodland Association**

**IB.5.** *J. californica* is the characteristic small tree or large shrub with a mixture of other shrub species including the characteristic yucca-like *Nolina parryi.*
**California Juniper/Beargrass *(Juniperus californica/Nolina parryi)* Woodland Association**

**Section II**

**II.** Stands characterized by nonconiferous trees including broad-leaf evergreen or deciduous species.
**Broad-Leaved Woodland and Forest**

**IIA.** Stands characterized by tall monocot trees of Southwest Desert affinities.

**IIA.1.** Stands characterized by the California Fan Palm (*Washingtonia filifera*), associated with springs and moist canyon bottoms in a few places in the park. Other riparian tree species (*Populus fremontii, Salix laevigata*) may be associated with them and may be codominant.
**California Fan Palm (*Washingtonia filifera*) Alliance**

**IIA.2.** Stands characterized by the Joshua Tree (*Yucca brevifolia*). *Y. brevifolia* maintains at least 1 percent cover, evenly distributed across the stand. Dominant understory species are shrub species such as *Coleogyne ramosissima, Opuntia ramosissima,* or the perennial grass *Pleuraphis rigida*. Common in shallow, upland soils throughout the mid and upper elevations of the park. *Yucca brevifolia* and *Juniperus californica* may both codominate in the tree or tall shrub layer. If *Pinus monophylla* and *Yucca brevifolia* codominate, then use *Pinus monophylla* alliance.
**Joshua Tree *(Yucca brevifolia)* Wooded Shrubland Alliance**

Six associations have been tentatively defined from the park.

**IIA.2.a.** *Yucca brevifolia* forms a widely scattered emergent but evenly distributed overstory over the more abundant short shrub *Coleogyne ramosissima*.
**Joshua Tree/Blackbush *(Yucca brevifolia/Coleogyne ramosissima)* Wooded Shrubland Association**

**IIA.2.b.** *Yucca brevifolia* and *Juniperus californica* codominate (usually between 1 percent and 5 percent cover each) in the tall shrub or tree layer with *Coleogyne ramosissima* as the principle understory shrub.
**Joshua Tree/California Juniper/Blackbush *(Yucca brevifolia/Juniperus californica/Coleogyne ramosissima)* Wooded Shrubland Association**

**IIA.2.c.** *Yucca brevifolia* and *Juniperus californica* both codominate between 1 percent and 5 percent cover, with Nevada Ephedra as the principal understory shrub.
**Joshua Tree/California Juniper/Nevada Ephedra *(Yucca brevifolia - Juniperus californica/Ephedra nevadensis)* Wooded Shrubland Association**

**IIA.2.d.** *Yucca brevifolia* occurs in upper bajada washes and arroyo margins with the large rosaceous shrub *Prunus fasciculata* as the principal understory species.
**Joshua Tree/Desert Almond *(Yucca brevifolia/Prunus fasciculata)* Wooded Shrubland Association**

**IIA.2.e**. *Yucca brevifolia* occurs as a regularly distributed emergent over a shrub understory of Creosote Bush and Mojave Yucca. These stands typically occur on lower elevation slopes and alluvial fans than the previously listed associations.
**Joshua Tree/Creosote Bush – Mojave Yucca *(Yucca brevifolia/Larrea tridentata - Yucca schidigera)* Wooded Shrubland Association**

**IIA.2.f.** *Yucca brevifolia* occurs as a regularly distributed emergent over Creosote Bush with the bunchgrass *Pleuraphis rigida* common and evenly distributed in the understory.
**Joshua Tree/Creosote Bush/Big Galleta *(Yucca brevifolia/Larrea tridentata - Pleuraphis rigida)* Wooded Shrubland Association**

**IIB.** Stands characterized by widespread winter-deciduous, broad-leaved (including pinnate-leaved, e.g., *Prosopis*) species of trees or tall shrubs usually associated with places that remain moist throughout the growing season.

**IIB.1.** The spreading tall shrub or short tree, Honey Mesquite (*Prosopis glandulosa*), is dominant (at least 2 percent absolute cover). If other tree or large shrub species are present, none have more cover or are any taller. Associated with alkaline wetlands and dune margins locally in the eastern portion of the park.
**Honey Mesquite (*Prosopis glandulosa*) Woodland Alliance (no associations defined for the park)**

**IIB.2.** The broad-leaved deciduous tree Fremont Cottonwood (*Populus Fremontii)* is conspicuous and the dominant tree throughout the stand. Associated with springs scattered throughout the park, may be mixed with Willow (Salix) species at lower cover.
**Fremont Cottonwood (*Populus fremontii*) Woodland Alliance (no associations defined for this project)**

**IIB.3.** Red Willow (*Salix laevigata*) is the dominant tree in stands, usually associated with permanent moisture in canyons and at springs, occasional throughout the park.
**Red Willow (*Salix laevigata*) Forest Alliance (no associations defined for the park)**

**Section III**

**III.** Stands characterized by thorny, extremely xeromorphic trees including Blue Palo Verde (*Cercidium floridum,* also known as *Parkinsonia florida*) and Ironwood (*Olneya tesota*).

**IIIA.** Stands characterized by Blue Palo Verde (*Cercidium floridum*) as solely dominant in the sparse short tree or tall shrub layer. If Ironwood (*Olneya tesota*) is present, it is significantly less in cover in the tree or shrub layer than *C. floridum.* Characteristic of washes in the lower-elevation (Colorado Desert) portion of the park.
**Blue Palo Verde (*Cercidium floridum*) Extremely Xeromorphic Evergreen Shrubland Alliance**

Two associations have been defined from JOTR.

**IIIA.1**. Blue Palo Verde forms an open to emergent short tree or tall shrub layer with the constant presence of Desert Lavender (*Hyptis emoryi*) as scattered shorter shrubs.
**Blue Palo Verde/Desert Lavender (*Cercidium floridum /Hyptis emoryi*) Association**

**IIIA.2.** Stands dominated by *Cercidium floridum* in the tree layer. *Hymenoclea salsola* and the Desert Willow (*Chilopsis linearis)* are the most abundant in the shrub layer.
**Blue Palo Verde/Desert Willow (*Cercidium floridum/Chilopsis linearis)* Association**

**IIIB.** Stands characterized by the short tree Desert Ironwood (*Olneya tesota*) strongly dominating an emergent tree layer, often mixed with other tall shrubs. If *Cercidium floridum* is present, it is in substantially lower cover in both tree and shrub layers. Associated with washes and bajadas, with occasional sheet flow in the Colorado Desert portion of the Park.
**Desert Ironwood (*Olneya tesota*) Extremely Xeromorphic Evergreen Woodland Alliance (provisional new alliance)**

A single association has been defined from the park, characterized by the presence of Desert Lavender (*Hyptis emoryi*) in the understory.
**Desert Ironwood/Desert Lavender (*Olneya tesota/Hyptis emoryi*) Xeromorphic Woodland Association**

**IIIC.** Stands characterized by a mixture of Desert Ironwood and Blue Palo Verde, both in relatively low cover as emergent tall shrubs or short trees over desert scrub. Local stands appear to be in fan or bajada settings, without strong wash geomorphology, and relatively low cover of both tall species. Only two plots are assigned to this alliance currently; no associations are defined.
**Blue Palo Verde-Desert Ironwood *(Cercidium floridum* = *Parkinsonia florida* - *Olneya tesota*) Woodland Alliance**

**Division B: Shrub Vegetation**

Vegetation characterized by shrubs of various heights. Trees if present, are usually insignificant (<1 percent cover) and not evenly scattered throughout the stand. This division is categorized into three sections: (1) shrublands of wet to moist localities including springs, seasonally flooded stream channels, and so forth; (2) moderately tall shrublands (shrub canopy ranging from >0.5 m to 4 m) of drier localities from intermittently flooded desert washes to dry uplands; and (3) dwarf shrublands where the average height of shrubs is 0.5 m or less.

**Section I**

**I.** Stands characterized by shrubs of localities remaining wet to moist through the growing season.

**IA.** Stands characterized by winter-deciduous shrubs of the genus *Salix* (Willows)

> **I.A.1.** Narrow-Leaf Willow the dominant shrub. Local stands around freshwater springs scattered throughout the park. No associations have been defined locally, and no samples taken, but small stands are known from the park.
> **Narrow-Leaf Willow (*Salix exigua*) Deciduous Shrubland Alliance**

**IB.** Stands characterized by the winter deciduous broom-like shrub, False Willow (*Baccharis sergiloides).* Occasional in upper-elevation canyons and below flowing springs. No associations defined locally, one sample taken.
**False Willow (*Baccharis sergiloides*) Intermittently Flooded Shrubland Alliance**

**Section II**

**II.** Stands characterized by a canopy or emergent layer of moderately tall to dwarf shrubs, ranging in a variety of settings from the higher mountains to the lowest portions of the park. This key is based on species composition and contains the largest number of choices in the entire key. A stand is most easily identified if you proceed through all of the choices until you reach a description that fits the characteristics of dominance specified. It is categorized into two subsections, one with Creosote Bush as a common and characteristic component and the other without Creosote Bush as a common and characteristic component.

**Subsection IIA.** Vegetation with Creosote Bush (*Larrea tridentata*) as a characteristic tall shrub (generally >= 1 percent and evenly distributed across the stand). No shrub with cover greater than *Larrea tridentata* with the following exceptions: *Ambrosia dumosa*, *Encelia farinosa, Krameria* spp. *Bebbia juncea, Ericameria teretifolia* or *Acamptopappus sphaerocephalus*. *Ephedra nevadensis* may have higher cover, but no more than three times. Go to IIA.1.

**IIA.1.** *Ambrosia dumosa* present (>=1 percent cover), may have higher cover than *Larrea tridentata.* If *Encelia farinosa* is present, go to IIA.3. Widespread on all but the hottest and most rocky, sandy, or alkaline areas of the middle and lower elevations.
**Creosote Bush - Burro Bush *(Larrea tridentata-Ambrosia dumosa)* Shrubland Alliance**

The *Larrea tridentata - Ambrosia dumosa* Shrubland Alliance is one of the most diverse alliances in the Mojave and Northern Sonoran deserts. It is represented in JOTR by seven associations, all defined first in this project. In addition to these identified below, there are several other variations that have not been substantiated. These will only be keyable to the alliance level in the following key:

**IIA.1.a.** Simple, widespread association with the main two shrubs Creosote Bush and Burro Bush (*Larrea tridentata* and *Ambrosia dumosa)*. No other shrubs common or characteristic.
**Creosote Bush - Burro Bush (*Larrea tridentata - Ambrosia dumosa)* Shrubland Association**

**IIA.1.b.** Creosote Bush and Burro Bush common with White Rhatany (*Krameria grayi*), a common and characteristic associate.
**Creosote Bush - Burro Bush - White Rhatany (*Larrea tridentata - Ambrosia dumosa - Krameria grayi)* Shrubland Association**

**IIA.1.c.** Creosote Bush and Burro Bush joined by Schott's Indigo Bush (*Psorothamnus schottii*), often in washes and on bajadas subject to sheet flow in the lower parts of the park including Pinto Basin.
**Creosote Bush - Burro Bush - Indigo Bush (*Larrea tridentata -Ambrosia dumosa - Psorothamnus schottii)* Shrubland Association**

**IIA.1.d**. Creosote Bush and Burro Bush accompanied by the perennial grass Big Galleta (*Pleuraphis rigida*). Generally present on sandy fans and lower bajadas and occasionally at the edges of sand sheets and dunes.
**Creosote Bush - Burro Bush - Big Galleta (*Larrea tridentata - Ambrosia dumosa - Pleuraphis rigida)* Shrubland Association**

**IIA.1.e.** Creosote Bush and Burro Bush accompanied by the usually leafless and green-stemmed Desert Senna (*Senna armata*), usually associated with small, sandy washes on mid and lower alluvial fans at middle elevations in the park.

**Creosote Bush - Burro Bush – Spiny Senna (*Larrea tridentata - Ambrosia dumosa - Senna armata)* Shrubland Association**

**IIA.1.f.** Creosote Bush and Burro Bush accompanied by Mojave Yucca (*Yucca schidigera*) at a cover of less than the total cover of either Creosote Bush or Burro Bush. Common at mid elevations on upper fans and hills in the Mojave Desert portion of the park. If *Y. schidigera* is greater than 2 percent cover with a comparable cover of Creosote Bush or Burro Bush, the stand falls into the Mojave Yucca Alliance.
**Creosote Bush - Burro Bush - Mojave Yucca (*Larrea tridentata - Ambrosia dumosa - Yucca schidigera)* Shrubland Association**

**IIA.1.g.** Creosote Bush and Burro Bush accompanied by the short, rounded subshrub Brittlebush (*Encelia farinosa*) at less cover than either *Larrea* or *Ambrosia.* This type usually occurs on lower-elevation slopes in the park. If at mid elevations, it is usually on southerly facing exposures.
**Creosote Bush - Burro Bush - Brittlebush (*Larrea tridentata - Ambrosia dumosa - Encelia farinosa)* Shrubland Association**

**IIA.2** *Encelia farinosa* present (>=1 percent cover), may have higher cover than *Larrea tridentata*. *Ambrosia dumosa* may be present but at generally low cover (usually less than *Encelia*). Widespread on hot (southerly exposure) mountain slopes and upper bajadas.
**Creosote Bush - Brittlebush *(Larrea tridentata-Encelia farinosa)* Shrubland Alliance**

The *Larrea tridentata - Encelia farinosa* Shrubland Alliance is represented by three associations in JOTR.

**IIA.2.a.** Creosote Bush, Burro Bush, and Brittlebush are all >1 percent cover, and Brittlebush exceeds or equals Burro Bush in cover. Common on lower elevations on neutral, rocky slopes or on steep, south facing slopes at mid elevations throughout the park.
**Creosote Bush – Brittlebush - Burro Bush (*Larrea tridentata - Encelia farinosa - Ambrosia dumosa)* Association**

**IIA.2.b.** Creosote Bush and Brittlebush are both codominant in the shrub layer with Burro Bush absent or insignificant and no other shrubs in higher cover. This is the simple and common association of the alliance on southerly facing slopes at mid elevations throughout the park.
**Creosote Bush - Brittlebush (*Larrea tridentata - Encelia farinosa)* Shrubland Association**

**IIA.2.c.** Creosote Bush and Brittlebush are both codominant, with the tall, wand-like Ocotillo *(Fouquieria splendens)* as an emergent evenly spaced, though low in

cover. Locally distributed on lower fans in Pinto Basin and perhaps elsewhere in the Colorado Desert portion of the park.
**Creosote Bush – Brittlebush - Ocotillo *(Larrea tridentata - Encelia farinosa - Fouquieria splendens)* Shrubland Association**.

**IIA.3.** Associated shrubs other than *Ambrosia dumosa* or *Encelia farinosa* may be present or absent. Except for shrubs listed above in Subsection IIA, cover of associated shrub species (on an individual basis) is less than *Larrea tridentata.*
**Creosote Bush *(Larrea tridentata)* Shrubland Alliance**.

There are three associations identified in the park, along with several single sample variants that, at this point, can only be keyed to the alliance level.

**IIA.3.a**. Creosote Bush is the sole dominant shrub, with little else in the shrub layer. A monoculture associated with lower bases of fans and bajadas that may be sandy or have had past disturbance (at least, in other parts of the Mojave Desert).
**Creosote Bush *(Larrea tridentata)* (Undifferentiated) Shrubland Association**

**IIA.3.b**. Creosote Bush forms a simple shrub layer, with the tufted perennial Big Galleta grass *(Pleuraphis rigida)* evenly distributed in the understory. Generally in sandy areas at lower elevations at the bases of bajadas and adjacent to sand fields.
**Creosote Bush - Big Galleta *(Larrea tridentata/Pleuraphis rigida)* Shrubland Association**

**IIA.3.c.** Creosote Bush is the sole dominant medium tall shrub, with an even distribution of Cheesebush and few other shrubs. Generally associated with minor washes and disturbed areas in middle to lower elevations of the park.
**Creosote Bush - Cheesebush *(Larrea tridentata - Hymenoclea salsola)* Shrubland Association**

**Subsection IIB.** Creosote Bush (*Larrea tridentata*), if present, generally not one of the shrub species producing the greatest cover (however, it may be present and even conspicuous). Other shrubs (other than listed in couplet IIA) are typically dominant.

**IIB.1.** Stands characterized (1 percent or higher cover) by the large shrub or small tree Desert Willow *(Chilopsis linearis)*. No other tree-sized or tall shrub species equals or exceeds *Chilopsis linearis* cover. Known from washes at mid to low elevations throughout the park.
**Desert Willow *(Chilopsis linearis)* Intermittently Flooded Shrubland Alliance**

A single, broadly defined association is known from the park. *Chilopsis linearis* is the dominant tall shrub or small tree and the less abundant, though constant

*Hymenoclea salsola* is in the shrub layer. *Prunus fasciculata* and *Acacia greggii* are nearly as common as *Chilopsis* within a few stands.
**Desert Willow (*Chilopsis linearis*) Association**

**IIB.2.** Vegetation dominated by tall, shrubby, invasive *Tamarix* spp. (either *T. ramosissima, T. chinensis*, or other similar species but not including the less invasive, taller *T. aphylla*). *Tamarix* spp. should strongly dominate (>60 percent relative cover) over native tall shrubs and/or low trees to be considered as alliance. Not widespread within the park; in moist environments near springs and streams with semipermanent moisture.
**Tamarisk *(Tamarix* spp.*)* Seminatural Flooded Shrubland Alliance**

**IIB.3**. Cheesebush (*Hymenoclea salsola)* >1 percent cover and greater cover than other shrubs. Found commonly in wash environments or disturbed environments. Currently, no associations are defined in the park. Stands are variable in composition. Stands vary from monospecific to stands with the following species present: *Petalonyx thurberi, Eriogonum plumatella, Salazaria mexicana*, *Larrea tridentata*, *Senna armata*, *Psorothamnus armata*, *and Tetracoccus hallii.*
**Cheesebush *(Hymenoclea salsola)* Shrubland Alliance**

**IIB.4.** California (or flat-top) Buckwheat (*Eriogonum fasciculatum*) >=2 percent with no other shrub species exceeding it in cover. Usually in disturbed, shallow soils on slopes and pediments near interface with mid- and upper-elevation zones. No associations defined locally.
**California Buckwheat (*Eriogonum fasciculatum)* Shrubland Alliance**

**IIB.5.** Bladder-Sage (or Paper-Bag Bush) (*Salazaria mexicana*) >=2 percent cover, with no other shrub species exceeding it in cover**.** Usually of washes, but may occur on burns or in other disturbed uplands. This alliance is not defined at the association level locally.
**Bladder-Sage *(Salazaria mexicana)* Shrubland Alliance**

**IIB.6.** Mojave Yucca (*Yucca schidigera)* >=2 percent cover. May have other shrub specie, including *Eriogonum fasciculatum*, *Ephedra nevadensis*, *Larrea tridentata, Ambrosia dumosa, Tetracoccus hallii*, and *Senna armata,* relatively common. Widespread in the middle elevations of the park, usually on upper fans and hillslopes.
**Mojave Yucca *(Yucca schidigera)* Shrubland Alliance**

Four associations have been defined locally.

**IIB.6.a.** Mojave Yucca, often codominant with Blackbush *(Coleogyne ramosissima)*. On pediments and hillslopes near the upper-elevation range of the alliance.
**Mojave Yucca - Blackbush *(Yucca schidigera - Coleogyne ramosissima)* Shrubland Association**

**IIB.6.b.** Mojave Yucca associates with Creosote Bush and with Jojoba *(Simmondsia chinensis)*. Occasional on rocky slopes and bajadas near the lower-elevation extent of the alliance.
**Mojave Yucca - Creosote Bush - Jojoba *[Yucca schidigera - Larrea tridentata (-Simmondsia chinensis)]* Shrubland Association**

**IIB.6.c.** Mojave Yucca associates with Creosote Bush and Burro Bush *(Ambrosia dumosa)*. Common on bajadas and gentle hillslopes at the lower-elevation extent of the alliance near the transition with the Creosote Bush-Burro Bush alliance. In these stands, Mojave yucca is 2 percent or greater cover but may codominate with the other two shrubs.
**Mojave Yucca - Creosote Bush - Burro Bush *(Yucca schidigera - Larrea tridentata - Ambrosia dumosa)* Shrubland Association**

**IIB.6.d.** Mojave Yucca occurs with several other shrubs and with the perennial Big Galleta grass (*Pleuraphis rigida*). Usually on upper bajadas with a relatively sandy substrate.
**Mojave Yucca/Big Galleta (*Yucca schidigera/Pleuraphis rigida)* Shrubland Association**

**IIB.7.** *Coleogyne ramosissima* >=2 percent cover. *Ephedra nevadensis* and/or *Krameria grayi* can have up to twice the cover of *Coleogyne ramosissima*. Typically dominates stands, but may be exceeded by species of disturbance (*Hymenoclea salsola, Salazaria mexicana, Ericameria* spp., or *Eriogonum fasciculatum*). A widespread type of shallow, rocky soils on upper bajadas, pediments, and hillslopes. This alliance is not defined at the association level locally.
**Blackbush *(Coleogyne ramosissima)* Shrubland Alliance**

**IIB.8.** Burro Bush (*Ambrosia dumosa*) >1 percent cover, and no other species with equal or higher cover. Occasional on lower, sandy flats or on hillslopes, usually at lower elevations. May occur on edges of washes.
**Burro Bush *(Ambrosia dumosa)* Dwarf Shrubland Alliance**

A single association has been defined locally with the perennial Big Galleta grass (*Pleuraphis rigida*) as a conspicuous associate.
**Burro Bush - Big Galleta *(Ambrosia dumosa - Pleuraphis rigida)* Dwarf Shrubland Association**

**IIB.9.** Brittlebush (*Encelia farinosa)* is dominant (at least >1%), and no other species have equal or higher cover, except possibly *Lycium andersonii*. Occasional on hot, rocky slopes at lower elevations in the park. In the few stands sampled, *Ambrosia dumosa*, *Lycium andersonii,* and *Fagonia laevis* have been noted as associated species. No associations have been defined locally.

**Brittlebush *(Encelia farinosa)* Shrubland Alliance**

**IIB.10.** Anderson's Desert-Thorn or Wolfberry (*Lycium andersonii*) is the dominant species. Usually occurs on rocky slopes at low to mid elevations in scattered locations throughout the park.
**Anderson's Boxthorn (*Lycium andersonii*) Shrubland Alliance**

This alliance is represented in the Park by one association, defined first in this project, the **Anderson's Desert-Thorn – Jojoba - Big Galleta *(Lycium andersonii–Simmondsia chinensis–Pleuraphis rigida)* Shrubland Association**

**IIB.11.** A saltbush species (*Atriplex* spp.) provides >= half of all shrub cover.

**IIB.11.a.** Four-Wing Saltbush *(Atriplex canescens)* with highest shrub cover. Typically of low-lying playa edges, dune aprons, or edges of alkaline wetlands from low- to mid-elevation zones. This alliance is not defined at the association level locally.
**Four-Wing Saltbush *(Atriplex canescens)* Shrubland Alliance**

**IIB.11.b.** Desert Holly *(Atriplex hymenelytra)* >1 percent cover, and no other species with equal or higher cover. May occur on hot, rocky slopes; dry bajadas; or alkaline badlands and playa edges.
**Desert Holly *(Atriplex hymenelytra)* Shrubland Alliance**

This alliance is represented in the park by one association, defined first in this project.
**Desert Holly - Creosote Bush - Burro Bush *(Atriplex hymenelytra - Larrea tridentata - Ambrosia dumosa)* Shrubland Association**

**IIB.12.** Catclaw (*Acacia greggii*) >=2 percent cover. No other single, tall shrub species with greater cover, but *Prunus fasciculata* or *Hyptis emoryi* may be equal or slightly greater cover than *Acacia.* Smaller shrubs, such as *Ericameria paniculata* or *Hymenoclea salsola,* can have higher cover but no more than twice the cover of *Acacia greggii.* Occurs in washes and arroyos, as well as upland valleys and bouldery slopes. In addition to the following described associations, this alliance may also include the following shrub species in some stands that have as yet been undefined at the association level: *Peucephyllum schottii, Tetracoccus hallii, Ephedra californica*, *Chilopsis linearis*, *Ephedra nevadensis*, *Lycium cooperi, Viguiera parishii*, *Yucca schidigera, Nolina bigelovii,* and *Eriogonum fasciculatum.*
**Catclaw *(Acacia greggii)* Shrubland Alliance**

This alliance is represented in the park by three associations, all defined first in this project.

**IIB.12.a.** Catclaw and the shrubby Desert Almond (*Prunus fasciculata*) co-occur, often both codominant in small arroyos and washes on upper fans and in mountains at mid to upper elevations of the park.
**Catclaw - Desert Almond *(Acacia greggii - Prunus fasciculata)* Shrubland Association**

**IIB.12.b.** Catclaw is the major tall shrub, but Sweetbush *(Bebbia juncea)* is a common short shrub. Generally of rocky washes at lower elevations.
**Catclaw - Sweetbush *(Acacia greggii - Bebbia juncea)* Shrubland Association**

**IIB.12.c.** Catclaw and Desert lavender *(Hyptis emoryi)* are both common and characteristic. Of lower-elevation, rocky washes and occasionally rocky slopes.
**Catclaw - Desert-Lavender (*Acacia greggii - Hyptis emoryi)* Shrubland Association**

**IIB.13.** Vegetation either dominated or codominated by California Ephedra (*Ephedra californica*), typically in broad, active washes of mid to upper bajadas and fans. Ranging somewhat locally throughout the southwestern, central, and eastern portions of the area. Other species common in this alliance include *Hymenoclea salsola, Viguiera parishii,* and *Pleuraphis rigida.*
**California Ephedra *(Ephedra californica)* Intermittently Flooded Shrubland Alliance**

This alliance is represented in JOTR by one association.
**California Ephedra (*Ephedra californica)* Shrubland Association**

**IIB.14.** Desert Almond (*Prunus fasciculata*) >=2 percent cover. Must be 25 percent or more of total vegetative cover of stand. *Gutierrezia sarothrae* may have higher cover. If *Prunus fasciculata* co-occurs with other tall shrubs, such as *Acacia greggii*, it must have twice the cover of other species to make the alliance definition. Typically of washes and arroyos at the mid and upper elevations of the park, but may occur on wash terraces and in valleys. The following species are common associates: *Salazaria mexicana*, *Ericameria teretifolia, Yucca schidigera*, *Rhus trilobata*, and *Purshia tridentata*.
**Desert Almond (*Prunus fasciculata)* Shrubland Alliance**

A single, broadly defined association has been identified from the park.
**Desert Almond *(Prunus fasciculata)* Intermittently Flooded Shrubland Association**

**IIB.15**. Smoketree (*Psorothamnus spinosus*) >=2 percent cover. No other species with greater or equal cover. Of low-elevation, active washes, mostly in southern and central portion of mapping area. Some of the upper-elevation examples of these stands may have California Buckwheat (*Eriogonum fasciculatum*). The Desert Willow (*Chilopsis linearis*) may occasionally occur in some stands.
**Smoketree *(Psorothamnus spinosus)* Intermittently Flooded Shrubland Alliance**

This alliance is represented in JOTR by two associations.

**IIB.15.a.** Smoketree occurs in stands with Desert Lavender (*Hyptis emoryi*) and Catclaw (*Acacia greggii*). Usually in lower-elevation, rocky washes and arroyos, but may also occur on bouldery slopes.
**Smoketree - Desert-Lavender - Catclaw Association *(Psorothamnus spinosus - Hyptis emoryi - Acacia greggii)* Association**

**IIB.15.b.** Smoketree occurs in association with Desert Tea *(Ephedra californica)*. Usually in sandy washes at mid elevations of the park.
**Smoketree/Desert Tea Association *(Psorothamnus spinosus - Ephedra californica)* Association**

**IIB.16**. Desert False Willow (*Baccharis sergiloides*), dominant. Typically of intermittent springs and washes in mid and upper elevations, usually in granitic washes and adjacent to springs. This alliance is not defined at the association level locally.
**Desert False Willow *(Baccharis sergiloides)* Intermittently Flooded Shrubland Alliance**

**IIB.17.** Nevada Ephedra (*Ephedra nevadensis*) >=2 percent cover. No other species with greater cover, with the exceptions of *Acamptopappus sphaerocephalus* or *Chrysothamnus viscidiflorus*. This alliance is not defined at the association level locally.
**Nevada Ephedra (*Ephedra nevadensis)* Shrubland Alliance**

**IIB.18.** Rubber Rabbitbrush (*Ericameria nauseosa*) >=2 percent. *Ericameria nauseosa* must have 25 percent or greater relative cover in the shrub layer. Occasional in upper-elevation zones, usually in areas with fire or flood history. This alliance is not defined at the association level locally.
**Rubber Rabbitbrush *(Ericameria nauseosa)* Shrubland Alliance**

**IIB.19.** Paniculate or Black-Stem Rabbitbrush (*Ericameria paniculata*) >=2 percent. *Ericameria paniculata* must be >=25 percent of all cover. Occasional throughout broad elevation range in much of the mapping area in relatively large, recently active washes. This alliance is not defined at the association level locally.
**Paniculate Rabbitbrush *(Ericameria paniculata)* Intermittently Flooded Shrubland Alliance**

**IIB.20**. Round-Leaf Rabbitbrush (*Ericameria teretifolia*) >=2 percent cover. No other species with greater or equal cover. Usually of disturbed uplands**,** in the upper elevations of the park often adjacent to *Juniperus californica* stands**.** This alliance is not defined at the association level locally.
**Round-Leaf Rabbitbrush *(Ericameria teretifolia)* Shrubland Alliance**

**IIB.21.** Spiny Hop-Sage (*Grayia spinosa*) >=2 percent cover; no other species with greater cover, except *Ericameria cooperi* or *Lycium andersonii. Lycium andersonii* may dominate in some circumstances. *This alliance has not been formally sampled in the park, but anecdotal evidence suggests that it does locally occur on upper fans and pediments in the middle to higher elevations of the park.*
**Spiny Hop-Sage *(Grayia spinosa)* Shrubland Alliance**

**IIB.22.** Vegetation characterized by the tall, aromatic shrub Desert Lavender (*Hyptis emoryi)*. Generally, other shrub species are not in high cover, but stands may include *Acacia greggii* and *Sarcostemma cynanchoides*. In rocky washes of upper bajadas and low-elevation canyons throughout the park.
**Desert Lavender *(Hyptis emoryi)* Intermittently Flooded Shrubland Alliance**

This alliance is represented in the park by one broadly defined association.
**Desert-Lavender *(Hyptis emoryi)* Shrubland Association**

**IIB.23.** Stands dominated by Teddy-Bear Cholla (*(Opuntia bigelovii)*. Local in Pinto Basin on rocky fans.
**Teddy-Bear Cholla (*Opuntia bigelovii*) Shrubland Alliance**

The alliance is represented locally by a single association.
**Teddy-Bear Cholla *(Opuntia bigelovii)* Shrubland Association**

**IIB.24.** Vegetation characterized by the low diffuse Desert Sunflower or Parish Viguiera (*Viguiera parishii*) with >=2 percent cover. No other species with greater or equal cover. Stands typically occur on rocky hillslopes just above the *Larrea tridentata-Ambrosia dumosa* zone or, rarely, in washes. Other common species in the stands include *Ephedra nevadensis*, *Hyptis emoryi,* and *Encelia farinosa*.
**Parish Viguiera (*Viguiera parishii)* Shrubland Alliance**

This alliance is represented in the park by one association, defined first in this project.
**Parish Viguiera/California Buckwheat *(Viguiera parishii/Eriogonum fasciculatum)* Shrubland Association.** Where California Buckwheat is the most common associate and may codominate.

**IIB.25**. The Yucca-like tall shrub Parry Beargrass (*Nolina parryi*) >3 percent cover. Uncommon, scattered in high portions of the Little San Bernardino Mountains on rocky slopes near other montane alliances such as Single-Leaf Pinyon (*Pinus monophylla*) and Muller Oak (*Quercus cornelius-mulleri)*. No associations have been defined locally.
**Parry Beargrass *Nolina parryi* Shrubland Alliance**

**IIB.26.** *Purshia tridentata* >=2 percent cover. If *Artemisia tridentata* or *Ephedra viridis* are present, they have less than 1 percent cover. A local type in high mountains (stands observed occur adjacent to *Juniperus californica* stands on upper fans and near arroyos of the western portion of mapping area. No associations have been defined locally.
**Antelope Bush *(Purshia tridentata)* Shrubland Alliance**

**IIB.27.** Vegetation characterized by Muller or Desert Scrub Oak (*Quercus cornelius-mulleri)*. The oak is > or + 2 percent cover and is not exceeded by any tree cover such as California Juniper or Single-Leaf Pinyon Pine.
**Muller Oak (*Quercus Cornelius-mulleri*) Shrubland Alliance**

Two associations have been defined locally.

**IIB.27.a.** Muller Oak is the dominant overstory shrub over a scattered, shorter shrub layer characterized by Linear-Leafed Goldenbush (*Ericameria linearifolia*) and California Buckwheat (*Eriogonum fasciculatum*). Common on slopes of higher mountains.
**Muller Oak/California Buckwheat - Linear-Leafed Goldenbush (*Quercus cornelius-mulleri/Eriogonum fasciculatum-Ericameria linearifolia*) Shrubland Association**

**IIB.27.b.** Muller Oak occurs with the shorter shrub Blackbush (*Coleogyne ramosissima*) on upper fans and relatively linear hillslopes of the upper elevations.
**Muller's Oak/Blackbush (*Quercus cornelius-mulleri/Coleogyne ramosissima)* Shrubland Association**

**IIB.28.** Bigberry Manzanita (*Arctostaphylos glauca*), dominant, at least 2 percent cover with no other shrub species equaling or exceeding it in cover. Occasional stands on high and relatively warm slopes of the Little San Bernardino Mountains. No associations defined locally.
**Bigberry Manzanita (*Arctostaphylos glauca*) Shrubland Alliance**

**IIB.29.** Stands dominated by the Euphorbiaceous shrub *Tetracoccus hallii*. Stands are generally centered in the southern-central portion of the park from low-elevation wash margins near the Eagle Mine to rocky uplands in the vicinity of Cottonwood Springs. Insufficient information exists to define an alliance, so these stands are considered unique at this point.
**Hall's Tetracoccus *(Tetracoccus hallii)* Unique Stands**

**IIB.30.** Stands dominated by the large shrub known as Lotebush *(Ziziphus obtusifolia)*. Stands occur adjacent to small washes in the southern portion of the park near Cottonwood Springs and, so far, are not known elsewhere.
**Lotebush (*Ziziphus obtusifolia)* Unique Stands (one plot)**

**IIB.31.** Stands are distinguished by the dominance of the Chuparosa (*Justicia californica*). Occasional stands associated with low-elevation washes at the southern portion of the park near other stands of Colorado Desert wash vegetation (*Olneya tesota* and *Cercidium floridum* Alliance stands or *Hyptis emoryi* stands). So far, not described elsewhere and currently treated as unique stands.
**Chuparosa *(Justicia californica)* Unique Stands**

**Division C**: **Herbaceous Vegetation**

Two sections are included: (1) perennial grasslands and (2) annual grasslands.

**Section I**

**I.** Stands dominated by perennial grasses.
**Perennial Grasslands**

**IA.** Big Galleta Grass (*Pleuraphis rigida*) >=2 percent. This species occurs in low, sandy areas and occasionally uplands at mid elevations, often with emergent shrubs such as *Yucca schidigera* and *Ephedra nevadensis*. As an alliance in the park, it is generally uncommon in upland areas, such as upper bajadas, sandy washes, and intermontane valleys, and somewhat more common in low, sandy areas. In addition to the association described below, several stands include several shrubs such as *Hymenoclea salsola*, *Lycium cooperi,* and *Ephedra nevadensis* in total lower cover than the grass cover. Other unclassified stands suggest a relatively pure association with little other perennial cover but Big Galleta.
**Big Galleta *(Pleuraphis rigida)* Herbaceous Alliance**

This alliance is represented in the park by one association, first described for this project. It is characteristic of low flats adjacent to sandy playas, such as Pleasant Valley, and characterized by the presence of scattered shrubs of Four-wing Saltbush.
**Big Galleta -Four-wing *(Pleuraphis rigida - Atriplex canescens)* Grassland Association**

**IB.** Vegetation characterized by the dominance of the bunch grass Desert Needlegrass *(Achnatherum speciosum)*. Rare in mapping area, usually in small enclaves surrounded by more extensive upland vegetation of mid- to upper-elevation alliances such as *Coleogyne ramosissima* Shrubland. No associations defined.
**Desert Needlegrass *(Achnatherum speciosum)* Herbaceous Alliance**

**Section II**

**II.** Stands dominated by annual grasses, locally in all cases, these species are nonnatives. Stands fluctuate, depending on annual variation in timing and amount of precipitation.
No perennial species (either shrubs or herbs) totaling greater than 10 percent absolute cover.

**Annual Grasslands**

**IIA.** Vegetation dominated by Cheatgrass (*Bromus tectorum*). Occasional in postburn situations, mostly at mid and upper elevations and associated with former stands of *Yucca brevifolia, Pinus monophylla, Coleogyne ramosissima,* and *Juniperus californica* alliances.
**Cheatgrass (*Bromus tectorum*) Annual Herbaceous Alliance**

**IIB.** Vegetation dominated by Red Brome (*Bromus madritensis* ssp. *rubens*). Generally present in disturbed areas in middle elevations of the park.
**Red Brome (*Bromus madritensis* ssp. *rubens*) Annual Herbaceous Alliance**

# VEGETATION DESCRIPTIONS

## Montane Woodland and Scrub

### California Juniper *(Juniperus californica)* Wooded Shrubland Alliance

The *Juniperus californica* Wooded Shrubland Alliance occurs in the central California coast ranges, Southern California mountains and valleys, Northern California interior coast ranges, Sierra Nevada, Sierra Nevada foothills, and Mojave Desert.

Fire intervals have decreased substantially in vegetation types dominated by California Juniper since the introduction of nonnative, annual grasses. Summer or fall fire in stands with an intermittent to continuous understory of nonnative, annual grasses leads to the near complete loss of California Juniper within the fire perimeter. Brooks (personal communication 2000) has observed substantial losses of stands of California juniper types in JOTR as a result of fire.

This alliance is represented in JOTR by five associations, all defined first in this project. These five include the California Juniper/Muller Oak - Blackbush *(Juniperus californica/Quercus cornelius-mulleri - Coleogyne ramosissima)* Woodland Association, California Juniper/Blackbush - Mojave Yucca (*Juniperus californica/Coleogyne ramosissima - Yucca schidigera)* Woodland Association, California Juniper/Mojave Yucca/Big Galleta (*Juniperus californica/*(*Yucca schidigera)/Pleuraphis rigida)* Woodland Association, California Juniper/Blackbush (*Juniperus californica/Coleogyne ramosissima)* Woodland Association, and California Juniper/Beargrass (*Juniperus californica/Nolina parryi)* Woodland Association.

In addition to the associations described below, five unclassified alliance-level samples were taken that suggest further variation, three of which have signatures distinct enough for mapping (their mapping codes are provided below). These include

> *Juniperus californica,* undifferentiated, with *Encelia farinosa* (MDEI: 141-2-8)
> *Juniperus californica/Viguiera parishii - Salazaria mexicana* (JOTR: 11B-06-2)
>
> *Juniperus californica*/*Tetracoccus hallii* (JOTR: 34-06-4), Mapping Code: 10029
> *Juniperus californica/Nolina bigelovii - Viguiera parishii* (JOTR: 32-08-3, 34A-03-2), Mapping Code: 10030 (= *Juniperus californica/Viguiera parishii – (Nolina bigelovii)*
> *Juniperus californica/Yucca schidigera* (JOTR: 20-13-1), Mapping Code: 10031 (= *Juniperus californica/Yucca schidigera – [Tetracoccus hallii])*

This alliance has been subjected to several fires in recent years within the park and consists of a somewhat confusing array of samples, in part, as a result of postfire, seral conditions. With more

study, the preliminary descriptions of these associations may be revised to be phases under a more simplified group of associations, perhaps delineated by slope position (upper fan and bajada types with higher *Coleogyne* and *Pleuraphis* cover versus hill and mountain types with larger surface area covered by rock that tend to have more *Quercus cornelius-mulleri* and/or *Nolina parryi* and *Eriogonum fasciculatum*).

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*Juniperus californica/Quercus cornelius-mulleri - Coleogyne ramosissima* Woodland Association (Mapping Code: 21233)

| | |
|---|---|
| COMMON NAME | California Juniper/Muller's Oak - Blackbush Woodland Association |
| SYNONYM | Desert Woodland Association (Leary 1977) |
| PHYSIOGNOMIC CLASS | Woodland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Woodland |
| PHYSIOGNOMIC GROUP | Temperate or Subpolar Needle-Leaved Evergreen Woodland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Rounded-Crowned Temperate or Subpolar Needle-Leaved Evergreen Woodland |
| ALLIANCE | *Juniperus californica* Wooded Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Upland |

RANGE
Globally
This association is described only from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory. This type may also occur in other portions of the desert slopes of the transverse and peninsular ranges of Southern California.

JOTR
Stands of the *Juniperus californica/Quercus cornelius-mulleri - Coleogyne ramosissima* Woodland Association are found in the western part of the park in pinyon/juniper areas, in the Covington Flats area, and in the Little San Bernardino Mountains.

ENVIRONMENTAL DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of *Juniperus californica/Quercus cornelius-mulleri - Coleogyne ramosissima* Woodland Association are found at high elevations (above 3,500 ft.; 1,000 m) on variable slope exposures. This association is found on gentle to somewhat steep (4–23 degree) undulating slopes of

erosional highlands, alluvial plains, and intramontane alluvial plains. The substrate surface consists of 0–5 percent bedrock, 0–<1 percent boulder, 0–5 percent stone, 0–5 percent cobble, 25–>75 percent gravel, and 50–>75 percent fines cover. Litter consists of <1–10 percent cover. Soil textures include medium sand, moderately coarse sandy loam, medium to very fine sandy loam, and medium silt loam. Soil is derived from granitoid or metamorphic, parent material. These sites generally experience low to high competition from exotic species (2–20 percent nonnatives).

MOST ABUNDANT SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Herbaceous | *Bromus madritensis* |
| Shrub | *Coleogyne ramosissima, Quercus cornelius-mulleri* |
| Tree | *Juniperus californica, Pinus monophylla* |

CHARACTERISTIC SPECIES
Globally
This association is known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Shrub | *Quercus cornelius-mulleri, Coleogyne ramosissima, Yucca schidigera, Ericameria linearifolia* |
| Tree | *Juniperus californica, Pinus monophylla, Yucca brevifolia* |

VEGETATION DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Juniperus californica/Quercus cornelius-mulleri - Coleogyne ramosissima* Woodland Association form an open woodland with 0 percent cover at <1 cm tall, 0–5 percent cover at 1–25 cm tall, 0–5 percent cover at 25–50 cm tall, 1–25 percent cover at 50 cm to 1 m tall, 5–50 percent cover at 1 m to 3 m tall, and 1–5 percent cover at 3 m to 5 m tall. Total vegetative cover ranges from 20–26 percent.

This association is dominated by *Pinus monophylla* in the tree and shrub layers. *Juniperus californica* is always a shrub in JOTR, although the National Vegetation Classification System (NVCS) considers it a tree. *Quercus Cornelius-mulleri* and *Coleogyne ramosissima* are abundant in the shrub layer. The exotic grass species *Bromus madritensis* is also abundant in the

understory herb layer. *Yucca brevifolia* is a characteristic tree species. *Yucca schidigera* and *Ericameria linearifolia* are characteristic shrub species. *Ephedra nevadensis, Nolina parryi, Achnatherum speciosum, Eriophyllum confertiflorum, Opuntia echinocarpa, Opuntia basilaris, Dichelostemma capitatum,* and *Purshia* sp. are often present in this association. The exotic species *Erodium cicutarium* also frequently occurs in this association.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G3 S3.1

RANK JUSTIFICATION
This vegetation is likely limited to the desert edge of the peninsular range of Southern California and adjacent Baja California (Mexico). Throughout most of its range, it has suffered decimation through increased fire frequency, and in several areas, large stands have been fragmented by housing developments.

DATABASE CODE

COMMENTS
Globally
This association is known only from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Many areas near Covington Flats have been burned within the last five years.

Plots used for this description: N=4. MDEI: 118-1-4, 118-1-6, 120-4-7, 120-4-8

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*Juniperus californica/Coleogyne ramosissima - Yucca schidigera* Woodland Association
(Mapping Code: 10021)

| | |
|---|---|
| COMMON NAME | California Juniper/Blackbush - Mojave Yucca Woodland Association |
| SYNONYM | *Coleogyne ramosissima - Yucca schidigera - Juniperus californica* association (Leary 1977); Desert Shrub Woodland Community (Hogan 1977). |
| PHYSIOGNOMIC CLASS | Woodland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Woodland |
| PHYSIOGNOMIC GROUP | Temperate or Subpolar Needle-Leaved Evergreen Woodland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Rounded-Crowned Temperate or Subpolar Needle-Leaved Evergreen Woodland |

ALLIANCE *Juniperus californica* Wooded Shrubland Alliance
CLASSIFICATION CONFIDENCE LEVEL 2
USFWS WETLAND SYSTEM Upland

RANGE
Globally
Although this association is only known from Joshua Tree National Park, it is likely to occur elsewhere in the Mojave Desert. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Juniperus californica/Coleogyne ramosissima - Yucca schidigera* Woodland Association are found in the western part of the park.

ENVIRONMENTAL DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of *Juniperus californica/Coleogyne ramosissima - Yucca schidigera* Woodland Association are found at mid to high elevations (4,000–4,600 ft.; 1,200–1,400 m) on gentle to moderate slopes (0–6 degrees) within convex, concave, and undulating slopes of rocky highlands and upland, alluvial deposits. They occur most frequently on gently sloping upper portions of fans, near the base of mountains. Soils are typically sandy (including coarse, medium and fine sand and coarse, medium, and fine, loamy sand) and formed on sialic sediment, plutonic, and noncalcareous, metamorphic, parent material. The substrate surface in this association is composed of 0–1 percent bedrock, 0–1 percent boulder, 0 percent stone, 2–4 percent cobble, 3–22 percent gravel, and 18–69 percent fines cover. Litter consists of 1–5 percent cover. This association experiences low to high levels of disturbance due to competition from exotics (0 %–12%).

MOST ABUNDANT SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Herbaceous | *Bromus madritensis rubens* |
| Shrub | *Coleogyne ramosissima, Yucca schidigera, Eriogonum fasciculatum* |
| Tree | *Juniperus californica* |

CHARACTERISTIC SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Shrub | *Coleogyne ramosissima, Yucca schidigera, Opuntia basilaris, Opuntia echinocarpa* |
| Tree | *Juniperus californica, Yucca brevifolia* |

VEGETATION DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Juniperus californica/Coleogyne ramosissima - Yucca schidigera* Woodland Association form an open to intermittent woodland with <1 percent cover at <1 cm tall, 1–12 percent cover at 1–25 cm tall, <1–7 percent cover at 25–50 cm tall, 4–35 percent cover at 50 cm to 1 m tall, <1–10 percent cover at 1 m–3 m tall, and <1–5 percent cover at 3–5 m tall. Total vegetative cover ranges from 23–53 percent.

This association is dominated by *Juniperus californica, Coleogyne ramosissima, Yucca schidigera,* and *Eriogonum fasciculatum* in the tree and shrub layer. The exotic species *Bromus madritensis rubens* is dominant in the understory herb layer. *Yucca brevifolia* is a characteristic tree species, but usually at less than 2 percent cover. *Opuntia basilaris* and *Opuntia echinocarpa* are consistently present in the shrub layer. *Acamptopappus sphaerocephalus* can be common in some stands. *Echinocereus engelmannii, Ephedra nevadensis, Salazaria mexicana, Tetradymia* sp*., Pleuraphis rigida,* rock lichen, and cryptobiotic crust frequently contribute to minor cover in this association.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G4 S4

RANK JUSTIFICATION
This association is likely to be found throughout the upper-elevation portions of the western Mojave Desert and perhaps southwestern Nevada. It has likely experienced some diminution due to unnaturally high fire frequency.

DATABASE CODE

COMMENTS
Globally

JOTR
Plot data from Watts *et al.* (1998) were not used to write description, due to the small size of the plots. However, they have eight plots collected from the Malapai Hill USGS quadrangle, which suggest this type is common.

Plots used for this description: N=3. JOTR: 3-14-04, 11B-06-1, 18-27-7; WATTS: N=8 (Descriptions were written without WATTS data.)

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*Juniperus californica/(Yucca schidigera)/Pleuraphis rigida* Woodland Association (Mapping Codes: 10033, 10034)

| | |
|---|---|
| COMMON NAME | California Juniper/(Mojave Yucca)/Big Galleta Woodland Association |
| SYNONYM | Desert Woodland Association (Leary 1977) |
| PHYSIOGNOMIC CLASS | Woodland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Woodland |
| PHYSIOGNOMIC GROUP | Temperate or Subpolar Needle-Leaved Evergreen Woodland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Rounded-Crowned Temperate or Subpolar Needle-Leaved Evergreen Woodland |
| ALLIANCE | *Juniperus californica* Wooded Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Upland |

RANGE
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Juniperus californica/(Yucca schidigera)/Pleuraphis rigida* Woodland Association are found in the western part of the park. Plots were located within the Joshua Tree South, Malapai Hill, and Rockhouse Canyon 7.5-minute topographic quadrangles.

ENVIRONMENTAL DESCRIPTION

Globally

This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory. This type may also occur in other portions of the desert slopes of the southern Mojave Desert.

JOTR

Stands of *Juniperus californica/(Yucca schidigera)/Pleuraphis rigida* Woodland Association are found at mid to high elevations (3,500–4,400 ft.; 1,000–1,300 m) on gentle to somewhat steep (<1–22 degree) slopes that are on the northeast to southwest facing sides of rocky highlands and upland, alluvial deposits. Soil textures are generally sandy (includes coarse, medium, and fine sand and coarse, medium, and fine, loamy sand) from sialic sediment, plutonic, noncalcareous, metamorphic, or granitic, parent material. These sites can be rocky, with boulder cover of 0–12 percent, rock cover of 0–3 percent, stone cover of 0–20 percent, cobble cover of 0–30 percent, gravel of 5–25 percent, and fines of 21 to 80 percent. Litter cover varies from 1–15 percent. These sites generally experience low to moderate competition from exotics (1–3 percent cover).

MOST ABUNDANT SPECIES

Globally

This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Herbaceous | *Pleuraphis rigida* |
| Shrub | *Yucca schidigera* |
| Tree | *Juniperus californica* |

CHARACTERISTIC SPECIES

Globally

This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Herbaceous | *Pleuraphis rigida, Achnatherum speciosum* |
| Shrub | *Yucca schidigera, Eriogonum fasciculatum, Ephedra nevadensis, Opuntia echinocarpa* |
| Tree | *Juniperus californica* |

VEGETATION DESCRIPTION

Globally

This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Juniperus californica /(Yucca schidigera)/Pleuraphis rigida* Woodland Association form open woodlands with 0–<1 percent cover at <1 cm tall, <1–2 percent cover at 1–25 cm tall, 1–4 percent cover at 25–50 cm tall, 2–4 percent cover at 50 cm to 1 m tall, 3–10 percent cover at 1 m–3 m tall, and <1 percent cover at 3 m to 5 m tall. Total vegetative cover ranges from 13–20 percent. Stands in the park are often extensive.

This association is dominated by *Juniperus californica* and *Yucca schidigera* in the tree and shrub layer, and *Pleuraphis rigida* is dominant in the understory herb layer. Characteristic shrub species include *Eriogonum fasciculatum, Ephedra nevadensis,* and *Opuntia echinocarpa.* Characteristic herb species include *Pleuraphis rigida* and *Achnatherum speciosum.* The exotic species *Bromus madritensis* usually contributes minor cover in the herb layer. *Ericameria cooperi, Krameria erecta, Simmondsia chinensis,* and *Salazaria mexicana* are occasionally present.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G3 S3

RANK JUSTIFICATION
This association is likely to be restricted to the western Mojave Desert and subject to detrimental increases in fire frequency.

DATABASE CODE

COMMENTS
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Several plots lacking *Pleuraphis rigida* but having *Eriogonum fasciculatum* and usually *Yucca schidigera* (JOTR: 03-14-3; LONG: VMAL97-13, VMAL97-14, VMAL97-15, VMAL97-21, VMAL97-48) suggest a distinctive phase. Other environmental conditions are similar to this association.

Plots used for this description: N=6. JOTR: 06A-08-4, 20-13-5, 20-13-6, 21-14-4; LONG: VMAL97-12, VMAL97-20.

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*Juniperus californica/Coleogyne ramosissima* Woodland Association (Mapping Code: 10025)

COMMON NAME California Juniper/Blackbush Woodland Association

| | |
|---|---|
| SYNONYM | *Coleogyne ramosissima - Yucca schidigera - Juniperus californica* Association (Leary 1977) |
| PHYSIOGNOMIC CLASS | Woodland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Woodland |
| PHYSIOGNOMIC GROUP | Temperate or Subpolar Needle-Leaved Evergreen Woodland |
| PHYSIOGNOMIC SUBGROUP | Natural/ Seminatural |
| FORMATION | Rounded-Crowned Temperate or Subpolar Needle-Leaved Evergreen Woodland |
| ALLIANCE | *Juniperus californica* Wooded Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Upland |

RANGE
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Juniperus californica/Coleogyne ramosissima* Woodland Association are found in the western part of the park.

ENVIRONMENTAL DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Juniperus californica/Coleogyne ramosissima* Woodland Association are found at high elevations (4,300–5,100 ft.; 1,300–1,600 m), most frequently on the upper portions of fans near the base of mountains. Slopes vary from gentle to steep (<1 to 28 degrees). Soil texture ranges from coarse sand through moderately fine, silty, clay loam. Soils are formed on sialic sediment, plutonic, noncalcareous, metamorphic, or granitic, parent material. The substrate surface consists of 0–1 percent boulder cover, 0–4 percent rock cover, 0–20 percent stone cover, 0–25 percent cobble cover, 4–30 percent gravel cover, and 15–82 percent fines cover. Litter cover varies from 0–7 percent. These sites generally experience low to high levels of competition from exotic species (<1–16 percent cover).

MOST ABUNDANT SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Herbaceous *Achnatherum speciosum, Bromus madritensis*
Shrub *Juniperus californica, Coleogyne ramosissima*

CHARACTERISTIC SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Herbaceous *Achnatherum speciosum*
Shrub *Juniperus californica, Coleogyne ramosissima, Ephedra nevadensis, Eriogonum fasciculatum, Yucca schidigera*
Tree *Yucca brevifolia*

VEGETATION DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Juniperus californica/Coleogyne ramosissima* Woodland Association form a sparse to intermittent woodland with <1–2 percent cover at <1 cm tall, <1–7 percent cover at 1–25 cm tall, <1–4 percent cover at 25-50 cm tall, 3–35 percent cover at 50 cm to 1 m tall, 4-7 percent cover at 1 m–3 m tall, and 0–<1 percent cover at 3–5 m tall. Total vegetative cover ranges from 9–44 percent.

This association is dominated by the shrub species *Juniperus californica* and *Coleogyne ramosissima. Achnatherum speciosum* is dominant in the herb layer. The exotic species *Bromus madritensis* is also abundant in the herb layer. *Yucca brevifolia* is characteristically present. Characteristic shrub species include *Ephedra nevadensis, Eriogonum fasciculatum,* and *Yucca schidigera.* Cryptobiotic crust is a characteristic component of the understory. Frequently, *Sphaeralcea ambigua, Pleuraphis rigida, Prunus fasciculata, Gutierrezia microcephala, Opuntia ramosissima,* and the exotic species *Bromus tectorum* are found contributing minor cover in this association.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G3 S3.2

RANK JUSTIFICATION
Likely to be threatened by increased fire frequency, due to invasive grass fuels and naturally limited to relatively small areas of the upper western Mojave Desert.

DATABASE CODE

COMMENTS
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Several of the locally described *Juniperus californica* types contain *Achnatherum speciosum*. This grass is considered to be a normal, postfire, successional species to stands in the general zone of Coleogyne ramosissima dominance (M. Brooks, personal communication 2000, Sawyer and Keeler-Wolf 2005 ms).

Plots used for this description: N=5. JOTR: 09A-05-1, 14-10-2, 19-21-1; LONG: VBRC97-1[1], VMAL97-25. Note: two WATTS plots seemed to fit this association but were not used in developing the description.

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*Juniperus californica/Nolina parryi* Woodland Association (Mapping Codes: 10033, 10034)

| | |
|---|---|
| COMMON NAME | California Juniper/Beargrass Woodland Association |
| SYNONYM | Desert Woodland Association (Leary 1977) |
| PHYSIOGNOMIC CLASS | Woodland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Woodland |
| PHYSIOGNOMIC GROUP | Temperate or Subpolar Needle-Leaved Evergreen Woodland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Rounded-Crowned Temperate or Subpolar Needle-Leaved Evergreen Woodland |
| ALLIANCE | *Juniperus californica* Wooded Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Upland |

RANGE
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory. This type may also occur in other portions of the desert slopes of the transverse and peninsular ranges of Southern California.

JOTR
Stands of the *Juniperus californica/Nolina parryi* Woodland Association are found in the western part of the park. Plots were located within the Keys View, Queen Mountain, and Joshua Tree South 7.5 minute topographic quadrangles.

ENVIRONMENTAL DESCRIPTION

Globally

This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

Stands of *Juniperus californica/Nolina parryi* Woodland Association are found at high elevations (4,400–5,000 ft.; 1,300–1,500 m) of northeast and southwest facing slopes. This association is found on slopes that are more than moderately steep (>6 degrees), on rocky highlands that are convex, concave, and undulating. Soil textures range from coarse sand to moderately fine, silty, clay loam, and are derived from sialic sediment, plutonic, or noncalcareous, metamorphic, parent material. These sites can be rocky with 12–19 percent boulder cover, 3–14 percent rock cover, 8–20 percent stone cover, 9–18 percent cobble cover, 10–16 percent gravel cover, and 10–21 percent fines cover. Litter ranges from 3–15 percent cover. These sites generally experience low to moderate levels of competition from exotics (2–11 percent cover).

MOST ABUNDANT SPECIES

Globally

This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Herbaceous | *Bromus madritensis rubens, Eriogonum fasciculatum, Achnatherum speciosum* |
| Shrub | *Nolina parryi* |
| Tree | *Juniperus californica* |

CHARACTERISTIC SPECIES

Globally

This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Herbaceous | *Eriogonum fasciculatum, Achnatherum speciosum, Echinocereus engelmannii, Stephanomeria* spp.*, Pleuraphis rigida, Galium angustifolium,* Lichen |
| Shrub | *Nolina parryi, Chrysothamnus teretifolius, Coleogyne ramosissima, Yucca schidigera, Viguiera parishii, Opuntia basilaris* |
| Tree | *Juniperus californica, Pinus monophylla, Yucca brevifolia* |

VEGETATION DESCRIPTION

Globally

This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Juniperus californica/Nolina parryi* Woodland Association form a sparse to open woodland (or more realistically, shrubland as the dominant *J. californica* individuals are typically shrubs in this association) with <1 percent cover at <1 cm tall, 1–4 percent cover at 1–25 cm tall, 1–2 percent cover at 25–50 cm tall, 2–4 percent cover at 50 cm to 1 m tall, and 2–6 percent cover at 1 m–3 m tall. Total vegetative cover ranges from 7–18 percent.

This association is dominated by *Juniperus californica* and *Nolina parryi* in the tall shrub layer. *Eriogonum fasciculatum* is an important small shrub. The grass *Achnatherum speciosum* is the predominant herb species. *Pinus monophylla* and *Yucca brevifolia* are characteristic tree species but with usually less than 1 percent cover. Characteristic shrub species include *Chrysothamnus teretifolius, Coleogyne ramosissima, Yucca schidigera, Viguiera parishii,* and *Opuntia basilaris.* Characteristic herb species include *Achnatherum speciosum, Echinocereus engelmannii, Stephanomeria* spp., *Pleuraphis rigida,* and *Galium angustifolium*. *Galium angustifolium, Opuntia basilaris, Pleuraphis rigida,* and *Yucca brevifolia* are often found in this association. The exotic species *Bromus madritensis rubens* and *Bromus tectorum* are consistently present in the understory herb layer. *Quercus cornelius-mulleri, Viguiera parishii, Ephedra nevadensis, Lotus rigidus, Brickellia arguta, Mirabilis bigelovii, Opuntia echinocarpa, Salazaria mexicana,* and *Salvia mohavensis* are frequently present.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G3 S3.2

RANK JUSTIFICATION
This association is likely to be somewhat threatened due to higher than natural fire frequencies, as with other California juniper associations.

DATABASE CODE

COMMENTS
Globally
With further analysis, this association may be found to be a phase of a more widespread association containing *J. californica* and *Achnatherum speciosum*.

JOTR
Five Watts plots and two JOTR plots (08A-02-6, 08A-04-6) are similar to this but lack the *Nolina parryi*. They suggest perhaps a broader interpretation of an association named California Juniper/Desert Needlegrass (*Juniperus californica/Achnatherum speciosum*).

Plots used for this description: N=4. JOTR: 06A-08-3, 08A-04-7, 14-10-1, 18-27-2

## Singleleaf Pinyon Pine (*Pinus monophylla)* Woodland Alliance

This alliance occurs in the Southeastern Great Basin, Mono Basin, Mojave Desert, Sierra Nevada, Southern California Mountains and Valleys, Nevada, Utah, Arizona, and Idaho.

Prescribed fire has commonly been used by range managers to open up *Pinus monophylla* stands and promote grass and other forage species. However, it is no longer an effective management option on some *Pinus monophylla* sites where prolonged tree dominance due to fire suppression has reduced the understory. Fuels on such sites are often insufficient to carry fire. In addition, understory plants in closed stands do not respond as well to fire as those in more open stands. When fires do occur in closed stands, they are usually of such high severity that soil seed reserves are depleted. Without successful postfire seeding, highly flammable annual grass communities often establish. Losses due to fire in some areas of its range are likely a combination of fire suppression and high cover of *Bromus tectorum.*

This alliance is represented in JOTR by two associations, both defined first in this project. These include the Singleleaf Pinyon Pine/Muller's Oak (*Pinus monophylla/Quercus cornelius-mulleri)* Woodland Association and the Singleleaf Pinyon Pine/California Juniper/Desert Needlegrass *(Pinus monophylla*/*Juniperus californica/Achnatherum speciosum)* Woodland Association.

*Pinus monophylla/Quercus cornelius-mulleri* Woodland Association (Mapping Code: 10161)

| | |
|---|---|
| COMMON NAME | Singleleaf Pinyon Pine/Muller's Oak Woodland Association |
| SYNONYM | Desert Woodland Association (Leary 1977) |
| PHYSIOGNOMIC CLASS | Woodland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Woodland |
| PHYSIOGNOMIC GROUP | Temperate or Subpolar Needle-Leaved Evergreen Woodland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Rounded-Crowned Temperate or Subpolar Needle-Leaved Evergreen Woodland |
| ALLIANCE | *Pinus monophylla* Woodland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Upland |

RANGE
Globally
Although the Singleleaf Pinyon Pine (*Pinus monophylla)* Woodland Alliance occurs in the southeastern Great Basin, Mono Basin, Mojave Desert, Sierra Nevada, Southern California mountains and valleys, Nevada, Utah, Arizona, and Idaho, this association is only known from

Joshua Tree National Park. Information about its global characteristics is not available without additional inventory. This type may also occur in other portions of the desert slopes of the transverse and peninsular ranges of Southern California.

JOTR
Stands of the *Pinus monophylla/Quercus cornelius-mulleri* Woodland Association are found in the western part of the park. Plots were located within the Joshua Tree South, Indian Cove, Queen Mountain, Yucca Valley South, East Deception Canyon and Malapai Hill 7.5 minute topographic quadrangles.

ENVIRONMENTAL DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of *Pinus monophylla/Quercus cornelius-mulleri* Woodland Association are found at mid to high elevations (4,000–5,400 ft.; 1,200–1,600 m) on generally northerly trending slopes of erosional highlands, arroyos, and alluvial fans. This association is found on often convex, but also linear, concave, undulating surfaces of flat to steep (0–40 degrees) slopes. Soil textures range from coarse sand to very fine sandy loam of granitoid, sialic sediment, plutonic, and noncalcareous, metamorphic, parent material. These sites can be rocky with 0–15 percent boulder cover, 0–36 percent rock cover, 0–20 percent stone cover, 0–10 percent cobble cover, 3–79 percent gravel cover, and 4–30 percent fines cover. Litter ranges from 2-30 percentcover. These sites generally experience low to high levels of competition from exotics (1–15 percent cover), low to moderate levels of disturbance from trampling, and low levels of disturbance from erosional rills.

MOST ABUNDANT SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Herbaceous | *Bromus madritensis* |
| Shrub | *Quercus cornelius-mulleri* |
| Tree | *Pinus monophylla* |

CHARACTERISTIC SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Herbaceous | *Achnatherum speciosum* |
| Shrub | Q*uercus cornelius-mulleri, Ericameria linearifolia, Eriogonum fasciculatum, Opuntia basilaris,* |
| Tree | *Pinus monophylla, Yucca brevifolia* |

VEGETATION DESCRIPTION

Globally

This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

Stands of the *Pinus monophylla/Quercus cornelius-mulleri* Woodland Association form an open to intermittent woodland with 0–1 percent cover at <1 cm tall, 0–5 percent cover at 1–25 cm tall, 0–15 percent cover at 25–50 cm tall, 0–12 percent cover at 50 cm to 1 m tall, 5–40 percent cover at 1–3 m tall, and 0-17 percent cover at 3–5 m tall, and 0–5 at 5–10 m tall. Total vegetative cover ranges from 11–43 percent.

Stands of this association are dominated by *Pinus monophylla* and *Quercus cornelius-mulleri* in the tree and shrub layer, respectively. The exotic species *Bromus madritensis* is usually abundant. Characteristic species include *Achnatherum speciosum, Ericameria linearifolia, Eriogonum fasciculatum, Opuntia basilaris,* and *Yucca brevifolia*. Also, crustose lichens, *Nolina parryi, Gutierrezia microcephala,* and *Opuntia echinocarpa* are often present. *Juniperus californica* is occasionally common.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G4 S3

RANK JUSTIFICATION

This association is likely to be localized in the transverse and peninsular ranges of California and adjacent Baja California, Mexico.

DATABASE CODE

COMMENTS

Globally

Similar vegetation exists in Anza Borrego Desert State Park but lacks sufficient sampling to substantiate if it is the same association.

JOTR

Fires in the Covington Flat area have removed much of the *Pinus monophylla* from former stands of this association in the past decade. *Quercus cornelius-mulleri* typically is resprouting following these fires.

Plots used for this description: N=13. JOTR: 06A-03-1, 06A-03-5, 06A-08-2, 16-24-3, 16-26-2, 17-27-1, 18-27-5, 18-28-2; LONG: VMAL97-46, VMAL97-47; MDEI: 120-1-1, 120-1-6, 120-1-7, 120-4-4, 120-4-6. Several Watts (n=4) plots also seem to fall into this association.

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*Pinus monophylla/Juniperus californica/Achnatherum speciosum* Woodland Association
(Mapping Code: 10162)

| | |
|---|---|
| COMMON NAME | Singleleaf Pinyon Pine/California Juniper/Desert Needlegrass Woodland Association |
| SYNONYM | Desert Woodland Association (Leary 1977) |
| PHYSIOGNOMIC CLASS | Woodland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Woodland |
| PHYSIOGNOMIC GROUP | Temperate or Subpolar Needle-Leaved Evergreen Woodland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Rounded-Crowned Temperate or Subpolar Needle-Leaved Evergreen Woodland |
| ALLIANCE | *Pinus monophylla* Woodland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Upland |

RANGE
Globally
Although the Singleleaf Pinyon Pine (*Pinus monophylla)* Woodland Alliance occurs in the southeastern Great Basin, Mono Basin, Mojave Desert, Sierra Nevada, Southern California mountains and valleys, Nevada, Utah, Arizona, and Idaho, this association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory. This association may also occur elsewhere in the Mojave Desert.

JOTR
Stands of the *Pinus monophylla/Juniperus californica/Achnatherum speciosum* Woodland Association are found in the western portion of the park, particularly on the slopes of Queen Mountain. Plots were located with the Queen Mountain, Cottonwood Springs, and Joshua Tree South 7.5 minute topographic quadrangles.

ENVIRONMENTAL DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of *Pinus monophylla/Juniperus californica/Achnatherum speciosum* Woodland Association are found at high elevations (4,300–4,800 ft.; 1,300–1,500 m) on undulating and concave slopes of erosional highland and rocky highlands. This association is found on gentle to steep (1–30 degree) slopes that are generally north trending. Soils are usually sandy (includes coarse, medium and fine sand; coarse, medium, and fine, loamy sand) and derived from sialic sediments, plutonic, and noncalcareous, metamorphic, or granitic, parent material. These sites tend to be rocky with boulder cover of 5–27 percent, rock cover of 1–37 percent, stone cover of 5–25 percent, cobble cover of 5–25 percent, gravel of 2–75 percent, and fines of <1–75 percent. Litter ranges from <1–7 percent cover. These sites generally experience low-impact levels from competition from exotics (<1–1%).

MOST ABUNDANT SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Herbaceous | *Achnatherum speciosum, Nolina parryi* |
| Shrub | *Juniperus californica* |
| Tree | *Pinus monophylla* |

CHARACTERISTIC SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Herbaceous | *Achnatherum speciosum, Nolina parryi, Sphaeralcea ambigua, Lotus rigidus* |
| Shrub | *Juniperus californica, Eriogonum fasciculatum, Echinocereus engelmannii, Ephedra nevadensis, Gutierrezia* sp., *Salvia mohavensis* |
| Tree | *Pinus monophylla* |

VEGETATION DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Pinus monophylla/Juniperus californica/Achnatherum speciosum* Woodland Association form an open woodland with less than 1 percent cover at <1 cm tall, 0–5 percent cover at 1–25 cm tall, 1–5 percent cover at 25–50 cm tall, 1–4 percent cover at 50 cm to 1 m tall, 1–25 percent cover at 1-3 m tall, and 2–8 percent cover at 3-5 m tall. Total vegetative cover tends to be approximately 25 percent.

This association is dominated by *Pinus monophylla* in the tree layer and *Juniperus californica* in the shrub layer. *Achnatherum speciosum* and *Nolina parryi* are most common and consistent in the herb layer. *Eriogonum fasciculatum, Echinocereus engelmannii, Ephedra nevadensis, Gutierrezia* sp. and *Salvia mohavensis* are characteristic shrub species. Characteristic herb species include *Sphaeralcea ambigua* and *Lotus rigidus. Keckiella antirrhinoides* can be abundant at some sites. Often present in the stands are *Yucca schidigera, Mirabilis bigelovii, Chrysothamnus teretifolius, Brickellia arguta, Ericameria cuneata,* and moss and lichen. The exotic species *Bromus madritensis rubens* and *Bromus tectorum* are also frequently present.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G3 S3

RANK JUSTIFICATION
This association is likely to be restricted to the Western Mojave Desert and subject to detrimental increases in fire frequency.

DATABASE CODE

COMMENTS
Globally

JOTR
Fires have been extensive in stands in the vicinity of Quail Mountain. This is the upper elevation equivalent of the *Juniperus californica /Nolina parryi* association. As in many parts of the Mojave Desert, *Pinus monophylla* tends to have a higher elevation distribution than *Juniperus californica*.

Plots used for this description: JOTR: 18-27-6, 34A-03-1; MDEI: 118-1-7.

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**Bigberry Manzanita *(Arctostaphylos glauca)* Shrubland Alliance**

This alliance is not defined at the association level locally. The following general description will serve to distinguish the local stand(s).

| | |
|---|---|
| COMMON NAME | Bigberry Manzanita Chaparral |
| SYNONYM | None |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Shrubland |
| PHYSIOGNOMIC GROUP | Temperate Broad-Leaved Evergreen Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Semi-natural |
| FORMATION | Sclerophyllous Temperate Broad-Leaved Evergreen Shrubland |

ALLIANCE *Arctostaphylos glauca* Shrubland Alliance
CLASSIFICATION CONFIDENCE LEVEL 1
USFWS WETLAND SYSTEM Upland

RANGE
Globally
The *Arctostaphylos glauca* Shrubland Alliance occurs in the central California coast, Southern California coast, and Southern California mountains and valley regions in California and in Baja California, Mexico.

JOTR
Plots of this alliance were located near South Park Peak on the Yucca Valley South 7.5 minute topographic quadrangle.

ENVIRONMENTAL DESCRIPTION
Globally
The *Arctostaphylos glauca* Shrubland Alliance occurs on north facing slops of outcrops and ridges and on alluvial fans in shallow, coarse-textured, sometimes ultramafic-derived soils. Elevations range from 1,000 to 5,000 feet (300 to 1,500 m).

JOTR

MOST ABUNDANT SPECIES
Globally
Shrub *Arctostaphylos glauca*, *Adenostoma fasciculatum, A. glandulosa, Ceanothus cuneatus, C. leucodermis, Cercocarpus betuloides, Quercus berberidifolia, Q. wislizeni, Rhamnus ilicifolia, Salvia mellifera*, *Yucca whipplei*

JOTR
Herbaceous *Bromus madritensis rubens*
Shrub *Arctostaphylos glauca, Quercus cornelius-mulleri, Ericameria linearifolia*
Tree *Pinus monophylla*

CHARACTERISTIC SPECIES
Globally
Shrub *Arctostaphylos glauca*

VEGETATION DESCRIPTION
Globally
*Arctostaphylos glauca* is sole or dominant shrub in canopy. Emergent trees may be present. Shrubs are generally < 8 m, and the canopy continuous. The ground layer is sparse.

JOTR
The local expression of this alliance is limited to small stands usually adjacent to stands of Muller oak (*Q. cornelius-mulleri*). They tend to occur in more xeric locations than the oaks (southerly facing steep slopes).

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK

RANK JUSTIFICATION

DATABASE CODE

COMMENTS
Globally
Individual *A. glauca* plants may become tree-like in old stands. Borchert *et al.* (2004) reports that stands are small (> 0.5 ha) within a mosaic with more extensive alliances.

JOTR
One sample in JOTR suggested further variation than what is currently reported from this Alliance.

*Arctostaphylos glauca* - *Quercus Cornelius-mulleri* (JOTR: 03-14-1)

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**Muller's Oak *(Quercus cornelius-mulleri)* Shrubland Alliance**

The *Quercus cornelius-mulleri* Shrubland Alliance occurs in the Mojave Desert and in the inner peninsular ranges of Southern California and adjacent Baja California, Mexico (Keeler-Wolf *et al.* 1998).

This alliance is represented in JOTR by two associations, both defined first in this project. These are the Muller's Oak/California Buckwheat - Interior Goldenbush (*Quercus cornelius-mulleri/Eriogonum fasciculatum - Ericameria linearifolia)* Shrubland Association and the Muller's Oak/Blackbush (*Quercus cornelius-mulleri/Coleogyne ramosissima)* Shrubland Association.

---

*Quercus cornelius-mulleri/Eriogonum fasciculatum - Ericameria linearifolia* Shrubland Association (Mapping Code: 21234)

| | |
|---|---|
| COMMON NAME | Muller's Oak/California Buckwheat - Interior Goldenbush Association |

| | |
|---|---|
| SYNONYM | Desert Woodland Association (Leary 1977); Chaparral Woodland (Hogan 1977) |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Shrubland |
| PHYSIOGNOMIC GROUP | Temperate Broad-Leaved Evergreen Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Sclerophyllous Temperate Broad-Leaved Evergreen Shrubland |
| ALLIANCE | *Quercus cornelius-mulleri* Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Upland |

RANGE
Globally
This association is known from Joshua Tree National Park and Anza-Borrego Desert State Park (San Diego County). It was first defined by Keeler-Wolf *et al.* (1998) from the peninsular ranges of San Diego County. Similar stands have been observed in the eastern San Bernardino mountains north of Pioneertown and may occur northwest toward Cajon Pass and south of Hesperia (San Bernardino County).

JOTR
Stands of the *Quercus cornelius-mulleri/Eriogonum fasciculatum - Ericameria linearifolia* Association is found in the western part of the park in the Covington Flats area and in the Little San Bernardino Mountains. Samples were located within the Joshua Tree South, East Deception Canyon, and Yucca Valley South 7.5 minute topographic quadrangles.

ENVIRONMENTAL DESCRIPTION
Globally
This association, as described in Anza-Borrego (Keeler-Wolf *et al.* 1998), occurs on desert slopes in granitic mountains and hills between 3,400 and 5,000 feet (1,000 and 1,500 m) elevation. It is the most common form of "desert transition chaparral" in Anza-Borrego.

JOTR
Stands of *Quercus cornelius-mulleri/ Eriogonum fasciculatum - Ericameria linearifolia* Association are found at high elevations (4,300 – 5,200 ft.; 1,300 – 1,600 m) on convex or rounded, linear or even, concave, and undulating slopes of rocky highlands that vary from neutral to >6 degree slopes. Aspects are generally south or southeast. Soils are usually sands but are occasionally loams and are formed from sialic sediment, plutonic, and noncalcareous, metamorphic, parent material. Rock cover consists of 0–6 percent bedrock, 0–9 percent boulder, 0–8 percent stone, 1–10 percent cobble, 15–28 percent gravel, and 22–47 percent fines. Litter ranges from 4–17 percent cover. These sites generally experience low to high disturbance levels from exotics species (<1–10 percent cover), moderate levels of disturbance from foot traffic/trampling, and moderate to high disturbance levels from improper burning regime (2 out of 6 plots sampled were recovering from recent fires).

MOST ABUNDANT SPECIES
Globally

| | |
|---|---|
| Herbaceous | *Bromus tectorum, Bromus madritensis rubens* |
| Shrub | *Eriogonum fasciculatum* |
| Tree | *Quercus cornelius-mulleri* |

JOTR

| | |
|---|---|
| Herbaceous | *Bromus tectorum, Bromus madritensis rubens* |
| Shrub | *Eriogonum fasciculatum* |
| Tree | *Quercus cornelius-mulleri* |

CHARACTERISTIC SPECIES
Globally

| | |
|---|---|
| Herbaceous | *Achnatherum coronatum, Achnatherum speciosum, Galium angustifolium, Nolina bigelovii* |
| Shrub | *Quercus cornelius-mulleri Eriogonum fasciculatum, Ericameria linearifolia, Opuntia basilaris* |

This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Herbaceous | *Achnatherum coronatum, Achnatherum speciosum, Galium angustifolium, Nolina parryi* |
| Shrub | *Quercus cornelius-mulleri, Eriogonum fasciculatum, Ericameria linearifolia, Opuntia basilaris* |

VEGETATION DESCRIPTION
Globally
In Anza-Borrego Desert State Park, Muller oak forms a scattered canopy (3-12%) over low desert shrubs including *Eriogonum fasciculatum, Ericameria linearifolia, and Opuntia basilaris.* At Anza-Borrego, this association may also have other evergreen shrubs, such as *Juniperus californica, Rhus ovata, Cercocarpus betuloides*, and *Ceanothus greggii*, but these other species are usually much less common than the Muller Oak (Keeler-Wolf *et al.* 1998).

JOTR
Stands of the *Quercus cornelius-mulleri/Eriogonum fasciculatum - Ericameria linearifolia* Association form an open woodland with 0–<1 percent cover at <1 cm tall, 2-13 percent cover at 1–25 cm tall, <1–3 percent cover at 25-50 cm tall, <1–14 percent cover at 50 cm to 1 m tall, 3–18 percent cover at 1–3 m tall, and 0–6 percent at 3-5 m tall. Total vegetative cover ranges from 10-–3 percent.

This association is dominated by *Quercus cornelius-mulleri* in the tree layer and *Eriogonum fasciculatum* in the shrub layer. The exotic species *Bromus tectorum* and *Bromus madritensis rubens* are consistently abundant in the understory herb layer.

*Ericameria linearifolia* and *Opuntia basilaris* are characteristic shrub associates. Characteristic herb species of this association are *Achnatherum coronatum, A. speciosum, Galium angustifolium,* and *Nolina parryi.* Rock lichen is also a characteristic component in the understory. *Opuntia echinocarpa, Yucca brevifolia, Eriophyllum confertiflorum, Chrysothamnus teretifolius, Yucca schidigera,* and *Encelia virginensis* are often found in this association. *Arctostaphylos glauca* and *Juniperus californica* are common in some stands.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G 4 S4

RANK JUSTIFICATION
This is a common type on the desert slopes of the Transverse and Peninsular Ranges of California.

DATABASE CODE

COMMENTS
Globally

JOTR

Plots used for this description: JOTR: 03-14-2, 06A-03-2, 06A-03-3, 08A-04-5, 08B-02-1, 09A-05-2; LONG: VMAL97-22

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*Quercus cornelius-mulleri/Coleogyne ramosissima* Shrubland Association (Mapping Code: 21233)

| | |
|---|---|
| COMMON NAME | Muller's Oak/Blackbush Shrubland Association |
| SYNONYM | Desert Woodland Association (Leary 1977) |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Shrubland |
| PHYSIOGNOMIC GROUP | Temperate Broad-Leaved Evergreen Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Sclerophyllous Temperate Broad-Leaved Evergreen Shrubland |
| ALLIANCE | *Quercus cornelius-mulleri* Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Upland and Palustrine |

RANGE
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Quercus cornelius-mulleri/Coleogyne ramosissima* Shrubland Association are found in the western portion of the park. Plots were located within the Keys View, East Deception Canyon, and Indian Cove 7.5 minute topographic quadrangles.

ENVIRONMENTAL DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of *Quercus cornelius-mulleri/Coleogyne ramosissima* Shrubland Association are found at mid to high elevations (3,500–5,100 ft.; 1,100–1,600 m) on convex or rounded, concave, undulating, and hummocky slopes of rocky highlands and upland, alluvial deposits. Slope (<1 degree to >6 degree) and aspect vary (northeast, neutral, and southwest facing slopes). Soils are usually sands (includes coarse, medium, and fine sand; coarse, medium, and fine, loamy sand) formed from sialic sediment, plutonic, and noncalcareous, metamorphic, parent material. Rock cover consists of 0–<1 percent bedrock, 0–4 percent boulder, 0–8 percent stone, 1–11 percent cobble, 0–35 percent gravel, and 11–72 percent fines. Litter ranges from 2–5 percent cover. These sites generally experience low to high disturbance levels from exotics species (0–12 percent cover) and low disturbance levels from foot traffic and trampling.

MOST ABUNDANT SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Herbaceous | *Bromus madritensis rubens* |
| Shrub | *Coleogyne ramosissima, Juniperus californica* |
| Tree | *Quercus cornelius-mulleri* |

CHARACTERISTIC SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Herbaceous | *Achnatherum speciosum* |

| | |
|---|---|
| Shrub | *Coleogyne ramosissima, Juniperus californica, Echinocereus triglochidiatus, Eriogonum fasciculatum* |
| Tree | *Quercus cornelius-mulleri, Yucca brevifolia* |

VEGETATION DESCRIPTION

Globally

This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

Stands of the *Quercus cornelius-mulleri/Coleogyne ramosissima* Shrubland Association form an open shrubland with 0-6 percent cover at <1 cm tall, <1–6 percent cover at 1–25 cm tall, 1–6 percent cover at 25–50 cm tall, 7–12 percent cover at 50 cm to 1 m tall, 2–12 percent cover at 1–3 m tall, and <1–3 percent cover at 3–5 m tall. Total vegetative cover ranges from 19–29 percent.

This association is dominated by *Quercus cornelius-mulleri* in the tree layer. The shrub layer is dominated by *Coleogyne ramosissima* and *Juniperus,* and the understory herb layer is dominated by the exotic species *Bromus madritensis rubens*. *Yucca brevifolia* is characteristically found in the tree canopy. Characteristic shrub species include *Echinocereus triglochidiatus* and *Eriogonum fasciculatum*. *Achnatherum speciosum* is characteristically in the understory herb layer. Cryptobiotic crust can be a common component within some stands. Occasional associates include *Ephedra nevadensis, Ericameria cooperi, Ericameria linearifolia, Opuntia erinacea, Pinus monophylla,* and rock lichen.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G3 S3.2

RANK JUSTIFICATION

This association is probably limited to the north slope of the San Bernardino Mountains and the Little San Bernardino Mountains. Some stands have been diminished by increased fire frequency.

DATABASE CODE

COMMENTS

Globally

JOTR

Many areas of this association near Covington Flats have been burned within the last five years.

Plots used for this description: JOTR: 08A-02-4, 09A-05-3, 15-25-2, 14-10-3

**Rubber Rabbitbrush *(Ericameria nauseosa =Chrysothamnus nauseosus)* Shrubland Alliance**

This alliance is not defined at the association level locally. The following general description will serve to distinguish the local stand(s).

| | |
|---|---|
| COMMON NAME | Rubber Rabbitbrush Scrub |
| SYNONYM | None |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Shrubland |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Evergreen Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Semi-natural |
| FORMATION | Facultatively Deciduous Extremely Xeromorphic Subdesert Shrubland |
| ALLIANCE | *Ericameria nauseosa* Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 1 |
| USFWS WETLAND SYSTEM | Upland |

RANGE
Globally
The *Ericameria nauseosa* Shrubland Alliance occurs in the central California coast ranges, Northern California interior coast ranges, Southern Cascades, Sierra Nevada, Modoc Plateau, Southern California mountains and valleys, Mojave Desert, Mono, southeastern Great Basin, and northwestern basin and range regions of California, and in the intermountain West.

JOTR

ENVIRONMENTAL DESCRIPTION
Globally
The *Ericameria nauseosa* Shrubland Alliance occurs in all topographic settings in well-drained, sandy, or gravelly soil, from 150 to 10,000 feet (45 to 3,000 m) in elevation.

JOTR
The only sampled example of this alliance occurs in upper elevation areas near Covington Flats along a small drainage within the vicinity of *Juniperus californicus* alliance stands. Disturbance from occasional flooding may be responsible for its presence.

MOST ABUNDANT SPECIES
Globally

| | |
|---|---|
| Shrub | *Ericameria nauseosa, Artemisia tridentata, Chrysothamnus viscidiflorus, Ephedra* spp., *Purshia tridentata* |
| Tree | *Juniperus* spp., *Pinus* spp. |

JOTR
Herbaceous *Carex douglasii*
Shrub *Ericameria nauseosa*

CHARACTERISTIC SPECIES
Globally
Shrub *Ericameria nauseosa*

VEGETATION DESCRIPTION
Globally
*Ericameria nauseosa* is the sole or dominant shrub in canopy. Emergent junipers or pines may be present, or emergent shrubs may occur over a ground layer of grass. Trees are scattered, if present. Shrubs are generally < 3 m tall with a continuous, intermittent, or open canopy. The ground layer is sparse or grassy.

JOTR
*Ericameria nauseosa* is a scattered shrub in the only sample. *Carex douglasii* is a rhizomatous species and is associated with moist, often disturbed, and somewhat alkaline areas.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G5 S5

RANK JUSTIFICATION
This is a widespread alliance in Great Basin and in eastern California, related to disturbance.

DATABASE CODE

COMMENTS
Globally
California stands are dominated by any of eight subspecies of *Ericameria nauseosa*. Some subspecies are local, while others have extensive ranges. Which subspecies are sufficiently common to characterize California vegetation is not known, since few ecologists make determinations of them.

*Ericameria nauseosa* is a fast growing shrub that characteristically dominates in areas after disturbance. It blooms in the late summer and fruits in the fall. The wind-dispersed seeds do not require stratification, and seeds germinate in the early spring. Plants grow about 10 years. *Ericameria nauseosa* is variable browse for livestock and wildlife, depending on subspecies and ecotype. Its resinous foliage burns readily with high moisture content. It may resprout after fire and wind-dispersed seed readily colonize areas after fire from neighboring plants.

This alliance is indicative of recent disturbance including fire, flood, and mechanical clearing. The existence of large areas of this alliance in an area suggests a level of disturbance greater than the norm.

JOTR
The following sample in JOTR suggested further variation than what is currently reported from this Alliance.

*Ericameria nauseosa/Carex douglasii* (JOTR: 08A-04-2)

---

**Round-Leaved Rabbitbrush *(Ericameria teretifolia =Chrysothamnus teretifolius)* Shrubland Alliance**

This alliance is not defined at the association level locally. The following general description will serve to distinguish the local stand(s):

| | |
|---|---|
| COMMON NAME | Round-Leaved *Rabbitbrush Scrub* |
| SYNONYM | None |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Shrubland |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Evergreen Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Semi-natural |
| FORMATION | Facultatively Deciduous Extremely Xeromorphic Subdesert Shrubland |
| ALLIANCE | *Ericameria teretifolia* Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Upland |

RANGE
Globally
The *Ericameria teretifolia* Shrubland Alliance occurs in the Mojave Desert, Northern California interior coast ranges, Sierra Nevada foothills, central California coast ranges, and Southern California mountains and valley regions of California. It has been sampled in the Mojave Desert (Thomas *et al.* 2004) and also in Anza-Borrego Desert State Park of San Diego County, California (Keeler-Wolf *et al.* 1998).

JOTR
Restricted to upper elevations within the vicinity of stands of California juniper and *Viguiera parishii*.

ENVIRONMENTAL DESCRIPTION
Globally
This alliance occurs on ridges, slopes, and in valleys on soils derived from bedrock or alluvium.

JOTR
This alliance occurs at 3,800 feet (1,200 m) on bouldery slopes at the base of mountains.

MOST ABUNDANT SPECIES
Globally
Herbaceous *Muhlenbergia porteri, Pleuraphis jamesii, P. rigida, Poa secunda, Stipa speciosa*
Shrub *Ericameria teretifolia, Artemisia ludoviciana, Ephedra viridis, Eriogonum fasciculatum, Grayia spinosa, Gutierrezia microcephala, Opuntia acanthocarpa, Prunus fasciculata, Salazaria mexicana, Salvia dorrii, Sphaeralcea ambigua, Stephanomeria pauciflora*

JOTR
Herbaceous *Achnatherum speciosum*
Shrub *Ericameria teretifolia*

CHARACTERISTIC SPECIES
Globally
Shrub *Ericameria teretifolia*

VEGETATION DESCRIPTION
Globally
*Ericameria teretifolia* is dominant or important in the shrub canopy. Shrubs are < 2 m, with an intermittent to sparse canopy. The ground layer consists of grasses and is intermittent to sparse.

JOTR
*Ericameria teretifolia, Viguiera parishii*, and *Eriogonum fasciculatum* are dominant or important in the shrub layer. *Acacia greggii* and *Gutierrezia microcephala* are also present in the shrub layer. *Stephanomeria* sp. and *Aristida* purpurea are common in the herb layer.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G4 S4

RANK JUSTIFICATION
This is a common, early seral alliance throughout the Mojave and upper Sonoran Deserts.

DATABASE CODE

COMMENTS
Globally
In the Mojave Desert and peninsular range/Colorado Desert borderland, the *E. teretifolia* alliance is one of several mid-elevation, xeromorphic, upland scrub alliances above the broad belt of *Larrea tridentata - Ambrosia dumosa* but below the high-elevation scrubs with *Artemisia tridentata* and the *Pinus monophylla* belt. It is found in disturbed areas including burns, washes,

and heavily grazed sites. *Ericameria teretifolia* nearly always shares the short shrub canopy with other shrub species. As with other members of its genus, it is a relatively short-lived shrub, which may seed and germinate abundantly after disturbance.

This alliance is a seral type that should be considered as part of the natural spatio-temporal matrix of mid-to-upper desert vegetation. Stands ideally should be small. Large stands are indicative of some disturbance process that is out of synchrony with historic disturbance events (fire, road development, perhaps intensive grazing).

JOTR
The following samples in JOTR suggested further variation than what is currently reported from this Alliance:

*Ericameria teretifolia* - *Viguiera parishii* (JOTR: 22-32-3)
*Ericameria teretifolia* - *Gutierrezia microcephala* (Watts: N=2)

---

**Desert False Willow (*Baccharis sergiloides*) Intermittently Flooded Shrubland Alliance**

This alliance is not defined at the association level locally, and is represented by one sampled plot (JOTR: 16-26-4). The following general description will serve to distinguish the local stand(s).

| | |
|---|---|
| COMMON NAME | Desert False Willow Intermittently Flooded Shrubland Alliance |
| SYNONYM | None |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Shrubland |
| PHYSIOGNOMIC GROUP | Temperate Broad-Leaved Evergreen Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Semi-natural |
| FORMATION | Sclerophyllous Temperate Broad-Leaved Evergreen Shrubland |
| ALLIANCE | *Baccharis sergiloides* Intermittently Flooded Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Wetland |

RANGE
Globally
The *Baccharis sergiloides* Intermittently Flooded Shrubland Alliance occurs in the Mojave Desert and Southern California mountains and valley regions of California and in Nevada, Arizona, and northern Mexico.

JOTR
The sampled plot occurs in Rattlesnake Canyon on the Indian Cove 7.5 minute topographic quadrangle.

ENVIRONMENTAL DESCRIPTION
Globally
The *Baccharis sergiloides* Intermittently Flooded Shrubland Alliance occurs in washes, arroyos, and canyon bottoms. Stands are restricted to intermittently flooded drainages, seeps, and springs. Soils are seasonally saturated and range from gravelly to sandy to medium fine, sandy loam. Elevation ranges from 3,000 to 6,000 feet (900 to 1,800 m).

JOTR
This alliance occurs in narrow, granitic canyons with intermittent stream flows in the higher mountains of the western part of the park.

MOST ABUNDANT SPECIES
Globally

| | |
|---|---|
| Shrub | *Baccharis sergiloides, Eriogonum fasciculatum, Gutierrezia microcephala, Lotus rigidus, Yucca schidigera, Ericameria linearifolia, Sphaeralcea ambigua, Acacia greggii, Opuntia acanthocarpa, Artemisia ludoviciana, Prunus fasciculata, Rhus trilobata* |
| Tree | *Populus fremontii, Salix* spp. |

JOTR

| | |
|---|---|
| Shrub | *Baccharis sergiloides, Salix exigua* |
| Tree | *Fraxinus velutina* |

CHARACTERISTIC SPECIES
Globally

| | |
|---|---|
| Shrub | *Baccharis sergiloides* |

VEGETATION DESCRIPTION
Globally
*Baccharis sergiloides* is the sole or dominant shrub in canopy. Emergent *Populus fremontii* and *Salix* species may be present. Shrubs are generally < 5 m tall, and the canopy open to continuous. The understory is sparse to intermittent.

JOTR
In the park, this alliance is characterized by a very sparse cover of *Baccharis sergiloides, Salix exigua*, and *Fraxinus velutina* (1 percent each) in the shrub layer, and a very sparse herb cover of primarily *Epilobium canum* and *Bromus madritensis rubens*.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G4 S4

RANK JUSTIFICATION
This alliance is widespread in upper-elevation Mojave and adjacent Great Basin Deserts along washes and intermittent channels.

DATABASE CODE

COMMENTS
Globally
*Baccharis sergiloides* is a common shrub of moist canyon bottoms, seeps, and springs in the mountains of the Mojave Desert. It occurs in similar habitats in the desert facing, peninsular and transverse ranges of California. Stands are typically small and are tied to relatively moist, intermittently flooded stretches of desert mountain canyon bottoms or borders and tails of springs and seeps. Boulders and bedrock typically break up the stands, although rooting substrate is typically relatively fine sand. Evens (2000) found this alliance only on granitic substrates in the narrower canyons of the eastern Mojave Desert mountains. She describes variation in this association based on associated species and microtopography ranging from flat, sandy stretches and bouldery ravines with >10 percent slope to vertical waterfalls on bedrock. In comparison to other canyon alliances in the eastern Mojave, the *Baccharis sergiloides* alliance has the most ecological overlap with the *Salix exigua* alliance, suggesting relatively high subsurface moisture requirements.

As with other members of the genus, *Baccharis sergiloides* produces abundant seed that is easily dispersed on the wind, with the assistance of substantial pappus bristles. Little specific information exists on the autecology of the species. Its longevity and relationship to fire and mechanical disturbance are not known. However, as with other similar species (*e.g., Baccharis sarothroides, B. pilularis, and B. salicifolia*), it probably does resprout following disturbance and does not attain great age.

JOTR

This alliance is represented by one sampled plot (JOTR:16-26-4).

---

**Antelope Bush *(Purshia tridentata)* Shrubland Alliance**

This alliance is not defined at the association level locally. The following general description will serve to distinguish the local stand(s):

| | |
|---|---|
| COMMON NAME | Antelope Bush Shrubland |
| SYNONYM | None |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Shrubland |

| | |
|---|---|
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Evergreen Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Semi-natural |
| FORMATION | Facultatively Deciduous Extremely Xeromorphic Subdesert Shrubland |
| ALLIANCE | *Purshia tridentata* Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 1 |
| USFWS WETLAND SYSTEM | Upland |

RANGE
Globally
The *Purshia tridentata* Shrubland Alliance occurs in the Klamath Mountains, southern Cascades, subalpine Sierra Nevada, Modoc Plateau, northern and eastern Southern California mountains and valleys, Mojave Desert, Mono, southeastern Great Basin, and northwestern basin and range regions of California, and in the intermountain West.

JOTR
This alliance occurs in the Little San Bernardino Mountains in the western portion of the park, mostly at about 4,000 feet (1,200 m).

ENVIRONMENTAL DESCRIPTION
Globally
This alliance occurs on slopes and flats in well-drained, rapidly permeable soils, from 3,000 to 11,000 feet (900 to 3,350 m) in elevation.

JOTR
No local environmental data is available for this alliance.

MOST ABUNDANT SPECIES
Globally

| | |
|---|---|
| Shrub | *Purshia tridentata*, *Artemisia tridentata*, *Chrysothamnus nauseosus, Cercocarpus ledifolius*, *Chrysothamnus viscidiflorus, Ephedra viridis*, *Prunus andersonii*, *Tetradymia canescens* |
| Tree | *Pinus* spp., *Juniperus* spp., *Yucca brevifolia* |

JOTR
*Petalonyx thurberi, Psorothamnus fremontii, Purshia tridentata*
Herbaceous
Shrub

CHARACTERISTIC SPECIES
Globally
Herbaceous
Shrub
Tree

VEGETATION DESCRIPTION
Globally
*Purshia tridentata* is the sole, dominant, or important shrub, with *Artemisia tridentata* or *Ericameria nauseosa* in canopy. Emergent junipers, pines, or *Yucca brevifolia* may be present. Shrubs are generally < 5 m tall; the cover continuous, intermittent, or open. The ground layer is sparse or grassy.

JOTR

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G5 S4

RANK JUSTIFICATION
This is a common alliance in eastern California and throughout the Great Basin.

DATABASE CODE

COMMENTS
Globally
Some stands of this alliance may have scattered trees. *Purshia tridentata* is also an important understory shrub in open woodland and forest alliances in transmontane California.

In *The Jepson Manual* (Hickman 1993), *Purshia tridentata* includes two varieties that are treated as species in many manuals. *Purshia tridentata* var. *glandulosa* and *Purshia tridentata* var. *tridentata* are generally differentiated by range, but both grow in the southeastern Great Basin. Both varieties are included in this alliance.

*Purshia tridentata* var. *tridentata* is a long-lived (125 years +), deep-rooted shrub that varies greatly in habit and local ecotypic response. An erect form tends to grow at lower elevations than a decumbent form that is more common at moister, higher ones. It establishes easily on disturbed sites that have some plant cover. Cleaned and cached seeds can be carried by ants, birds, and rodents up to 1,000 feet (350 m) from source shrubs. Seedling establishment is sporadic and episodic, occurring in years of heavy seed crop, moderate rodent populations, sufficiently cold winters to promote seed ripening, and favorable spring and summer moisture and temperature conditions. Many stands tend to be all one age.

*Purshia tridentata* var. *tridentata* is an important browse for livestock in the spring and wildlife in the winter. It is often killed by fire. It regenerates after fire by resprouting or by seedlings from cached seed. The erect form resprouts from buds just above the root collar; the decumbent form resprouts from buds just above the root collar or buds along layered branches. Young shrubs less than five-years old and those over 60 years do not resprout as well as mid-aged, vigorously

growing ones. Fires that reduce duff, litter, and competitive plants in years of favorable conditions are associated with high seedling establishment.

*Purshia tridentata* var. *glandulosa* is a long-lived, deep-rooted shrub, varying in habit and in local ecotypic response. This subspecies establishes easily on disturbed sites that have some plant cover. Seeds are cleaned and cached by ants, birds, and rodents, and seedling establishment is sporadic. High seed production often follows periods of favorable precipitation. This variety generally grows in drier environments than *Purshia tridentata* var. *tridentata*

*Purshia tridentata* var. *glandulosa* is important browse for mule deer, especially in the winter. It is not easily killed by fire, readily resprouts after fire, and can persist with recurring fire. It regenerates after fire by resprouting or by seedlings from cached seed. It resprouts from buds just about the root collar, along upright and layered branches, or roots.

This alliance is generally considered to be on the decline in much of its California range due to an altered fire regime (intervals have become too frequent, and stands have been converted to *Ericameria nauseosa*, *Bromus tectorum,* or *Taeniatherum caput-medusae*). Long-term, intensive grazing has also reduced the vigor and reproductive capacity of some stands. Stands of this alliance are extremely important rangelands for livestock and for deer, due to the palatability of *Purshia tridentata.* Thus, proper management is economically and ecologically important.

JOTR
The following samples in JOTR are characteristic of the *Purshia tridentata* alliance:

*Purshia tridentata* Undifferentiated (Long: VCOT98-1, VMAL98-42)

---

**Parry Nolina (*Nolina parryi)* Shrubland Alliance**

This alliance is not defined at the association level locally. The following general description will serve to distinguish the local stand(s):

| | |
|---|---|
| SYNONYM | None |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Shrubland |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Evergreen Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Succulent Extremely Xeromorphic Evergreen Shrubland |
| ALLIANCE | *Nolina parryi* Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Upland |

RANGE
Globally
The *Nolina parryi* Shrubland Alliance occurs in the Mojave Desert and Southern California mountains, valleys, and Sierra Nevada regions of California. It is known from widely scattered sites including the Kingston Range, eastern escarpment of the San Jacinto Mountains, and Joshua Tree National Park.

JOTR
No local distribution data is available for the park.

ENVIRONMENTAL DESCRIPTION
Globally
This alliance occurs on ridges and slopes on soils derived from bedrock or colluvium. Substrates are largely granitic or crystalline metamorphic, (including calcareous types). *Nolina parryi* alliance tends to occur in steep, very rocky areas or on moderately steep desert slopes where total vegetation cover is less than 40 percent. Elevations range from 2,000 to 7,000 feet (600 to 2,100 m).

JOTR
No environmental data for this alliance is available for the park.

MOST ABUNDANT SPECIES
Globally

| | |
|---|---|
| Herbaceous | *Achnatherum speciosum*, *Poa secunda* |
| Shrub | *Nolina parryi, Artemisia ludoviciana, Coleogyne ramosissima, Eriogonum fasciculatum, Eriogonum heermannii, Ericameria teretifolia, Gutierrezia microcephala, Opuntia acanthocarpa, Salazaria mexicana, Salvia mohavensis, Thamnosma montana, Yucca schidigera* |
| Tree | *Pinus monophylla, Juniperus californica* |

JOTR

| | |
|---|---|
| Herbaceous | *Achnatherum speciosum* |
| Shrub | *Nolina parryi* |

CHARACTERISTIC SPECIES
Globally

| | |
|---|---|
| Shrub | *Nolina parryi* |

VEGETATION DESCRIPTION
Globally
*Nolina parryi* is the dominant or important shrub in overstory. Emergent trees may be present over a shrub canopy. *Achnatherum speciosum* and *Poa secunda* may form a scattered grass understory. Shrubs are 0.5–4 m tall and form an intermittent to open canopy. Grasses are 0.5–1 m tall and also form an intermittent to open canopy.

JOTR
The local stands are found in the upper-elevation zones associated with California Juniper, Muller Oak, and Single-Leaf Pinyon Pine.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G3 S3.2

RANK JUSTIFICATION
This is a rare and local alliance of the Mojave and western margin of the Sonoran Desert.

DATABASE CODE

COMMENTS
Globally
*Nolina parryi* is a conspicuous, tufted, liliaceous shrub to small tree (up to 5 m) that forms scattered stands in desert or desert border mountains. *Nolina parryi* alliance is one of several mid-elevation, xeromorphic, upland scrub alliances above the broad belt of *Larrea tridentata-Ambrosia dumosa* but below the high-elevation scrubs with *Artemisia tridentata* and the *Pinus monophylla* woodland belt. It is localized in the Mojave Desert, the peninsular ranges, and the southern Sierra Nevada.

Natural disturbance in *Nolina parryi* alliance was probably limited to occasional fires, which had a likely neutral or negative effect. Related species (*Nolina macrocarpa*) have been shown to crown sprout from the caudex in light severity fires. However, the thick thatch of leaves that develops on older plants tends to increase heat and, thus, older plants tend to succumb to moderate-to-severe fire (FEIS 2001). Anecdotal evidence (Desert Workshop, January 2000) suggests that individual *Nolina* are relatively fire hardy and will resprout.

*Nolina parryi* stands are highly localized and regularly occur in steep, rocky slopes or on bouldery terrain. This suggests that the alliance requires more moisture (channeled along cracks in bedrock) than is modally available. Stands tend to diminish immediately off outcrops and are replaced by other vegetation more suitably adapted to deeper soils. This includes *Coleogyne ramosissima, Salazaria mexicana, Eriogonum fasciculatum, Juniperus californica,* and *Quercus cornelius-mulleri* alliances. At the upper limits of its elevation range *Nolina parryi* gives way to *Pinus monophylla* or *Pinus jeffreyi* alliance.

Stands are localized and appear naturally uncommon. Since they are typically isolated from dense vegetation and human influence, the alliance is likely to maintain similar disturbance patterns to pre-European days. Because adjacent vegetation is becoming more prone to frequent fire, further study and monitoring of postfire response to individuals of *Nolina parryi* would be useful.

JOTR
The single plot sampled by Watts was insufficient to assign to an association. The following sample in JOTR suggested further variation than what is currently reported from this alliance:

*Nolina parryi/Achnatherum speciosum* (Watts n=1)

---

**Cheatgrass (*Bromus tectorum)* Annual Grassland Alliance**

This alliance is not defined at the association level locally. The following general description will serve to distinguish the local stand(s):

| | |
|---|---|
| COMMON NAME | Cheatgrass Annual Grassland Alliance |
| SYNONYM | None |
| PHYSIOGNOMIC CLASS | Herbaceous Vegetation |
| PHYSIOGNOMIC SUBCLASS | Annual Graminoid or Forb Vegetation |
| PHYSIOGNOMIC GROUP | Temperate or Subpolar Annual Grasslands or Forb Vegetation |
| PHYSIOGNOMIC SUBGROUP | Semi-natural |
| FORMATION | Short Temperate Annual Grassland |
| ALLIANCE | *Bromus tectorum* Annual Grassland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 1 |
| USFWS WETLAND SYSTEM | Upland |

RANGE
Globally
The *Bromus tectorum* Annual Grassland Alliance occurs in humid, temperate, and dry domains of California and all United States. It is native to southern Europe and southwestern Asia.

JOTR
The single plot in the park was located on the Joshua Tree South 7.5 minute quadrangle.

ENVIRONMENTAL DESCRIPTION
Globally
This alliance occurs from sea level to 7,000 feet (2,100 m) in elevation.

JOTR
The single plot described in the park was at 4,600 feet (1,400 m) in elevation at mid-slope. It was sampled in an area that was burned two years previously.

MOST ABUNDANT SPECIES
Globally
Herbaceous *Bromus tectorum*, *Agropyron desertorum*, *Elymus elymoides, E. smithii, Oryzopsis hymenoides, Stipa comata*

JOTR
Herbaceous *Bromus tectorum*

CHARACTERISTIC SPECIES
Globally
Herbaceous *Bromus tectorum*

VEGETATION DESCRIPTION
Globally
*Bromus tectorum* is dominant grass in the ground layer; native grasses and emergent shrubs may be present. The grass canopy is < 1 m and is continuous to open.

JOTR

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G5 S5

RANK JUSTIFICATION
This is painfully abundant throughout the Great Basin and in higher elevations throughout the southwestern deserts.

DATABASE CODE

COMMENTS
Globally
Rarely has the vegetation pattern of a large area been so rapidly changed as with the spread of *Bromus tectorum* in the intermountain West (Upadhyaya *et al.* 1986). *B. tectorum* competes well with established plants for soil moisture and promotions of frequent fires. Once established, it greatly increases the potential and reoccurrence of fires. In many invaded areas, the fire cycle has been shortened to three to five years. Not only are these areas burned more often but the fires are also more uniform, with fewer patches of unburned plants (Whisenant 1990). This fire cycle considerably reduces the capability of perennials and promotes the dominance of *B. tectorum*.

This annual grass is favored by cultivation, frequent fire, and overgrazing. Seeds germinate in the fall if water is available and grow until temperatures fall. Seeds may also germinate in the spring and even in the summer. Plants grow as long as soil moisture is present, commonly maturing, fruiting, and drying by late June. As the plants mature and cure, they change from bright green to red–purple to straw. Seeds accumulate in the litter from earlier plants. The moist litter offers perfect conditions for seed germination. Plant production varies among years, depending on seasonal precipitation and temperature patterns.

*B. tectorum* is useful spring forage for livestock. Plants produce much seed and create stands of continuous fuel. The rates of spread, size, and frequency of fire increase with the presence of *B.*

*tectorum*. Cured plants are extremely flammable and are a fire hazard for a longer period during the year than native grasses. Their seed bank may not be reduced greatly by a fire that significantly impacts native plants. In addition, seed establishment of native species is reduced if they geminate in the spring with already established plants.

JOTR

The following sample in JOTR suggested further variation than what is currently reported from this Alliance:

*Bromus tectorum* fire plot (JOTR: 08B-02-2)

## Mojavean Upper Bajada Scrub

### Joshua Tree (*Yucca brevifolia)* Wooded Shrubland Alliance

The *Yucca brevifolia* Wooded Shrubland Alliance occurs in the Mojave Desert and southeastern Great Basin regions of California, and in southern Nevada, western Arizona, and southwestern Utah.

*Yucca brevifolia* is a long-lived plant (> 150 years), although the exact age is difficult to determine, since annual rings are not produced and many individuals may regenerate vegetatively. Juvenile *Yucca brevifolia* are generally unbranched; middle-aged plants are forked and dense. Older trees generally have a single stem and an open crown. Seedlings are uncommon on many harsh sites, except following a series of wet years. Some researchers believe that sexual reproduction was much more important during more favorable climatic regimes (late Pleistocene), when summers were cooler and annual precipitation greater (FEIS 2001). Vegetative reproduction is now the most important mode of regeneration on many sites. *Yucca brevifolia* can sprout from roots and underground rhizomes, which are fast growing and numerous.

Natural stand dynamics are at least partially related to fire, although not so strongly as in the *Yucca brevifolia/*herbaceous alliance. Summer lighting strikes are relatively frequent in the high desert stands in the northern, southern, and eastern Mojave with large individuals of *Yucca brevifolia* making suitable targets. The fire resistance of trees increases with age. The thick mat of dried leaves along the trunk decreases with age, and the corky bark of older trunks serves as a firebreak between surface fuels and the flammable shag on upper limbs (FEIS 2001). However, observations by R. Minnich (personal communication 2000) suggest that even large trees are susceptible to fire, with many scorched trees dying within five years. Grazing history has changed the fire regime by increasing nonnative, annual grasses. The former regime was probably once per century.

*Yucca brevifolia* is generally capable of vigorous root and stump sprouting after fire. Seed can remain viable in the soil for several years. Reestablishment through on-site or off-site seed is possible, particularly on more mesic sites or in favorable years. Little is known of the resprouting response of *Yucca brevifolia* to variable timing of fires and of various ecotypes' responses to fire. According to Minnich (personal communication), although vigorous sprouting may take place in some populations following fire, others will not sprout. More seriously, those that do sprout tend to die within a few years either by rodent predation or by other causes.

Certain associations, including *Yucca brevifolia/Lycium, Yucca brevifolia/Salazaria mexicana,* and *Yucca brevifolia/Opuntia acanthocarpa,* are probably related to disturbance including fire and grazing. Other associations, including *Yucca brevifolia/Larrea tridentata - Eriogonum fasciculatum, Yucca brevifolia/Larrea tridentata - Ephedra nevadensis, Yucca brevifolia/Artemisia tridentata,* and *Yucca brevifolia/Coleogyne ramosissima,* probably have relatively low fire frequencies. Fire frequencies in areas invaded by annual, exotic grasses (*Bromus madritensis, B. tectorum, Schismus* spp.) are likely to have increased as a result of both natural and human-caused ignitions and changed the understory composition and density of *Yucca brevifolia*. There has likely been a reduction in stands with fire sensitive shrubs (*e.g., Larrea tridentata, Coleogyne*) as a result. Destruction or degradation of individual stands has resulted from off-highway vehicle (OHV) activity and vandalism, and extensive vandalism has occurred in many Joshua Tree woodlands in California.

Livestock have heavily grazed many Joshua tree woodlands. Grazing systems do not improve range conditions because of the extreme aridity and harshness of the environment. Efforts to improve these ranges tend to be expensive and yield few beneficial results.

The *Yucca brevifolia* Wooded Shrubland Alliance is represented in JOTR by six associations, all defined first in this project. These include Joshua Tree/Blackbush (*Yucca brevifolia/Coleogyne ramosissima)* Wooded Shrubland Association, Joshua Tree/California Juniper/Blackbush (*Yucca brevifolia/Juniperus californica/Coleogyne ramosissima)* Wooded Shrubland Association, Joshua Tree/California Juniper/Nevada Ephedra *(Yucca brevifolia - Juniperus californica/Ephedra nevadensis)* Wooded Shrubland Association, Joshua Tree/Creosote Bush – Mojave Yucca (*Yucca brevifolia/Larrea tridentata - Yucca schidigera)* Wooded Shrubland Association, *Yucca brevifolia/Larrea tridentata - Pleuraphis rigida* Wooded Shrubland Association, and Joshua Tree/Desert Almond (*Yucca brevifolia/Prunus fasciculata)* Wooded Shrubland Association.

In addition to these associations, several unclassified alliance-level samples were taken in the park suggesting further variation. These include

*Yucca brevifolia/Atriplex canescens* (JOTR: 06A-03-4)
*Yucca brevifolia/Ephedra nevadensis/Pleuraphis rigida* (JOTR: 03-14-5, 11B-06-3)
*Yucca brevifolia/Juniperus californica - Yucca schidigera* (JOTR: 20-13-2)

*Yucca brevifolia/Coleogyne ramosissima* Wooded Shrubland Association (Mapping Code: 13012)

| | |
|---|---|
| COMMON NAME | Joshua Tree/Blackbush Wooded Shrubland Association |
| SYNONYM | *Coleogyne ramosissima - Yucca schidigera - Yucca brevifolia* association (Leary 1977) |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Shrubland |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Evergreen Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Extremely Xeromorphic Evergreen Shrubland With a Sparse Tree Layer |
| ALLIANCE | *Yucca brevifolia* Wooded Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Upland |

RANGE
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory. This association may also occur elsewhere in the Mojave Desert. Other stands similar in composition have been seen elsewhere in the Mojave Desert (T. Keeler-Wolf, personal observation), but have not been defined.

JOTR
Stands of the *Yucca brevifolia/Coleogyne ramosissima* Wooded Shrubland Association are found in the northwestern part of the park and were sampled within the Indian Cove and Joshua Tree South 7.5 minute topographic quadrangles.

ENVIRONMENTAL DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of *Yucca brevifolia/Coleogyne ramosissima* Wooded Shrubland Association are found at mid to high elevations (4,000–4,300 ft.; 1,200–1,300 m) on southwest, west, northwest, and north facing slopes. This association generally occurs on gentle (1-5 degree), linear to undulating slopes of intramontane, alluvial plains and old alluvial deposits undergoing dissection. Soil textures are medium sand, moderately coarse sandy loam, and medium to very fine, sandy loam derived from granitic, parent material. These sites tend to be gravelly with gravel cover of 25–75 percent and fines cover of 50–75 percent. Litter ranges from 1 to 5 percent cover. These sites generally experience low to moderate levels of competition from exotics (4–8 percent cover).

MOST ABUNDANT SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Shrub | *Coleogyne ramosissima, Hymenoclea salsola* |
| Tree | *Yucca brevifolia* |

CHARACTERISTIC SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Herbaceous | *Achnatherum speciosum* |
| Shrub | *Coleogyne ramosissima, Hymenoclea salsola, Atriplex* sp.*, Opuntia echinocarpa* |
| Tree | *Yucca brevifolia* |

VEGETATION DESCRIPTION
Globally

This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Yucca brevifolia/Coleogyne ramosissima* Wooded Shrubland Association form an open woodland with 0 percent cover at <1 cm tall, 0-5 percent cover at 1–25 cm tall, 0–25 percent cover at 25–50 cm tall, 1–25 percent cover at 50 cm to 1 m tall, 1–25 percent cover at 1–3 m tall, and 1–5 percent cover at 3–5 m tall. Total vegetative cover ranges from 14–30 percent.

This association is dominated by *Yucca brevifolia* in the tree layer and *Hymenoclea salsola* and *Coleogyne ramosissima* in shrub layer. *Opuntia echinocarpa, Atriplex* sp.*,* and *Achnatherum speciosum* are characteristic in the understory shrub and herb layers. Often found in the stands are *Ephedra viridis, Ericameria* sp.*,* and *Pleuraphis rigida. Ephedra nevadensis* is common in some stands. The exotic species *Bromus madritensis* is also common at some stands.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G4 S3

RANK JUSTIFICATION
Likely to also occur in Nevada, but likely to be somewhat threatened by increased fire frequency and development

DATABASE CODE

COMMENTS
Globally
This type is likely to occur in the Mojave Desert in Nevada and elsewhere in the California Mojave Desert. Both the main nominate species of this association have similar ecological amplitudes and are likely to overlap throughout much of the Mojave Desert.

JOTR

Much of this type has undergone recent burning in the Covington Flats area.

Plots used for this description: MDEI: 101-7-1, 101-7-3, 101-7-4, 118-1-1, 118-1-8

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*Yucca brevifolia/Juniperus californica/Coleogyne ramosissima* Wooded Shrubland Association (Mapping Code: 13015)

| | |
|---|---|
| COMMON NAME | Joshua Tree/California Juniper/Blackbush Association |
| SYNONYM | *Yucca schidigera - Yucca brevifolia - Juniperus californica - Coleogyne ramosissima* association (Leary 1977) |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Shrubland |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Evergreen Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Extremely Xeromorphic Evergreen Shrubland With a Sparse Tree Layer |
| ALLIANCE | *Yucca brevifolia* Wooded Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Upland and Palustrine |

RANGE
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Yucca brevifolia/Juniperus californica/Coleogyne ramosissima* Wooded Shrubland Association occur in the western portion of the park and were sampled within the Keys View and Joshua Tree South 7.5 minute topographic quadrangles.

ENVIRONMENTAL DESCRIPTION

Globally

This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

Stands of *Yucca brevifolia/Juniperus californica/Coleogyne ramosissima* Wooded Shrubland Association are found at high elevations (4,300–5,500 ft.; 1,300–1,700 m) on linear and concave sites that are within drainages of washes and upland, alluvial deposits. Soil textures are usually sandy, ranging from coarse sand to fine, loamy sand, and soils are formed on sialic sediment, plutonic, or noncalcareous, metamorphic, parent material. Coarse fragment composition in these stands is 0 percent rock and boulder, <1 percent stone, <1 percent cobble, 2-30 percent gravel, and 45-64 percent fines. Litter ranges from 4-9 percent cover. These sites generally experience moderate levels of disturbance from exotic species (4-8 percent cover exotics).

MOST ABUNDANT SPECIES

Globally

This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Herbaceous | *Bromus madritensis rubens* |
| Shrub | *Coleogyne ramosissima, Hymenoclea salsola* |
| Tree | *Juniperus californica, Yucca brevifolia* |

CHARACTERISTIC SPECIES

Globally

This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Herbaceous | *Achnatherum speciosum* |
| Shrub | *Coleogyne ramosissima, Ephedra nevadensis* |
| Tree | *Juniperus californica, Yucca brevifolia* |

VEGETATION DESCRIPTION

Globally

This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

Stands of the *Yucca brevifolia - Juniperus californica/Coleogyne ramosissima* Wooded Shrubland Association form an open shrubland with 0–2 percent cover at <1 cm tall, <1-8 percent cover at 1–25 cm tall, 1–7 percent cover at 25–50 cm tall, 5–27 percent cover at 50

cm to 1 m tall, 3–5 percent cover at 1–3 m tall, and 2–4 percent cover at 3–5 m tall. Total vegetative cover ranges from 16–38 percent.

This association is dominated by the tall shrub or short tree species *Juniperus californica* and *Yucca brevifolia. Hymenoclea salsola, Coleogyne ramosissima* are the most abundant shrub species. The exotic species *Bromus madritensis rubens* is abundant in the herb layer. *Ephedra nevadensis* is characteristically in the shrub layer, and *Achnatherum speciosum* is characteristically in the herb layer. *Grayia spinosa* and the exotic species *Bromus tectorum* are common within some stands. Frequently found contributing to minor cover in this association are *Atriplex canescens, Eriogonum fasciculatum,* cryptobiotic crust, *Lycium cooperi, Opuntia basilaris,* and *Opuntia echinocarpa.*

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G4 S3

RANK JUSTIFICATION
Likely to be widespread in the California Mojave and possibly in Nevada, though stands and site quality are reduced due to increased fire frequency and invasive exotic grass cover.

DATABASE CODE

COMMENTS
Globally
Probably occurs elsewhere in the Mojave. This association differs from the *Y. brevifolia/ Coleogyne ramosissima* association described above by the constant presence of *Juniperus californica* and by the typically sandier substrate with less small rocks and gravel.

JOTR

Plots used for this description: JOTR: 06A-08-1, 08A-02-1, 15-09-1; LONG: VBRC97-1[2], VKEY97-1

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*Yucca brevifolia - Juniperus californica/Ephedra nevadensis* Wooded Shrubland Association (Mapping Code: 13015)

| | |
|---|---|
| COMMON NAME | Joshua Tree/California Juniper/Nevada Ephedra Association |
| SYNONYM | Desert Woodland Association (Leary 1977) |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Shrubland |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Evergreen Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |

| | |
|---|---|
| FORMATION | Extremely Xeromorphic Evergreen Shrubland With a Sparse Tree Layer |
| ALLIANCE | *Yucca brevifolia* Wooded Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Upland |

RANGE
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Yucca brevifolia - Juniperus californica/Ephedra nevadensis* Wooded Shrubland Association occur in the western portion of the park and were sampled within the Malapai Hill and Joshua Tree South 7.5 minute topographic quadrangles.

ENVIRONMENTAL DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of *Yucca brevifolia - Juniperus californica/Ephedra nevadensis* Wooded Shrubland Association are found at high elevations (4,900–5,000 ft.; 1,490–1,520 m) on linear sites of bottom/plains and upland, alluvial deposits. This association is found on flat to gentle (0–2 degree) slopes. Soils have textures ranging from coarse sand to very fine sandy loam, and are derived from sialic sediment, plutonic, and noncalcareous, metamorphic, granitic, parent material. The rock component consists of 0 percent bedrock cover, 0 percent boulder cover, 0 percent stone cover, 0–<1 percent cobble cover, 17–59 percent gravel cover, and 35–54 percent fines cover. These sites generally experience moderate to high levels of disturbance from exotic species (6–12%).

MOST ABUNDANT SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Herbaceous | *Achnatherum speciosum, Bromus madritensis rubens, Bromus tectorum,* |
| Shrub | *Ephedra nevadensis, Eriogonum fasciculatum Juniperus californica,* |
| Tree | *Yucca brevifolia* |

CHARACTERISTIC SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Herbaceous | *Achnatherum speciosum, Sphaeralcea ambigua* |
| Shrub | *Ephedra nevadensis, Eriogonum fasciculatum, Juniperus californica, Gutierrezia microcephala, Coleogyne ramosissima, Atriplex canescens, Opuntia echinocarpa, Lycium* sp. |
| Tree | *Yucca brevifolia* |

VEGETATION DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Yucca brevifolia - Juniperus californica/Ephedra nevadensis* Wooded Shrubland Association form an open shrubland with <1 percent cover at <1 cm tall, 1–12 percent cover at 1–25 cm tall, 2–6 percent cover at 25–50 cm tall, 4-8 percent cover at 50 cm to 1 m tall, 1-5 percent cover at 1 m–3 m tall, <1–3 percent cover at 3–5 m tall, and 2–3 percent cover at 5–10 m tall. Total vegetative cover ranges from 20–21 percent.

This association is dominated by *Yucca brevifolia*, *Ephedra nevadensis, Eriogonum fasciculatum,* and *Juniperus californica* in the tree and shrub layers. *Achnatherum speciosum* is dominant in the understory herb layer, although exotic species Bromus *madritensis rubens* and *Bromus tectorum* are also abundant in the herb layer. Shrub species often present in this association include *Gutierrezia microcephala, Coleogyne ramosissima, Atriplex canescens, Opuntia echinocarpa,* and *Lycium* sp. *Sphaeralcea ambigua* is a frequently present herb. *Hymenoclea salsola* is common within some stands. The exotic herb species *Erodium cicutarium* is also common in some stands.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G3 S3

RANK JUSTIFICATION
Probably restricted to the western Mojave Desert in California and reduced by development and increased fire due to fine fuels from invasive exotic grasses.

DATABASE CODE

COMMENTS
Globally

JOTR

Plots used for this description: JOTR: 08A-02-2, 08A-04-4; LONG: VMAL97-34

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*Yucca brevifolia/Larrea tridentata - Yucca schidigera* Wooded Shrubland Association (Mapping Code: 13016)

| | |
|---|---|
| COMMON NAME | Joshua Tree/Creosote Bush – Mojave Yucca Association |
| SYNONYM | *Coleogyne ramosissima - Yucca schidigera - Yucca brevifolia* association (Leary (1977) |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Shrubland |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Evergreen Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Extremely Xeromorphic Evergreen Shrubland With a Sparse Tree Layer |
| ALLIANCE | *Yucca brevifolia* Wooded Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Upland |

RANGE
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Yucca brevifolia/Larrea tridentata - Yucca schidigera* Wooded Shrubland Association occur in the western portion of the park and were sampled within the Queen Mountain, Rockhouse Canyon, and Indian Cove 7.5 minute topographic quadrangles.

ENVIRONMENTAL DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of *Yucca brevifolia/Larrea tridentata - Yucca schidigera* Wooded Shrubland Association are found at mid to high elevations (3,500–4,600 ft.; 1,000–1,400 m) on convex, linear, and undulating, gentle (<1 degree) slopes of upland, alluvial deposits and fluvial floodplain and channels. Soils are typically sand (includes coarse, medium, and fine sand; coarse medium, and

fine, loamy sand) and are formed on sialic sediment, plutonic, and noncalcareous, metamorphic, parent material. The rock component consists of 0 percent bedrock cover, 0 percent boulder cover, 0 percent stone cover, 0–2 percent cobble cover, 4–25 percent gravel cover, and 50–64 percent fines cover. Litter ranges from 2–13 percent cover. These sites generally experience moderate disturbance levels from competition from exotics (2–3 percent cover) and occasionally moderate levels of disturbance from foot traffic/trampling.

MOST ABUNDANT SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Herbaceous | *Bromus madritensis* |
| Shrub | *Larrea tridentata, Yucca schidigera, Salazaria mexicana* |
| Tree | *Yucca brevifolia* |

CHARACTERISTIC SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Shrub | *Larrea tridentata, Yucca schidigera, Acamptopappus sphaerocephalus, Ephedra nevadensis, Hymenoclea salsola, Krameria* sp., *Opuntia echinocarpa* |
| Tree | *Yucca brevifolia* |

VEGETATION DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Yucca brevifolia/Larrea tridentata - Yucca schidigera* Wooded Shrubland Association form an open woodland with <1–2 percent cover at <1 cm tall, 2–3 percent cover at 1–25 cm tall, 1–3 percent cover at 25–50 cm tall, 2–7 percent cover at 50 cm to 1 m tall, 7–15 percent cover at 1–3 m tall, and 0–2 percent cover at 3-5 m tall. Total vegetative cover ranges from 20–26 percent.

This association is dominated by the tree and shrub species *Yucca brevifolia, Larrea tridentata, Yucca schidigera, and Salazaria mexicana*. The exotic species *Bromus madritensis* is dominant in the understory herb layer. Characteristic shrub species include *Acamptopappus sphaerocephalus, Ephedra nevadensis, Hymenoclea salsola, Krameria* sp., and *Opuntia echinocarpa. Coleogyne ramosissima, Eriogonum fasciculatum,* and a cryptobiotic crust is

frequently present. The exotic species *Erodium cicutarium* is also frequently present in this association.

OTHER NOTEWORTHY SPECIES
*Coryphantha alversonii* was found in one of three plots. *Coryphantha alversonii* is a List 4 plant in the CNPS Inventory of Rare and Endangered Plants of California (CNPS 2001). It is found in Imperial, Riverside, and San Bernardino Counties at low to high elevations (240 – 5,000 ft.; 73 – 1,500 m). (Syn: *Escobaria vivipara var. alversonii* in the Jepson Manual.)

CONSERVATION RANK G4 S4

RANK JUSTIFICATION
This association is likely to be found throughout the upper elevations of the Mojave Desert in California, Arizona, and Nevada.

DATABASE CODE

COMMENTS
Globally

JOTR

Plots used for this description: JOTR: 15-25-3, 18-27-4, 21-14-2; LONG: VMAL97-4; WATTS n=18

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*Yucca brevifolia/Larrea tridentata - Pleuraphis rigida* Wooded Shrubland Association (Mapping Code: 13016)

| | |
|---|---|
| COMMON NAME | Joshua Tree/Creosote Bush - Big Galleta Wooded Shrubland Association |
| SYNONYM | *Yucca brevifolia – Hilaria rigida* association (Leary 1977); *Hilaria rigida-Coleogyne ramosissima* type (Hogan 1977) |
| PHYSIOGNOMIC CLASS | Herbaceous Vegetation |
| PHYSIOGNOMIC SUBCLASS | Perennial Graminoid Vegetation |
| PHYSIOGNOMIC GROUP | Temperate or Subpolar Grassland with a Sparse Tree Layer |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Medium-Tall Temperate or Subpolar Grassland with a Sparse Needle-Leaved Evergreen or Mixed Tree Layer |
| ALLIANCE | *Yucca brevifolia* Wooded Herbaceous Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Upland |

RANGE
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Yucca brevifolia/Larrea tridentata - Pleuraphis rigida* Wooded Shrubland Association occur in the western portion of the park and were sampled within the Malapai Hill 7.5 minute topographic quadrangle.

ENVIRONMENTAL DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of *Yucca brevifolia/Larrea tridentata - Pleuraphis rigida* Wooded Shrubland Association are found at high elevations (over 4,000 ft.; 1,200 m) on linear slopes on the toe slopes of alluvial fans or bajadas, at the mid one-third of slopes, and on upland, alluvial deposits. This association is found on flat to gentle (0-–5 degree) slopes facing south, north, and northeast. Soils have textures ranging from coarse sand to moderately coarse sandy loam, and are derived from sandy alluvium, sialic sediment, and plutonic, noncalcareous, metamorphic, and granitic, parent material. The rock component consists of 0 percent bedrock cover, 0 percent boulder cover, 0 percent stone cover, <1 percent cobble cover, 5–83 percent gravel cover, and up to 63 percent fines cover. Litter consists of 5–30 percent cover. These sites generally experience moderate levels of disturbance from exotic species (3-27%) and low levels of disturbance from off-road vehicle activity.

MOST ABUNDANT SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Herbaceous | *Bromus madritensis, Erodium cicutarium, Pleuraphis rigida* |
| Shrub | *Hymenoclea salsola, Opuntia echinocarpa, Eriogonum fasciculatum, Larrea tridentata, Yucca schidigera, Ericameria cooperi, Salazaria mexicana, Coleogyne ramosissima* |
| Tree | *Yucca brevifolia* |

CHARACTERISTIC SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Herbaceous | *Pleuraphis rigida* |
| Shrub | *Hymenoclea salsola, Opuntia echinocarpa, Eriogonum fasciculatum, Larrea tridentata, Yucca schidigera, Ericameria cooperi, Salazaria mexicana, Ephedra nevadensis, Krameria grayi, Opuntia ramosissima, Echinocereus engelmannii* |
| Tree | *Yucca brevifolia* |

VEGETATION DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Yucca brevifolia/Larrea tridentata - Pleuraphis rigida* Wooded Shrubland Association form an open shrubland with 0–1 percent cover in the emergent tree layer, 19–27 percent cover in the open shrub layer, and 5–41 percent cover in the sparse to intermittent herb layer. Exotic species contribute to 3–27 percent cover in the herb layer. Total vegetative cover in this association ranges from 27–48 percent.

This association is dominated by *Yucca brevifolia* in the emergent tree layer and a variety of understory shrubs including *Hymenoclea salsola, Opuntia echinocarpa, Eriogonum fasciculatum, Larrea tridentata, Yucca schidigera, Coleogyne ramosissima*, *Ericameria cooperi, Salazaria mexicana.* The understory herb layer is dominated by *Pleuraphis rigida.* The exotic species *Bromus madritensis* and *Erodium cicutarium* are also abundant in the herb layer. Characteristic shrub species include *Ephedra nevadensis, Krameria grayi, Opuntia ramosissima,* and *Echinocereus engelmannii*. Frequently present are *Achnatherum speciosum and Acacia greggii,* and *Krameria erecta* can be common within some stands.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G4 S3

RANK JUSTIFICATION
This association is relatively uncommon but also occurs in Nevada and possibly Arizona.

DATABASE CODE

COMMENTS
Globally

JOTR

Plots used for this description: JOTR: 19-21-2; LONG: VMAL97-5, VMAL97-7, VMAL97-31

*Yucca brevifolia/Prunus fasciculata* Wooded Shrubland Association

| | |
|---|---|
| COMMON NAME | Joshua Tree/Desert Almond Wooded Shrubland Association |
| SYNONYM | *Yucca brevifolia-Stipa speciosa* association (Leary 1977) |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Shrubland |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Evergreen Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Extremely Xeromorphic Evergreen Shrubland With A Sparse Tree Layer |
| ALLIANCE | Yucca brevifolia Wooded Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Upland |

RANGE
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Yucca brevifolia/Prunus fasciculata* Wooded Shrubland Association were sampled in the park within the Joshua Tree South, Queen Mountain, and Malapai Hill 7.5 minute topographic quadrangles.

ENVIRONMENTAL DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of *Yucca brevifolia/Prunus fasciculata* Wooded Shrubland Association are found at high elevations (4,500–4,900 ft.; 1,400–1,500 m) on flat to gentle (0–1 degree) linear and undulating, upland, alluvial deposits and washes. Soils have textures ranging from coarse sand to fine, loamy sand, and occur on evaporate (playa), sialic sediment, and plutonic, noncalcareous, metamorphic, and granitic, parent material. Soils tend to be gravelly with 0 percent bedrock cover, 0 percent boulder cover, 0–<1 percent stone cover, 0-3 percent cobble cover, 12–60 percent gravel cover, and 37–57 percent fines cover. Litter cover ranges from 7–30 percent. These sites generally experience high levels of disturbance from exotic species (10–15 percent cover), moderate levels of disturbance from grazing, and moderate levels of disturbance from foot traffic and trampling.

MOST ABUNDANT SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Herbaceous | *Bromus madritensis rubens* |
| Shrub | *Prunus fasciculata, Hymenoclea salsola, Salazaria mexicana, Larrea tridentata, Acacia greggii, Acamptopappus sphaerocephalus* |
| Tree | *Yucca brevifolia* |

CHARACTERISTIC SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Shrub | *Hymenoclea salsola, Acamptopappus sphaerocephalus, Prunus fasciculata, Opuntia echinocarpa* |
| Tree | *Yucca brevifolia* |

VEGETATION DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Yucca brevifolia/Prunus fasciculata* Wooded Shrubland Association form an open shrubland with 0 percent cover at <1 cm tall, 10–15 percent cover at 1–25 cm tall, 1–3 percent cover at 25–50 cm tall, 1–2 percent cover at 50 cm to 1 m tall, 6–11 percent cover at 1–3 m tall, and 2–8 percent cover at 3–5 m tall. Total vegetative cover ranges from 23–30 percent.

This association is dominated by *Yucca brevifolia* in the tree layer. *Hymenoclea salsola, Salazaria mexicana, Larrea tridentata, Acacia greggii, Acamptopappus sphaerocephalus,* and *Prunus fasciculata* are most abundant in the shrub layer. *Opuntia echinocarpa* is characteristically present. *Ephedra nevadensis, Yucca schidigera, Phoradendron californicum,* and *Lycium cooperi* are frequently present in the shrub layer. The exotic species *Bromus madritensis rubens* is consistently abundant in the understory herb layer.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G3 S3

RANK JUSTIFICATION
This association is likely localized in higher elevations of southern and eastern Mojave Desert.

DATABASE CODE

COMMENTS
Globally

JOTR
This is a provisional association that may be related to other upper-elevation *J. brevifolia* alliance stands but appears to be largely restricted to wash edges and upper fans and valleys.

Plots used for this description: JOTR: 08A-04-1, 18-27-1; LONG: VMAL97-4[2]

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**Joshua Tree (*Yucca brevifolia)* Wooded Herbaceous Alliance**

This alliance is defined first in this project, and is represented in JOTR by one association, the Joshua Tree/Big Galleta *(Yucca brevifolia/Pleuraphis rigida)* Wooded Herbaceous Association. See the discussion of the *Yucca brevifolia* Wooded Shrubland Alliance for management considerations for this alliance.

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*Yucca brevifolia/Pleuraphis rigida* Wooded Herbaceous Association (Mapping Code: 13021)

| | |
|---|---|
| COMMON NAME | Joshua Tree/Big Galleta Shrubland Association |
| SYNONYM | *Yucca brevifolia – Hilaria rigida* association (Leary 1977); *Hilaria rigida - Coleogyne ramosissima* type (Hogan 1977) |
| PHYSIOGNOMIC CLASS | Herbaceous Vegetation |
| PHYSIOGNOMIC SUBCLASS | Perennial Graminoid Vegetation |
| PHYSIOGNOMIC GROUP | Temperate or Subpolar Grassland with a Sparse Tree Layer |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Medium-Tall Temperate or Subpolar Grassland with a Sparse Needle-Leaved Evergreen or Mixed Tree Layer |
| ALLIANCE | *Yucca brevifolia* Wooded Herbaceous Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Upland |

RANGE
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Yucca brevifolia/Pleuraphis rigida* Shrubland Association occur in the western portion of the park, such as in Lost Horse Valley and Black Rock Valley, and were sampled within the Malapai Hill and Indian Cove 7.5 minute topographic quadrangles.

ENVIRONMENTAL DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of *Yucca brevifolia/Pleuraphis rigida* Shrubland Association are found at mid elevations (3,500–4,100 ft.; 1,000–1,200 m) on linear slopes of arroyos, bottom/plains, toe slopes (alluvial fans or bajadas), and alluvial deposits undergoing dissection. These sites tend to be on mostly north facing, and occasionally west facing, gentle (1–2 degree) slopes. Soil textures range from coarse loamy sand to fine, loamy sand derived from granite and sometimes silty alluvium parent material. Soils tend to be gravelly with 0–<1 percent bedrock cover, 0 percent boulder cover, 0–<1 percent stone cover, 0–<1 percent cobble cover, 50–93 percent gravel cover, and 25–>75 percent fines cover. Litter cover ranges from 0–20 percent. These sites generally experience high levels of disturbance from exotic species (5–25 percent cover).

MOST ABUNDANT SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Herbaceous | *Pleuraphis rigida, Bromus madritensis, Erodium cicutarium* |
| Tree | *Yucca brevifolia* |

CHARACTERISTIC SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Herbaceous | *Pleuraphis rigida* |
| Shrub | *Yucca schidigera, Hymenoclea salsola, Ephedra viridis, Opuntia echinocarpa, Salazaria mexicana* |
| Tree | *Yucca brevifolia* |

VEGETATION DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Yucca brevifolia/Pleuraphis rigida* Shrubland Association have a variable structure with an open shrubland with 0–3 percent cover in the emergent tree layer, 3–21 percent cover in the open shrub layer, and 2–36 percent cover in the sparse to intermittent herb layer. Exotic species contribute to 5–25 percent cover in the herb layer. Total vegetative cover in this association can range from 7–40 percent.

This association is dominated by *Yucca brevifolia* in the emergent tree layer. The sparse to open shrub layer includes a variety of characteristic species such as *Yucca schidigera, Hymenoclea salsola, Ephedra viridis, Opuntia echinocarpa,* and *Salazaria mexicana. Pleuraphis rigida* is abundant in the understory herb layer. The exotic species *Bromus madritensis* and *Erodium cicutarium* are abundant in the understory herb layer. Frequently present are *Opuntia ramosissima, Acamptopappus sphaerocephalus, Ambrosia dumosa,* and *Atriplex canescens.*

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G4 S3

RANK JUSTIFICATION
Relatively uncommon in California, mostly in the central and Eastern Mojave. Probably occurs in Nevada.

DATABASE CODE

COMMENTS
Globally

JOTR

Plots used for this description: MDEI: 101-7-7, 157-2-6; LONG: VMAL97-6, VMAL97-37

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**Blackbush (*Coleogyne ramosissima)* Shrubland Alliance (Mapping Code: 28023)**

This alliance is not defined at the association level locally. The following general description will serve to distinguish the local stand(s).

COMMON NAME Blackbush Scrub
SYNONYM None

| | |
|---|---|
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Shrubland |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Evergreen Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Semi-natural |
| FORMATION | Facultatively Deciduous Extremely Xeromorphic Subdesert Shrubland |
| ALLIANCE | *Coleogyne ramosissima* Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 1 |
| USFWS WETLAND SYSTEM | Upland |

RANGE
Globally
This alliance occurs in the southern mountains and valleys, Mojave Desert, Mono Basin, and southeast Great Basin regions of California to Nevada, Arizona, Utah, and Colorado.

JOTR
This alliance occurs in the western and western-central portion of the park. Most pure stands are located in the western part of the park on the north slopes of the Hexie Mountains.

ENVIRONMENTAL DESCRIPTION
Globally
The *Coleogyne ramosissima* Alliance occurs on mesas, alluvial slopes, and bajadas in soils that are highly variable; generally coarse-textured and well-drained; and often dolomitic, limestone-derived or with a caliche layer. The elevation ranges from 3,000–5,500 ft (900–1,700 m).

JOTR
In JOTR, the *Coleogyne ramosissima* Alliance occurs on ridgetops and convex slopes from 3,600–5,050 feet (1,100–1,500 m) in elevation.

MOST ABUNDANT SPECIES
Globally

| | |
|---|---|
| Shrub | *Coleogyne ramosissima, Artemisia spinescens, Artemisia tridentata, Atriplex confertifolia, Ephedra* spp., *Eriogonum fasciculatum, Grayia spinosa, Krascheninnikovia lanata, Menodora spinescens, Salazaria mexicana, Thamnosma montana* |
| Tree | *Juniperus californica, Pinus monophylla, Yucca brevifolia* |

JOTR

| | |
|---|---|
| Shrub | *Coleogyne ramosissima, Eriogonum fasciculatum, Viguiera parishii*, *Lycium andersonii*, *Tetracoccus hallii, Ambrosia dumosa* |

CHARACTERISTIC SPECIES
Globally
Herbaceous

Shrub
Tree

VEGETATION DESCRIPTION
Globally
*Coleogyne ramosissima* is sole or dominant in the shrub canopy; emergent trees may be present. Shrubs are < 1 m and the canopy continuous. The ground layer is sparse.

JOTR

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G5 S4

RANK JUSTIFICATION
This type is widespread at the alliance level, though threatened by increased fire frequency carried by invasive exotic, annual grasses.

DATABASE CODE

COMMENTS
Globally
*Coleogyne ramosissima,* or Blackbush, is in a monotypic genus restricted to the arid southwestern United States, Stebbins and Major (1965) consider it a paleoendemic. According to Browns and West (1976) *Coleogyne ramosissima* is a relict species that may be on its way to extinction. This alliance occurs at transitional elevations between the Mojave Desert and the Great Basin Desert. Over the past few years, plot data (Thomas *et al.* 2003, Keeler-Wolf 2004, MS) have confirmed the intermediate relationship between the two deserts.
Elements of the lower, hotter Mojavean flora may be mixed with *Coleogyne ramosissima* Shrubland including *Larrea tridentata-Ambrosia dumosa, Yucca schidigera*, and *Yucca brevifolia* Shrublands. Upper elevation stands may mix with *Artemisia tridentata, Atriplex confertifolia, Ephedra nevadensis, Juniperus californica, Juniperus osteosperma,* and *Pinus monophylla*-dominated alliances. Blackbush is also found in the peninsular ranges as far south as Anza-Borrego Desert State Park, where it forms intermittent stands between *Yucca schidigera* Shrubland Alliance stands and *Juniperus californica* or *Pinus monophylla* dominated stands.

*Coleogyne ramosissima* is a long-lived shrub, up to 400 years in age (Webb *et al.* 1988). Individual plants produce relatively few seeds, which are relatively large and less mobile than other shorter-lived species in genera such as *Ericameria, Atriplex*, and *Artemisia*. Browns and West (1976) report that while some *Coleogyne ramosissima* seed germinate on the surface, seedlings often emerge from rodent caches. Seedling survival is poor, with most not surviving beyond cotyledon stage. *Coleogyne* stands are notably depauperate in seedlings and young plants, suggesting that pulse establishment after favorable weather conditions are rare. Growth rates for the species are very slow (Webb *et al.* 1988). Densities of *Coleogyne* stands vary and

individuals in a stand are evenly distributed (Lei 2001a), suggesting strong competition for moisture and other resources.

*Coleogyne* is typically killed outright by fire, and since most stands are relatively dense and monospecific, even low-frequency fire can destroy significant portions of stands for long periods. Recovery from fire is slow. Sinuous, sharp transitions between remnant stands of *Coleogyne ramosissima* and adjacent stands that may have been burned more than 50 years ago are frequently obvious. Lei (2001b) found most seeds in seed bank were killed in a lightning fire. Long-distance dispersal with relatively poorly dispersed seeds from adjacent stands is required for re-establishment. For a fire to carry through a *Coleogyne ramosissima* stand, not only does the stand need to be relatively dense but climatic conditions also need to be favorable (strong winds and dry conditions). Fire frequency is not high in these stands, since they occur in relatively low lightning frequency areas. In much of its range, the Blackbush-dominated alliance may be succeeded postfire by several phases of vegetation including an *Achnatherum speciosum*-dominated phase, an *Eriogonum fasciculatum*–dominated phase, an *Ericameria teretifolia*–dominated phase, or a *Salazaria mexicana*–dominated phase (Brooks and Minnich, MS, and Keeler-Wolf, personal observation).

Increased fire frequency in the California deserts is an adverse impact on this alliance. The presence of nonnative, annual grasses, such as *Bromus madritensis* and *Bromus tectorum,* can contribute to carrying fire into and through Blackbush stands (Brooks, in press 2003). Although relatively widespread in California, the alliance is sporadically distributed, particularly toward the south of its range. Some parts of the desert (e.g., Anza-Borrego) have very spotty distributions of this alliance. Extralimital and isolated stands are particularly vulnerable to fire.

JOTR

The following samples in JOTR suggested further variation than what is currently reported from this Alliance:

*Coleogyne ramosissima* - *Eriogonum fasciculatum* (Watts n=17)
*Coleogyne ramosissima* - *Viguiera parishii* (JOTR: 22-26-1, 23-20-2)
*Coleogyne ramosissima* - *Lycium andersonii* (JOTR: 15-09-2)
*Coleogyne ramosissima* - *Tetracoccus hallii* - *Ambrosia dumosa* (JOTR: 33-07-5)

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**California Buckwheat (*Eriogonum fasciculatum*) Shrubland Alliance**

This alliance is not defined at the association level locally. The following general description will serve to distinguish the local stand(s):

| | |
|---|---|
| COMMON NAME | California Buckwheat Shrubland |
| SYNONYM | None |
| PHYSIOGNOMIC CLASS | Shrubland |

| | |
|---|---|
| PHYSIOGNOMIC SUBCLASS | Evergreen Shrubland |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Evergreen Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Semi-natural |
| FORMATION | Facultatively Deciduous Extremely Xeromorphic Subdesert Shrubland |
| ALLIANCE | *Eriogonum fasciculatum* Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 1 |
| USFWS WETLAND SYSTEM | Upland |

RANGE
Globally
The *Eriogonum fasciculatum* Shrubland Alliance occurs in the Southern California coast, southern central California coast ranges, Southern California mountains and valleys, Mojave Desert, and western Colorado Desert regions in California, and in Baja California, Mexico.

JOTR
This alliance is fairly common in the upper-elevation portions of the park, mostly in the west. It commonly associates with other upper-elevation alliances such as *Juniperus californica, Pinus monophylla, Quercus cornelius-mulleri,* and *Salazaria mexicana*.

ENVIRONMENTAL DESCRIPTION
Globally
This alliance occurs on slopes and rarely flooded, low-gradient deposits. Soils are shallow and rocky. It also occurs in wetland habitats such as washes, intermittent channels, and arroyos. Soils are coarse, well drained, and moderately acidic to slightly saline. Elevation ranges from 0 to 3,800 feet (1,200 m).

JOTR
Locally, it is often associated with granitic substrates.

MOST ABUNDANT SPECIES
Globally

| | |
|---|---|
| Shrub | *Eriogonum fasciculatum, Ambrosia dumosa, Artemisia californica, Baccharis pilularis, Encelia californica, Encelia farinosa, Isocoma menziesii, Lotus scoparius, Malacothamnus fasciculatum, Mimulus aurantiacus*, *Salvia apiana, Salvia mellifera, Yucca schidigera* |
| Tree | *Juniperus californica, Juniperus osteosperma* |

JOTR

| | |
|---|---|
| Shrub | *Eriogonum fasciculatum, Salazaria mexicana* |

CHARACTERISTIC SPECIES
Globally
Herbaceous

Shrub
Tree

VEGETATION DESCRIPTION
Globally
*Eriogonum fasciculatum* is the sole, dominant, or important shrub with *Ambrosia dumosa* or other species in the shrub canopy. Emergent trees and larger shrubs may be present. Shrubs are generally < 1 m tall and the canopy continuous or intermittent. The ground layer is variable and may be grassy.

JOTR

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK

RANK JUSTIFICATION

DATABASE CODE

COMMENTS
Globally
*Eriogonum fasciculatum* is a semiwoody, many branching shrub that often occurs on coarse-textured soils that may be moderately saline. It produces conspicuous flowers over much of the year with low seed set. Seed germination requires stratification and does not require a fire-related stimulus. It establishes after disturbance by fire, flood, or livestock. It rarely resprouts after disturbance and can be replaced by longer living species in areas of longer periods between disturbances.

This alliance is extensive at mid- and upper-elevations in the Mojave Desert with *Ambrosia dumosa, Coleogyne ramosissima, Ephedra nevadensis, Ericameria teretifolia, Hymenoclea salsola, Larrea tridentata, Pleuraphis jamesii, Salazaria mexicana, Yucca schidigera, and/or Viguiera parishii* and emergent trees of *Juniperus californica or Juniperus osteosperma.*

This alliance is easily encountered in the western Colorado Desert where it commonly contains *Ambrosia dumosa, Encelia farinosa, Eriogonum wrightii* ssp. *membranaceum, Hymenoclea salsola, Juniperus californica, Simmondsia chinensis*, and/or *Viguiera parishii.*

JOTR

The following sample in JOTR suggested further variation than what is currently reported from this Alliance:

*Eriogonum fasciculatum* undifferentiated (LONG: VAL97-23)

## Desert Willow (*Chilopsis linearis)* Shrubland Alliance

The *Chilopsis linearis* alliance occurs strictly in washes and arroyos in the southern Mojave, Colorado, and sporadically in the Sonoran Deserts of California. Although the alliance is widely distributed, stands are local and do not occur in many of the washes that would seem suitable.

This alliance is represented in JOTR by one association, defined first in this project.

*Chilopsis linearis* Shrubland Association (Mapping Code: 15013)

| | |
|---|---|
| COMMON NAME | Desert - Willow Association |
| SYNONYM | None |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Deciduous Shrubland |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Deciduous Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Intermittently Flooded Extremely Xeromorphic Deciduous Subdesert Shrubland |
| ALLIANCE | *Chilopsis linearis* Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Upland and Palustrine |

RANGE
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Chilopsis linearis* Shrubland Association were sampled within the park within the Cottonwood Springs, Pinto Wells, Joshua Tree South, Indian Cove, Pinto Mountain, and Malapai Hill 7.5 minute topographic quadrangles.

ENVIRONMENTAL DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of *Chilopsis linearis* Shrubland Association are found at low to mid elevations (1,000–3,700 ft.; 300–1,100 m) within drainages and on gentle (1-6 degree) slopes. This association is found primarily on linear and sometimes concave washes. Soil textures include a range from

coarse sand to moderately fine, silty, clay, loam from granitic, parent material. Rock cover consists of 0 percent bedrock cover, 0 percent boulder cover, 0–4 percent stone cover, 0–20 percent cobble cover, 1–55 percent gravel cover, and 42–86 percent fines cover. Litter cover ranges from 1–10 percent. These sites generally experience low to high levels of disturbance from exotic species (0–10 percent cover), moderate levels of disturbance from vandalism and dumping, and high levels of disturbance from foot traffic/trampling.

MOST ABUNDANT SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Shrub *Hymenoclea salsola, Chilopsis linearis*

CHARACTERISTIC SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Shrub *Hymenoclea salsola, Chilopsis linearis*

VEGETATION DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Chilopsis linearis* Shrubland Association form a sparse to open shrubland with 0–<1 percent cover at <1 cm tall, 0–2 percent cover at 1–25 cm tall, 0–1 percent cover at 25–50 cm tall, 0–3 percent cover at 50 cm to 1 m tall, 1–6 percent cover at 1–3 m tall and 2–15 percent cover at 3–5 m tall, and 1 percent cover at 5–10 m tall. Total vegetative cover ranges from 8-30 percent. Exotic species tend to be low but can occasionally be as high as 10 percent (0-10%).

This association is dominated by *Chilopsis linearis* and, less abundantly, *Hymenoclea salsola* in the tree and shrub layer. *Prunus fasciculata* and *Acacia greggii* are common within a few stands. A variety of species is present in this association; however, *Amaranthus* sp. is frequently present.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G4 S3

RANK JUSTIFICATION
Stands are sporadic throughout the eastern and southern Mojave Desert.

DATABASE CODE

COMMENTS
Globally
Related stands have been described by Evens (2000) and Thomas *et al.* (2004) in the eastern Mojave Desert. Some consolidation of associations is likely to occur with further analysis.

JOTR

Plots used for this description: JOTR: 10B-01-5, 14-27-3, 32-06-1, 32-26-4, 32-06-4, 56-06-6, 33-07-4; LONG: VMAL97-19

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**Nevada Ephedra *(Ephedra nevadensis)* Shrubland Alliance (Mapping Code: 24001 = 24012)**

This alliance is not defined at the association level locally. The following general description will serve to distinguish the local stand(s):

| | |
|---|---|
| COMMON NAME | *Nevada Ephedra Alliance* |
| SYNONYM | None |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Shrubland |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Evergreen Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Semi-natural |
| FORMATION | Broad-Leaved and Microphyllous Evergreen Extremely Xeromorphic Subdesert Shrubland |
| ALLIANCE | *Ephedra nevadensis* Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 1 |
| USFWS WETLAND SYSTEM | Upland |

RANGE
Globally
The *Ephedra nevadensis* Shrubland Alliance occurs in the Mojave Desert, southeastern Great Basin, and Mono Basin.

JOTR
This alliance occurs in the eastern, southeastern, central, and northwest-central portions of the park and was sampled in Berdoo Canyon and elsewhere on the Rockhouse Canyon 7.5 minute quadrangle.

ENVIRONMENTAL DESCRIPTION
Globally
The *Ephedra nevadensis* Shrubland Alliance occurs on dry, open slopes of ridges and in canyons, arroyos, floodplains, and washes. Soils are well-drained, gravelly or rocky, and may be alkaline or saline. Elevation ranges from 3,300 – 6,000 feet (1,000 – 1,800 m).

JOTR
This alliance occurs mostly below 3,000 feet (900 m) within the park.

MOST ABUNDANT SPECIES
Globally

| | |
|---|---|
| Herbaceous | *Elymus elymoides, Achnatherum hymenoides, Pleuraphis jamesii, Poa scabrella, Achnatherum speciosum* |
| Shrub | *Ephedra nevadensis, Atriplex confertifolia, Lycium andersonii, Salazaria mexicana*, *Artemisia tridentata, Coleogyne ramosissima, Ericameria cooperi, Eriogonum fasciculatum, Grayia spinosa, Menodora spinescens, Yucca schidigera* |
| Tree | *Yucca brevifolia* |

JOTR

| | |
|---|---|
| Herbaceous | |
| Shrub | *Ephedra nevadensis, Viguiera parishii, Eriogonum fasciculatum, Salazaria mexicana, Encelia virginensis* |
| Tree | |

CHARACTERISTIC SPECIES
Globally

| | |
|---|---|
| Shrub | *Ephedra nevadensis* |

VEGETATION DESCRIPTION
Globally
*Ephedra nevadensis* is dominant or important in the shrub layer. Emergent *Yucca brevifolia* trees may be present. Shrubs are generally < 2 m, and the canopy is intermittent to open. The ground layer is open, and annuals are seasonally present.

JOTR

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G4 S4

RANK JUSTIFICATION
This alliance is fairly common throughout the mid- and upper-elevations of the Mojave Desert, and is likely also in Nevada and Arizona.

DATABASE CODE

COMMENTS
Globally
Stands of *Ephedra nevadensis* alliance are common but generally widely scattered throughout the Mojave and southeastern Great Basin sections of California. *Ephedra nevadensis* is a component of many alliances including the *Atriplex confertifolia, Coleogyne ramosissima, Grayia spinosa, Juniperus osteosperma, Larrea tridentata - Ambrosia dumosa, Lycium andersonii, Menodora spinescens, Pleuraphis jamesii, Yucca brevifolia,* and *Yucca schidigera* alliances. Stands may be, in part, related to disturbance from fire or grazing. These stands often have a high diversity of perennial species and may include 35 species of shrubs (Reid *et al.* 1999). *Ephedra nevadensis* occupies a similar climatic zone to *G. spinosa* but appears to segregate from it primarily based on soil depth. *G. spinosa* tends to prefer deeper alluvial soils than *E. nevadensis*.

The alliance is indicative of relatively disturbed sites within the upper Mojave and the lower Great Basin Deserts. Yoder (1983) suggests it is the result of heavy use by livestock in *Artemisia tridentata* or *Coleogyne ramosissima* stands. *E. nevadensis* is considered to be the most palatable and sought out by livestock of the ephedras. It resprouts readily following browsing and light to moderate fire. Its seed set is variable but can be prolific in wet years. It is a relatively slow growing shrub and may slowly spread and replicate itself clonally. Seed viability is short (generally < 5 years), although seeds do germinate from rodent caches with favorable moisture. Seedlings are very tolerant of drought and generally establish well following fall or winter planting.

*E. nevadensis* generally sprouts from the root or crown after fire. However, under certain circumstances, regenerative structures may be eliminated by hot fires. Periods of above normal precipitation can contribute to increased stand flammability by promoting the growth of annuals such as *Bromus madritensis* and *B. tectorum.*

The current extent of this alliance is not well known. However, stands should be monitored and disturbance effects quantified throughout its range. It is not likely to have been an extensive type and may have increased as a result of more frequent and extensive fires and livestock use over the last 100 years or more. The high diversity of shrub species in some stands should be investigated more closely. Is this diversity related to disturbance regime, and if so, what does this say about the appropriateness of disturbance for maintaining floristic diversity in the desert?

JOTR

The following samples in JOTR suggested further variation than what is currently reported from this Alliance:

*Ephedra nevadensis* (Undifferentiated) (Watts n=2)
*Ephedra nevadensi - Viguiera parishii* (JOTR: 17-03-1, 20-13-3)

*Ephedra nevadensis - Pleurocoronis pluriseta* (JOTR: 15-18-1)

## California Ephedra (*Ephedra californica*) Intermittently Flooded Shrubland Alliance

*Ephedra californica* is a widespread shrub of the Mojave/Sonoran Desert of California, ranging up the central coast ranges to Merced County (CalFlora 2000). It is a component of several alliances including: *Psorothamnus spinosus, Larrea tridentata - Ambrosia dumosa, Atriplex canescens, Atriplex polycarpa, Fouquieria splendens,* and *Yucca schidigera.* Stands of *Ephedra californica* alliance are scattered throughout the Mojave, Sonoran, and Colorado Desert sections of California. Such stands are most commonly associated with washes. These stands are usually of low diversity associated with the active portions of washes. In washes, the *Ephedra californica* alliance occupies a similar ecological zone to *Hymenoclea salsola* alliance, but is often found in slightly less disturbed micro sites as along low terraces and banks of washes (Evens 2000 and personal observation, T. Keeler-Wolf). Some stands are associated with sand sheets, dunes, and other sandy substrates. On these nonalluvial substrates, the stands often associate with perennial grasses such as *Pleuraphis rigida, Achnatherum hymenoides,* and *Achnatherum speciosum*. The isolated stands of *Ephedra californica - Isomeris arborea - Ericameria linearifolia* found in the inner coast range, called Monvero Dunes community by Holland (1986), are found on ancient, stabilized, diatomaceous dunes. It is interesting to note that *Isomeris arborea* is often a characteristic associated with species with this alliance from the isolated coast range stands to the eastern Mojave Desert wash stands (Sawyer and Keeler-Wolf 1995, Evens 2000).

The *Ephedra californica* alliance is indicative of low-gradient wash sites within the mid and lower elevations of the Mojave Desert. It occurs along washes ranging from 10 to 100 m in width and with variable slope aspect. Large, continuous stands are found along some washes in the eastern Mojave Desert, but many are small stands less than 100 square meters. Stands on sand sheets tend to stabilize and form mounds. *Ephedra californica* is a clonal species and may spread by underground rhizomes, making it well adapted to shifting sand and alluvial substrates.

This alliance is represented in JOTR by one association, the California Ephedra (*Ephedra californica)* Shrubland Association.

*Ephedra californica* Shrubland Association

| | |
|---|---|
| COMMON NAME | Desert Tea Shrubland Association |
| SYNONYM | *Ambrosia dumosa*-Mixed Shrub Association (Leary 1977); *Hymenoclea salsola - Eriogonum californica - Eriogonum fasciculatum* type (Hogan 1977) |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Deciduous Shrubland |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Deciduous Shrubland |

| | |
|---|---|
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Intermittently Flooded Extremely Xeromorphic Deciduous Subdesert Shrubland |
| ALLIANCE | *Ephedra californica* Intermittently Flooded Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Upland and Palustrine |

RANGE
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Ephedra californica* Shrubland Association were sampled in the park within the Seven Palms Valley, Malapai Hill, and Queen Mountain 7.5 minute topographic quadrangles.

ENVIRONMENTAL DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of *Ephedra californica* Shrubland Association are found at low to mid elevations (1,700–4,200 ft.; 500–1,300 m) on gentle to moderate (2 to >6 degrees) slopes in drainages, on convex, undulating, and linear slopes of rocky highlands and washes. Aspects are north and northeast facing. Soils are usually sand (includes coarse, medium, and fine sand; coarse, medium, and fine, loamy sand) formed from sialic sediment, plutonic, and noncalcareous, metamorphic, and granitic, parent material. Rock cover consists of 0–3 percent bedrock, 0–6 percent boulder, 0–15 percent stone, 4–20 percent cobble, 20–36 percent gravel, and 8–64 percent fines. Litter ranges from 1–34 percent cover. These sites generally experience low- to high-disturbance levels from exotics species (<1–37 percent cover).

MOST ABUNDANT SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Herbaceous | *Bromus madritensis, Pleuraphis rigida* |
| Shrub | *Hymenoclea salsola, Ephedra californica, Ambrosia dumosa, Viguiera parishii* |

CHARACTERISTIC SPECIES

Globally

This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Herbaceous | *Pleuraphis rigida* |
| Shrub | *Hymenoclea salsola, Ephedra californica, Ambrosia dumosa, Viguiera parishii, Salazaria mexicana, Eriogonum fasciculatum, Larrea tridentata, Krameria grayi, Opuntia echinocarpa, Simmondsia chinensis, Yucca schidigera* |

VEGETATION DESCRIPTION

Globally

This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

Stands of the *Ephedra californica* Shrubland Association form an open to intermittent shrubland 0 percent tree cover, 6–34 percent shrub cover, and 1–41 percent herbaceous cover. Total vegetative cover ranges from 11–44 percent. Exotic species cover is generally low but might be as high as 37 percent (range: <1 percent–37%) in some stands.

This association is dominated by the shrub species *Ephedra californica, Hymenoclea salsola, Ambrosia dumosa,* and *Viguiera parishii. Pleuraphis rigida* is the dominant herb species. The exotic species *Bromus madritensis* is often present and occasionally abundant in the herb layer. *Eriogonum fasciculatum* is characteristic in this association. Species that are often present include *Salazaria mexicana, Larrea tridentata, Krameria grayi, Mirabilis bigelovii, Opuntia echinocarpa, Simmondsia chinensis,* and *Yucca schidigera.* The exotic species *Schismus* is also often present. *Senna armata* and the exotic species *Erodium cicutarium* can be common within some stands.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G3 S3

RANK JUSTIFICATION

This association is likely to be restricted to washes in the southwestern Mojave Desert. It may also occur in the adjacent Sonoran Desert (Colorado Desert) of California.

DATABASE CODE

COMMENTS
Globally
Other stands of this association or one similar have been seen in Anza-Borrego Desert State Park and in the eastern Mojave Desert of California (Keeler-Wolf personal observation, 2002).

JOTR

Plots Used for This Description: JOTR: 01-02-2, 23-34-1; LONG: VMAL97-33; WATTS n=9

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**Paper-Bag Bush (*Salazaria mexicana)* Shrubland Alliance (Mapping Code: 28140)**

This alliance is not defined at the association level locally. The following general description will serve to distinguish the local stand(s):

| | |
|---|---|
| COMMON NAME | Paper-Bag Bush Scrub |
| SYNONYM | None |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Shrubland |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Evergreen Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Semi-natural |
| FORMATION | Facultatively Deciduous Extremely Xeromorphic Subdesert Shrubland |
| ALLIANCE | *Salazaria mexicana* Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Upland |

RANGE
Globally
Stands have been observed throughout the northern, eastern, southern, and central Mojave Desert of California and in Arizona.

JOTR
Stands of this alliance occur in the postburn areas in Covington Flat.:

ENVIRONMENTAL DESCRIPTION
Globally
Most stands of the *Salazaria mexicana* Shrubland Alliance occur in washes, although some are on slopes with disturbance. A few exist in rocky southwest facing areas without evident disturbance. Soils are colluvial or alluvial and may be disturbed. Elevation ranges from 2,800–5,500 ft. (850–1,700 m).

JOTR
The *Salazaria mexicana* Shrubland Alliance was mapped in areas above 2,000 feet (600 m) in elevation.

MOST ABUNDANT SPECIES
Globally
Herbaceous
Shrub *Salazaria mexicana, Achnatherum speciosum, Atriplex confertifolia, Ephedra nevadensis, Eriogonum fasciculatum, Grayia spinosa, Hymenoclea salsola, Krascheninnikovia lanata, Larrea tridentata*, *Lycium andersonii, Mirabilis bigelovii, Salvia dorrii*, *Thamnosma montana, Viguiera reticulata*
Tree *Acacia greggii,* and *Yucca brevifolia*

JOTR
Shrub *Salazaria mexicana*

CHARACTERISTIC SPECIES
Globally
Shrub *Salazaria mexicana*

VEGETATION DESCRIPTION
Globally

*Salazaria mexicana* is the sole or dominant shrub in canopy. Emergent *Acacia greggii* and *Yucca brevifolia* may be present. Shrubs are generally < 3 m tall and form a canopy that is continuous, intermittent, or open. The ground layer is sparse.

JOTR

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G4 S4

RANK JUSTIFICATION
This alliance is fairly common in the Mojave Desert at upper-elevation, disturbed sites.

DATABASE CODE

COMMENTS
Globally
Many other mid- and upper-elevation alliances have *Salazaria mexicana* including *Juniperus californica, Eriogonum fasciculatum, Ephedra nevadensis, Larrea tridentata-Ambrosia dumosa, Coleogyne ramosissima, Hymenoclea salsola, Yucca brevifolia,* and *Yucca schidigera.* This

alliance appears to be local and largely disturbance related. It is characterized by the dominance of *Salazaria mexicana* but, most frequently, is mixed with several other shrubs.

Small stands of this alliance occur in washes and on disturbed, upland sites (disturbed by livestock or OHV activity). The life history attributes of *Salazaria mexicana* are not well known. Webb *et al.* (1988) demonstrate that *Salazaria mexicana* can reestablish ghost town sites readily. It is also common on actively eroding edges of alluvial terraces, along with other disturbance-related taxa such as *Hymenoclea salsola, Acamptopappus sphaerocephalus, Eriogonum inflatum,* and *Ephedra nevadensis.*

JOTR

The following samples in JOTR suggested further variation than what is currently reported from this Alliance:

> *Salazaria mexicana - Bebbia juncea - Viguiera parishii* (MDEI: 141-2-6)
> *Salazaria mexicana - Acacia greggii* (JOTR: 33-07-6)

In addition, a mapping unit dominated by *Salazaria mexicana* was distinguishable, although this vegetation type was not sampled or described.

> Dense rivulets within desert pavement – Includes: *Salazaria mexicana – Krameria* spp. – *Encelia farinosa – Hyptis emoryi – Eriogonum fasciculatum – Hymenoclea salsola – Acacia greggii – Tetracoccus hallii* (Mapping Code: 27001)

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**Mojave Yucca *(Yucca schidigera)* Shrubland Alliance**

The *Yucca schidigera* Shrubland Alliance occurs in the Mojave Desert, Southern California mountains and valleys, Colorado Desert, and Sonoran Desert regions of California and in Nevada, Utah, Arizona, and Baja California, Mexico.

This alliance is often considered part of the Creosote bush scrub, which is better thought of as a collection of alliances. *Yucca schidigera* is one of the most characteristic shrubs of the mid-elevation eastern and central Mojave Desert and desert slopes of the transverse and peninsular ranges. *Yucca schidigera* rarely is a dominant. However, it is a good indicator species even at relatively low cover values. Ordination and classification of plots in the central Mojave Desert (Keeler-Wolf MS) suggest that *Yucca schidigera* alliance is ecologically similar to the *Yucca brevifolia* alliances, although it tends to occur at slightly lower elevations and on more shallow soils. It grades into *Larrea tridentata - Ambrosia dumosa* alliance at lower elevations and is similar to several other mid-elevation alliances including *Ephedra nevadensis* (rockier slopes), *Coleogyne ramosissima* (often caliche layer), *Grayia spinosa* (deeper alluvial soils), and *Eriogonum fasciculatum* and *Salazaria mexicana* (higher disturbance).

*Yucca schidigera* is a long-lived species indicative of long, persisting stands of vegetation that have not recently been brought back to primary succession. Evidence suggests that slow growing species, such as *Yucca schidigera,* are particularly susceptible to deep soil disturbances and recover very slowly (Tratz 1978). Although *Yucca schidigera* may persist for long periods, other components of the stand may be less persistent. Unlike a number of associated desert species, *Yucca schidigera* is generally not killed by fire even when above ground vegetation is totally consumed. In chaparral-desert ecotones of southern California, less than 10 percent of all Mojave yuccas were actually killed by fire (Tratz 1978). In desert grassland, only a few plants were killed by a summer fire, which removed old shoots to or near the ground level (Vasek *et al.* 1975). Mechanical injury other than fire can also result in resprouting, although the more severe the injury, the less vigorous the sprouting (Vasek *et al.* 1995). It can sprout from roots protected by overlying soil, or from surviving active tissues at the stem base. Certain dry, rocky sites occupied by *Yucca schidigera* may lack sufficient fuels to carry a fire under ordinary circumstances. It is likely that stands with a high understory cover of *Pleuraphis* or disturbance-related shrubs may have had higher fire frequencies than those with long-lived, non-sprouting desert shrubs.

Very few seedlings have been observed in many of the harsher *Yucca schidigera* stands. Reproduction by seed may have been much more important during more favorable climatic regimes. Most regeneration today probably occurs through root sprouting, after fire or mechanical disturbance.

This is a naturally diverse upland scrub, and much of its biodiversity can be accounted for by the nonfire-adapted, slow growing, nonsprouting shrubs. Continued high-fire frequencies in stands of *Yucca schidigera* should reduce the diversity of nonfire resistant species and increase the cover of fire-adapted grasses and short-lived, colonizing perennials. Other disturbance-adapted alliances, such as *Acacia greggii, Ericameria teretifolius, Eriogonum fasciculatum,* and *Salazaria mexicana,* may increase relative to *Yucca schidigera* stands if fire and the fire carrying annual grasses continue to increase in the desert. Response of *Yucca schidigera* to fire may vary according to fire severity and intensity, season of burn, and specific site characteristics. These should be investigated.

This alliance is represented in JOTR by four associations, all defined first in this project. These four include the Mojave Yucca - Blackbush *(Yucca schidigera - Coleogyne ramosissima)* Shrubland Association*,* Mojave Yucca - Creosote Bush - Jojoba *[Yucca schidigera - Larrea tridentata (-Simmondsia chinensis)]* Shrubland Association, Mojave Yucca - Creosote Bush - Burro Bush *(Yucca schidigera - Larrea tridentata - Ambrosia dumosa)* Shrubland Association, and the Mojave Yucca/Big Galleta (*Yucca schidigera/Pleuraphis rigida)* Shrubland Association.

In addition to the associations described below, four unclassified, alliance-level samples were taken that suggest further variation, one of which has a signature distinct enough for mapping.

*Yucca schidigera - Eriogonum fasciculatum* (MDEI: 157-2-1)
*Yucca schidigera - Ephedra nevadensis* (JOTR: 20-13-4)

*Yucca schidigera - Larrea tridentata - Senna armata* (JOTR: 21-34-2, LONG: VMAL97-10)
*Yucca schidigera –Tetracoccus hallii* (JOTR: 33-11-1, 33-11-3) (Mapping Code: 29035)

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*Yucca schidigera - Coleogyne ramosissima* Shrubland Association (Mapping Code: 29032)

| | |
|---|---|
| COMMON NAME | Mojave Yucca - Blackbush Shrubland Association |
| SYNONYM | *Coleogyne ramosissima - Yucca schidigera* association (Leary 1977) |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Shrubland |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Evergreen Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Succulent Extremely Xeromorphic Evergreen Shrubland |
| ALLIANCE | *Yucca schidigera* Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Upland |

RANGE
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Yucca schidigera - Coleogyne ramosissima* Shrubland Association occur in the south and west-central and northwest central portions of the park and were sampled within the East Deception Canyon, Cottonwood Springs, Indian Cove, and Queen Mountain 7.5 minute topographic quadrangles.

ENVIRONMENTAL DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of *Yucca schidigera - Coleogyne ramosissima* Shrubland Association are found at mid to high elevations (3,100–5,000 ft.; 900–1,500 m) on gentle to moderate (1–6 degrees) convex and concave slopes of rocky highlands. Soil textures range from coarse sand to moderately fine, silty, clay loam formed on calcareous-carbonate, sialic sediment, plutonic, and noncalcareous, metamorphic, parent material. Rock content in this association consists of 0–1 percent bedrock, 0–3 percent boulder, 0–13 percent stone, 3–18 percent cobble, 19–49 percent gravel, and 1–45 percent fines cover. Litter consists of 0–14 percent cover. This association often experiences low to high levels of disturbance from competition from exotics (<1–7%).

MOST ABUNDANT SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Shrub *Yucca schidigera, Coleogyne ramosissima*

CHARACTERISTIC SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Shrub *Yucca schidigera, Coleogyne ramosissima, Eriogonum fasciculatum, Acacia greggii, Opuntia echinocarpa, Viguiera parishii*

VEGETATION DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Yucca schidigera - Coleogyne ramosissima* Shrubland Association form an open shrubland with <1 percent cover at <1 cm tall, <1–7 percent cover at 1–25 cm tall, 1–4 percent cover at 25–50 cm tall, 1–11 percent cover at 50 cm to 1 m tall, 0–15 percent cover at 1–3 m tall, and 0–<1 percent at 3-5 m tall. Total vegetative cover ranges from 14–29 percent.

This association is dominated by the shrub species *Yucca schidigera* and *Coleogyne ramosissima.* Characteristic shrub species include *Eriogonum fasciculatum, Acacia greggii, Opuntia echinocarpa,* and *Viguiera parishii.* Rock lichen is a characteristic component in this association. The exotic species *Bromus madritensis* is often abundant. Cryptobiotic crust, *Echinocereus engelmannii, Ephedra nevadensis, Krameria grayi, Lycium andersonii, Opuntia basilaris, Eriogonum inflatum, Escobaria vivipara, Pleuraphis rigida,* and *Stephanomeria pauciflora* are frequently present. The exotic species *Erodium cicutarium* is frequently present as well. Occasionally, *Achnatherum speciosum* is common. *Chrysothamnus teretifolius, Adenophyllum porophylloides, Bebbia juncea, Larrea tridentata, Mirabilis bigelovii, Opuntia ramosissima, Xylorhiza tortifolia, Encelia actoni, Hymenoclea salsola,* and *Ambrosia dumosa* occasionally contribute to minor cover.

OTHER NOTEWORTHY SPECIES
*Tetracoccus hallii* was found in one of five plots. *Tetracoccus hallii* is a List 4 plant in the CNPS Inventory of Rare and Endangered Plants of California (CNPS 2001). It is found in Imperial,

Riverside, and San Bernardino Counties and in Arizona and Baja California at low to high elevations (98–4,000 ft.; 30–1,200 m).

CONSERVATION RANK G4 S4

RANK JUSTIFICATION
This association is fairly common in upper elevations of the Mojave Desert and is likely to occur in Nevada and Arizona as well as California.

DATABASE CODE

COMMENTS
Globally

JOTR

Plots used for this description: JOTR: 09A-06-1, 16-24-1, 19-27-1, 22-32-2, 31-07-3, 21-31-1; WATTS n=3

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*Yucca schidigera - Larrea tridentata (-Simmondsia chinensis)* Shrubland Association

| | |
|---|---|
| COMMON NAME | Mojave Yucca - Creosote Bush (- Jojoba) Shrubland Association |
| SYNONYM | *Yucca schidigera* - Mixed Shrub Association (possibly) (Leary 1977) |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Shrubland |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Evergreen Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Succulent Extremely Xeromorphic Evergreen Shrubland |
| ALLIANCE | *Yucca schidigera* Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Upland |

RANGE
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Yucca schidigera - Larrea tridentata* Shrubland Association were sampled in the park within the Malapai Hill, Cottonwood Springs, and Porcupine Wash 7.5 minute topographic quadrangles.

ENVIRONMENTAL DESCRIPTION

Globally

This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

Stands of *Yucca schidigera - Larrea tridentata* Shrubland Association are found at low to mid elevations (2,900–4,300 ft.; 880–1,300 m) on gentle to moderate (1–6 degrees), undulating slopes of bajadas and upland, alluvial deposits. Soil textures range from coarse sand to moderately fine, silty, clay loam formed on granitic, sialic sediment, plutonic, and noncalcareous, metamorphic, parent material. Rock content in this association consists of 0 percent bedrock, 0 percent boulder, 0–<1 percent stone, 0–1 percent cobble, 3–25 percent gravel, and 61–75 percent fines cover. Litter consists of 1–7 percent cover. This association experiences low to moderate levels of disturbance from competition from exotics (<1–2%) and sometimes low levels of disturbance from vandalism, litter, and dumping.

MOST ABUNDANT SPECIES

Globally

This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

Shrub *Yucca schidigera, Larrea tridentata, Simmondsia chinensis*

CHARACTERISTIC SPECIES

Globally

This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

Shrub *Yucca schidigera, Larrea tridentata, Simmondsia chinensis*, *Opuntia echinocarpa*, *Opuntia ramosissima*

VEGETATION DESCRIPTION

Globally

This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

Stands of the *Yucca schidigera - Larrea tridentata* Shrubland Association form an open shrubland with 0–<1 percent cover at <1 cm tall, <1–1 percent cover at 1–25 cm tall, <1 percent cover at 25–50 cm tall, 2–5 percent cover at 50 cm to 1 m tall, 9–14 percent cover at 1–3 m tall, and <1–4 percent cover at 3–5 m tall. Total vegetative cover ranges from 15–28 percent.

This association is dominated by the shrub species *Yucca schidigera, Larrea tridentata,* and *Simmondsia chinensis. Opuntia echinocarpa* and *Opuntia ramosissima* are characteristically present. The exotic species *Erodium cicutarium* is also consistently present. *Salazaria mexicana, Senna armata, Krameria grayi, Hymenoclea salsola, Eriogonum fasciculatum, Porophyllum gracile,* and *Pectis papposa* are frequently present. The exotic species *Bromus madritensis* is also a frequent occurrence.

OTHER NOTEWORTHY SPECIES
Evidence of desert tortoises was noted in one of three plots.

*Tetracoccus hallii* was found in one of three plots. *Tetracoccus hallii* is a List 4 plant in the CNPS Inventory of Rare and Endangered Plants of California (CNPS 2001). It is found in Imperial, Riverside, and San Bernardino Counties and in Arizona and Baja California at low to high elevations (100–4,000 ft.; 30–1,200 m).

CONSERVATION RANK G3 S3

RANK JUSTIFICATION
This association is likely to be uncommon in the borderlands between the Mojave and Sonoran Desert.

DATABASE CODE

COMMENTS
Globally

JOTR

Plots used for this description: JOTR: 20B-04-1, 33-07-2; MDEI: 128-1-8

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*Yucca schidigera - Larrea tridentata - Ambrosia dumosa* Shrubland Association (Mapping Code: 29033)

| | |
|---|---|
| COMMON NAME | Mojave Yucca - Creosote Bush - Burro Bush Shrubland Association |
| SYNONYM | *Yucca schidigera - Ambrosia dumosa* association (Leary 1977) |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Shrubland |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Evergreen Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Succulent Extremely Xeromorphic Evergreen Shrubland |
| ALLIANCE | *Yucca schidigera* Shrubland Alliance |

CLASSIFICATION CONFIDENCE LEVEL 2
USFWS WETLAND SYSTEM Upland

RANGE
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Yucca schidigera - Larrea tridentata - Ambrosia dumosa* Shrubland Association occur mostly near the Hexie Mountains and north of the Little San Bernardino Mountains and were sampled within the Washington Wash, Fried Liver Wash, and Porcupine Wash 7.5 minute topographic quadrangles.

ENVIRONMENTAL DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of *Yucca schidigera - Larrea tridentata - Ambrosia dumosa* Shrubland Association are found at mid elevations (2,600–3,700 ft.; 800–1,110 m) on gentle to moderate (3–9 degrees), linear and undulating slopes of bajadas and erosional highlands. Aspects are north, northeast, and east. Soil textures range from medium sand to very fine, sandy loam formed on plutonic and metamorphic, parent material. Rock content in this association consists of 0 percent bedrock, 0–25 percent boulder, 0–5 percent stone, <1–50 percent cobble, 0–>75 percent gravel, and 5–>75 percent fines cover. Litter consists of <1 percent cover. This association experiences high levels of disturbance from competition from exotics (8–19%).

MOST ABUNDANT SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Herbaceous *Schismus barbatus*
Shrub *Yucca schidigera, Larrea tridentata, Ambrosia dumosa*

CHARACTERISTIC SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Herbaceous *Mirabilis bigelovii, Pleuraphis rigida*
Shrub *Yucca schidigera, Larrea tridentata, Ambrosia dumosa, Opuntia echinocarpa, Opuntia ramosissima, Simmondsia chinensis, Encelia farinosa, Eriogonum inflatum, Krameria grayi, Lycium andersonii*

VEGETATION DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Yucca schidigera - Larrea tridentata - Ambrosia dumosa* Shrubland Association form an open shrubland with 0–<1 percent cover at <1 cm tall, <1–5 percent cover at 1–25 cm tall, 1–25 percent cover at 25–50 cm tall, <1–5 percent cover at 50 cm to 1 m tall, and 1–25 percent cover at 1–3 m tall. Total vegetative cover ranges from 15–28 percent.

This association is dominated by *Yucca schidigera, Larrea tridentata,* and *Ambrosia dumosa* in the shrub layer. The exotic species *Schismus barbatus* is dominant in the understory herb layer. Characteristic shrub species include *Opuntia echinocarpa, Opuntia ramosissima, Simmondsia chinensis, Encelia farinosa, Eriogonum inflatum, Krameria grayi,* and *Lycium andersonii.* Characteristic herb species include *Mirabilis bigelovii* and *Pleuraphis rigida.* The exotic species *Erodium cicutarium* is abundant in some stands. Frequently, *Acacia greggii, Echinocereus engelmannii, Ephedra californica, Ephedra nevadensis, Escobaria vivipara, Senna armata,* and *Bromus madritensis* are found contributing minor cover is this association.

OTHER NOTEWORTHY SPECIES
*Tetracoccus hallii* was found in one of four plots. *Tetracoccus hallii* is a List 4 plant in the CNPS Inventory of Rare and Endangered Plants of California (CNPS 2001). It is found in Imperial, Riverside, and San Bernardino Counties and in Arizona and Baja California at low to high elevations (98–4,000 ft.; 30–1,200 m).

CONSERVATION RANK G4 S4

RANK JUSTIFICATION This association is likely to be found in many other parts of the Mojave Desert.

DATABASE CODE

COMMENTS
Globally

JOTR

Plots used for this description: MDEI: 154-1-6, 154-3-4, 155-1-6, 155-1-8; LONG: VMAL97-17

*Yucca schidigera/Pleuraphis rigida* Shrubland Association (Mapping Code: 29034)

| | |
|---|---|
| COMMON NAME | Mojave Yucca/Big Galleta Shrubland Association |
| SYNONYM | *Yucca schidigera - Ambrosia dumosa* association (Leary 1977) |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Shrubland |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Evergreen Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Succulent Extremely Xeromorphic Evergreen Shrubland |
| ALLIANCE | *Yucca schidigera* Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Upland |

RANGE
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Yucca schidigera/Pleuraphis rigida* Shrubland Association occur in the Little San Bernardino Mountains, often in postburn areas, and were sampled within the Rockhouse Canyon, Malapai Hill, and Washington Wash 7.5 minute topographic quadrangles.

ENVIRONMENTAL DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of *Yucca schidigera/Pleuraphis rigida* Shrubland Association are found at mid to high elevations (3,500–4,200 ft.; 1,000–1,300 m) on gentle to moderate (<1-6 degrees) slopes. These sites are found on rocky highlands and bajadas. Soils range from moderately coarse, sandy loams to moderately fine, silty, clay loams formed on sialic sediment, plutonic, and noncalcareous, metamorphic, parent material. Rock content in this association consists of 0–2 percent bedrock, 0–5 percent boulder, 0–10 percent stone, 0–36 percent cobble, 15–75 percent gravel, and 15–>75 percent fines cover. Litter consists of 2–8 percent cover. This association experiences low to high levels of disturbance from competition from exotics (<1–3%).

MOST ABUNDANT SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Herbaceous | *Pleuraphis rigida* |
| Shrub | *Yucca schidigera* |

CHARACTERISTIC SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Herbaceous | *Pleuraphis rigida* |
| Shrub | *Echinocereus engelmannii, Eriogonum fasciculatum, Krameria erecta, Salazaria mexicana, Opuntia echinocarpa, Viguiera parishii* |
| Tree | *Yucca brevifolia* |

VEGETATION DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Yucca schidigera/Pleuraphis rigida* Shrubland Association form a sparse shrubland with 0–<1 percent cover at <1 cm tall, <1–3 percent cover at 1–25 cm tall, 1–5 percent cover at 25–50 tall, 1–5 percent cover at 50 cm to 1 m tall, 2–5 percent cover at 1–3 m tall, and 0-<1 percent cover at 3–5 m tall. Total vegetative cover ranges from 9–11 percent.

This association is dominated by *Yucca schidigera* in the shrub layer and *Pleuraphis rigida* in the understory herb layer. *Yucca brevifolia* is a characteristic tree species but at very low cover. *Echinocereus engelmannii, Eriogonum fasciculatum, Krameria erecta, Salazaria mexicana, Opuntia echinocarpa,* and *Viguiera parishii* are characteristic shrub species. *Pleuraphis rigida* is the characteristic herb species. The exotic species *Bromus madritensis* and *Erodium cicutarium* are characteristically present. Species that are frequently found in these stands include *Larrea tridentata, Opuntia ramosissima, Ephedra nevadensis, Adenophyllum porophylloides, Ericameria cooperi, Simmondsia chinensis, Sphaeralcea ambigua,* and *Coleogyne ramosissima.*

OTHER NOTEWORTHY SPECIES
*Coryphantha alversonii* was found in one of four plots. *Coryphantha alversonii* is a List 4 plant in the CNPS Inventory of Rare and Endangered Plants of California (CNPS 2001). It is found in

Imperial, Riverside, and San Bernardino Counties at low to high elevations (240–5,000 ft.; 73 – 1,500 m). (Syn: *Escobaria vivipara var. alversonii* in the Jepson Manual.)

Evidence of tortoises was noted in one of four plots

CONSERVATION RANK G3 S3

RANK JUSTIFICATION
This association is likely to be relatively uncommon throughout its range in the Mojave Desert.

DATABASE CODE

COMMENTS
Globally

JOTR

Plots used for this description: JOTR: 21-14-3, 21-27-1, 23-20-1; MDEI: 157-2-8

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**Desert Almond *(Prunus fasciculata)* Intermittently Flooded Shrubland Alliance**

The *Prunus fasciculata* Intermittently Flooded Shrubland Alliance occurs in the Mojave Desert region of California and in Arizona.

*Prunus fasciculata* is a common, large shrub of wash margins in the upper Mojave Desert. Keeler-Wolf *et al. (*1999) have identified it as the highest elevation component of the wash continuum in the Mojave Desert. Thus, this alliance receives higher precipitation and cooler temperatures than other wash vegetation. It is characterized by the dominance of *Prunus fasciculata* but is most frequently mixed with several other shrubs.

Small stands of this alliance occur in canyons, arroyos, and washes and on disturbed, upland sites (disturbed by livestock or OHV activity). The life history attributes of *Prunus fasciculata* are not well known. More information is needed on the role these stands play in the upper Mojave Desert.

This alliance is represented in JOTR by one association, defined first in this project, the Desert Almond *(Prunus fasciculata)* Intermittently Flooded Shrubland Association.

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*Prunus fasciculata* Intermittently Flooded Shrubland Association (Mapping Code: 32010)

COMMON NAME Desert Almond Intermittently Flooded Shrubland Association

| | |
|---|---|
| SYNONYM | None |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Deciduous Shrubland |
| PHYSIOGNOMIC GROUP | Intermittently Flooded Extremely Xeromorphic Deciduous Subdesert Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Intermittently Flooded Extremely Xeromorphic Deciduous Subdesert Shrubland |
| ALLIANCE | *Prunus fasciculata* Intermittently Flooded Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Upland and Palustrine |

RANGE
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Prunus fasciculata* Intermittently Flooded Shrubland Association occur primarily in broad, sandy washes in the Coxcomb, Eagle, and Hexie Mountains and are most abundant in the western Pinto Mountains and the northwest portion of the Little San Bernardino Mountains. Stands were sampled within the Queen Mountain, Joshua Tree South, Rockhouse Canyon, Porcupine Wash, and Malapai Hill 7.5 minute topographic quadrangles.

ENVIRONMENTAL DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of *Prunus fasciculata* Intermittently Flooded Shrubland Association are found at mid to high elevations (2,900–4,900 ft.; 880–1,500 m) within the drainages of washes and bajadas on gentle to moderate slopes (1-6 degrees). Microtopography varies and may be convex, linear, concave, or undulating. Soil textures typically are sandy (includes coarse, medium, and fine sand; coarse, medium, and fine, loamy sand) and soils are formed on calcareous-carbonate, sialic sediment, plutonic, and noncalcareous, metamorphic, parent materials. The rock component in this association is comprised of 0–35 percent bedrock, 0–20 percent boulder, 0–4 percent stone, 0–4 percent cobble, 1–62 percent gravel, and 0–94 percent fines cover. Litter cover is <1–25 percent. These sites experience low to high levels of disturbance from competition from exotics (<1–11%).

MOST ABUNDANT SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Herbaceous | *Bromus madritensis* |
| Shrub | *Prunus fasciculata, Hymenoclea salsola, Salazaria mexicana, Acacia greggii, Yucca schidigera* |

CHARACTERISTIC SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Herbaceous | *Achnatherum speciosum* |
| Shrub | *Prunus fasciculata, Hymenoclea salsola, Salazaria mexicana, Acacia greggii, Yucca schidigera, Eriogonum fasciculatum, Ephedra nevadensis, Phoradendron californicum* |

VEGETATION DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Prunus fasciculata* Intermittently Flooded Shrubland Association form a sparse to open shrubland with <1–1 percent cover at <1 cm tall, <1–6 percent cover at 1-25 cm tall, <1–3 percent cover at 25-50 cm tall, <1–6 percent cover at 50 cm to 1 m tall, 1–7 percent cover at 1-3 m tall, and <1 percent cover at 3–5 m tall. Total vegetative cover ranges from 1–15 percent.

This association is dominated by shrub species *Prunus fasciculata, Hymenoclea salsola, Salazaria mexicana, Acacia greggii,* and *Yucca schidigera. Rhus trilobata* is occasional at higher elevations. The exotic species *Bromus madritensis* is dominant in the understory herb layer. Characteristic shrub species include *Eriogonum fasciculatum, Ephedra nevadensis,* and *Phoradendron californicum.* Characteristic herb species, including *Achnatherum speciosum Juniperus californica, Larrea tridentata, Opuntia echinocarpa,* and *Yucca brevifolia,* frequently contribute to minor cover. The exotic species *Erodium cicutarium* is also frequently present.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G4 S4

RANK JUSTIFICATION
This association is likely to be widespread in the upper elevations of the Mojave Desert.

DATABASE CODE

COMMENTS
Globally

JOTR

Plots used for this description: JOTR: 08A-02-3, 08A-02-5, 18-24-1, 18-27-3, 21-14-1; MDEI 128-1-6; LONG: VCOT97-2, VMAL97-39; Watts n=3

## Lower Mojave Scrub

### Creosote Bush *(Larrea tridentata)* Shrubland Alliance

The *Larrea tridentata* Shrubland Alliance occurs in the Mojave Desert of California and in Arizona, Nevada, New Mexico, and Texas. This alliance is also a widespread disturbance type that has spread into former desert grasslands and mixed shrublands.

This alliance is represented in JOTR by three associations, all defined first in this project. These include the Creosote Bush *(Larrea tridentata)* (Undifferentiated) Shrubland Association, the Creosote Bush - Big Galleta *(Larrea tridentata/Pleuraphis rigida)* Shrubland Association, and the Creosote Bush - Cheesebush *(Larrea tridentata - Hymenoclea salsola)* Shrubland Association.

In addition to the associations described below, several unclassified, alliance-level samples were taken that suggest further variation. These include:

*Larrea tridentata Undifferentiated Playa Type* (JOTR: 49A-14-1; Watts 4-15-96-2A)
*Larrea tridentata - Yucca schidigera - Ephedra californica* (JOTR: 14-27-1; Watts n=3)
*Larrea tridentata - Ephedra californica/cryptobiotic crust* (JOTR: 56 - 22-2)
*Larrea tridentata - Senna armata - Ephedra californica* (JOTR: 21-27-2, 22-26-5)
*Larrea tridentata - Justicia californica* (JOTR: 32-06-2)
*Larrea tridentata - Psorothamnus schottii* (JOTR: 26-26-1)
*Larrea tridentata/Brandegea bigelovii* (JOTR: 37B-21-1)
*Larrea tridentata - Tetracoccus hallii* (JOTR: 31-09-4)
*Larrea tridentata - Lycium andersonii* (JOTR: 31-09-3)
*Larrea tridentata - Viguiera parishii* (JOTR: 34B-07-1)
*Larrea tridentata - Pleurocoronis pluriseta* (MDEI: 57-15-6, 57-15-8)

*Larrea tridentata* (Undifferentiated) Shrubland Association (Mapping Codes: 27019, 27022)

| | |
|---|---|
| COMMON NAME | Creosote Bush Shrubland Association |
| SYNONYM | *Larrea tridentata – Ambrosia dumosa* association (Leary 1977) |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Shrubland (scrub) |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Evergreen Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Broad-Leaved and Microphyllous Evergreen Extremely Xeromorphic Subdesert Shrubland |
| ALLIANCE | *Larrea tridentata* Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Upland |

RANGE
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Larrea tridentata* (Undifferentiated) Shrubland Association occur in the central and eastern portions of the park and were sampled within the Pinto Mountain, Malapai Hill, and Clarks Pass 7.5 minute topographic quadrangles.

ENVIRONMENTAL DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of *Larrea tridentata* (Undifferentiated) Shrubland Association are found at low to mid elevations (1,600–3,900 ft.; 480–1,200 m) in drainages on undulating and linear slopes of washes and upland, alluvial deposits. These sites tend to be on gentle slopes (<1–6 degree). Soils are usually sands (includes coarse, medium, and fine sand, coarse, medium, and fine, loamy sand) formed from sialic sediment, plutonic, and noncalcareous, metamorphic, and granitic, parent material. Rock cover consists of 0 percent bedrock, 0 percent boulder, 0 percent stone, 0–<1 percent cobble, 3–25 percent gravel, and 63–87 percent fines. Litter ranges from <1–5 percent cover. These sites experience low to moderate levels of disturbance from exotics species (0–<1%), low levels of disturbance from foot traffic/trampling, and low levels of disturbance from vandalism/dumping/litter.

MOST ABUNDANT SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Shrub *Larrea tridentata*

CHARACTERISTIC SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Herbaceous *Amaranthus* sp., *Chamaesyce* sp., *Pectis papposa, Pleuraphis rigida*
Shrub *Ambrosia dumosa, Hymenoclea salsola*

VEGETATION DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Larrea tridentata* (Undifferentiated) Shrubland Association form a sparse to open shrubland with 0–<1 percent cover at <1 cm tall, 1–5 percent cover at 1–25 cm tall, 0–<1 percent cover at 25–50 cm tall, <1 percent cover at 50 cm to 1 m tall, and 6–13 percent cover at 1–3 m tall. Total vegetative cover ranges from 7–15 percent.

This association is dominated by *Larrea tridentata* in the shrub layer. The associated shrubs *Ambrosia dumosa* and *Hymenoclea salsola* are characteristically present; however, they provide significantly less cover than *L. tridentata*. *Amaranthus* sp., *Chamaesyce* sp., *Pectis papposa, Pleuraphis rigida,* and cryptobiotic crust are characteristic in the understory herb layer. *Pectis papposa* is occasionally common in some stands. Occasionally present are *Ephedra nevadensis, Mirabilis bigelovii, Salazaria mexicana*, and *Yucca schidigera*.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G5 S5

RANK JUSTIFICATION
This simple association is likely to be widespread in the Mojave Desert.

DATABASE CODE

COMMENTS
Globally

JOTR

Plots used for this description: JOTR: 21-27-3, 21-27-4, 32-26-3, 41-40-2; LONG: VBAR97-1-1, VBAR97-1-1

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*Larrea tridentata/Pleuraphis rigida* Shrubland Association

| | |
|---|---|
| COMMON NAME | Creosote Bush - Big Galleta Shrubland Association |
| SYNONYM | *Larrea tridentata - Ambrosia dumosa* association (Leary 1977); *Hilaria rigida - Larrea tridentata* community (Hogan 1977) |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Shrubland (scrub) |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Evergreen Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Broad-Leaved and Microphyllous Evergreen Extremely Xeromorphic Subdesert Shrubland |
| ALLIANCE | *Larrea tridentata* Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Upland |

RANGE
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Larrea tridentata/Pleuraphis rigida* Shrubland Association were sampled in the park within the Pinto Mountain, Malapai Hill, Pinto Wells, and New Dale 7.5 minute topographic quadrangles.

ENVIRONMENTAL DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of *Larrea tridentata/Pleuraphis rigida* Shrubland Association are found at low elevations (1,000–1,700 ft.; 300–500 m) on north and northeast facing slopes. This association is found on gentle (<1–5 degrees), linear and undulating slopes of upland, alluvial deposits, pluvial

floodplains, modern flood plains, alluvial fans/bajadas, mid one-third of slopes, and lower one-third of slopes. Soils range from coarse sands to moderately fine, silty, clay loams formed on sialic sediment, plutonic, and noncalcareous, metamorphic, sandy alluvial, basalt, and granitic, parent material. Rock content in this association consists of 0–3 percent bedrock, 0–2 percent boulder, 0–15 percent stone, 0–81 percent cobble, 0–70 percent gravel, and 0–85 percent fines cover. Litter cover is <1–25 percent. These sites generally experience low to high levels of disturbance from competition from exotic species (0–19%) and low levels of disturbance from off-road vehicle activity.

MOST ABUNDANT SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Herbaceous *Pleuraphis rigida*
Shrub *Larrea tridentata*

CHARACTERISTIC SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Herbaceous *Pleuraphis rigida*
Shrub *Larrea tridentata*

VEGETATION DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Larrea tridentata/Pleuraphis rigida* Shrubland Association form a sparse to intermittent shrubland with 0–1 percent cover in the tree layer, <1–31 percent cover in the shrub layer, and 0–50 percent cover in the herb layer. Total vegetative cover ranges from 1–50 percent.

This association is dominated by the shrub species *Larrea tridentata* and herb species *Pleuraphis rigida*. *Senna armata* and cryptobiotic crust are common within some stands. The exotic species *Bromus madritensis* can also be common within some stands.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G4 S3

RANK JUSTIFICATION
Relatively uncommon in California, but likely to occur in Sonoran Desert in Arizona and Mexico

DATABASE CODE

COMMENTS
Globally

JOTR

Plots used for this description: JOTR: 32-26-2, 56-06-1, 56-06-2; LONG: VEGE3, VMAL97-53, VPWELL97-1 (2), VPWELL97-1 (3), VMAL97-24; MDEI: 61-7-3; WATTS: n=1

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*Larrea tridentata* - *Hymenoclea salsola* Shrubland Association (Mapping Code: 27011)

| | |
|---|---|
| COMMON NAME | Creosote Bush - Cheesebush Shrubland Association |
| SYNONYM | *Larrea tridentata – Ambrosia dumosa* association (Leary 1977) |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Shrubland (scrub) |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Evergreen Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Broad-Leaved and Microphyllous Evergreen Extremely Xeromorphic Subdesert Shrubland |
| ALLIANCE | *Larrea tridentata* Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Upland and Palustrine |

RANGE
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Larrea tridentata* - *Hymenoclea salsola* Shrubland Association were sampled in the park within the Conejo Well, Seven Palms Valley, Malapai Hill, and Fountain Peak 7.5 minute topographic quadrangles.

ENVIRONMENTAL DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of *Larrea tridentata - Hymenoclea salsola* Shrubland Association are found at low to mid elevations (1,600–3,800 ft.; 480–1,100 m), usually on north and northeast facing slopes. This association is found on gentle to somewhat steep (2–25 degrees) slopes of undulating and linear bajadas, washes, and midslopes. Soils range from coarse sands to very fine, sandy loams formed from sialic sediment, plutonic, and noncalcareous, metamorphic, and granitic, parent material. Rock content in this association consists of 0 percent bedrock, 0–<1 percent boulder, 0–5 percent stone, <1–25 percent cobble, 7–83 percent gravel, and 5–60 percent fines cover. Litter cover is <1–15 percent. These sites generally experience low to high levels of disturbance from competition from exotic species (0–11%) and low levels of disturbance from vandalism/dumping/litter.

MOST ABUNDANT SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Shrub *Larrea tridentata, Hymenoclea salsola*

CHARACTERISTIC SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Shrub *Larrea tridentata, Hymenoclea salsola, Opuntia echinocarpa, Opuntia ramosissima, Acacia greggii*

VEGETATION DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Larrea tridentata - Hymenoclea salsola* Shrubland Association form a sparse to open shrubland with 0–1 percent cover in the tree layer, 8–12 percent cover in the shrub layer, and <1–7 percent cover in the herb layer. Total vegetative cover ranges from 8–16 percent. Exotic species contribute to 0–11 percent cover.

This association is dominated by *Larrea tridentata* and *Hymenoclea salsola* in the shrub layer. Characteristic shrub species include *Opuntia echinocarpa, Opuntia ramosissima, and Acacia greggii*. The exotic species *Schismus barbatus, Erodium cicutarium*, and *Bromus madritensis* can be common at some sites. Occasionally, other shrub species are present including *Ambrosia*

*dumosa, Eriogonum fasciculatum, Eriogonum plumatella, Isomeris arborea, Krameria grayi, Lycium cooperi, Phoradendron californicum, Salazaria mexicana, Senna armata*, and *Simmondsia chinensis*. The herbaceous layer tends to be sparse and include species such as *Mirabilis bigelovii*.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G5 S5

RANK JUSTIFICATION
This is likely to be a common type throughout the Mojave and probably parts of the Sonoran Desert. It is a common, disturbance-related vegetation type.

DATABASE CODE

COMMENTS
Globally

JOTR

Plots used for this description: JOTR: 01-02-1; MDEI: 128-6-1, 158-1-1; LONG:_VMAL97-5[2]

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**Creosote Bush - Burro Bush *(Larrea tridentata - Ambrosia dumosa)* Shrubland Alliance (Mapping Code: 27030)**

The *Larrea tridentata - Ambrosia dumosa* Shrubland Alliance occurs in the Mojave Desert, Sonoran Desert, Colorado Desert, southeastern Great Basin, Nevada, and Arizona, and Sonora and Baja California, Mexico.

The co-occurrence of the medium to tall shrub *Larrea tridentata* over the subshrub *Ambrosia dumosa* defines the matrix vegetation of the vast majority of the California hot deserts. This is the most widespread and abundant desert alliance in California. It is the modal vegetation of the bajadas, alluvial fans, and lower slopes of these areas with a wide range of variability defined within the alliance. Conditions range from extremely hot, dry stands with very low species diversity below sea level in the Salton Sink and Death Valley to relatively diverse, mesic stands at >3,500 feet (1,000 m) in the eastern Mojave.

This alliance is related ecologically to several upland alliances. The *Larrea tridentata* alliance is, in some cases, a degraded version of the *Larrea tridentata - Ambrosia dumosa,* with little or no *Ambrosia dumosa*, a result of very poor, shallow soils or heavy grazing pressure. The *Ambrosia dumosa* alliance shows relatively high recent disturbance from fire or mechanical removal of vegetation or occurs on relatively clay rich soils. *Atriplex confertifolia*, *Coleogyne ramosissima, Grayia spinosa, Yucca schidigera,* and *Yucca brevifolia* alliances occur in moister and/or cooler

settings, whereas the *Larrea tridentata-Encelia farinosa alliance* occurs in hotter, more exposed settings, as does *Atriplex hymenelytra*. The *Hymenoclea salsola* alliance occurs in heavily grazed and otherwise disturbed settings. The *Atriplex polycarpa* and *Atriplex spinescens* alliances occur in heavier soil and more alkaline settings.

Much has been written on the ecology of these two species (Vasek and Barbour 1977 and FEIS 2001). *Larrea tridentata* is a very long-lived shrub (up to 10,000 + years in clones) and, under good conditions, develops a deep and widely spreading root system. *Ambrosia dumosa* is a short-lived shrub living generally < 50 years, (although it does have limited cloning abilities, Wright and Howe 1989) with relatively shallow and restricted roots. Both species tap different water resources and employ different strategies for desert survival. *Ambrosia dumosa*, with its high recruitment and mortality rates, dominates in the colonizing stage, and *Larrea tridentata*, with low recruitment and mortality, eventually dominates the landscape, although colonizing species usually remain present. In the Sonoran Desert, *Larrea tridentata* uses *Ambrosia dumosa* as a nurse plant (McAuliffe 1988). *Larrea tridentata* exhibits root-mediated allelopathy. In a laboratory study, test roots grew freely through soil occupied by *Ambrosia dumosa* roots, but *Ambrosia dumosa* test roots grew at reduced rates soil occupied by *Larrea tridentata.* Mature *Larrea tridentata* may be allelopathic to its own seedlings, encouraging an open community structure (FEIS 2001).

Natural disturbance in most *Larrea tridentata - Ambrosia dumosa* stands involves shifting moisture availability related to series of wet and dry years. Both species may die following long periods of severe drought, but *Larrea tridentata* typically will persist longer and can resprout from the base when moisture returns. *Ambrosia dumosa* individuals die more quickly from drought stress but will regenerate from seed banks and off-site dispersal quickly following sufficient precipitation. Wind and substrate deflation also act as disturbance agents in some stands on sandy substrates. Both species will grow in sand. However, *Larrea tridentata* tends to persist and dominate on deeper, mobile sand dunes, while both *Ambrosia dumosa* and *Larrea tridentata* occupy dune aprons, sand sheets, and stabilized dunes. Succession on a cleared and bulldozed site in the eastern Mojave has been studied by Vasek (1980). He found rapid recolonization by *Ambrosia dumosa, Encelia farinosa, Opuntia bigelovii,* and *Stephanomeria pauciflora*, while *Larrea tridentata* colonized more slowly.

In the modal Mojave, Colorado, and Sonoran Desert landscapes, both species tend to co-occur in mixed stands. *Ambrosia dumosa* occurs without *Larrea tridentata* in active wash terraces with a higher salinity or alkalinity than *Larrea tridentata* can tolerate. *Ambrosia dumosa* also occurs in recently disturbed areas where it can more quickly recolonize by seed than *Larrea tridentata*. *Larrea tridentata* occurs without *Ambrosia dumosa* in areas where grazing or drought stress has eliminated *Ambrosia dumosa.* The *Larrea tridentata-Ambrosia dumosa* Shrubland Alliance is replaced by *Atriplex polycarpa, Atriplex canescens,* or *Atriplex spinescens* in alkaline soils and gives way to the *Larrea tridentata –Encelia farinosa or Atriplex hymenelytra* alliances in extremely hot, dry situations.

*Larrea tridentata* and *Ambrosia dumosa* are poorly adapted to fire because of their limited sprouting ability (FEIS 2001). The resinous foliage of *Larrea tridentata*, however, is very flammable. Even light intensity fires can cause close to 100 percent mortality in both shrubs (Brown and Minnich 1986). The recent invasion of nonnative grasses in the hot deserts of California has rapidly increased fire frequencies and has led to the destruction and degradation of many acres of *Larrea tridentata-Ambrosia dumosa* Shrubland Alliance, particularly in the western Mojave and Colorado Deserts. Although fire is thought of as a natural exclusionary process for *Larrea tridentata* in Arizona, New Mexico, and Texas desert grasslands (FEIS 2001), it is a de-stabilizing influence in the California deserts where desert grasslands typically occur without fire (*Pleuraphis rigida*) or are in cooler or wetter areas than *Larrea tridentata-Ambrosia dumosa* stands (*Achnatherum speciosum, Pleuraphis jamesii*, *Poa secunda*).

The *Larrea tridentata - Ambrosia dumosa* Shrubland Alliance is represented in JOTR by seven associations, all defined first in this project. These are the Creosote Bush - Burro Bush (*Larrea tridentata - Ambrosia dumosa)* Shrubland Association, Creosote Bush - Burro Bush - White Rhatany (*Larrea tridentata - Ambrosia dumosa - Krameria grayi)* Shrubland Association, Creosote Bush - Burro Bush - Indigo Bush (*Larrea tridentata -Ambrosia dumosa - Psorothamnus schottii)* Shrubland Association, Creosote Bush - Burro Bush - Big Galleta (*Larrea tridentata - Ambrosia dumosa - Pleuraphis rigida)* Shrubland Association, Creosote Bush - Burro Bush – Spiny Senna (*Larrea tridentata - Ambrosia dumosa - Senna armata)* Shrubland Association, Creosote Bush - Burro Bush - Mojave Yucca (*Larrea tridentata - Ambrosia dumosa - Yucca schidigera)* Shrubland Association, and Creosote Bush - Burro Bush - Brittlebush (*Larrea tridentata - Ambrosia dumosa - Encelia farinosa)* Shrubland Association.

In addition to the associations described below, unclassified, alliance-level samples were taken in JOTR that suggest further variation, three of which have photo signatures distinct enough to allow mapping. These include:

*Larrea tridentata - Ambrosia dumosa* (JOTR: 38-28-3, 49A-14-2; LONG: VBE97-1)
*Larrea tridentata - Ambrosia dumosa - Lycium andersonii* (MDEI: 129-2-6; Watts n=2)
*Larrea tridentata - Ambrosia dumosa - Hymenoclea salsola* (JOTR: 37B-17-3)
*Larrea tridentata - Ambrosia dumosa - Petalonyx thurberi* (JOTR: 56-06-3, 56-06-5)
*Larrea tridentata - Ambrosia dumosa - Ephedra nevadensis* (JOTR: 8-03-4)

*Larrea tridentata - Ambrosia dumosa - Ephedra californica* (JOTR: 32-18-1, 32-18-2; LONG: VIND97-1; Watts n=2) (Mapping Code: 27047)
*Larrea tridentata - Ambrosia dumosa - Viguiera parishii* (JOTR: 128-1-7; MDEI 162-1-8, 128-1-7) = *Larrea tridentata – (Ambrosia dumosa – Viguiera parishii)* Higher Elevation Type (Mapping Code: 27046)
*Larrea tridentata - Ambrosia dumosa - Tetracoccus hallii* (JOTR: 33-11-5) = *Larrea tridentata – (Ambrosia dumosa) – Tetracoccus hallii – (Yucca schidigera)* (Mapping Code: 27043)

*Larrea tridentata - Ambrosia dumosa* Shrubland Association (Mapping Codes: 27011, 27031)

| | |
|---|---|
| COMMON NAME | Creosote Bush - Burro Bush Shrubland Association |
| SYNONYM | *Larrea tridentata - Ambrosia dumosa* association (Leary 1977) |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Shrubland (scrub) |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Evergreen Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Broad-Leaved and Microphyllous Evergreen Extremely Xeromorphic Subdesert Shrubland |
| ALLIANCE | *Larrea tridentata - Ambrosia dumosa* Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Upland |

RANGE
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
This association is the most common type in the park. Stands of the *Larrea tridentata - Ambrosia dumosa* Shrubland Association occur throughout the park and are best developed in the Pinto Basin and east of the Coxcomb Mountains. Stands were sampled within the San Bernardino Wash, Pinto Wells, Clarks Pass, and Conejo Well 7.5 minute topographic quadrangles.

ENVIRONMENTAL DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of *Larrea tridentata - Ambrosia dumosa* Shrubland Association are found at low elevations (1,000–2,200 ft.; 300–700 m), typically on linear but occasionally on convex or rounded slopes and hummocks or swales. This association usually occurs on upland, alluvial deposits; however, it can sometimes occur on rocky highlands. Slopes are gentle to moderate (<1–6 degrees) in steepness. Soils are usually sandy but range to fine clay. Parent material is usually sialic sediment or noncalcareous, metamorphic, but may be igneous. Rock content in this association consists of 0 percent bedrock, 0–<1 percent boulder, 0–<1 percent stone, 0-45 percent cobble, <1–70 percent gravel, and 2–95 percent fines cover. Litter cover is <1-3 percent. These sites generally experience low to moderate levels of disturbance from competition from exotic species (0–<1%).

MOST ABUNDANT SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory. It is likely to be widespread and common throughout the Mojave and northern Sonoran Desert.

JOTR
Shrub *Larrea tridentata*

CHARACTERISTIC SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Herbaceous *Oenothera deltoides*
Shrub *Ambrosia dumosa*

VEGETATION DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Larrea tridentata - Ambrosia dumosa* Shrubland Association form a sparse shrubland with 0–<1 percent cover at <1 cm tall, <1–2 percent cover at 1–25 cm tall, <1–1 percent cover at 25-50 cm tall, <1–3 percent cover at 50 cm to 1 m tall, and <1–4 percent cover at 1–3 m tall. Total vegetative cover ranges from 2–6 percent.

This association is dominated by *Larrea tridentata* in the shrub layer. *Ambrosia dumosa* is less abundant and is characteristic in this association. *Oenothera deltoides* is characteristic in the herbaceous layer. Cryptobiotic crust is often found on the ground. Occasionally, *Krameria grayi* is also present.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G5 S5

RANK JUSTIFICATION
This association is likely to be widespread and common throughout the Mojave and northern Sonoran Desert

DATABASE CODE

COMMENTS
Globally
Many samples from the *Larrea tridentata-Ambrosia dumosa* alliance collected in the central Mojave Vegetation database (Thomas *et al.* 2004) are likely to fall into this association.

JOTR

Plots used for this description: JOTR: 35C-08-2, 37B-17-2, 37B-21-2, 37B-21-4, 40A-07-4, 44-16-2, 44-18-1, 56-06-4

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*Larrea tridentata - Ambrosia dumosa - Krameria grayi* Shrubland Association

| | |
|---|---|
| COMMON NAME | Creosote Bush - Burro Bush - White Rhatany Shrubland Association |
| SYNONYM | *Larrea tridentata - Ambrosia dumosa* association (Leary 1977) |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Shrubland (scrub) |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Evergreen Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Broad-Leaved and Microphyllous Evergreen Extremely Xeromorphic Subdesert Shrubland |
| ALLIANCE | *Larrea tridentata - Ambrosia dumosa* Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Upland |

RANGE
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory. It is likely to be widespread in the lower elevations of the Mojave and western Sonoran Deserts.

JOTR
Stands of the *Larrea tridentata - Ambrosia dumosa - Krameria grayi* Shrubland Association were sampled in the park within the East Deception Canyon and Clarks Pass 7.5 minute topographic quadrangles.

ENVIRONMENTAL DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of *Larrea tridentata - Ambrosia dumosa - Krameria grayi* Shrubland Association are found at low to mid elevations (1,900–3,200 ft.; 580–980 m) on undulating and convex or rounded slopes of rocky highlands and erosional highlands. Aspect varies and included north and southwest. This association is found on gentle to somewhat steep (1–17 degree) slopes. Soils textures range from coarse sand to moderately fine, silty, clay loam. Soils formed from sialic sediment, plutonic, and noncalcareous, metamorphic, parent material. Rock content in this association consists of 0–5 percent bedrock, 0–5 percent boulder, 0–25 percent stone, 1–50 percent cobble, 25–>75 percent gravel and 5–27 percent fines cover. Litter cover is 1–2 percent. These sites generally experience low to moderate levels of disturbance from competition from exotic species (<1%).

MOST ABUNDANT SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Shrub *Ambrosia dumosa, Larrea tridentata*

CHARACTERISTIC SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Shrub *Ambrosia dumosa, Larrea tridentata, Krameria grayi*

VEGETATION DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Larrea tridentata - Ambrosia dumosa - Krameria grayi* Shrubland Association form a sparse to open shrubland with 0-<1 percent cover at <1 cm tall, <1–5 percent cover at 1–25 cm tall, <1–5 percent cover at 25–50 cm tall, <1–5 percent cover at 50 cm to 1 m tall, and 1–12 percent cover at 1-3 m tall. Total vegetative cover ranges from 7–14 percent.

This association is dominated by *Ambrosia dumosa* and *Larrea tridentata* in the shrub layer. *Krameria grayi* is a characteristic shrub species. *Erioneuron pulchellum* is often present in this association. The exotic species *Schismus* is also frequently present in the herbaceous layer.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G5 S5

RANK JUSTIFICATION
This association is presumed to be a common and widespread type in California, southern Nevada, and western Arizona.

DATABASE CODE

COMMENTS
Globally

JOTR

Plots used for this description: JOTR: 08-03-3, 43-20-4; MDEI: 156-2-8; LONG: VBE97-2

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*Larrea tridentata - Ambrosia dumosa - Psorothamnus schottii* Shrubland Association (Mapping Code: 27047)

| | |
|---|---|
| COMMON NAME | Creosote Bush - Burro Bush - Indigo Bush Shrubland Association |
| SYNONYM | *Larrea tridentata - Ambrosia dumosa* association (Leary 1977) |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Shrubland (scrub) |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Evergreen Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Broad-Leaved and Microphyllous Evergreen Extremely Xeromorphic Subdesert Shrubland |
| ALLIANCE | *Larrea tridentata - Ambrosia dumosa* Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Upland, Palustrine |

RANGE
Globally
This association is known from Joshua Tree National Park and from Anza-Borrego Desert State Park, San Diego County, California (Keeler-Wolf *et al.* 1998).

JOTR
Stands of the *Larrea tridentata - Ambrosia dumosa - Psorothamnus schottii* Shrubland Association are found primarily in the central portion of the park and were within the Fried Liver Wash 7.5 minute topographic quadrangle.

ENVIRONMENTAL DESCRIPTION
Globally
This association has been described from Anza-Borrego Desert State Park, San Diego County, California (Keeler-Wolf *et al.* 1998). There it occurs at low to mid elevations in the Sonoran Desert portion of the park, often in or adjacent to low-energy washes and bajadas subject to sheet flow.

JOTR
Stands of the *Larrea tridentata - Ambrosia dumosa - Psorothamnus schottii* Shrubland Association are found at mid elevations (2,000–2,500 ft.; 600–770 m) on linear, convex, and undulating slopes of washes and upland, alluvial deposits. These sites tend to be flat to gentle (0–2 degrees). Soils are usually sandy (includes coarse, medium, and fine sand, coarse, medium, and fine, loamy sand) and are formed on sialic sediments, plutonic, and noncalcareous, metamorphic, parent material. Rock content in this association consists of 0 percent bedrock, 0 percent boulder, 1–5 percent stone, 10–13 percent cobble, 5–30 percent gravel, and 40–>75 percent fines cover. Litter cover is 1–5 percent. These sites generally experience low to moderate levels of disturbance from competition from exotic species (1–2%).

MOST ABUNDANT SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Herbaceous | *Schismus* sp. |
| Shrub | *Larrea tridentata, Psorothamnus schottii, Hymenoclea salsola* |

CHARACTERISTIC SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Shrub | *Larrea tridentata, Psorothamnus schottii, Hymenoclea salsola, Ambrosia dumosa, Hyptis emoryi* |

VEGETATION DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Larrea tridentata - Ambrosia dumosa - Psorothamnus schottii* Shrubland Association form an open/sparse shrubland with <1 percent cover at <1 cm tall, <1–1 percent

cover at 1–25 cm tall, <1–1 percent cover at 25-50 cm tall, <1–3 percent cover at 50 cm to 1 m tall, and 3–13 percent cover at 1–3 m tall. Total vegetative cover ranges from 14-15 percent.

This association is dominated by *Larrea tridentata, Psorothamnus schottii,* and *Hymenoclea salsola* in the shrub layer. The exotic species *Schismus* sp. is dominant in the herb layer. Characteristic shrub species include *Ambrosia dumosa* and *Hyptis emoryi.* Frequently present species include *Opuntia ramosissima, Physalis* sp.*, Allionia incarnata,* and *Chamaesyce* sp. Cryptobiotic crust is also a frequent component in this association.

OTHER NOTEWORTHY SPECIES
Evidence of desert tortoises was noted in one of three plots.

CONSERVATION RANK G4 S3

RANK JUSTIFICATION
This association is likely to be restricted to the upper elevations of the Sonoran Desert in Southern California and adjacent Baja California, Mexico.

DATABASE CODE

COMMENTS
Globally
In some cases, *P. schottii* is higher cover than *Larrea tridentata* or *Ambrosia dumosa.*

JOTR

Plots used for this description: JOTR: 27B-12-3, 27B-12-4; MDEI:153-1-1

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*Larrea tridentata - Ambrosia dumosa - Pleuraphis rigida* Shrubland Association (Mapping Code: 27021)

| | |
|---|---|
| COMMON NAME | Creosote Bush - Burro Bush - Big Galleta Shrubland Association |
| SYNONYM | *Larrea tridentata - Ambrosia dumosa* association (Leary 1977); *Ambrosia dumosa* community (with *Larrea* and *Hilaria*) (Hogan 1977) |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Shrubland (scrub) |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Evergreen Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Broad-Leaved and Microphyllous Evergreen Extremely Xeromorphic Subdesert Shrubland |
| ALLIANCE | *Larrea tridentata - Ambrosia dumosa* Shrubland Alliance |

CLASSIFICATION CONFIDENCE LEVEL 2
USFWS WETLAND SYSTEM Upland and Palustrine

RANGE
Globally
This association is only known from Joshua Tree National Park, although several plots sampled by Thomas *et al.* (2004) in the central Mojave Desert are likely to be considered this type. Information about its global characteristics is not available without additional inventory and analysis.

JOTR
Stands of the *Larrea tridentata - Ambrosia dumosa - Pleuraphis rigida* Shrubland occur primarily in the north central and eastern portion of the park and were sampled within the San Bernardino Wash, Porcupine Wash, Indian Cove, Pinto Mountain, Clarks Pass, Malapai Hill, Joshua Tree South, and Cadiz Valley Southwest 7.5 minute topographic quadrangles.

ENVIRONMENTAL DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory. It is likely to be found elsewhere in the Mojave Desert, particularly in sandy situations.

JOTR
Stands of *Larrea tridentata - Ambrosia dumosa - Pleuraphis rigida* Shrubland are found at low to mid elevations (1,400–3,500 ft.; 420–1,050 m) on a variety of sites including drainages of washes, on upland, alluvial deposits, on rocky highlands, plains, toe slopes, and dune fields and sand sheets. Microtopography tends to be linear or even, hummock or swale, undulating, and convex or rounded. Slopes are flat to moderate (<1 to >6 degrees) but are more typically flat to gentle. Aspects include north, northeast, and southeast. Soils are usually sandy (includes coarse, medium and fine sand, coarse, medium, and fine, loamy sand) and rarely clay (includes fine, sandy clay, fine, silty clay, fine clay, medium silt). These sites occur on granitic, sialic sediments, plutonic, and noncalcareous, metamorphic, parent material. Rock content in this association consists of 0–2 percent bedrock, 0 percent boulder, 0–1 percent stone, 0–<1 (22 percent on one plot) cobble, 0–79 percent gravel, and 42–90 percent fines cover. Litter cover is 1–25 percent. These sites generally experience low to high levels of disturbance from competition from exotic species (0–35%) and low levels of disturbance from foot traffic and trampling.

MOST ABUNDANT SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Herbaceous *Pleuraphis rigida*
Shrub *Larrea tridentata, Ambrosia dumosa*

CHARACTERISTIC SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Herbaceous *Pleuraphis rigida*
Shrub *Larrea tridentata, Ambrosia dumosa, Opuntia echinocarpa*

VEGETATION DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Larrea tridentata - Ambrosia dumosa - Pleuraphis rigida* Shrubland form a sparse to open shrubland with 0–4 percent cover at <1 cm tall, <1–4 percent cover at 1–25 cm tall, <1–4 percent cover at 25–50 cm tall, <1–12 percent cover at 50 cm to 1 m tall, and 1–15 percent cover at 1-3 m tall. Total vegetative cover ranges from 6–22 percent.

This association is dominated by the shrub species *Larrea tridentata* and *Ambrosia dumosa* and the herb species *Pleuraphis rigida.* Characteristically present is *Opuntia echinocarpa.* Cryptobiotic crust, *Pectis papposa,* and *Krameria grayi* are often found in this association. The exotic species *Bromus madritensis* can be common within some stands.

OTHER NOTEWORTHY SPECIES
Evidence of tortoises was noted in four of 16 plots. *Tetracoccus hallii* was found in two of 16 plots. *Tetracoccus hallii* is a List 4 plant in the CNPS Inventory of Rare and Endangered Plants of California (CNPS 2001). It is found in Imperial, Riverside, and San Bernardino counties and in Arizona and Baja California at low to high elevations (100–4,000 ft.; 30–1,200 m).

CONSERVATION RANK G4 S3

RANK JUSTIFICATION
*Pleuraphis rigida* in combination with *L. tridentata* occurs typically on sandy substrates only in the central and eastern portions of the California Mojave Desert.

DATABASE CODE

COMMENTS
Globally

JOTR

Plots used for this description: JOTR: 14-27-2, 29B-02-1, 31-09-1, 31-09-2, 32-26-1, 37B-21-3, 38-28-1, 41-40-1, 44-18-3, 46-19-1, 49A-14-3, 49A-14-4, 49A-14-5, 57-18-3; LONG: VEGE-2, VIND97-1, VMAL97-16, VMAL97-40, VPAN97-1

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*Larrea tridentata - Ambrosia dumosa - Senna armata* Shrubland Association (Mapping Code: 27047)

| | |
|---|---|
| COMMON NAME | Creosote Bush - Burro Bush - Spiny Senna Shrubland Association |
| SYNONYM | *Larrea tridentata - Ambrosia dumosa* association (Leary 1977); C*assia armata - Larrea tridentata* community (Hogan 1977) |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Shrubland (scrub) |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Evergreen Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Broad-Leaved and Microphyllous Evergreen Extremely Xeromorphic Subdesert Shrubland |
| ALLIANCE | *Larrea tridentata-Ambrosia dumosa* Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Upland |

RANGE
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Larrea tridentata - Ambrosia dumosa - Senna armata* Shrubland Association occur primarily in the central portion of the park and were sampled within the Washington Wash, Porcupine Wash, Indian Cove, and Queen Mountain 7.5 minute topographic quadrangles.

ENVIRONMENTAL DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Larrea tridentata - Ambrosia dumosa - Senna armata* Shrubland Association are found at mid elevations (2,600–3,400 ft.; 790–1,040 m) on flat to moderate slopes. Aspect is north and northeast. This association occurs on rocky highlands, upland alluvial, deposits, bajadas, and intermontane areas. Microtopography is often linear; however, it can also be undulating, concave, or hummocky. Soils range from coarse sands to moderately fine, silty, clay loams formed from granitic, parent material. Rock content in this association consists of 0–2 percent bedrock, 0–3 percent boulder, 0–10 percent stone, 0–15 percent cobble, 5–>75 percent gravel, and 5–82 percent fines cover. Litter cover is <1–5 percent. These sites generally experience low to high levels of disturbance from competition from exotic species (0–7%).

MOST ABUNDANT SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Herbaceous | *Schismus barbatus* |
| Shrub | *Larrea tridentata, Ambrosia dumosa, Senna armata* |

CHARACTERISTIC SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Herbaceous | *Schismus barbatus* |
| Shrub | *Larrea tridentata, Ambrosia dumosa, Senna armata, Krameria sp., Opuntia echinocarpa* |

VEGETATION DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Larrea tridentata - Ambrosia dumosa - Senna armata* Shrubland Association form an open shrubland with 0–<1 percent cover at <1 cm tall, <1–1 percent cover at 1–25 cm tall, <1–2 percent cover at 25-50 cm tall, <1–3 percent cover at 50 cm to 1 m tall, and 3–9 percent cover at 1–3 m tall. Total vegetative cover ranges from 11–15 percent.

This association is dominated by the shrub species *Larrea tridentata, Ambrosia dumosa,* and *Senna armata.* The exotic species *Schismus barbatus* is dominant in the herb layer. *Krameria* sp. and *Opuntia echinocarpa* are characteristic shrub species. *Opuntia ramosissima, Hymenoclea*

*salsola,* and *Yucca schidigera* are often present in this association. The exotic species *Bromus madritensis* is often present in the herb layer.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G4 S3

RANK JUSTIFICATION
This association is likely to be found along washes in much of the central and southern Mojave Desert of California.

DATABASE CODE

COMMENTS
Globally

JOTR
This is another wash margin or bajada/fan association that is typically found in positions slightly higher up the fan and along less frequently flooded washes and channels than the *L. tridentata - A. dumosa - Psorothamnus schottii* association.

Plots used for this description: JOTR: 28-11-1, 28-11-2, 29B-02-3, 33-16-1; MDEI: 157-1-6, 158-1-8, 160-2-6; LONG: LIZ-1

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*Larrea tridentata - Ambrosia dumosa - Yucca schidigera* Shrubland Association (Mapping Code: 27045)

| | |
|---|---|
| COMMON NAME | Creosote Bush - Burro Bush - Mojave Yucca Shrubland Association |
| SYNONYM | *Larrea tridentata - Ambrosia dumosa* association (Leary 1977) |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Shrubland (scrub) |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Evergreen Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Broad-Leaved and Microphyllous Evergreen Extremely Xeromorphic Subdesert Shrubland |
| ALLIANCE | *Larrea tridentata - Ambrosia dumosa* Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Upland, Palustrine |

RANGE
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory. Similar plots were collected throughout much of the central Mojave Desert by Thomas *et al.* (2004).

JOTR
Stands of the *Larrea tridentata - Ambrosia dumosa - Yucca schidigera* Shrubland Association occur in the south central and west central part of the park and were sampled within the Porcupine Wash, Indian Cove, Malapai Hill, and Queen Mountain 7.5 minute topographic quadrangles.

ENVIRONMENTAL DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of *Larrea tridentata - Ambrosia dumosa - Yucca schidigera* Shrubland Association are found at mid elevations (2,700–2,900 ft.; 800–880 m) on convex, linear, and undulating slopes that are gentle to somewhat steep (2–24 degrees). Aspect varies and includes northwest, north, northeast, and southeast. This association occurs on upland, alluvial deposits, washes, erosional highlands, alluvial fan/bajadas, and ridgetops. Soils are usually sandy (ranging from coarse sand to fine, loamy sand) and sometimes loamy (from moderately coarse, sandy loam to moderately fine, silty, clay loam). This association typically occurs on sialic sediment, plutonic, and noncalcareous, metamorphic, gneiss/biotite gneiss, and granitic, parent materials. The rock component in this association consists of 0–75 percent bedrock, 0–5 percent boulder, 0–10 percent stone, 0–24 percent cobble, 1–63 percent gravel, and 0–80 percent fines cover. Litter cover is <1–25 percent. These sites generally experience low to high levels of disturbance from competition from exotic species (<1–14%).

MOST ABUNDANT SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Shrub *Larrea tridentata, Ambrosia dumosa*

CHARACTERISTIC SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Herbaceous *Pleuraphis rigida*
Shrub *Larrea tridentata*, *Ambrosia dumosa, Yucca schidigera, Krameria grayi, Senna armata, Salazaria mexicana, Opuntia ramosissima, Opuntia echinocarpa*

VEGETATION DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Larrea tridentata - Ambrosia dumosa - Yucca schidigera* Shrubland Association form a sparse to open shrubland with <1–23 percent cover in the ground layer, 7–25 percent cover in the shrub layer, and 0–1 percent cover in the tree layer. Total vegetative cover ranges from 9–33 percent.

This association is dominated by the shrub species *Larrea tridentata* and *Ambrosia dumosa.* Characteristic shrubs include *Yucca schidigera, Krameria grayi, Senna armata, Salazaria mexicana, Opuntia ramosissima,* and *Opuntia echinocarpa. Pleuraphis rigida* is characteristic in the herb layer. The exotic species *Erodium cicutarium* is also found in many of the stands. *Bromus madritensis* can be abundant in some stands where it occurs. Frequent associates in this association include *Thamnosma montana, Prunus fasciculata,* and *Eriogonum fasciculatum.*

OTHER NOTEWORTHY SPECIES
Evidence of tortoises was noted in one of six plots.

CONSERVATION RANK G5 S5

RANK JUSTIFICATION
This association is likely widespread in the Mojave Desert.

DATABASE CODE

COMMENTS
Globally

JOTR
This is a common type in the park, and it occurs on a variety of substrates and landforms in the mid elevations.

Plots used for this description: JOTR: 33-16-2, 34B-07-2; MDEI: 157-1-8, 160-2-1; LONG: VMAL97-8, VMAL97-9; Watts n=6

*Larrea tridentata - Ambrosia dumosa - Encelia farinosa* Shrubland Association

| | |
|---|---|
| COMMON NAME | Creosote Bush - Burro Bush - Brittlebush Shrubland Association |
| SYNONYM | *Larrea tridentata - Ambrosia dumosa* association (Leary 1977); *Encelia farinosa - Eriogonum fasciculatum - Ambrosia dumosa* community (Hogan 1977) |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Shrubland (scrub) |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Evergreen Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Broad-Leaved and Microphyllous Evergreen Extremely Xeromorphic Subdesert Shrubland |
| ALLIANCE | *Larrea tridentata - Ambrosia dumosa* Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Upland |

RANGE
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory. Several stands from the central Mojave Desert of California (Thomas *et al.* 2004) are similar if not identical to this association. Other plots collected in Anza-Borrego Desert State Park (Keeler-Wolf *et al*. 1998) are also likely to be considered this association. Plots from both of these studies have been insufficiently analyzed to determine whether they are analogous to this description.

JOTR
Stands of the *Larrea tridentata - Ambrosia dumosa - Encelia farinosa* Shrubland Association were sampled in the park within the East Deception Canyon, Fried Liver Wash, Pinto Wells, Cottonwood Springs, Pinto Mountain, Clarks Pass, Porcupine Wash, Coxcomb Mountains, and Conejo Well 7.5 minute topographic quadrangles.

ENVIRONMENTAL DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory. Other stands in the Mojave and Anza-Borrego appear to occur on rocky highlands and upper bajadas similar to the stands of this type at JOTR.

JOTR
Stands of *Larrea tridentata - Ambrosia dumosa - Encelia farinosa* Shrubland Association are found at low to mid elevations (1,200–3,200 ft.; 360–980 m) on linear and undulating, gentle to

steep slopes (<1-29 degrees). Aspect varies and includes north, northeast, east, southwest, and west. This association occurs on rocky highlands; upland, alluvial deposits; and erosional highlands. Soils are usually sandy (ranging from coarse to fine, loamy sands) and rarely loamy (ranging from moderately coarse, sandy loam to moderately fine, silty, clay loam). This association typically occurs on granitic/igneous (rarely metamorphic), parent material. Rock content in this association consists of 0–5 percent bedrock, 0–25 percent boulder, 0–50 percent stone, <1–75 percent cobble, 5–>75 percent gravel, and <1–87 percent fines cover. Litter cover is 0–25 percent. These sites generally experience low to moderate levels of disturbance from competition from exotic species (0–<1%).

MOST ABUNDANT SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Shrub *Larrea tridentata, Ambrosia dumosa*

CHARACTERISTIC SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Shrub *Larrea tridentata, Ambrosia dumosa, Encelia farinosa*

VEGETATION DESCRIPTION
Globally
This association is only described from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory and analysis.

JOTR
Stands of the *Larrea tridentata - Ambrosia dumosa - Encelia farinosa* Shrubland Association form a sparse to open shrubland with 0-<1 percent cover at <1 cm tall, 0–2 percent cover at 1–25 cm tall, <1-–5 percent cover at 25–50 cm tall, <1–3 percent cover at 50 cm to 1 m tall, 0–9 percent cover at 1–3 m tall, and 0-<1 percent cover at 3–5 m tall. Total vegetative cover ranges from 5–13 percent.

This association is dominated by the shrub species *Larrea tridentata* and *Ambrosia dumosa*. *Encelia farinosa* is characteristic. Occasionally, cryptobiotic crust, *Opuntia basilaris, Mirabilis bigelovii, Fagonia laevis,* and *Opuntia ramosissima* are present. The exotic species *Schismus barbatus* is also occasionally present.

OTHER NOTEWORTHY SPECIES
*Tetracoccus hallii* was found in one of 11 plots. *Tetracoccus hallii* is a List 4 plant in the CNPS Inventory of Rare and Endangered Plants of California (CNPS 2001). It is found in Imperial, Riverside, and San Bernardino counties and in Arizona and Baja California at low to high elevations (100–4,000 ft.; 30–1,200 m).

CONSERVATION RANK G5 S5

RANK JUSTIFICATION
This association is likely to be proven a common type in the Mojave and upper Sonoran Deserts of California and adjacent Mexico, Nevada and Arizona.

DATABASE CODE

COMMENTS
Globally

JOTR

Plots used for this description: JOTR: 8-03-05, 27B-12-5, 31-07-2, 32-26-5, 33-16-4, 43-20-3, 44-18-5, 59-05-1, 63-18-1; MDEI: 156-2-6, 156-2-7, 63-2-6

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**Hall's Tetracoccus *(Tetracoccus hallii)* Unique Stands (Mapping Code: 28180)**

*Tetracoccus hallii,* a CNPS List 4 plant, forms occasional stands in JOTR. *Tetracoccus hallii* is a List 4 plant in the CNPS Inventory of Rare and Endangered Plants of California (CNPS 2001). It is found in Imperial, Riverside, and San Bernardino Counties and in Arizona and Baja California at low to high elevations (100–4,000 ft.; 30–1,200 m). In JOTR, the species tends to form small stringers along low-elevation washes surrounded by old, alluvial surfaces (desert pavement). This species also occurs as members of other alliances (*Coleogyne ramosissima, Larrea - Ambrosia*, and *Juniperus californica*) at mid elevations in the south-central portion of the park.

Two plots were sampled that do not provide enough information to define an alliance or association. These plots are temporarily placed here until further information is available on their relationship to other alliances and associations.

*Tetracoccus hallii - Nolina bigelovii - Simmondsia chinensis* (JOTR: 34-06-2)
*Tetracoccus hallii - Viguiera parishii - Acacia greggii* (JOTR: 33-07-1)

**Four-wing Saltbush *(Atriplex canescens)* Shrubland Alliance (Mapping Code: 28080)**

This alliance is not defined at the association level locally. The following general description will serve to distinguish the local stand(s):

| | |
|---|---|
| COMMON NAME | Four-wing Saltbush Shrubland |
| SYNONYM | None |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Shrubland |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Evergreen Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Semi-natural |
| FORMATION | Facultatively Deciduous Extremely Xeromorphic Subdesert Shrubland |
| ALLIANCE | *Atriplex canescens* Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 1 |
| USFWS WETLAND SYSTEM | Upland |

RANGE
Globally
The *Atriplex canescens* Shrubland Alliance occurs in the Mojave Desert, Colorado Desert, Sonoran Desert, Great Valley, central California coast ranges, Southern California mountains and valleys, and southeastern Great Basin regions of California, and in the intermountain West.

JOTR
A significant stand exists in Pleasant Valley, although stands occur elsewhere in the central portion of the park.

ENVIRONMENTAL DESCRIPTION
Globally
This alliance occurs on soils of old beach and lake deposits, on dissected, alluvial fans, and rolling hills. Soils may be carbonate rich, alkaline, sandy, or sandy, clay loams. The alliance occurs in wetland habitats such as washes, playa lake beds, and shores. Elevations range from -240 to 4800 feet (-73 to 1,470 m).

JOTR

MOST ABUNDANT SPECIES
Globally

| | |
|---|---|
| Shrub | *Atriplex canescens, Ambrosia dumosa, Atriplex confertifolia, Atriplex polycarpa, Chrysothamnus viscidiflorus, Ephedra viridis, Grayia spinosa, Hymenoclea salsola, Isomeris acradenia, Larrea tridentata, Suaeda moquinii* |

Tree *Prosopis glandulosa*

JOTR
Herbaceous
Shrub
Tree

CHARACTERISTIC SPECIES
Globally
Shrub *Atriplex canescens*

VEGETATION DESCRIPTION
Globally
*Atriplex canescens* is the sole or dominant shrub in canopy; emergent *Prosopis glandulosa* may be present. Shrubs are generally < 3 m tall with an open or intermittent canopy. Trees are <5 m and scattered. The ground layer is variable and seasonally present and includes annual herbs and nonnative grasses.

JOTR

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G5 S5

RANK JUSTIFICATION
This alliance is abundant throughout the Western North America deserts.

DATABASE CODE

COMMENTS
Globally
This alliance is often considered part of the chenopod, or saltbush, scrub. Most stands of these vegetation types are dominated by one or more perennial species of *Atriplex*. These scrubs are better thought of as a collection of alliances consisting of *Atriplex polycarpa, Atriplex spinescens, Atriplex lentiformis, Atriplex hymenelytra,* and/or *Atriplex confertifolia* alliances. In California, this alliance occurs in the low hills of the inner south coast range. It also occurs widely in the Mojave, Colorado, and Sonoran Deserts. In California, ecological settings for the alliance are variable. They include sandy dune aprons and low dunes, as in Death Valley and Saline Valley, and moderately alkaline playas such as Silver Dry Lake and Superior Dry Lake. In the hot deserts of California, *Atriplex canescens* appears to have more of an affinity for windblown sand than other *Atriplex* shrubs and frequently forms part of the dune margin matrix with stands of *Prosopis glandulosa, Pleuraphis rigida,* and *Larrea tridentata-Ambrosia* alliances. It also mixes regularly with other species of *Atriplex* to form mixed stands in washes

(*Atriplex canescens* - *Atriplex polycarpa*) and on playa and playa edges (*Atriplex canescens s-Atriplex confertifolia*).

Associated alliances range from wetland types, such as *Scirpus americanus, Distichlis spicata, Pluchea sericea,* and *Juncus balticus,* to playa types, such as *Suaeda moquinii, Allenrolfea occidentalis,* and *Atriplex polycarpa,* to upland types, such as *Atriplex confertifolia, Grayia spinosa,* and *Coleogyne ramosissima.* The wide variety of ecological settings is at least partially explained by chromosomal differences in populations. Different ploidy levels of *Atriplex canescens* appear to occupy different ecoregions. These include hot desert and cold desert ecotypes (FEIS 2001). The species has been considered as the most rapidly evolving shrub in North America (FEIS 2001).

*Atriplex canescens* is a very widespread species throughout the western United States. It has been used extensively for rehabilitation of mine excavations in Wyoming and Montana. It colonizes readily from seed and does not appear to require mycorrhizal associations to grow vigorously. Tolerant of grazing, the species is also resistant to fire because of moist and non-volatile leaf composition. If top killed, it sprouts prolifically (FEIS 2001). Natural disturbance processes probably did not involve fire to any great degree in most California stands, except the cismontane ones. Fire may be more important currently as a result of invasion of *Bromus* spp. in understory and increased human-caused ignitions.

In general, this alliance is in good shape throughout its range. Its ability to tolerate alkaline soils and grazing, fire, and other disturbance bodes well for its persistence, although sensitivity to high levels of grazing and fire at certain times of year should be investigated (FEIS 2001).

JOTR
This alliance is largely restricted to the margin of low-salinity playas such as in Pleasant Valley. It appears to be commonly associated with the nonnative grass Bromus madritensis.

The following samples in JOTR suggested further variation than what is currently reported from this Alliance:

> *Atriplex canescens* Undifferentiated (Watts: 4-16-96-1A, 4-16-96-1B; LONG: VMAL97-1, VMAL97-1-M, VMAL97-3)
> *Atriplex canescens*/*Bromus madritensis* (LONG: VMAL97-4M)
> *Atriplex canescens*/*Achnatherum speciosum* (JOTR: 08A-04-3)

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**Cheesebush (*Hymenoclea salsola*) Shrubland Alliance (Mapping Code: 28110)**

This alliance is not defined at the association level locally. The following general description will serve to distinguish the local stand(s):

COMMON NAME Cheesebush Scrub

| | |
|---|---|
| SYNONYM | None |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Shrubland |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Evergreen Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Semi-natural |
| FORMATION | Facultatively Deciduous Extremely Xeromorphic Subdesert Shrubland |
| ALLIANCE | *Hymenoclea salsola* Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 1 |
| USFWS WETLAND SYSTEM | Upland |

RANGE
Globally
The *Hymenoclea salsola* Shrubland Alliance occurs in the Mojave Desert, Sonoran Desert, Colorado Desert, southeastern Great Basin, Great Valley, and central California coast ranges regions of California and in Arizona, Nevada, and perhaps Utah.

JOTR
Stands are common throughout the park, with larger stands found in Queen and Pleasant Valleys.

ENVIRONMENTAL DESCRIPTION
Globally
The *Hymenoclea salsola* Shrubland Alliance occurs in valleys and flats in rarely flooded, low-gradient deposits. Soils are shallow and are sandy, gravelly, or disturbed desert pavement. The alliance occurs in wetland habitats such as washes, intermittent channels, and arroyos. Soils are coarse, well drained, and moderately acidic to slightly saline. Elevation ranges from 0 to 5,000 feet (1,500 m).

JOTR

MOST ABUNDANT SPECIES
Globally

| | |
|---|---|
| Herbaceous | *Bromus madritensis* |
| Shrub | *Hymenoclea salsola, Ephedra californica, Encelia farinosa, Ericameria paniculata, Eriogonum fasciculatum, Larrea tridentata, Opuntia echinocarpa, O. basilaris, Psorothamnus schottii, Salazaria mexicana* |
| Tree | *Acacia greggii, Cercidium floridum, Chilopsis linearis, Olneya tesota, Psorothamnus spinosus* |

JOTR

| | |
|---|---|
| Shrub | *Hymenoclea salsola* |

CHARACTERISTIC SPECIES
Globally
Shrub *Hymenoclea salsola*

VEGETATION DESCRIPTION
Globally
*Hymenoclea salsola* is the sole or dominant shrub in the overstory. Emergent trees may be present. *Bromus madritensis* and other weedy annuals may be in ground layer. Shrubs have an open to intermittent cover and are <2 m tall. The ground layer is sparse or seasonally present.

JOTR

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK

RANK JUSTIFICATION

DATABASE CODE

COMMENTS
Globally
*Hymenoclea salsola* is widespread in many alliances in the hot deserts of California. However, canopy dominance by *Hymenoclea salsola* is necessary to define the alliance.

The *Hymenoclea salsola* alliance is the most ubiquitous native indicator of recent disturbance throughout the hot deserts of California. It occurs commonly in washes but also in burned and heavily grazed areas from below sea level to at least 5,000 feet (1,530 m). Natural disturbance is most frequently caused by flooding. However, it has benefited from increased fire frequencies resulting from the fuels built up from nonnative, annual *Bromus* spp. It has also benefited from the overgrazing by livestock in certain parts of the desert. Thus, it currently occupies upland sites as well as wash and bottomland sites throughout its distribution.

Relationships to other vegetation types are varied given its geographic and ecological range. In many lower elevation washes, it occurs adjacent *to Psorothamnus spinosus, Olneya tesota, Cercidium floridum*, *Atriplex polycarpa, Ephedra californica*, and *Bebbia juncea* alliances. At mid elevations, it is commonly associated with *Ericameria paniculata, Salazaria mexicana, Chilopsis linearis, Eriogonum fasciculatum, Ephedra californica, Larrea tridentata, Larrea tridentata-Ambrosia dumosa,* and *Yucca brevifolia* alliances. On calcareous substrates, it may occur with *Encelia virginensis* and *Viguiera reticulata* alliance in washes and on slopes with *Artemisia nova*. It occurs adjacent to *Acacia greggii* alliance stands in both washes and upland settings. In some upland settings, it may occur with nonnative *Bromus madritensis* stands. It may coexist with *Atriplex confertifolia, Prunus fasciculata,* and *Chrysothamnus nauseosus* stands at high elevations.

The *Hymenoclea salsola* alliance is indicative of disturbed sites within a broad ecological zone. In wash and arroyo settings, flooding regimes for the alliance are generally of high frequency and variable intensity. The seeds have high viability and germination rates compared to other desert shrubs. Seeding is prolific, and flowering, leaf-flush, and seed set are opportunistic whenever water is available (FEIS 2001). The species is short-lived and has a shallow root system consisting of a relatively short taproot with prominent laterals. It not only seeds from adjacent sites and colonizes bare mineral soil, but it also resprouts following mechanical, aboveground damage from flood and fire (FEIS 2001). *Hymenoclea salsola* stands recover quickly after fire via off-site seeds and sprouting.

*Hymenoclea salsola,* with its natural colonizing ability, is well-suited for being the primary early seral wash alliance through most of the hot deserts of California. However, its current distribution is out of synchrony with its historic distribution in much of the desert, a result of recent human-mediated disturbance patterns. This is another alliance where coincidence of non-native, annual grass invasion and human-related fires have conspired to threaten the structure and diversity of the vegetation. In the deserts, fires should be excluded at all times of the year and core areas should be identified where grass cover is low and, thus, stands are defensible.

JOTR

The following samples in JOTR suggested further variation than what is currently reported from this Alliance:

*Hymenoclea salsola* Undifferentiated (LONG: VMAL97-41, VKEY97-1; MDEI: 157-1-1, 157-2-1)
*Hymenoclea salsola/Petalonyx thurberi* (LONG: VMAL97-35,)
*Hymenoclea salsola*/*Eriogonum plumatella* (LONG: n=1)
*Hymenoclea salsola - Larrea tridentata* (JOTR: 08-03-1, 43-20-1)
*Hymenoclea salsola - Senna armata* (LONG: LIZ-1, VMAL97-18)
*Hymenoclea salsola - Tetracoccus hallii* (JOTR: 31-07-1)

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**Paniculate Rabbitbrush *(Ericameria paniculata = Chrysothamnus paniculatus)* Shrubland Alliance**

This alliance is not defined at the association level locally. The following general description will serve to distinguish the local stand(s):

| | |
|---|---|
| COMMON NAME | Paniculate Rabbitbrush Scrub |
| SYNONYM | None |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Shrubland |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Evergreen Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Semi-natural |

| | |
|---|---|
| FORMATION | Facultatively Deciduous Extremely Xeromorphic Subdesert Shrubland |
| ALLIANCE | *Ericameria paniculata* Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 1 |
| USFWS WETLAND SYSTEM | Upland |

RANGE
Globally
The *Ericameria paniculata* Shrubland Alliance occurs in the Sonoran, Colorado, and southeastern Great Basin regions of California.

JOTR
The single sample of this alliance occurs on the Cottonwood Springs 7.5 minute quadrangle in the southern portion of JOTR.

ENVIRONMENTAL DESCRIPTION
Globally
The *Ericameria paniculata* Shrubland Alliance occurs in washes, intermittent channels, and arroyos. Soils are coarse, well drained, and moderately acidic to slightly saline.

JOTR

MOST ABUNDANT SPECIES
Globally

| | |
|---|---|
| Shrub | *Ericameria paniculata, Ambrosia eriocentra, Brickellia incana, Hymenoclea salsola, Encelia farinosa, Encelia virginensis actoni, Ephedra nevadensis, E. californica, Stephanomeria pauciflora* |
| Tree | *Acacia greggii*, *Chilopsis linearis* |

JOTR

| | |
|---|---|
| Shrub | *Ericameria paniculata* |

CHARACTERISTIC SPECIES
Globally

| | |
|---|---|
| Shrub | *Ericameria paniculata* |

VEGETATION DESCRIPTION
Globally
*Ericameria paniculata* is dominant in the shrub canopy. Emergent *Acacia greggii* and *Chilopsis linearis* trees may be present and are usually < 5 m. Shrubs are <3 m tall and form an intermittent or open canopy. The ground layer is sparse, and annual herbs or grasses are seasonally present.

JOTR

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G5 S5

RANK JUSTIFICATION
This alliance is likely to be widespread in washes throughout the Mojave and adjacent northern Sonoran Desert.

DATABASE CODE

COMMENTS
Globally
*E. paniculata* alliance is widespread, though localized in washes and other fluvial channels throughout the hot deserts of California and adjacent Arizona, Nevada, and Utah. Its center of distribution is in the Mojave Desert, where it occupies active washes and adjacent terraces. It is commonly known as Black-Stemmed Rabbitbrush from a rust that causes distinct black bands around the young stems. As with other "rabbitbrush" species (*Chrysothamnus, sensu lato,* or *Ericameria*) it is relatively short lived and well adapted to disturbance. However, it is not typically found in upland stands as is *Ericameria nauseosus*, or *E. viscidiflorus*. With *E. paniculata*, stands are largely limited to fluvial disturbance. Many stands are monospecific and may be relatively dense, with little or no understory.

Most stands are found in medium to large washes where flooding events are regular (at least some water flows every few years). Stands typically occupy wash bottoms in broad, braided-channel washes and terraces in narrower, higher-energy washes, suggesting that high rates of scour and flooding intensities are not conducive to high-density establishment. Seeding is prolific in the fall (September–November). The windblown seed will lodge in gravel and irregularities in the wash bottoms, becoming further dispersed and activating germination when flooding comes. *E. paniculata* grows quickly in favorable sites and may reach 4 m in height. However, shrub life span is relatively short. Some resprouting may occur following minor damages from flood or fire, but moderate to severe fire likely kills shrubs (FEIS 2001). Large flooding events may destroy and eliminate all shrubs in the main watercourse, but seedling recruitment from adjacent individuals in protected microsites may be rapid. *E. paniculata* does not occur at high elevations or further north in the Great Basin as with several other *Ericameria* spp. It may be relatively frost sensitive. In the warm deserts of California, it is limited to sites with higher moisture than surrounding modal environments; thus, it occurs in washes only. Fire is not likely to be an important agent of disturbance in this alliance; however, *E. paniculata* is preadapted to fire should it occur.

Short-lived communities, such as these, are relatively unscathed by human interactions, except for OHV impacts and gravel mining within the wash environment. Further information on the ecological relationships between similar, short-lived, shrubby, wash vegetation alliances should be investigated.

JOTR

The following sample in JOTR suggested further variation than what is currently reported from this Alliance:

*Ericameria (=Chrysothamnus) paniculatus - Acacia greggii* (JOTR: 32-08-2)

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**Parish Viguiera *(Viguiera parishii)* Shrubland Alliance (Mapping Code: 28130)**

The *Viguiera parishii* Shrubland Alliance occurs in the Southern California mountains and valleys, Mojave Desert, Sonoran Desert, and Colorado Desert regions of California.

This scrub occurs on moderate to steep slopes and may contain a high diversity of perennial species. It occupies a transition zone between the lower, hot Sonoran Desert and higher, cooler Mojave Desert or peninsular ranges. The species is more widespread in Southern California than is the alliance.

Since this vegetation covers a large area in the Colorado Desert/peninsular range borderland, it is important to understand the vegetation dynamics of this type. Monitoring and study are needed.

This alliance is represented in JOTR by one association, defined first in this project, the Parish Viguiera/California Buckwheat *(Viguiera parishii/Eriogonum fasciculatum)* Shrubland Association.

In addition to the association described below, one unclassified, alliance-level sample was taken suggesting further variation.

*Viguiera parishii -Hyptis emoryi* (MDEI: 154-3-1)

---

*Viguiera parishii/Eriogonum fasciculatum* Shrubland Association (Mapping Code: 28133)

| | |
|---|---|
| COMMON NAME | Parish Viguiera/California Buckwheat Shrubland Association |
| SYNONYM | *Ambrosia dumosa* – Mixed Shrub Association (Leary 1977) |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Deciduous Shrubland |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Deciduous Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Extremely Xeromorphic Deciduous Subdesert Shrubland Without Succulents |
| ALLIANCE | *Viguiera parishii* Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |

USFWS WETLAND SYSTEM Upland

RANGE
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory. The alliance and probably this same association have been reported from Anza-Borrego Desert State Park, San Diego County (Keeler-Wolf *et al.* 1998).

JOTR
Stands of the *Viguiera parishii/Eriogonum fasciculatum* Shrubland Association are found across the park but were sampled within the Malapai Hill and Seven Palms Valley 7.5 minute topographic quadrangles.

ENVIRONMENTAL DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of *Viguiera parishii/Eriogonum fasciculatum* Shrubland Association are found on somewhat steep to steep (23-40 degree) slopes facing north, northeast, east, southeast, and west. This association is found on undulating and linear sites located at the middle to upper one-third of slopes and on erosional highlands. Soils texture includes coarse, loamy sand to moderately fine, silty, clay loam derived from metamorphic, basalt, gneiss/biotite gneiss, and granitic, parent material. Rock content in this association consists of 0–45 percent bedrock, 1–35 percent stone, 1–38 percent cobble, 5–39 percent gravel, and 0–>75 percent fines cover. Litter consists of <1–15 percent cover. This association experiences low to high levels of disturbance from competition from exotics (0-20%).

MOST ABUNDANT SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Herbaceous *Bromus madritensis*
Shrub *Viguiera parishii, Eriogonum fasciculatum*

CHARACTERISTIC SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Herbaceous *Achnatherum speciosum, Pleuraphis rigida*
Shrub *Viguiera parishii, Eriogonum fasciculatum, Ambrosia dumosa, Gutierrezia microcephala*

VEGETATION DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Viguiera parishii/Eriogonum fasciculatum* Shrubland Association form an open, two-story shrubland with 7–17 percent cover in the shrub layer and 4–23 percent cover in the herbaceous layer. Total vegetative cover ranges from 14–27 percent.

This association is dominated by *Viguiera parishii* and *Eriogonum fasciculatum* in the shrub layer. The exotic species *Bromus madritensis* is dominant in the understory herb layer. Characteristic shrub species include *Viguiera parishii, Eriogonum fasciculatum, Ambrosia dumosa,* and *Gutierrezia microcephala*. Characteristic herb species include *Achnatherum speciosum* and *Pleuraphis rigida.* Frequently, *Simmondsia chinensis* is present. *Mirabilis bigelovii, Salazaria mexicana, Lycium andersonii,* and *Stephanomeria exigua* are occasionally present.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G4 S4

RANK JUSTIFICATION
This association is apparently fairly widespread in the southern Mojave and adjacent northwestern Sonoran Desert.

DATABASE CODE

COMMENTS
Globally

JOTR

Plots used for this description: JOTR: 16-26-1, 32-17-1, 58B-01-3; MDEI: 141-2-7, 154-3-1; LONG: LIZ-2, VMAL97-11, VMAL97-27, VMAL97-28, VMAL97-32, VMAL97-36, VMAL 97-52

**Anderson's Box-Thorn *(Lycium andersonii)* Shrubland Alliance**

The *Lycium andersonii* Shrubland Alliance occurs in the southern Great Basin and the higher elevations of the Mojave Desert, stretching sporadically to cismontane Southern California (western Riverside County).

This alliance is represented in JOTR by one association, defined first in this project, the Anderson's Desert-Thorn – Jojoba - Big Galleta *(Lycium andersonii–Simmondsia chinensis–Pleuraphis rigida)* Shrubland Association.

*Lycium andersonii–Simmondsia chinensis–Pleuraphis rigida* Shrubland Association (Mapping Code: 24001=24012)

| | |
|---|---|
| COMMON NAME | Anderson's Desert-Thorn – Jojoba - Big Galleta Shrubland Association |
| SYNONYM | *Ambrosia dumosa* – Mixed Shrub Association (Leary 1977) |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Shrubland |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Evergreen Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Facultatively Deciduous Extremely Xeromorphic Subdesert Shrubland |
| ALLIANCE | *Lycium andersonii* Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Upland |

RANGE
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Lycium andersonii–Simmondsia chinensis–Pleuraphis rigida* Shrubland Association were sampled in the park within the Malapai Hill, Queen Mountain, and Fried Liver Wash 7.5 minute topographic quadrangles.

ENVIRONMENTAL DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of *Lycium andersonii–Simmondsia chinensis–Pleuraphis rigida* Shrubland Association are found at low elevations (2,900–3,700 ft.; 890–1,100 m) on moderate to somewhat steep (6–21 degrees), concave and undulating slopes of rocky highlands and erosional highlands. Soil textures are sand (ranging from coarse to fine, loamy sand) and loam (ranging from moderately coarse, sandy loam to moderately fine, silty, clay loam) formed on sialic sediment, plutonic, and noncalcareous, metamorphic, parent material. Rock content in this association consists of 0–5 percent bedrock, 2–50 percent boulder, 15–50 percent stone, 5–30 percent cobble, 18–75 percent gravel, and 1–20 percent fines cover. Litter consists of 3–10 percent cover. This association sometimes experiences low to high levels of disturbance from competition from exotics (1–7%).

MOST ABUNDANT SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Herbaceous | *Pleuraphis rigida, Bromus madritensis* |
| Shrub | *Lycium andersonii, Simmondsia chinensis* |

CHARACTERISTIC SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Herbaceous | *Pleuraphis rigida, Galium* sp. |
| Shrub | *Lycium andersonii, Simmondsia chinensis, Viguiera parishii, Ambrosia dumosa* |

VEGETATION DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Lycium andersonii–Simmondsia chinensis–Pleuraphis rigida* Shrubland Association form an open shrubland with <1–5 percent cover at <1 cm tall, <1–5 percent cover at 1–25 cm tall, 2–5 percent cover at 25–50 cm tall, 1–5 percent cover at 50 cm to 1 m tall, and 0–11 percent cover at 1–3 m tall. Total vegetative cover ranges from 10–16 percent.

This association is dominated by the shrub species *Lycium andersonii* and *Simmondsia chinensis* and herb species *Pleuraphis rigida*. The exotic species *Bromus madritensis* is also consistently abundant. Characteristic shrub species include *Viguiera parishii* and *Ambrosia dumosa. Galium* sp. is a characteristic herb species. *Ephedra nevadensis, Eriogonum fasciculatum, Senna armata,*

*Trixis californica, Salazaria mexicana, Adenophyllum porophylloides, Eriogonum inflatum, Krameria* sp., *Mirabilis bigelovii, Sphaeralcea ambigua, Stephanomeria* sp., *Xylorhiza tortifolia,* and lichen are frequently present in this association. The exotic species *Erodium cicutarium* is also frequently present.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G4 S3

RANK JUSTIFICATION
This association appears to be locally distributed, though the species (*L. andersonii*) is widespread.

DATABASE CODE

COMMENTS
Globally

JOTR

Plots used for this description: JOTR: 21-34-1, 22-26-2; MDEI: 154-3-8.

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**Catclaw *(Acacia greggii)* Shrubland Alliance**

The *Acacia greggii* Shrubland Alliance occurs in the Mojave Desert, Sonoran Desert, Colorado Desert, and Southern California mountain and valley regions of California and in south Nevada, west Arizona, and Baja California, Mexico.

In washes, the *Acacia greggii* Shrubland Alliance occupies habitat similar to other leguminous microphyll alliances in the Colorado and Sonoran Deserts. The *Acacia greggii* Shrubland Alliance extends farther north into the Mojave than any of these. Because it is relatively frost tolerant, it also ascends into the desert mountains and the adjacent desert transition zone of the peninsular ranges. It is considered a warm season rain species and does not occur in the western Mojave (Desert Workshop, personal communication).

Although commonly of washes, arroyos, and lower canyons, the *Acacia greggii* Shrubland Alliance may also occupy rocky slopes and valleys away from fluvial disturbance (Reid *et al.* 1999). In Anza-Borrego Desert State Park (Keeler-Wolf *et al.* 1998), it occurs in upland valleys up to 3,800 feet (1,260 m) and on south facing rocky, granitic slopes up to 4,500 feet (1,370 m). Evens (2000) indicates that of the six *Acacia greggii* associations she describes as occurring in washes and arroyos, only one occurs in lower-elevation canyons.

*Acacia greggii* is a large shrub or small tree of the southwest deserts. It is tied to fluvial disturbance in much of its range, lining small to relatively large active washes and arroyos. It is a vigorous sprouter, following flood damage, heavy browsing, or fire, and may be long lived (FEIS 2001). It is winter deciduous and requires greater concentrations of water than available in the modal desert landscape. It thus occupies washes, valley bottoms, and in some cases, slopes where outcrops and boulders channel surface water to roots. Stands are typically aged unevenly. *Acacia* seeds are nutritious and often cached and dispersed by small mammals. Seeds require scarification either through guts or abrasion of the seed coat for germination (Young and Young 1986). Recruitment is sporadic. Little information exists on variation in flood frequencies in the wash associations.

Fire was not likely to be an important disturbance prior to the advent of Eurasian annual grasses in portions of its upland distribution. However, in stands with *Pleuraphis rigida* understory, fire may have played a natural disturbance role. Once established, *Acacia greggii* individuals are notoriously difficult to kill (Desert Workshop, personal communication).

Natural flooding regimes in most wash and riparian settings are adequate for perpetuating the alliance rangewide. Some evidence points to the increase relative to less disturbance resistant desert alliances in upland stands. It its likely that continued high fire frequency in the upper-desert stands with nonnative grasses will benefit the *Acacia greggii* Shrubland Alliance to the detriment of stands of other nonfire tolerant alliances.

This alliance is represented in JOTR by three associations, all defined first in this project. These include the Catclaw - Desert Almond *(Acacia greggii - Prunus fasciculata)* Shrubland Association, Catclaw - Sweetbush *(Acacia greggii - Bebbia juncea)* Shrubland Association, and Catclaw - Desert-Lavender (*Acacia greggii - Hyptis emoryi)* Shrubland Association.

In addition to the associations described below, several unclassified, alliance-level samples were taken that suggest further variation. These include

*Acacia greggii - Peucephyllum schottii* (JOTR: 01-02-5)
*Acacia greggii - Tetracoccus hallii* (JOTR: 34-06-1)
*Acacia greggii - Ephedra californica* (JOTR: 44-16-1, 44-18-2)
*Acacia greggii - Chilopsis linearis* (JOTR: 10B-01-1)
*Acacia greggii - Ephedra nevadensis* (JOTR: 16-17-1, 18-28-1)
*Acacia greggii - Lycium cooperi* (JOTR: 10B-01-2)
*Acacia greggii - Viguiera parishii* (JOTR: 32-08-1 ; MDEI : 128-1-1)
*Acacia greggii - Yucca schidigera - Viguiera parishii* (JOTR: 16-24-2)
*Acacia greggii*/*Nolina bigelovii - Eriogonum fasciculatum* (JOTR: 58A-04-1)
*Acacia greggii*/*Hymenoclea salsola* (MDEI : 155-1-1)

In addition, one mapping unit dominated by *Acacia greggii* was distinguishable, although this vegetation type was not sampled or described.

*Acacia greggii* – (*Viguiera parishii – Eriogonum fasciculatum*) Upland slope type (Mapping Code: 36017)

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*Acacia greggii - Prunus fasciculata* Shrubland Association (Mapping Code: 36016)

| | |
|---|---|
| COMMON NAME | Catclaw - Desert Almond Shrubland Association |
| SYNONYM | None |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Deciduous Shrubland (Scrub) |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Deciduous Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Extremely Xeromorphic Deciduous Subdesert Shrubland Without Succulents |
| ALLIANCE | *Acacia greggii* Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Upland |

RANGE
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Acacia greggii - Prunus fasciculata* Shrubland Association occur mostly in the western and southwest central portion of the park but also at higher elevations in the eastern part of the park. Stands were sampled within the Porcupine Wash, Joshua Tree South, Cottonwood Springs, Malapai Hill, and Indian Cove 7.5 minute topographic quadrangles.

ENVIRONMENTAL DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of *Acacia greggii - Prunus fasciculata* Shrubland Association are found at mid elevations (3,200 to 5,000 ft.; 975 to 1,500 m) within drainages of washes and bajadas. Microtopography varies and may be convex, linear, concave, or undulating. Soil textures typically range from coarse sand to moderately fine, silty, clay loam. Parent material is typically granitic. The surface in this association is composed of 0–35 percent bedrock, 0–20 percent boulder, 0–6 percent stone, 0–7 percent cobble, 3–56 percent gravel, and 0–80 percent fines cover. Litter cover is 1–35 percent. These sites experience low to high levels of disturbance from competition from exotics (0–6%) and low to moderate levels of disturbance from foot traffic and trampling.

MOST ABUNDANT SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Herbaceous | *Bromus madritensis* |
| Shrub | *Acacia greggii, Prunus fasciculata, Hymenoclea salsola, Salazaria mexicana* |

CHARACTERISTIC SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Shrub | *Acacia greggii, Prunus fasciculata, Hymenoclea salsola, Salazaria mexicana, Eriogonum fasciculatum, Opuntia echinocarpa, Yucca schidigera* |

VEGETATION DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Acacia greggii - Prunus fasciculata* Shrubland Association form an open/sparse shrubland with 0–<1 percent cover at <1 cm tall, <1–6 percent cover at 1–25 cm tall, <1–2 percent cover at 25–50 cm tall, <1–5 percent cover at 50 cm to 1 m tall, 2–13 percent cover at 1-3 m tall and 0–2 percent cover at 3–5 m tall. Total vegetative cover ranges from 4–21 percent.

This association is dominated by the shrub species *Acacia greggii, Prunus fasciculata, Hymenoclea salsola,* and *Salazaria mexicana.* The understory herb layer is dominated by the exotic species *Bromus madritensis.* Characteristic shrub species include *Eriogonum fasciculatum, Opuntia echinocarpa,* and *Yucca schidigera.* The exotic species *Erodium cicutarium* is characteristically present in the herb layer. *Ephedra nevadensis, Mirabilis bigelovii, Simmondsia chinensis, Viguiera parishii,* and *Lycium* sp. frequently contribute minor cover.

OTHER NOTEWORTHY SPECIES
*Tetracoccus hallii* was found in two of six plots. *Tetracoccus hallii* is a List 4 plant in the CNPS Inventory of Rare and Endangered Plants of California (CNPS 2001). It is found in Imperial, Riverside, and San Bernardino Counties and in Arizona and Baja California at low to high elevations (100–4,000 ft.; 30–1,200 m).

Evidence of tortoises was noted in one of six plots.

CONSERVATION RANK G4 S4

RANK JUSTIFICATION
This association is probably relatively widespread in the mountains of the southern and eastern Mojave Desert.

DATABASE CODE

COMMENTS
Globally

JOTR

Plots used for this description: JOTR: 10B-01-4, 14-23-1, 22-32-1, 33-07-3, 33-11-2; LONG: VMAL97-49

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*Acacia greggii - Bebbia juncea* Shrubland Association (Mapping Code: 36015)

| | |
|---|---|
| COMMON NAME | Catclaw - Sweetbush Shrubland Association |
| SYNONYM | None |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Deciduous Shrubland (Scrub) |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Deciduous Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Extremely Xeromorphic Deciduous Subdesert Shrubland without Succulents |
| ALLIANCE | *Acacia greggii* Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Palustrine |

RANGE
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory. Similar stands have been sampled in Anza-Borrego Desert State Park (Keeler-Wolf *et al.* 1998).

JOTR
Stands of the *Acacia greggii - Bebbia juncea* Shrubland Association occur throughout the park and were sampled within the Conejo Well and Porcupine Wash 7.5 minute topographic quadrangles.

ENVIRONMENTAL DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of *Acacia greggii - Bebbia juncea* Shrubland Association are found at mid elevations (2,100 – 2,800 ft.; 640 – 850 m) on linear, concave, and undulating slopes of drainages on rocky highlands. Soils are typically sand (includes coarse, medium, and fine sand, coarse, medium, and fine, loamy sand) formed on sialic sediment, plutonic, and noncalcareous, metamorphic, parent material. Rock content in this association consists of 0–1 percent bedrock, 0 percent boulder, 2 percent stone, 5–10 percent cobble, 10–37 percent gravel, and 30–80 percent fines cover. Litter consists of <1 percent cover. This association occasionally experiences low levels of disturbance from competition from exotics (0–<1%) and high levels of disturbance from foot traffic and trampling.

MOST ABUNDANT SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Shrub | *Acacia greggii, Bebbia juncea, Lycium andersonii, Krameria grayi* |

CHARACTERISTIC SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Herbaceous | *Chamaesyce* sp., *Perityle emoryi, Plantago ovata* |
| Shrub | *Acacia greggii, Bebbia juncea, Ambrosia dumosa, Phoradendron californicum* |

VEGETATION DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Acacia greggii - Bebbia juncea* Shrubland Association form a sparse to open shrubland with 0-<1 percent cover at <1 cm tall, <1-1 percent cover at 1-25 cm tall, <1-3 percent cover at 25-50 cm tall, 1-5 percent cover at 50 cm to 1 m tall, 1-4 percent cover at 1-3m tall, and <1 percent cover at 3-5 m tall. Total vegetative cover ranges from 2-21 percent.

This association is dominated by the shrub species *Acacia greggii, Bebbia juncea, Lycium andersonii,* and *Krameria grayi.* Characteristic shrub species include *Ambrosia dumosa* and *Phoradendron californicum.* Characteristic herb species include *Chamaesyce* sp., *Perityle emoryi,* and *Plantago ovata*. A variety of other species have a high constancy (66%) and are often present in this association including *Allionia incarnata, Cryptantha* sp., *Hymenoclea salsola, Hyptis emoryi, Mirabilis bigelovii, Pectis papposa, Salvia columbariae, Viguiera parishii, Larrea tridentata, Simmondsia chinensis, Camissonia* sp., cryptobiotic crust, *Ephedra nevadensis, Lotus* sp., *Marina parryi, Oenothera deltoides, Phacelia* sp., *Salazaria mexicana, Senna armata, Stephanomeria* sp., and *Sphaeralcea ambigua.* The exotic species *Schismus* sp. is also frequently present.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G4 S4

RANK JUSTIFICATION
This association is likely to be common in the western Sonoran Desert and lower-elevation parts of the southern Mojave Desert.

DATABASE CODE

COMMENTS
Globally

JOTR

Plots used for this description: JOTR: 32-17-2, 40A-07-3, 40A-07-5

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*Acacia greggii - Hyptis emoryi* Shrubland Association (Mapping Code: 36015)

| | |
|---|---|
| COMMON NAME | Catclaw - Desert-Lavender Shrubland Association |
| SYNONYM | None |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Deciduous Shrubland (Scrub) |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Deciduous Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Extremely Xeromorphic Deciduous Subdesert Shrubland Without Succulents |
| ALLIANCE | *Acacia greggii* Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Palustrine |

RANGE
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory. This type or one very similar to it has been reported from Anza-Borrego Desert State Park (Keeler-Wolf *et al.* 1998).

JOTR
Stands of the *Acacia greggii - Hyptis emoryi* Shrubland Association occur throughout the park and were sampled within the Porcupine Wash, Coxcomb Mountains, and Rockhouse Canyon 7.5 minute topographic quadrangles.

ENVIRONMENTAL DESCRIPTION
Globally
This association is only known in detail from Joshua Tree National Park. Stands at Anza-Borrego Desert State Park (Keeler-Wolf *et al*. 1998) share many of the same characteristics as the locally described stands.

JOTR
Stands of the *Acacia greggii - Hyptis emoryi* Shrubland Association are found at low to mid elevations (1,200–2,600 ft.; 360–800 m) within linear and hummocky drainages of arroyos and washes. Soils are usually sand (includes coarse, medium, and fine sand, and coarse, medium, and fine, loamy sand) formed on sialic sediment, plutonic, and noncalcareous, metamorphic, parent material. Rock content in this association consists of 0–6 percent bedrock, 0–12 percent boulder, 2–8 percent stone, 10–18 percent cobble, 14–28 percent gravel, and 40–50 percent fines cover. Litter consists of 2–4 percent cover. This association sometimes experiences moderate levels of disturbance from foot traffic and trampling and low levels of disturbance from exotic species.

MOST ABUNDANT SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Shrub *Acacia greggii, Hyptis emoryi, Hymenoclea salsola*

CHARACTERISTIC SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Shrub *Acacia greggii, Hyptis emoryi, Hymenoclea salsola, Bebbia juncea, Encelia farinosa*

VEGETATION DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Acacia greggii - Hyptis emoryi* Shrubland Association form a sparse shrubland with 0-<1 percent cover at <1 cm tall, <1 percent cover at 1–25 cm tall, <1 percent cover at 25–50 cm tall, <1–4 percent cover at 50 cm to 1 m tall, and 3–5 percent cover at 1–3 m tall. Total vegetative cover ranges from 7–9 percent.

This association is dominated by shrub species *Hyptis emoryi, Acacia greggii,* and *Hymenoclea salsola.* Characteristic shrub species include *Bebbia juncea* and *Encelia farinosa.* Frequently occurring shrubs and herbs include *Ambrosia dumosa, Ephedra nevadensis, Phoradendron californicum, Larrea tridentata, Viguiera parishii, Adenophyllum porophylloides, Eriogonum inflatum, Allionia incarnata, Aristida sp., Brandegea bigelovii, Chamaesyce* sp., and *Mirabilis bigelovii.* Cryptobiotic crust is also frequently found in this association.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G4 S3

RANK JUSTIFICATION
This association is likely to be locally distributed in the lower-elevation washes of the southern Mojave and western Sonoran Deserts.

DATABASE CODE

COMMENTS
Globally

JOTR

Plots used for this description: JOTR: 17-05-1, 33-16-3, 63-18-2; MDEI: 63-2-1

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**Burro Bush *(Ambrosia dumosa)* Dwarf Shrubland Alliance (Mapping Code: 43013)**

The *Ambrosia dumosa* Dwarf Shrubland Alliance occurs in the Mojave Desert, Sonoran Desert, Colorado Desert, and southeastern Great Basin regions of California.

The *Ambrosia dumosa* Dwarf Shrubland Alliance is often considered part of creosote bush scrub. In this alliance, *Ambrosia dumosa* dominates or shares dominance with other low shrubs. Shrub density varies, as does diversity. Further sampling throughout much of the California desert over

the past several years has refined the description. It is now considered partly disturbance related, ecologically close to *Larrea tridentata-Ambrosia dumosa, Larrea tridentata-Encelia farinosa, Encelia farinosa,* and *Atriplex hymenelytra* shrubland alliances and extending from low elevations to over 5,400 feet (1,600 meters), where it is related to *Atriplex confertifolia* Shrubland and *Juniperus osteosperma* Wooded Shrubland Alliances. Species diversity is highly variable ranging from three to 20 perennial species. The Brittlebush-White Bursage (=Burro Bush) series of Sawyer and Keeler-Wolf (1995) has been subsumed partially by this alliance, which now includes all stands where *Ambrosia dumosa* dominates or shares dominance with *Encelia farinosa* (>/=50 percent relative cover).

*Ambrosia dumosa* is a short-lived shrub, living generally < 50 years, although it does have limited cloning abilities (Wright and Howe 1989). It has relatively shallow and restricted roots. It colonizes sites that have had vegetation removed mechanically more quickly than does *Larrea tridentata* (Vasek 1980). *Ambrosia dumosa*, with its high recruitment and mortality rates, dominates in the colonizing stage in many locally disturbed *Larrea tridentata-Ambrosia* stands in the Mojave and Sonoran Desert. *Ambrosia dumosa* is poorly adapted to fire because of its limited sprouting ability (FEIS 2001). Despite its adaptation to early seral transition states, *Ambrosia dumosa* stands often seem to be more defined by substrate than by a higher disturbance frequency, more than the modal *Larrea tridentata-Ambrosia dumosa* Shrubland Alliance. As a dominant indicator, *Ambrosia dumosa* occurs on sandy substrates (dune aprons, shallow blowsand, wash terraces), rocky hills (of calcareous, igneous, or sedimentary rock), or alluvial fans, particularly older ones with a developed caliche or clay layer. It tends to replace *Larrea tridentata* on soils with high clay content. *Ambrosia dumosa* is a species tolerant of harsh substrates (limestone) and also of local site disturbance (excellent recolonizing abilities from seed in adjacent seed sources). It is also removed from areas subjected to long-term, moderate-to-intense grazing, where the palatable foliage is selected over less palatable and more browse resistant *Larrea tridentata* and other large species.

Sensitivity to fire carried by nonnative, annual grasses and to overgrazing makes the absence of *Ambrosia dumosa* a good indicator of these types of unnatural disturbances. Fire and long-term, intensive grazing should be excluded from *Ambrosia dumosa* stands. Typical small-scale disturbance patterns that initiate small stands of *Ambrosia dumosa* (blading, excavation, spot fires) are not a normal part of the processes in the hot deserts of California. Natural stands of *Ambrosia dumosa* Dwarf-Shrubland Alliance are more related to particular substrate preferences.

This alliance is represented in JOTR by one association, defined first in this project, the Burro Bush - Big Galleta *(Ambrosia dumosa - Pleuraphis rigida)* Dwarf Shrubland Association.

In addition to the association described below, several unclassified, alliance-level samples were taken that suggest further variation. These include

*Ambrosia dumosa* (MDEI: 162-1-6, 162-1-8)
*Ambrosia dumosa - Senna armata/cryptobiotic crust* (JOTR: 56-22-1, 57-18-4)
*Ambrosia dumosa – Ephedra nevadense* (MDEI: 57-15-4)

*Ambrosia dumosa - Pleuraphis rigida* Dwarf Shrubland Association (Mapping Code: 43014)

| | |
|---|---|
| COMMON NAME | Burro Bush - Big Galleta Dwarf Shrubland Association |
| SYNONYM | *Ambrosia dumosa* - Mixed Shrub Association (Leary 1977) |
| PHYSIOGNOMIC CLASS | Dwarf Shrubland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Dwarf-Shrubland |
| PHYSIOGNOMIC GROUP | Needle-Leaved or Microphyllous Evergreen Dwarf-Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Caespitose Needle-Leaved or Microphyllous Evergreen Dwarf-Shrubland |
| ALLIANCE | *Ambrosia dumosa* Dwarf Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Upland |

RANGE
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Ambrosia dumosa - Pleuraphis rigida* Dwarf Shrubland Association are generally in the eastern portion of the park and were sampled within the Malapai Hill and Fried Liver Wash 7.5 minute topographic quadrangles.

ENVIRONMENTAL DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of *Ambrosia dumosa - Pleuraphis rigida* Dwarf Shrubland Association are found at mid elevations (3,000–3,400 ft.; 900–1,000 m) on convex and undulating, gentle to somewhat steep slopes (6-20 degrees). Aspect tends to be north facing and occasionally southwest facing. Sites are found on rocky highlands, erosional highlands, and the upper third of slopes. Soils are usually loam (ranging from moderately coarse, sandy loam to moderately fine, silty, clay loam) and derived from sialic sediment, plutonic, noncalcareous, metamorphic, gneissose, and granitic, parent material. Rock content in this association consists of 3–15 percent bedrock, 3–25 percent boulder, 5–25 percent stone, 23–35 percent cobble, 25–>75 percent gravel, and 5–25 percent fines cover. Litter consists of <1–10 percent cover. This association experiences low to high levels of disturbance from competition from exotics (<1–15%).

MOST ABUNDANT SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Herbaceous | *Pleuraphis rigida, Bromus madritensis* |
| Shrub | *Ambrosia dumosa, Simmondsia chinensis, Lycium andersonii, Viguiera parishii* |

CHARACTERISTIC SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Herbaceous | *Pleuraphis rigida, Eriogonum inflatum* |
| Shrub | *Ambrosia dumosa, Simmondsia chinensis, Lycium andersonii, Viguiera parishii, Krameria grayi* |

VEGETATION DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Ambrosia dumosa - Pleuraphis rigida* Dwarf Shrubland Association form a sparse to open shrubland with 1–<1 percent cover at <1 cm tall, <1–5 percent cover at 1–25 cm tall, 5–13 percent cover at 25–50 cm tall, 1–13 percent cover at 50 cm to 1 m tall, and 0–5 percent cover at 1–3 m tall. Total vegetative cover ranges from 9-18 percent.

This association is dominated by the shrub species *Ambrosia dumosa, Simmondsia chinensis, Lycium andersonii,* and *Viguiera parishii. Pleuraphis rigida* and the exotic species *Bromus madritensis* dominate the herb layer. *Krameria grayi* is characteristically present in the shrub layer. *Eriogonum inflatum* is characteristic in the herb layer. *Eriogonum fasciculatum, Opuntia echinocarpa, Salazaria mexicana, Mirabilis bigelovii, Sphaeralcea ambigua,* and *Xylorhiza tortifolia* are frequently found in this association. The exotic species *Erodium cicutarium* is also frequently present.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G4 S4

RANK JUSTIFICATION
This association is likely to be widespread in the southern Mojave and northwestern Sonoran Deserts.

DATABASE CODE

COMMENTS
Globally

JOTR

Plots used for this description JOTR: 22-26-4, 23-20-3; MDEI: 154-3-6; LONG: VMAL97-43

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**Big Galleta *(Pleuraphis rigida)* Grassland Alliance (Mapping Code: 59010)**

The *Pleuraphis rigida* Grassland Alliance occurs in the Mojave Desert, Sonoran Desert, Colorado Desert, and Southern California mountain and valley regions of California and in south Nevada, Arizona, and Mexico.

Many regional descriptions include this alliance in creosote bush scrub. Stands of this alliance often form fine-grain mosaics with stands *of Larrea tridentata, Lepidospartum tridentata - Ambrosia dumosa*, or *Yucca brevifolia* or *Yucca schidigera,* as *Pleuraphis rigida* may be a common ground layer species in shrub- or tree-dominated stands. Scattered trees and shrubs are typically emergent over a more continuous ground layer of *Pleuraphis rigida* in most stands. If *Pleuraphis rigida* is present without an emergent overstory of shrubs or trees, it technically becomes a different alliance by NVCS standards. However, virtually all California stands have at least 1 percent shrubs or trees emergent.

*Pleuraphis rigida* is a relatively rare alliance in the California deserts. It is considered a warm rain season species and does not occur in the western Mojave, where cold season rain predominates (G. Harris, personal communication). Its range has probably decreased in areas with prolonged, heavy grazing. It is bimodal in its distribution, either occurring in open stands around margins of dunes or other sandy areas at low elevations or in more closed, mid-elevation, upland sites on slopes and bajadas. In dune areas, it gives way to very open stands of *Panicum urvilleanum* on the deepest sand deposits and is often interspersed with small stands of the *Abronia villosa* alliance. Further separation of the sandy stands without shrubs into a medium tall bunch grassland may be warranted. In ecological literature, *Pleuraphis rigida* is referred to as *Hilaria rigida.*

*Pleuraphis rigida* is an unusual, shrubby looking grass with exposed renewal buds raised above the ground. It tolerates drought better than any other species in the genus (FEIS 2001). Its clumped growth form is a result of the tillers and short rhizomes it produces. Although fire effects are not well known compared to other species in its genus, it is likely to be relatively

sensitive to fire, particularly in its dried state (FEIS 2001). Although evidence is scant, conventional wisdom suggests *Pleuraphis rigida* stands have declined in areas with long-term, moderate to heavy grazing pressure (Desert Workshop, personal communication). In the lower Colorado River Valley of the Sonoran Desert and in some Mojave Desert communities, *Pleuraphis rigida* serves as the main stabilizer over wide areas of sand dunes. Stands in dune areas are relatively open and less likely to carry fire than even the open stands on rocky substrates. Thus, shifting sand and wind deflation are the primary agents of disturbance.

Some of the upland stands have clearly been affected by recent fire and seem to have maintained or extended themselves (Keeler-Wolf, personal observation), although they may be invaded by other shrubby, disturbance-related species.

Altered fire frequencies and increased livestock grazing have likely affected the nonsandy stands of *Pleuraphis rigida* throughout its range. It is particularly susceptible to these impacts when the grass is dry (which is most of the time). Further studies should be conducted to monitor change in the particularly sensitive upper-elevation, nonsandy stands. Stands on shallow, sandy soil are frequently invaded by the aggressive, nonnative, annual *Brassica tournefortii*. Intensive livestock grazing has probably negatively affected both sandy and nonsandy stands.

This alliance is represented in JOTR by one association, first described for this project, the Big Galleta - Four-wing *(Pleuraphis rigida - Atriplex canescens)* Grassland Association.

In addition to the association described below, several unclassified, alliance-level samples were taken that suggest further variation. These include

*Pleuraphis rigida - Lycium cooperi* (JOTR: 16-23-1, 10B-01-3)
*Pleuraphis rigida - Ephedra nevadensis* (JOTR: 22-18-1)

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*Pleuraphis rigida - Atriplex canescens* Grassland Association (Mapping Code: 59010)

| | |
|---|---|
| COMMON NAME | Big Galleta - Four-wing Saltbush Grassland Association |
| SYNONYM | *Hilaria rigida – Oryzopsis hymenoides* association (Leary 1977) |
| PHYSIOGNOMIC CLASS | Herbaceous |
| PHYSIOGNOMIC SUBCLASS | Perennial Graminoid |
| PHYSIOGNOMIC GROUP | Temperate or Subpolar Grassland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Medium-Tall Bunch Temperate or Subpolar Grassland |
| ALLIANCE | *Pleuraphis rigida* Grassland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Upland |

RANGE
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Pleuraphis rigida - Atriplex canescens* Grassland Association were sampled in the park within the Malapai Hill 7.5 minute topographic quadrangle.

ENVIRONMENTAL DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Pleuraphis rigida - Atriplex canescens* Grassland Association are found at mid elevations (3,200–3,300 ft.; 970–1,000 m) on gentle (1 degree) slopes facing north, northeast, and east. This association is found on playas. Soil texture ranges from coarse, loamy sand to very fine, sandy loam derived from sandy alluvium and granitic, parent material. Rock content in this association consists of 0 percent bedrock, 0 percent boulder, 0 percent stone, 1–5 percent cobble, 1–>75 percent gravel, and 0–>75 percent fines cover. Litter consists of <1–30 percent cover. This association experiences high levels of disturbance from competition from exotics (4–28%).

MOST ABUNDANT SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Herbaceous | *Pleuraphis rigida, Bromus madritensis, Erodium cicutarium, Schismus barbatus* |
| Shrub | *Atriplex canescens* |

CHARACTERISTIC SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Herbaceous | *Pleuraphis rigida* |
| Shrub | *Atriplex canescens* |

VEGETATION DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Pleuraphis rigida - Atriplex canescens* Grassland Association form a sparse to intermittent, two-story grassland with 3–34 percent cover at the ground layer and 3-21 percent cover at the shrub layer. Total vegetative cover ranges from 6–35 percent.

This association is dominated by the shrub species *Atriplex canescens* and herb species *Pleuraphis rigida.* The exotic species *Bromus madritensis, Schismus barbatus,* and *Erodium cicutarium* are usually abundant. Typically, the grass is substantially more abundant than the saltbush, thus suggesting the alliance is *Pleuraphis rigida* and not *A. canescens*.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G3 S3

RANK JUSTIFICATION
This association is not known outside the park.

DATABASE CODE

COMMENTS
Globally

JOTR

Plots used for this description: MDEI: 151-1-1, 151-1-6; LONG: VMAL97-1[1]

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**Common Mediterranean Grass *(Schismus barbatus)* Unique Stands**

The nonnative grass, *Schismus barbatus,* forms several stands in the park. These are sparsely vegetated, on level ground, and are adjacent to low-salinity playas. Two plots were sampled but do not provide enough information to define an alliance or association. These plots are temporarily placed here until further information is available on their relationship to other alliances and associations.

*Schismus barbatus* Undifferentiated (MDEI: 151-1-3, 151-98-1)

## Sonoran Desert Wash Woodland and Scrub

### Desert Willow (*Chilopsis linearis)* Shrubland Alliance (Mapping Code: 15012)

The *Chilopsis linearis* alliance occurs strictly in washes and arroyos in the southern Mojave, Colorado, and sporadically in the Sonoran Deserts of California. Although the alliance is widely distributed, stands are local and do not occur in many of the washes that would seem suitable. Note that this alliance description is also found in the Mojavean upper bajada scrub section, since this alliance also occurs in that ecological/geographical setting.

This alliance is represented in JOTR by one association, defined first in this project. In addition to this association, a single, unclassified, alliance-level sample has been taken, suggesting further variation.

*Chilopsis linearis - Prosopis glandulosa* (JOTR: 32-06-1)

*Chilopsis linearis* Shrubland Association

| | |
|---|---|
| COMMON NAME | Desert - Willow Association |
| SYNONYM | None |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Deciduous Shrubland |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Deciduous Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Intermittently Flooded Extremely Xeromorphic Deciduous Subdesert Shrubland |
| ALLIANCE | *Chilopsis linearis* Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Upland and Palustrine |

RANGE

Globally

This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory. It is likely that, as currently treated, this association is widespread and occurs in the southern Mojave and adjacent, northwestern Sonoran Desert. Similar stands have been inventoried in Anza-Borrego Desert State Park (Keeler-Wolf *et al.* 1998).

JOTR
Stands of the *Chilopsis linearis* Shrubland Association occur primarily in the central and eastern parts of the park and were sampled within the Cottonwood Springs, Pinto Wells, Joshua Tree South, Indian Cove, Pinto Mountain, and Malapai Hill 7.5 minute topographic quadrangles.

ENVIRONMENTAL DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of *Chilopsis linearis* Shrubland Association are found at low to mid elevations (1,000–3,700 ft.; 300–1,100 m) within drainages and on gentle (1-6 degree) slopes. This association is found primarily on linear and sometimes convex wash surfaces. Soil textures range from coarse sand to moderately fine, silty, clay loam from granitic, parent material. Rock cover consists of 0 percent bedrock cover, 0 percent boulder cover, 0–4 percent stone cover, 0–20 percent cobble cover, 1–55 percent gravel cover, and 42–86 percent fines cover. Litter cover ranges from 1–10 percent. These sites generally experience low to high levels of disturbance from exotic species (0–10 percent cover), moderate levels of disturbance from vandalism and dumping, and high levels of disturbance from foot traffic/trampling.

MOST ABUNDANT SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Shrub *Hymenoclea salsola, Chilopsis linearis*

CHARACTERISTIC SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Shrub *Hymenoclea salsola, Chilopsis linearis*

VEGETATION DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Chilopsis linearis* Shrubland Association form a sparse to open shrubland with 0-<1 percent cover at <1 cm tall, 0–2 percent cover at 1–25 cm tall, 0–1 percent cover at 25–50 cm tall, 0–3 percent cover at 50 cm to 1 m tall, 1–6 percent cover at 1–3 m tall, 2–15 percent cover at 3–5 m tall, and 1 percent cover at 5-10 m tall. Total vegetative cover ranges from 8–30 percent. Exotic species tend to be low but can occasionally be as high as 10 percent (0–10%).

This association is dominated by *Chilopsis linearis* and the less abundant *Hymenoclea salsola* in the tree and shrub layer. *Prunus fasciculata* and *Acacia greggii* are common within a few stands. A variety of species are present in this association; however, *Amaranthus* sp. is frequently present.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G4 S3

RANK JUSTIFICATION
This association is likely to occur outside California in southwestern Nevada, western Arizona, and perhaps northern Mexico (Baja, California).

DATABASE CODE

COMMENTS
Globally

JOTR

Plots used for this description: JOTR: 10B-01-5, 14-27-3, 32-26-4, 32-06-4, 56-06-6, 33-07-4; LONG: VMAL97-19

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**Blue Palo Verde (*Cercidium floridum = Parkinsonia floridum*) Woodland Alliance (Mapping Code: 16013)**

The *Cercidium floridum* Woodland Alliance occurs in scattered locations in the Sonoran and Colorado Deserts. In California, the *Cercidium floridum* Woodland Alliance is indicative of wash environments with a relatively high flood intensity and relatively high water availability. Blue Palo Verde is a facultative desert riparian species that may be restricted to washes or arroyos in parts of its range but also occurs in upland communities (in Arizona). In the more arid Colorado Desert, stands are generally restricted to the margins of washes and braided, unstable channels on bajadas but may occur on terraces if the water table is not deep. These woodlands usually occur as two strips of vegetation along the banks of a broad, sandy wash bed.

Abiotic and biotic agents aid in seed dispersal. The flat seeds of *Cercidium floridum* prevent air loft and allow downward dispersal into washes. Fruits and seeds do not float. Occasionally, Blue Palo Verde fruits disperse unopened. Some seed dispersal occurs via animals. Birds probably move seed upstream. Large seed banks of Blue Palo Verde may be present. Scarification from flash floods or other abrasive processes facilitates germination. *Cercidium floridum* germinates well on sandy deposits (FEIS 2001). Shade and litter beneath mature Blue Palo Verde alters seed microsites and make germination more likely (FEIS 2001). Rapid, deep root development is important for Blue Palo Verde establishment. Mature Blue Palo Verde has deep root systems that reach groundwater and make *Cercidium floridum* less vulnerable to drought.

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*Cercidium floridum* is a relatively slow growing and long-lived species. Natural recovery following disturbance is slow. Optimal conditions for reestablishment occur infrequently. It may take up to 60 years for these woodlands to reach predisturbance levels of biomass and 180 years to reach predisturbance levels of species diversity (FEIS 2001). In southeastern California, Blue Palo Verde is a nurse plant for saguaro *(Carnegiea gigantea)* (FEIS 2001). Saguaro eventually outlive or contribute to the death of paloverde species. Blue Palo Verde is susceptible to fire; its photosynthetic stems are probably easily killed by fire. It may sprout from the root crown if its postfire response is similar to its response to clipping.

Blue Palo Verde has successfully established by artificial seeding following highway construction (FEIS 2001). Blue Palo Verde naturally established following removal of invasive populations of saltcedar (*Tamarix ramosissima*). Seed predation by invertebrates, such as bruchid beetles, can lead to seed mortality of Blue Palo Verde.

Blue Palo Verde has decreased in some areas of Arizona, partly due to the erosion of broad, flat washes into narrow, steep-sided channels (FEIS 2001). In the microphyll woodlands of the desert washes, disturbance by off-road vehicles decreases density and biomass of perennial plants such as Blue Palo Verde. Young Blue Palo Verde can tolerate moderate grazing. In greenhouse tests, Blue Palo Verde sprouted following top removal. At a transplant site near Travertine Point, California, severely gnawed Blue Palo Verde transplants survived only when irrigated (FEIS 2001).

This alliance is represented in JOTR by two associations, defined first in this project, Blue Palo Verde/Desert-Lavender *(Cercidium floridum/Hyptis emoryi)* Association and the Blue Palo Verde/Desert-Willow *(Cercidium floridum/Chilopsis linearis)* Association. In addition, two unclassified, alliance-level samples were taken suggesting further variation.

*Cercidium floridum/Tetracoccus hallii* (JOTR: 32-08-6)
*Cercidium floridum/Larrea tridentata* (JOTR: 59-05-3)

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*Cercidium floridum/Hyptis emoryi* Association (Mapping Code: 16015)

COMMON NAME Blue Palo Verde/Desert-Lavender Association

| | |
|---|---|
| SYNONYM | *Larrea tridentata - Ambrosia dumosa* association (Leary 1977) |
| PHYSIOGNOMIC CLASS | Woodland |
| PHYSIOGNOMIC SUBCLASS | Deciduous Woodland |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Deciduous Woodland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Extremely Xeromorphic Deciduous Woodland |
| ALLIANCE | *Cercidium floridum (Parkinsonia florida)* Woodland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Upland and Palustrine |

RANGE
Globally
This association is only known from Joshua Tree National Park; however, similar stands have been sampled in Anza-Borrego Desert State Park (Keeler-Wolf *et al.* 1998). Information about its global characteristics is not available without additional inventory and analysis.

JOTR
Stands of the *Cercidium floridum/Hyptis emoryi* Association occur primarily along the southern edge and eastern portions of the park and were sampled within the Cottonwood Basin, Buzzard Springs, Victory Pass, Hayfield, and Pinto Wells 7.5 minute topographic quadrangles.

ENVIRONMENTAL DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Cercidium floridum/Hyptis emoryi* Association are found at low to mid elevations (1,400–2,400 ft.; 420–730 m). This association is usually found in drainages and rarely on <1–6 degree slopes. Macrotopography varies, but these stands are often found in washes and occasionally in fluvial floodplains and channels; arroyos; and upland, alluvial deposits. This association is typically located on a sandy substrate (includes coarse, medium, and fine sand and coarse, medium, and fine, loamy sand) derived from granitic, parent material. Rock cover consists of 0 percent bedrock cover, 0–5 percent boulder cover, 0–25 percent stone cover, 1–30 percent cobble cover, 7–33 percent gravel cover, and 10–51 percent fines cover. Litter cover ranges from 1–7 percent. Disturbance levels from exotic species are low to moderate. Disturbance levels from vandalism/dumping/litter are low.

MOST ABUNDANT SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Shrub | *Hyptis emoryi, Hymenoclea salsola* |
| Tree | *Cercidium floridum* |

CHARACTERISTIC SPECIES

Globally

This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Herbaceous | *Chamaesyce* sp. |
| Shrub | *Hyptis emoryi, Hymenoclea salsola, Acacia greggii, Bebbia juncea, Encelia farinosa* |
| Tree | *Cercidium floridum* |

VEGETATION DESCRIPTION

Globally

This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

Stands of the *Cercidium floridum/Hyptis emoryi* Association form an open shrubland with <1 percent cover at <1 cm tall, <1 percent cover at 1–25 cm tall, <1–3 percent cover at 25–50 cm tall, <1– percent cover at 50 cm to 1 m tall, 2–7 percent cover at 1–3 m tall, and 1-10 percent cover at 3–5 m tall. Total vegetative cover ranges from 8–16 percent. Exotic species contribute to 0–<1 percent cover.

This association is dominated by *Cercidium floridum* in the tree layer and *Hyptis emoryi* and *Hymenoclea salsola* in the shrub layer. Characteristic shrub and herb species are *Acacia greggii, Bebbia juncea, Encelia farinosa* and *Chamaesyce* sp. Cryptobiotic crust is an important characteristic understory component in this association. The exotic species *Schismus* sp. is consistently present. *Opuntia echinocarpa, Ambrosia dumosa, Opuntia basilaris, Opuntia ramosissima, Allionia incarnata, Larrea tridentata, Brandegea bigelovii,* and *Psorothamnus schottii* often occur in these stands.

OTHER NOTEWORTHY SPECIES

*Coryphantha alversonii* was found in one of ten plots. *Coryphantha alversonii* is a List 4 plant in the CNPS Inventory of Rare and Endangered Plants of California (CNPS 2001). It is found in Imperial, Riverside, and San Bernardino Counties at low to high elevations (240–5,000 ft.; 73–1,500 m). (Syn: *Escobaria vivipara var. alversonii* in the Jepson Manual.)

CONSERVATION RANK G4 S3

RANK JUSTIFICATION
This type is relatively rare in California but may be more common in the Sonoran Desert outside the state in Arizona and Baja California.

DATABASE CODE

COMMENTS
Globally

JOTR

Plots used for this description: JOTR: 24-06-2, 24-06-5, 25-04-2, 25-04-4, 39-02-1, 51-08-1, 53-08-1, 53-08-4, 53-08-5, 53-08-8, 59-05-2

---

*Cercidium floridum/Chilopsis linearis* Association

| | |
|---|---|
| COMMON NAME | Blue Palo Verde/Desert-Willow Association |
| SYNONYM | *Larrea tridentata-Ambrosia dumosa* association Leary (1977) |
| PHYSIOGNOMIC CLASS | Woodland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Woodland |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Deciduous Woodland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Extremely Xeromorphic Deciduous Woodland |
| ALLIANCE | *Cercidium floridum* Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Upland and Palustrine |

RANGE
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Cercidium floridum/Chilopsis linearis* Association were sampled in the park within the Pinto Wells and Cottonwood Springs 7.5 minute topographic quadrangles.

ENVIRONMENTAL DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Cercidium floridum/Chilopsis linearis* Association are found at low to mid elevations (1,000–2,700 ft.; 300–820 m) on gentle to moderate (1–6 degree), undulating and linear topography in washes. Soil textures range from coarse sand to moderately coarse, sandy, loam formed on sialic sediments, plutonic, noncalcareous, metamorphic, and granitic, parent material. Rock cover consists of 0 percent bedrock, 0 percent boulder, 0 percent stone, 0–<1 percent cobble, 0–77 percent gravel, and 0–85 percent fines. These sites generally experience no or low levels of disturbance from exotic species (0–<1 percent cover) and low levels of disturbance from foot traffic/trampling.

MOST ABUNDANT SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Shrub | *Hymenoclea salsola, Chilopsis linearis* |
| Tree | *Cercidium floridum* |

CHARACTERISTIC SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Shrub | *Hymenoclea salsola, Chilopsis linearis, Phoradendron californicum* |
| Tree | *Cercidium floridum* |

VEGETATION DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Cercidium floridum/Chilopsis linearis* Association form an open woodland with 0 percent cover at <1 cm tall, <1 percent cover at 1–25 cm tall, <1 percent cover at 25–50 cm tall, <1-2 percent cover at 50 cm to 1 m tall, 1 percent cover at 1–3 m tall, 5–6 percent cover at 3-–5 m tall, and 3–16 percent cover at 5–10 m tall. Total vegetative cover ranges from 12–27 percent. Exotic species contribute to minor cover in this association (0–<1%).

This association is dominated by *Cercidium floridum* in the tree layer. *Hymenoclea salsola* and *Chilopsis linearis* are the most abundant in the shrub layer. *Phoradendron californicum* is a characteristic shrub species. *Ambrosia dumosa* and *Acacia greggii* are frequently present, contributing minor cover.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G3 S3

RANK JUSTIFICATION
This association is not currently known outside JOTR.

DATABASE CODE

COMMENTS
Globally

JOTR

Plots used for this description: JOTR: 32-06-3, 56-06-7; LONG: VPWELL97-1-1

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**Ironwood *(Olneya tesota)* Woodland Alliance**

The *Olneya tesota* Woodland Alliance occurs in the Sonoran and Colorado Deserts of California. Compared to the *Cercidium floridum* alliance, this alliance is less restricted to washes and less tied to regular disturbance and regularly available moisture. However, in the driest parts of the Colorado and Sonoran deserts, this alliance is restricted to washes. Only in the central portions of the California Sonoran Desert is this alliance common away from major wash channels. These upland stands are typically open with less than 15 percent cover of *Olneya tesota.* They are thus better considered as sparsely wooded shrublands in the NVCS.

In California, the *Olneya tesota* alliance is indicative of both wash environments and upland environments. According to Young & Young (1986) and Shreeve & Wiggins (1964), seeds of *Olneya tesota* require no pretreatment but wetting and minor scarification for germination, suggesting that minor sheet flooding is sufficient for transport and germination. The distribution of *Olneya tesota* is strongly tied to minimum temperatures because the species is frost sensitive (Shreeve and Wiggins 1964). *Olneya tesota* is also drought sensitive, particularly in the upland portions of its range. Most large individuals show characteristic limb drop during drought, and most older trees have several dead stems and limbs. The leaves are evergreen (or very rarely drought or frost deciduous) and will remain on the tree until an osmotic threshold is reached or until a few weeks following a frost (Shreeve and Wiggins 1964). Prolonged saturation of the soil will also kill trees (Shreeve and Wiggins 1964), although this is more likely to happen in Sonora, Mexico, than in California. It is most abundant in areas of the Sonoran Desert with < 200 mm of annual rainfall. Thus, there are clear, physiological limits bounding the ecological distribution of the character species for this alliance.

The trees are generally slow growing and long lived, although actual ages are difficult to determine because rings are only laid down in favorable years.

*Olneya tesota* is highly valued for its wood, which has been used for charcoal and wood carvings. The latter fact has led to severely diminished stands in Sonora, Mexico. In California, threats come from OHV activity in washes. Fire does not seem to be an issue.

This alliance is represented in JOTR by one association defined first in this project, the Ironwood/Desert-Lavender (*Olneya tesota/Hyptis emoryi)* Association.

In addition, one mapping unit dominated by *Olneya tesota* was distinguishable, although this vegetation type was not sampled or described.

*Olneya tesota/(Larrea tridentata – Encelia farinosa)* Fan Type (Mapping Code: 16024)

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*Olneya tesota/Hyptis emoryi* Association (Mapping Code: 16025)

| | |
|---|---|
| COMMON NAME | Ironwood/Desert-Lavender Woodland Association |
| SYNONYM | None |
| PHYSIOGNOMIC CLASS | Woodland |
| PHYSIOGNOMIC SUBCLASS | Deciduous Woodland |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Deciduous Woodland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Sclerophyllous Extremely Xeromorphic Evergreen Woodland |
| ALLIANCE | *Olneya tesota* Woodland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Upland and Palustrine |

RANGE
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory. It is likely to be common in the northern and eastern Colorado Desert of California but has not been studied in great detail yet.

JOTR
Stands of the *Olneya tesota/Hyptis emoryi* Association occur along the southern edge of the park and were sampled within the Cottonwood Springs, Victory Pass, and east of Victory Pass 7.5 minute topographic quadrangles.

ENVIRONMENTAL DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Olneya tesota/Hyptis emoryi* Association are found at low to mid elevations (700–2,000 ft.; 200–600 m) on linear and undulating sites within drainages and on gentle to moderate (1-6 degree) slopes of upland, alluvial deposits and washes. Soils are usually sands (includes coarse, medium, and fine sand, and coarse, medium, and fine, loamy sand) formed from sialic sediments, plutonic, and noncalcareous, metamorphic, parent material. Rock cover consists of 0 percent bedrock, 0 percent boulder, <1–3 percent stone, <1–13 percent cobble, 25–35 percent gravel, and 35–50 percent fines. Litter ranges from 2–5 percent cover. These sites generally experience low to high levels of disturbance from exotic species (0–25) and moderate levels of disturbance from vandalism/dumping/litter.

MOST ABUNDANT SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Shrub | *Hyptis emoryi, Larrea tridentata* |
| Tree | *Olneya tesota* |

CHARACTERISTIC SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Herbaceous | *Chamaesyce* sp. |
| Shrub | *Hyptis emoryi, Hymenoclea salsola, Encelia farinosa* |
| Tree | *Olneya tesota* |

VEGETATION DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Olneya tesota/Hyptis emoryi* Association form an open shrubland with 0–<1 percent cover at <1 cm tall, <1–2 percent cover at 1–25 cm tall, <1–1 percent cover at 25–50 cm tall, <1–1 percent cover at 50 cm to 1 m tall, <1–8 percent cover at 1–3 m tall, 4–6 percent cover at 3–5 m tall, and 0-8 percent cover at 5–10 m tall. Total vegetative cover ranges from 11–20 percent.

This association is dominated by *Olneya tesota* in the tree layer. *Hyptis emoryi* and *Larrea tridentata* are the most abundant understory shrubs. *Hymenoclea salsola* and *Encelia farinosa*

are characteristically present in the shrub layer as well. *Chamaesyce* sp. is a characteristic herb. Frequent associations in these stands include *Allionia incarnata, Ditaxis neomexicana, Opuntia ramosissima,* and *Pectis papposa.*

OTHER NOTEWORTHY SPECIES
*Ditaxis serrata* var. *californica* was found in one of three plots. *Ditaxis serrata* var. *californica* is a List 3 plant in the CNPS Inventory of Rare and Endangered Plants of California (CNPS 2001). It is found in Riverside and San Diego Counties and in the Sonoran Desert in Mexico at low to mid elevations (100–3,300 ft.; 30–1,000 m). (Syn: *Ditaxis californica* in the Jepson Manual.)

CONSERVATION RANK G4 S3

RANK JUSTIFICATION
This association is likely to occur in much of the California Sonoran (eastern Colorado) Desert and adjacent Mexico and Arizona

DATABASE CODE

COMMENTS
Globally

JOTR

Plots used for this description: JOTR: 33-02-1, 53-08-2, 62-02-1

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**Blue Palo Verde-Ironwood [*Cercidium floridum (=Parkinsonia florida)-Olneya tesota]* Extremely Xeromorphic Deciduous Woodland Alliance**

This alliance is not defined at the association level locally. The following general description will serve to distinguish the local stand(s):

| | |
|---|---|
| COMMON NAME | Blue Palo Verde-Ironwood |
| SYNONYM | None |
| PHYSIOGNOMIC CLASS | Woodland |
| PHYSIOGNOMIC SUBCLASS | Deciduous Woodland |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Deciduous Woodland |
| PHYSIOGNOMIC SUBGROUP | Natural/Semi-natural |
| FORMATION | Drought Deciduous Extremely Xeromorphic Subdesert Woodland |
| ALLIANCE | *Cercidium floridum (=Parkinsonia florida)-Olneya tesota* Woodland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Upland |

RANGE
Globally
This alliance occurs in the Sonoran Desert region of California and adjacent Arizona and Mexico.

JOTR
This alliance occurs in the southern portion of the park near the southern border at low elevations.

ENVIRONMENTAL DESCRIPTION
Globally

JOTR
The two stands in the park occur along washes flowing across alluvial fans in the southern area of the park, at approximately 1,400 and 1,600 feet in elevation.

MOST ABUNDANT SPECIES
Globally
Tree *Cercidium floridum (=Parkinsonia florida), Olneya tesota, Prosopis glandulosa, Prosopis pubescens, Psorothamnus spinosa*

JOTR
Tree *Cercidium floridum (=Parkinsonia florida), Olneya tesota*
Shrub *Larrea tridentata, Opuntia bigelovii, Hyptis emoryi*

CHARACTERISTIC SPECIES
Globally
Tree *Cercidium floridum (=Parkinsonia florida), Olneya tesota, Prosopis glandulosa, Prosopis pubescens, Psorothamnus spinosa*

JOTR
Herb *Pectis papposa, Chamaesyce polycarpa, Stephanomeria pauciflora*
Shrub *Larrea tridentata, Opuntia bigelovii, Hyptis emoryi, Hymenoclea salsola*
Tree *Cercidium floridum (=Parkinsonia florida), Olneya tesota*

VEGETATION DESCRIPTION
Globally

JOTR
Stands are characterized by a mixture of Desert Ironwood and Blue Palo Verde, both in relatively low cover as emergent tall shrubs or short trees over desert scrub.

COMMENTS
Globally
These trees form mixed or single species stands in Colorado Desert washes. The mixed species stands of Blue Palo Verde, Ironwood, or Smoke Tree are included in this alliance at this time. Some extensive eastern Colorado Desert washes are dominated by Ironwood, while other stands are dominated by Blue Palo Verde. This alliance is similar in habitat to Catclaw Acacia series, which occurs in both Mojave and Colorado Deserts. Stands are transitional in character at intermediate elevations. Stands occur in arroyo margins and along other seasonal watercourses. These stands are characterized by a mixture of the two main small tree species where they occur between 30 and 60 percent relative cover in the tree layer.

JOTR

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G4 S3

RANK JUSTIFICATION
Widespread at the alliance level, though threatened by increased off-highway vehicle use and by invasive exotic annual species

DATABASE CODE
Two samples in JOTR suggested further variation than what is currently reported from this alliance.

*Olneya tesota - Cercidium floridum/Hyptis emoryi* (JOTR 53-08-7)
*Olneya tesota - Cercidium floridum/Larrea tridentata - Opuntia bigelovii* (JOTR 38-02-1)

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**Smoketree (*Psorothamnus spinosus)* Intermittently Flooded Shrubland Alliance**

The *Psorothamnus spinosus* Intermittently Flooded Shrubland Alliance occurs in the Mojave Desert, Sonoran Desert, and Colorado Desert regions of California; in south Nevada and west Arizona; and in Baja California Norte and Sonora, Mexico. In California, it occurs strictly in washes throughout the hot deserts and is strongly tied to active wash and arroyo channels where flooding is relatively common. Sawyer and Keeler-Wolf (1995) included this alliance within the "Blue Palo Verde-Ironwood-Smoketree series." Compared to other wash alliances characterized by tall, woody shrubs or small trees, *Psorothamnus spinosus* occurs in the most active channels; prefers sandy, not bouldery or cobbly substrates; and stands are relatively short lived. It occurs farther north in the Mojave (vicinity of Baker, Cady Mountains) and ascends to higher elevations (more cold tolerant) than *Olneya* or *Cercidium* alliances. In many cases, this alliance is part of a matrix with other shrub and small tree alliances comprising a patchwork of small stands within a

wash system. Compared to the *Chilopsis linearis* alliance, it is less cold tolerant and more likely to occupy wash bottoms as opposed to margins.

*Psorothamnus spinosus* is dependent upon intermittent flooding events for stand establishment. It is a relatively short-lived species with maximum ages probably not over 50 years. Seeds have a hard seed coat that requires scarification to germinate (Turner *et al.* 1995). Even-aged stands are common, although some stands have two or three age classes represented. It is possible that seeds survive for relatively long periods in the substrate and may even out survive existing plants. Flood intensities are highly variable and range from < 2 cfs to >10,000 cfs (Waananen and Crippen 1977). Peak discharge in many of the washes at 100-year flood intervals is <500 cfs (Waananen and Crippen 1977). It is likely that 25-year peak discharges as low as 16 cfs are adequate to initiate significant stand regeneration. The largest and densest stands occur primarily on sand or small gravel within channels of a wash, suggesting that minor flooding is responsible for establishment of the denser stands in most cases. Resprouting is evident after mechanical damage.

*Psorothamnus spinosus* is a flood-related alliance that is somewhat insensitive to human-mediated changes. For example, it occurs along modified channels adjacent to highways. A relatively frequent, uninterrupted flooding regime is required. Stands may wink in and out of existence, so big wash systems are needed to represent this alliance over the long term in conservation planning. Intensive human use of washes (OHV use and gravel mining) is detrimental to stands of the alliance.

This alliance is represented in JOTR by the Smoketree - Desert-Lavender - Catclaw Association *(Psorothamnus spinosus - Hyptis emoryi - Acacia greggii)* Association and the Smoketree/Desert Tea Association *(Psorothamnus spinosus - Ephedra californica)* Association, both first described for this project.

In addition to the associations described below, several unclassified, alliance-level samples were taken that suggest further variation. These include

*Psorothamnus spinosus - Acacia greggii* (JOTR: 37B-17-1)
*Psorothamnus spinosus*/*Eriogonum fasciculatum* (JOTR: 29B-02-2)
*Psorothamnus spinosus*/*Hymenoclea salsola* (MDEI: 158-1-6)

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*Psorothamnus spinosus - Hyptis emoryi - Acacia greggii* Association (Mapping Code: 16035)

| | |
|---|---|
| COMMON NAME | Smoketree - Desert-Lavender - Catclaw Association |
| SYNONYM | *Larrea tridentata - Ambrosia dumosa* association in Leary (1977) |
| PHYSIOGNOMIC CLASS | Woodland |
| PHYSIOGNOMIC SUBCLASS | Deciduous Woodland |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Deciduous Woodland |

| | |
|---|---|
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Thorn Extremely Xeromorphic Deciduous Woodland |
| ALLIANCE | *Psorothamnus spinosus* Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Palustrine |

RANGE
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory. This type is likely to occur in the adjacent parts of the Mojave and Sonoran deserts.

JOTR
Stands of the *Psorothamnus spinosus - Hyptis emoryi - Acacia greggii* Association are found primarily in the central and eastern portions of the park and were sampled in the Cottonwood Basin, Fried Liver Wash, Coxcomb Mountains, and San Bernardino Wash 7.5 minute topographic quadrangles.

ENVIRONMENTAL DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of *Psorothamnus spinosus - Hyptis emoryi - Acacia greggii* Association are found at low to mid elevations (1,200–2,100 ft.; 360–640 m) on swales and linear sites within the drainages of washes. Soils are usually sands (ranging from coarse to fine, loamy sand) formed from sialic sediments, plutonic, and noncalcareous, metamorphic, parent material. Rock cover consists of 0 percent bedrock, 0 percent boulder, 0 percent stone, 0–25 percent cobble, 3–32 percent gravel, and 25–85 percent fines. Litter ranges from 2–5 percent cover. These sites generally experience low levels of disturbance from competition from exotics (0–<1 percent cover) and moderate levels of disturbance from vandalism/dumping/litter.

MOST ABUNDANT SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Herbaceous | *Chamaesyce* sp. |
| Shrub | *Psorothamnus spinosus, Hyptis emoryi, Acacia greggii, Hymenoclea salsola* |

CHARACTERISTIC SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Herbaceous | *Chamaesyce* sp., *Mirabilis bigelovii, Brandegea bigelovii,* |
| Shrub | *Psorothamnus spinosus, Hyptis emoryi, Acacia greggii, Hymenoclea salsola, Psorothamnus schottii, Larrea tridentata, Encelia farinosa* |

VEGETATION DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Psorothamnus spinosus - Hyptis emoryi - Acacia greggii* Association form a sparse to open shrubland with 0–<1 percent cover at <1 cm tall, <1 percent cover at 1–25 cm tall, <1 percent cover at 25–50 cm tall, <1–2 percent cover at 50 cm to 1 m tall, 2-5 percent cover at 1–3 m tall, and <1–2 percent cover at 3-5 m tall. Total vegetative cover ranges from 5–15 percent.

This association is dominated by *Psorothamnus spinosus, Hyptis emoryi,* and *Acacia greggii,* and *Hymenoclea salsola* in the shrub layer and *Chamaesyce* sp. in the understory herb layer. Characteristic shrub species are *Psorothamnus schottii, Larrea tridentata, and Encelia farinosa. Mirabilis bigelovii* and *Brandegea bigelovii* are characteristic in the herb layer.

OTHER NOTEWORTHY SPECIES
*Coryphantha alversonii* was found in two of 20 plots. *Coryphantha alversonii* is a List 4 plant in the CNPS Inventory of Rare and Endangered Plants of California (CNPS 2001). It is found in Imperial, Riverside, and San Bernardino counties at low to high elevations (240–5,000 ft.; 73–1,500 m). (Syn: *Escobaria vivipara var. alversonii* in the Jepson Manual.)

CONSERVATION RANK G4 S3

RANK JUSTIFICATION
This association is restricted to small stands along washes in the warm deserts of California and perhaps adjacent Arizona and Mexico.

DATABASE CODE

COMMENTS
Globally

JOTR

Plots used for this description: JOTR: 25-04-1, 27B-12-6, 38-28-2, 63-18-3.

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*Psorothamnus spinosus - Ephedra californica* Association (Mapping Code: 16034)

| | |
|---|---|
| COMMON NAME | Smoketree/Desert Tea Association |
| SYNONYM | *Larrea tridentata - Ambrosia dumosa* Association (Leary 1977) |
| PHYSIOGNOMIC CLASS | Woodland |
| PHYSIOGNOMIC SUBCLASS | Deciduous Woodland |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Deciduous Woodland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Thorn Extremely Xeromorphic Deciduous Woodland |
| ALLIANCE | *Psorothamnus spinosus* Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Palustrine |

RANGE
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory. Evens (2000) has reported similar stands from the eastern Mojave Desert.

JOTR
Stands of the *Psorothamnus spinosus - Ephedra californica* Association occur in the central and eastern parts of the park and were sampled within the Cadiz Valley southwest, San Bernardino Wash, and Clarks Pass 7.5 minute topographic quadrangles.

ENVIRONMENTAL DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Psorothamnus spinosus - Ephedra californica* Association are found at low to mid elevations (1,500–2,600 ft.; 450–790 m) on swales and linear slopes within the drainages of washes. Soils are usually sands (ranging from coarse sand to fine, loamy sand) but are occasionally loams (ranging from moderately coarse, sandy loam to moderately fine, silty, clay loam) formed from igneous/volcanic or sialic sediments, plutonic, and noncalcareous, metamorphic, parent material. Rock cover consists of 0 percent bedrock, 0 percent boulder, 0 percent stone, 0–8 percent cobble, 8–21 percent gravel, and 60–80 percent fines. Litter ranges from 2–3 percent cover. These sites generally experience low levels of disturbance from

competition from exotics (0–<1 percent cover) and moderate levels of disturbance from road/trail construction/maintenance.

MOST ABUNDANT SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Shrub | *Ephedra californica*, *Hymenoclea salsola* |
| Tree | *Psorothamnus spinosus* |

CHARACTERISTIC SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Herbaceous | *Chamaesyce polycarpa, Sarcostemma cynanchoides* |
| Shrub | *Ephedra californica*, *Hymenoclea salsola, Larrea tridentata, Acacia greggii* |
| Tree | *Psorothamnus spinosus* |

VEGETATION DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Psorothamnus spinosus - Ephedra californica* Association form a sparse to open shrubland with 0–<1 percent cover at <1 cm tall, <1 percent cover at 1–25 cm tall, <1 percent cover at 25–50c m tall, 2–5 percent cover at 50 cm to 1 m tall, <1–4 percent cover at 1–3 m tall, and <1–1 percent cover at 3–5 m tall. Total vegetative cover ranges from 7–11 percent.

This association is dominated by *Psorothamnus spinosus* in the tree layer. *Ephedra californica* and *Hymenoclea salsola* are dominant shrub species. *Larrea tridentata* and *Acacia greggii* are characteristic shrub species in this association. Characteristically in the understory layer are herb species *Chamaesyce polycarpa,* and *Sarcostemma cynanchoides* and cryptobiotic crust. Occasionally, *Isomeris arborea, Camissonia* sp., *Chaenactis douglasii, Cryptantha* sp., *Lupinus arizonicus, Krameria grayi, Lepidium fremontii, Pleuraphis rigida, and Senna armata* are present in the association.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G4 S3

RANK JUSTIFICATION
This association is likely to occur as small, linear stands adjacent to washes in the eastern and southern Mojave and perhaps the northern Sonoran Desert of California, Arizona and adjacent Mexico.

DATABASE CODE

COMMENTS
Globally

JOTR

Plots used for this description: JOTR: 35C-08-1, 44-18-4, 58B-01-1, 58B-01-2

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**Mesquite (*Prosopis glandulosa)* Woodland Alliance, Shrubland Alliance Complex (Mapping Code: 16040)**

This alliance is not defined at the association level locally. The following general description will serve to distinguish the local stand(s):

| | |
|---|---|
| COMMON NAME | Mesquite Bosque, Mesquite Thicket |
| PHYSIOGNOMIC CLASS | Woodland |
| PHYSIOGNOMIC SUBCLASS | Deciduous Shrubland, Woodland |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Deciduous Shrubland, Woodland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Thorn Extremely Xeromorphic Deciduous Shrubland, Woodland |
| CLASSIFICATION CONFIDENCE LEVEL | 1 |
| USFWS WETLAND SYSTEM | Facultative Wetland |

RANGE
Globally
This alliance complex occurs in the Great Valley, Mojave Desert, Colorado Desert, Sonoran Desert, and southeastern Great Basin regions of California and in the southwestern United States and Baja California, Mexico.

JOTR
This alliance Complex is found in scattered locations in the western part of the park and was sampled in Rattlesnake Canyon on the Indian Cove 7.5 minute quadrangle, near Cottonwood Spring on the Cottonwood Spring quadrangle, and on the east of Victory Pass and Queen Mountain quadrangles.

ENVIRONMENTAL DESCRIPTION
Globally
These alliances occur on intermittently flooded, saturated soils of floodplains, stream banks, river terraces, washes, and arroyos and on fringes of playa lakes and surrounding alkali sinks from 240–3,500 feet (70–1,100 m) in elevation.

JOTR

MOST ABUNDANT SPECIES
Globally

| | |
|---|---|
| Herbaceous | |
| Shrub | *Allenrolfea occidentalis, Ambrosia dumosa, Atriplex canescens, A. polycarpa, Bebbia juncea, Petalonyx thurberi, Pluchea sericea, Rhus ovata*, *Suaeda moquinii* |
| Tree | *Prosopis glandulosa, Salix exigua* |

JOTR

| | |
|---|---|
| Herbaceous | |
| Shrub | *Atriplex canescens, Isomeris arborea* |
| Tree | *Prosopis glandulosa* |

CHARACTERISTIC SPECIES
Globally

| | |
|---|---|
| Herbaceous | |
| Shrub | *Allenrolfea occidentalis, Ambrosia dumosa, Atriplex canescens, A. polycarpa, Bebbia juncea, Petalonyx thurberi, Pluchea sericea, Rhus ovata*, *Suaeda moquinii* |
| Tree | *Prosopis glandulosa, Salix exigua* |

VEGETATION DESCRIPTION
Globally
*Prosopis glandulosa* is dominant or important in the shrub or tree canopy with *Salix exigua*. Trees or shrubs are generally <10 m tall. The canopy is continuous or open.

JOTR

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G5 S3

RANK JUSTIFICATION
This alliance complex is widespread in southwest North America but is relatively local and diminished in California due to groundwater pumping and other disturbance.

DATABASE CODE

COMMENTS

Globally

Plants in California are represented by *Prosopis glandulosa* var. *torreyana*, a deciduous, thorny shrub or small tree. It occurs in three habitats. Stands of broad-crowned trees along river margins grow to 10 m in height; stands of low spreading, multistemmed shrubs on sandy, windswept soils where dunes often form grow to 1 m in height; and stands of shrubs at springs and playa edges are somewhat intermediate in height.

*Prosopis glandulosa* resprouts if the aboveground portion of the plant is damaged. Natural disturbance processes in most California stands are related to flooding, shifting sand, and locally to fire, particularly at the edge of the peninsular ranges adjacent to chaparral stands. Groundwater pumping or alterations of the flooding regime have precipitated the decline of numerous stands in the deserts.

Little specific information exists on its fire response. Top kill and mortality of other mesquites *(P. glandulosa* var. *glandulosa, P. velutina)* are most influenced by the size of the plant and the intensity of the fire. Recent observations (T. Keeler-Wolf 1998) along the Colorado River, in Anza-Borrego State Park, and Joshua Tree National Park suggest that *P. g.* var. *torreyana* respond similarly.

Frost sensitivity of *P. glandulosa* limits the alliance's distribution to below 3,500 feet (1,100 m) in California. The low, shrubby forms at its extreme northerly and high-elevation occurrences may be due to occasional periods of cold weather. Fluvial activity along rivers and larger streams causes local site establishment when seeds germinate on bars but also depletes stands by undercutting and erosion. It is likely that the dune and playa margin clonal stands are very old and only very rarely augmented by seedling recruitment.

The chief use of *P. glandulosa* is for firewood. Some stands in California have been decimated. The sweet tasting pods are high in protein and sugars and are avidly eaten by most livestock. Livestock often remove fruits as high on the tree as they can reach and eat fallen pods lying on the ground (Becker 1982). *Tamarix* spp. have become established along many rivers and desert wetlands and replaced *P. glandulosa* stands. Groundwater pumping is a serious threat in many locations.

JOTR

The samples locally come from the shores of Palen Dry Lake on the eastern portion of the park and occur in relatively alkaline settings.

Several samples in JOTR suggested further variation than what is currently reported from this alliance complex.

*Prosopis glandulosa/Atriplex canescens* (JOTR: 16-26-3, 66-02-2)
*Prosopis glandulosa/Isomeris arborea* (JOTR: 18B-06-1, 32-08-5)

**Creosote Bush – Brittlebush *(Larrea tridentata - Encelia farinosa)* Shrubland Alliance**

The *Larrea tridentata - Encelia farinosa* Shrubland Alliance occurs in the Mojave Desert, Sonoran Desert, and Colorado Desert regions of California and in Arizona, Nevada, Utah, and Mexico.

Many of the stands formerly considered part of the *Encelia farinosa* series and *Larrea tridentata* series (Sawyer and Keeler-Wolf 1995) are actually composed of a mixture of both species. These stands hold together in quantitative analysis (Thomas *et al.* 2004). In areas where both alliances occur, *Larrea tridentata - Encelia farinosa* tends to occupy steeper, southerly or westerly exposures, while *Larrea tridentata - Ambrosia dumosa* stands occupy more gentle northerly or neutral exposures. Compared to *Larrea tridentata - Ambrosia dumosa* Alliance, it tends to be less diverse with a lower proportion of annual herbs (in good rain years). This alliance is widespread in the southern and central Mojave and occurs throughout much of the Sonoran and Colorado Deserts. It is related to both the *Encelia farinosa* and the *Larrea tridentata - Ambrosia dumosa* Shrubland Alliances. This alliance represents a drought tolerant extension of the *Larrea tridentata*-dominated American desert scrub, which is less cold hardy and more heat tolerant than the *Larrea tridentata - Ambrosia dumosa* Alliance. It also does not tolerate sandy or clay rich soils as much as the *Larrea tridentata - Ambrosia dumosa* Alliance.

Stand dynamics and relationships between the two major shrub species are similar to the *Larrea tridentata - Ambrosia dumosa* Alliance. *Encelia farinosa* is, like *Ambrosia dumosa*, a short-lived subshrub that forms an open to intermittent subcanopy beneath the taller *Larrea tridentata* shrubs. However, it is even more tolerant of hot, dry conditions and is more of an aggressive colonizer than *Ambrosia dumosa*. Leafing and flowering is opportunistic whenever moisture is available. *Encelia farinosa* rapidly colonizes burns and other disturbance in both the south coastal scrub and desert vegetation (FEIS 2001). *Encelia farinosa* is short lived; the maximum reported age is 32 years (FEIS 2001). It reproduces entirely by seed and resprouts weakly from damaged stems. It is frost sensitive, limiting its elevational and geographic range. It grows poorly on clay soils but survives on coarse, steep, and very rocky soils better than *Ambrosia dumosa*. It may replace longer-lived perennials after fire and, once established, may persist for decades. It is allelopathic to several winter annuals (FEIS 2001), suggesting that biodiversity is reduced if it replaces other desert vegetation. It is intolerant of heat from fire, making resprouting weak or nonexistent. However, it recolonizes from off-site seed readily. Recurrent desert fire selects *Encelia farinosa* over longer-lived shrubs. In general, because of the hot, dry conditions of most stands, *Larrea tridentata - Encelia farinosa* is typically even more open than stands of *Larrea tridentata - Ambrosia dumosa*. Despite the colonizing properties of *Encelia farinosa*, the *Larrea tridentata - Encelia farinosa* alliance is generally stable, occupying rocky, harsh sites that are not conducive to *Larrea tridentata - Ambrosia dumosa* alliance. Seral stages following fire or other unnatural disturbance are likely to involve a state dominated by *Encelia farinosa* for several years before *Larrea tridentata* and other long-lived shrubs reestablish.

This is another alliance where the coincidence of nonnative, annual grass invasion and human-related fires has conspired to threaten the structure and diversity of the vegetation. Fires should be excluded at all times of the year, and core areas should be identified where grass cover is low and thus stands are defensible. Unlike the *Larrea tridentata - Ambrosia dumosa* alliance, the rocky, steep nature of many of the stands precludes the establishment of dense cover of *Bromus madritensis,* and thus, the resistance of this alliance to nonnatural fire and weed invasion is relatively high.

The *Larrea tridentata - Encelia farinosa* Shrubland Alliance is represented by three associations in JOTR: Creosote Bush – Brittlebush - Burro Bush (*Larrea tridentata - Encelia farinosa - Ambrosia dumosa),* Creosote Bush - Brittlebush (*Larrea tridentata - Encelia farinosa)* Shrubland Association, and Creosote Bush – Brittlebush - Ocotillo *(Larrea tridentata - Encelia farinosa - Fouquieria splendens)* Shrubland Association.

In addition to the associations described below, one unclassified, alliance-level sample was taken in JOTR that suggests further variation.

*Larrea tridentata - Encelia farinosa - Bebbia juncea* (JOTR: 66-02-3)

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*Larrea tridentata - Encelia farinosa - Ambrosia dumosa* Shrubland Association (Mapping Code: 27057)

| | |
|---|---|
| COMMON NAME | Creosote Bush – Brittlebush - Burro Bush Shrubland Association |
| SYNONYM | *Larrea tridentata - Ambrosia dumosa* association (Leary 1977) |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Shrubland (scrub) |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Evergreen Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Facultatively Deciduous Extremely Xeromorphic Subdesert Shrubland |
| ALLIANCE | *Larrea tridentata - Encelia farinosa* Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Upland |

RANGE
Globally
This association is only defined from Joshua Tree National Park. However, plots with similar characteristics have been found throughout much of the central Mojave Desert (Thomas *et al.* 2004).

JOTR
Stands of the *Larrea tridentata - Encelia farinosa - Ambrosia dumosa* Shrubland Association were sampled in the park within the Seven Palms Valley, Porcupine Wash, Queen Mountain, Malapai Hill, Cottonwood Basin, Cottonwood Springs, Cadiz Valley southwest, east Deception Canyon, Seven Palms Valley, Hayfield, Rockhouse Canyon, Fried Liver Wash, Pinto Wells, Cadiz Valley southeast, Coxcomb Mountains, and Washington Wash 7.5 minute topographic quadrangles.

ENVIRONMENTAL DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. However, similar if not identical stands were inventoried by Thomas *et al.* (2004) and were described from rocky uplands, usually on southerly facing exposures below 1,000 m in the south-central and eastern Mojave Desert.

JOTR
Stands of the *Larrea tridentata - Encelia farinosa - Ambrosia dumosa* Shrubland Association are found at low to mid elevations (1,100–3,700 ft.; 330–1,100 m) in a variety of microtopographic situations on slopes that are flat to steep (0-32 degrees). This association can be found on all aspects of rocky highlands, upland, alluvial deposits, erosional highlands, and bottomlands/plains. Soil textures range from coarse to moderately fine, silty, clay loam of sialic sediment, plutonic, and noncalcareous, metamorphic, parent material. Rock content in this association consists of 0–50 percent bedrock, 0–27 percent boulder, 0–45 percent stone, 2–75 percent cobble, 5–75 percent gravel, and 0–60 percent fines cover. Litter cover is 0–8 percent. These sites usually experience low to rarely high levels of disturbance from competition from exotic species (0–%) and moderate levels of disturbance from vandalism/dumping/litter.

MOST ABUNDANT SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Shrub *Larrea tridentata, Ambrosia dumosa, Encelia farinosa*

CHARACTERISTIC SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Shrub *Larrea tridentata, Ambrosia dumosa, Encelia farinosa*

VEGETATION DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Larrea tridentata - Encelia farinosa - Ambrosia dumosa* Shrubland Association form an open/sparse shrubland with 0–<1 percent cover at <1 cm tall, <1–5 percent cover at 1–25 cm tall, <1–10 percent cover at 25–50 cm tall, <1–5 percent cover at 50 cm to 1 m tall, and 0–10 percent cover at 1–3 m tall. Total vegetative cover ranges from 5–15 percent (1 out of 20 plots has total vegetative cover of 35%).

This association is dominated and characterized by the shrub species *Larrea tridentata, Ambrosia dumosa,* and *Encelia farinosa.* Cryptobiotic crust, *Bebbia juncea,* and *Opuntia basilaris* are often present. Occasionally present are *Eriogonum inflatum, Pleuraphis rigida, Opuntia echinocarpa, Krameria grayi,* and *Viguiera parishii.*

OTHER NOTEWORTHY SPECIES
*Coryphantha alversonii* was found in two of 20 plots. *Coryphantha alversonii* is a List 4 plant in the CNPS Inventory of Rare and Endangered Plants of California (CNPS 2001). It is found in Imperial, Riverside, and San Bernardino Counties at low to high elevations (240–5,000 ft.; 73–1,500 m). (Syn: *Escobaria vivipara* var. *alversonii* in the Jepson Manual.)

*Tetracoccus hallii* was found in one of 20 plots. *Tetracoccus hallii* is a List 4 plant in the CNPS Inventory of Rare and Endangered Plants of California (CNPS 2001). It is found in Imperial, Riverside, and San Bernardino Counties and in Arizona and Baja California at low to high elevations (98–4,000 ft.; 30–1,200 m).

CONSERVATION RANK G5 S4

RANK JUSTIFICATION
This association is presumed to be common throughout much of the Mojave and adjacent Sonoran Desert.

DATABASE CODE

COMMENTS
Globally

JOTR

Plots used for this description: JOTR: 01-02-3, 1-02-6, 08-03-2, 17-03-2, 18B-06-2 , 22-26-3, 25-04-3, 25-04-5, 28B-13-1, 33-11-4, 39-02-3, 57-18-2, 59-05-4, 60B-07-1, 60B-07-3, 63-18-4, 63-18-5; 154-1-8; MDEI:153-1-6; LONG: VEGE1, VCOT97-1-2; WATTS n=2.

*Larrea tridentata - Encelia farinosa* Shrubland Association (Mapping Code: 27050)

| | |
|---|---|
| COMMON NAME | Creosote Bush - Brittlebush Shrubland Association |
| SYNONYM | *Larrea tridentata - Ambrosia dumosa* association (Leary 1977) |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Shrubland (scrub) |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Evergreen Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Facultatively Deciduous Extremely Xeromorphic Subdesert Shrubland |
| ALLIANCE | *Larrea tridentata - Encelia farinosa* Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Upland |

RANGE
Globally
This association is only definitively known from Joshua Tree National Park. However, it is suspected from much of the central and eastern Mojave and also from the western Sonoran Desert (Thomas *et al.* 2004, Keeler-Wolf *et al.* 1998).

JOTR
Stands of the *Larrea tridentata - Encelia farinosa* Shrubland Association were sampled in the park within the Fried Liver Wash, Victory Pass, east of Victory Pass, Conejo Well, Seven Palms Valley, Coxcomb Mountains, and Queen Mountain 7.5 minute topographic quadrangles.

ENVIRONMENTAL DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Larrea tridentata - Encelia farinosa* Shrubland Association are found at low to mid elevations (500–3,000 ft.; 150–900 m) on linear, concave, and undulating slopes that are gentle to steep (<1-30 degrees). This association can be found on all aspects of rocky highlands, upland, alluvial deposits, washes, erosional highlands, and inselbergs. Soil texture ranges from coarse sand to moderately fine, silty, clay loam, formed on gneissose, granitic, sialic sediment, plutonic, and noncalcareous, metamorphic, parent material. Rock content in this association consists of 0->75 percent bedrock, 0–25 percent boulder, 0–25 percent stone, 6–75 percent cobble, 5–80 percent gravel, and <1–75 percent fines cover. Litter cover is <1–7 percent. These sites usually experience low levels of disturbance from competition from exotic species (0–1%) and low to moderate levels of disturbance from vandalism, dumping, and litter.

MOST ABUNDANT SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Shrub *Encelia farinosa, Larrea tridentata*

CHARACTERISTIC SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Shrub *Encelia farinosa, Larrea tridentata*

VEGETATION DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Larrea tridentata - Encelia farinosa* Shrubland Association form a sparse to open shrubland with 0–<1 percent cover at <1 cm tall, <1–4 percent cover at 1–25 cm tall, <1–10 percent cover at 25–50 cm tall, <1–2 percent cover at 50 cm to 1 m tall, and 1–4 percent cover at 1–3 m tall. Total vegetative cover ranges from <1–20 percent.

This association is dominated and characterized by *Encelia farinosa* and *Larrea tridentata* in the shrub layer. *Ambrosia dumosa* is often found in this association at very low cover. Occasional species are *Ferocactus cylindraceus, Hyptis emoryi, Pleuraphis rigida, Eriogonum inflatum, Ditaxis neomexicana,* and *Allionia incarnata.* The exotic species *Schismus barbatus* may occasionally contribute to minor cover in this association. It is closely related to the previous L. tridentata-Encelia farinosa-Ambrosia dumosa association and may eventually be considered synonymous.

OTHER NOTEWORTHY SPECIES
*Coryphantha alversonii* was found in three of 18 plots. *Coryphantha alversonii* is a List 4 plant in the CNPS Inventory of Rare and Endangered Plants of California (CNPS 2001). It is found in Imperial, Riverside, and San Bernardino Counties at low to high elevations (240–5,000 ft.; 73–1,500 m). (Syn: *Escobaria vivipara* var. *alversonii* in the Jepson Manual.)

CONSERVATION RANK G5 S5

RANK JUSTIFICATION
This association is likely to be common throughout the warmer parts of the Mojave and adjacent western Sonoran Deserts.

DATABASE CODE

COMMENTS
Globally

JOTR
As with most drought deciduous dominant vegetation, the shrub cover may vary substantially between leaf on and leaf off conditions. *Encelia farinosa* responds relatively rapidly to significant precipitation and may produce new leaves within a week or two following rain.

Plots used for this description: JOTR: 26-24-3, 27B-12-1, 28B-13-3, 40A-07-1, 40A-07-2, 53-08-3, 62-02-2, 66-02-6; MDEI: 63-2-8, 63-7-6, 63-7-7, 63-7-8,129-2-7, 129-2-8, 153-1-7, 153-1-8, 154-3-7, 158-1-7, 162-1-7; LONG: VCOT-97-1.

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*Larrea tridentata - Encelia farinosa - Fouquieria splendens* Shrubland Association (Mapping Code: 27056)

| | |
|---|---|
| COMMON NAME | Creosote Bush – Brittlebush - Ocotillo Shrubland Association |
| SYNONYM | Southern Bench association (Leary 1977) |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Shrubland (scrub) |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Evergreen Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Facultatively Deciduous Extremely Xeromorphic Subdesert Shrubland |
| ALLIANCE | *Larrea tridentata - Encelia farinosa* Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Upland, Palustrine |

RANGE
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory. It is suspected throughout much of the Sonoran Desert of California, Arizona, and adjacent Mexico.

JOTR
Stands of the *Larrea tridentata - Encelia farinosa - Fouquieria splendens* Shrubland Association occur mostly along the southern edge of the park and were sampled within the Cottonwood Basin and Cottonwood Springs 7.5 minute topographic quadrangles.

ENVIRONMENTAL DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of *Larrea tridentata - Encelia farinosa - Fouquieria splendens* Shrubland Association are found at mid elevations (2,300–2,600 ft.; 700–800 m) on convex, linear, undulating slopes that are gentle to moderate (<1–6 degrees). This association is often found on upland, alluvial deposits and occasionally on rocky highlands. Soil texture tends to be sand (ranging from coarse sand to fine, loamy sand) derived from sialic sediment, plutonic, and noncalcareous, metamorphic, parent material. Rock content in this association consists of 0–20 percent bedrock, 0–4 percent boulder, 0–10 percent stone, 5–25 percent cobble, 12–30 percent gravel, and 15–65 percent fines cover. Litter consists of 2–4 percent cover. These sites usually experience low levels of disturbance from competition from exotic species (0–<1%).

MOST ABUNDANT SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Shrub | *Larrea tridentata, Encelia farinosa, Fouquieria splendens* |

CHARACTERISTIC SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Shrub | *Larrea tridentata, Encelia farinosa, Fouquieria splendens, Ambrosia dumosa, Opuntia basilaris, Opuntia ramosissima, Bebbia juncea, Krameria grayi, Opuntia echinocarpa, Hyptis emoryi* |
| Tree | *Cercidium floridum* |

VEGETATION DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Larrea tridentata - Encelia farinosa - Fouquieria splendens* Shrubland Association form a sparse to open shrubland with <1 percent cover at <1 cm tall, <1 percent cover at 1–25 cm tall, ,1–4 percent cover at 25–50 cm tall, <1-6 percent cover at 50 cm to 1 m tall, 1–4 percent cover at 1–3 m tall, 1–2 percent cover at 3–5 m tall, and 0–2 percent cover at 5–10 m tall. Total vegetative cover ranges from 6–13 percent.

This association is dominated by *Larrea tridentata, Encelia farinosa, and Fouquieria splendens* in the shrub and tree layer. *Ambrosia dumosa, Opuntia basilaris, Opuntia ramosissima*, *Bebbia juncea, Krameria grayi, Opuntia echinocarpa,* and *Hyptis emoryi* are consistently found contributing to minor cover in this association. The exotic species *Schismus* sp. and *Brassica tournefortii* also consistently contribute to minor cover. Cryptobiotic crust is a constant component. *Acacia greggii, Simmondsia chinensis, Ferocactus cylindraceus, Echinocereus engelmannii, Trixis californica, Chamaesyce* sp., *Stephanomeria pauciflora,* and *Eriogonum inflatum* are often present in these stands.

OTHER NOTEWORTHY SPECIES
*Coryphantha alversonii* was found in two of four plots. *Coryphantha alversonii* is a List 4 plant in the CNPS Inventory of Rare and Endangered Plants of California (CNPS 2001). It is found in Imperial, Riverside, and San Bernardino counties at low to high elevations (240–5,000 ft.; 73–1,500 m). (Syn: *Escobaria vivipara* var. *alversonii* in the Jepson Manual.)

CONSERVATION RANK G5 S3

RANK JUSTIFICATION
This association is likely to be globally widespread but is relatively local in California, primarily in the lower Colorado Desert subregion of the Sonoran Desert.

DATABASE CODE

COMMENTS
Globally

JOTR

Plots used for this description: JOTR: 24-06-1, 24-06-3, 24-06-4, 32-06-5

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**Brittlebush *(Encelia farinosa)* Shrubland Alliance (Mapping Code: 28033)**

This alliance is not defined at the association level locally. The following general description will serve to distinguish the local stand(s).

COMMON NAME Brittlebush Scrub

| | |
|---|---|
| SYNONYM | None |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Shrubland |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Evergreen Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Semi-natural |
| FORMATION | Facultatively Deciduous Extremely Xeromorphic Subdesert Shrubland |
| ALLIANCE | *Encelia farinosa* Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 1 |
| USFWS WETLAND SYSTEM | Upland |

RANGE
Globally
The *Encelia farinosa* Shrubland Alliance occurs in the southern mountains and valleys, Mojave Desert, Sonoran Desert, Colorado Desert, Mono Basin, and southeast Great Basin regions of California and in Nevada, Arizona, and Utah.

JOTR
This alliance occurs scattered over much except the northwest portion of the park and was sampled within the Seven Palms Valley, Cadiz Valley southwest, Coxcomb Mountains, and east of Victory Pass 7.5 minute quadrangles.

ENVIRONMENTAL DESCRIPTION
Globally
The *Encelia farinosa* Shrubland Alliance occurs on alluvial fans, and bajadas and other colluvium on upland slopes, and in small washes and rills. Soils are well drained, rocky, may have desert pavement surface, and are often derived from granitic or volcanic rock. Elevation ranges from –240 to 4,500 feet (-73 to 1,400 m).

JOTR
In JOTR, this alliance is often found in driest, hottest portions of the park on south facing slopes.

MOST ABUNDANT SPECIES
Globally

| | |
|---|---|
| Shrub | *Encelia farinosa, Ambrosia dumosa, Artemisia californica, Eriodictyon crassifolium, Eriogonum fasciculatum, Agave deserti, Ferocactus cylindraceus, Opuntia bigelovii, Echinocactus engelmannii, Salvia apiana, Yucca whipplei* |
| Tree | *Fouquieria splendens* |

JOTR

| | |
|---|---|
| Shrub | *Encelia farinosa, Ambrosia dumosa, Lycium andersonii, Fagonia laevis* |

CHARACTERISTIC SPECIES
Globally
Shrub *Encelia farinosa*

VEGETATION DESCRIPTION
Globally
*Encelia farinosa* is the sole or dominant shrub in the canopy, and emergent *Fouquieria splendens* may be present. Shrubs are <2 m and the canopy is open to intermittent and single layered. Trees are <5 m and scattered. The ground layer is open, and annuals are present seasonally.

JOTR

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G5 S4

RANK JUSTIFICATION
This alliance is likely widespread in the Sonoran Desert of southwest United States and adjacent Mexico.

DATABASE CODE

COMMENTS
Globally
The *Encelia farinosa* alliance represents a drought tolerant extension of the *Larrea tridentata*-dominated American desert scrub, which is less cold hardy and more heat tolerant than *Larrea tridentata-Ambrosia dumosa* alliance. It also does not tolerate sandy or clay rich soils as well as *Larrea tridentata-Ambrosia dumosa.* The virtual absence of *Larrea* in the overstory is sometimes related to the disturbance history of the stand. It may also be related to the steep, rocky nature of the stand. Cover is variable with many steep rocky stands averaging less than 10 percent total vegetation cover, while disturbance-related stands may approach 50 percent cover.

*Encelia farinosa* is, like *Ambrosia dumosa*, a short-lived subshrub that forms an open to intermittent subshrub canopy. However, it is even more tolerant of hot, dry conditions and is more of an aggressive colonizer than *Ambrosia dumosa.* Leafing and flowering is opportunistic whenever moisture is available. *Encelia farinosa* rapidly colonizes burns and other disturbance, both in the south coastal scrub and desert vegetation (FEIS 2001). *Encelia farinosa* is short lived, with maximum reported age 32 years (FEIS 2001). It reproduces entirely by seed and resprouts weakly from damaged stems. It is frost sensitive, limiting its elevational and geographic range. It grows poorly on clay soils but survives on coarse, steep, and very rocky soils better than *Ambrosia dumosa*. It may replace longer-lived perennials after fire and, once established, may persist for decades. It is allelopathic to several winter annuals (FEIS 2001), suggesting that biodiversity is reduced if it replaces other vegetation. It is intolerent of heat from fire, making resprouting weak or nonexistent. However, it recolonizes from off-site seed readily. Recurrent

desert fire selects *Encelia farinosa* over longer-lived shrubs. Despite the colonizing properties of *Encelia farinosa*, some stands of the *Encelia farinosa* alliance are generally stable, occupying rocky sites too harsh for the *Larrea tridentata - Encelia farinosa* alliance. Seral stages following fire or other unnatural disturbance are likely to involve a state dominated by *Encelia farinosa* for several years before *Larrea tridentata* and other long-lived shrubs reestablish. If *Larrea tridentata* reestablishes, the stands transcend to *Larrea tridentata - Encelia farinosa* alliance.

The coincidence of nonnative, annual grass invasion and human-related fires has conspired to threaten the structure and diversity of this vegetation. In the deserts, fires should be excluded at all times of the year, and core areas should be identified where grass cover is low and thus stands are defensible. Unlike the *Larrea tridentata - Ambrosia dumosa* alliance, the rocky, extremely xeric nature of many of the stands precludes the establishment of dense cover of *Bromus madritensis* and thus, the resistance of this alliance to nonnatural fire and weed invasion is relatively high. It is likely that this alliance is increasing relative to *Larrea tridentata-Encelia farinosa* or *Larrea tridentata-Ambrosia dumosa* in less rocky/steep parts of the desert where fires are relatively frequent.

JOTR

The following samples in JOTR suggested further variation than what is currently reported from this Alliance:

*Encelia farinosa-Ambrosia dumosa* (JOTR: 01-02-4)
*Encelia farinosa - Ambrosia dumosa –Lycium andersonii* (JOTR: 57-18-5)
*Encelia farinosa –Fagonia laevis* (JOTR: 63-18-6)
*Encelia farinosa* (JOTR: 66-02-5)

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**Desert Holly *(Atriplex hymenelytra)* Shrubland Alliance (Mapping Code: 28070)**

The *Atriplex hymenelytra* Shrubland Alliance occurs in the Mojave Desert, Sonoran Desert, Colorado Desert, and southeastern Great Basin regions of California. It occurs on alluvial fans; along washes; and on steep colluvium, recent lava flows, and cinder cones. Soils are derived from alluvium; colluvium; and residuum from metamorphic, igneous, and other sedimentary rocks and may be carbonate, alkaline, or salt rich. The alliance also occurs in wetland habitats such as intermittently flooded wash bottoms. Elevations range from -240 to 4,500 feet (-73 to 1,400 m).

This alliance is often considered part of either creosote bush scrub or saltbush scrubs. These scrubs are better thought of as a collection of alliances. This alliance shares species with the *Larrea tridentata, Larrea tridentata - Ambrosia dumosa* and *Larrea tridentata - Encelia farinosa* shrubland alliances. It is commonly found along drainages that dissect west facing bajadas and on western and southern slopes of very dry mountains. It is also found on desert pavement with very sparse vegetation. It may occupy rough lava and limestone deposits with skeletal soil and

heavy alkaline sea floor and lake sediments (mud hills). The density of shrubs is usually very low. This is the most xeric shrub alliance in the Mojave Desert. It persists in extremely hot, dry locations where virtually no other perennial shrub is able to flourish.

The *Atriplex hymenelytra* alliance has relatively simple seral relationships. *Atriplex hymenelytra* can be both an invader and a long-lived, stable component of the landscape. Studies at the Zzyzx Desert Studies Center (A. Romspert, personal communication 2000) indicate individuals are long lived and may undergo sex change based on age and environmental conditions. Recruitment at Trona Pinnacles is episodic; the last major event was 21 years ago, suggesting long viable seed in soil (G. Harris, personal communication 2000). Natural disturbance in the harsh upland environments comes mostly as shifts in moisture availability. A series of wetter years will shift *Atriplex hymenelytra* toward other desert alliances such as *Larrea tridentata, Larrea tridentata - Ambrosia dumosa,* or *Larrea tridentata - Encelia farinosa.* A series of drier years will eliminate individual *Atriplex hymenelytra* and other component species and leave only annual, ephemeral herb species, such as *Geraea canescens* and *Chorizanthe rigida*, in the seed bank.

Where *Atriplex hymenelytra* occurs in washes, it generally occupies the rocky, gravelly bottoms that have little or no organic buildup in the substrate. These washes may not receive water for several successive years. Surrounding upland vegetation may include *Larrea tridentata - Ambrosia dumosa, Larrea tridentata - Encelia farinosa,* or desert annuals. Tolerance of bare mineral substrate with low nutritional value and no apparent mycorrhizal associations confers an advantage for *Atriplex hymenelytra* in colonizing low-elevation washes as well as road cuts and other unnatural disturbances. *Tidestromia oblongifolia*, one of the most common associates of this alliance, is commonly found in disturbed sites (OHV areas, roadsides). It is possible that severe degradation of upland *Atriplex hymenelytra* stands can result in *Tidestromia oblongifolia* alliance, but this has not yet been described.

This alliance is represented in JOTR by one association defined first in this project, the Desert Holly - Creosote Bush - Burro Bush (*Atriplex hymenelytra - Larrea tridentata - Ambrosia dumosa)* Shrubland Association.

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*Atriplex hymenelytra - Larrea tridentata - Ambrosia dumosa* Shrubland Association

| | |
|---|---|
| COMMON NAME | Desert Holly - Creosote Bush - Burro Bush Shrubland Association |
| SYNONYM | *Larrea tridentata - Ambrosia dumosa* association (Leary 1977) |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Shrubland (scrub) |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Evergreen Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Facultatively Deciduous Extremely Xeromorphic Subdesert Shrubland |

ALLIANCE *Atriplex hymenelytra* Shrubland Alliance
CLASSIFICATION CONFIDENCE LEVEL 2
USFWS WETLAND SYSTEM Upland

RANGE
Globally
This association is only known from Joshua Tree National Park. However, other similar plots have been reported by Thomas *et al*. (2004) in other parts of the Mojave Desert. Similar stands have also been reported from Anza-Borrego Desert State Park but were placed in the Creosote Bush - Burro Bush Alliance (Keeler-Wolf *et al.* 1998).

JOTR
Stands of the *Atriplex hymenelytra - Larrea tridentata - Ambrosia dumosa* Shrubland Association were sampled in the park within the east of Victory Pass 7.5 minute topographic quadrangle. It was observed in the field in the southeast portion of the park adjacent to Highway 177 (AIS). Leary (1977) observed one isolated spot southwest of Pinto Wells on volcanic tuft.

ENVIRONMENTAL DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Atriplex hymenelytra - Larrea tridentata - Ambrosia dumosa* Shrubland Association are found at low elevations (475–525 ft.; 140–160 m) on linear and undulating, flat to moderate (0-6 degree) slopes of upland, alluvial deposits. Soils are usually sandy (includes coarse, medium, and fine sand and coarse, medium, and fine, loamy sand) from sialic sediment, plutonic, and noncalcareous, metamorphic, parent material. Rock content in this association consists of 0 percent bedrock, 0 percent boulder, 0–8 percent stone, 15–50 percent cobble, 30–51 percent gravel, and <1–30 percent fines cover. Litter cover is <1–2 percent. These sites generally experience low to high levels of disturbance from vandalism, dumping, and litter.

MOST ABUNDANT SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Shrub *Atriplex hymenelytra*

CHARACTERISTIC SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Herbaceous *Chamaesyce polycarpa, Oenothera deltoides*
Shrub *Atriplex hymenelytra, Larrea tridentata*

VEGETATION DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Atriplex hymenelytra - Larrea tridentata - Ambrosia dumosa* Shrubland Association form a sparse shrubland with 0–<1 percent cover at <1 cm tall, <1 percent cover at 1–25 cm tall, <1–1 percent cover at 25–50 cm tall, 1 percent cover at 50 cm to 1 m tall, and <1-4 percent cover at 1–3 m tall. Total vegetative cover ranges from 2–4 percent.

This association is dominated by *Atriplex hymenelytra*. *Larrea tridentata, Ambrosia dumosa,* and *Encelia farinosa* are often present in the shrub layer. Characteristic herb species include *Chamaesyce polycarpa* and *Oenothera deltoides*.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G4 S3

RANK JUSTIFICATION
This association is likely to be locally common in the lower, hotter portions of the Mojave Desert and adjacent Sonoran Desert.

DATABASE CODE

COMMENTS
Globally

JOTR

Plots used for this description: JOTR: 66-02-1, 66-02-4, 66-02-7

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**Desert Lavender *(Hyptis emoryi)* Intermittently Flooded Shrubland Alliance (Mapping Code: 28200)**

The *Hyptis emoryi* Shrubland Alliance occurs in the Colorado Desert, Sonoran Desert, and southern Mojave Desert in California; possibly in the Sonoran Desert in Arizona; and in Baja California, Mexico. Elevation ranges from 30 to 2,600 feet (9 to 800 m).

*Hyptis emoryi* forms scraggly stands along many of the minor washes in the low, hot, and very dry Colorado and Sonoran Deserts of California. They tend to occupy narrow washes with moderate to steep gradients. These stands generally occur along washes that are not big enough to support stands of the microphyllous legume trees of the desert. The *Hyptis emoryi* alliance appears to prefer the rocky and bouldery stretches of washes, rather than the broad and sandier portions. Stands are often only narrow strips that ascend drainages in old, dissected alluvial fans or badlands. This alliance seems to be limited by temperature since it does not ascend >2,600 feet (800 m) in the desert mountains or occur very far north into the Mojave Desert.

*Hyptis emoryi* appears to tolerate a high degree of flood disturbance. It is a long-lived species that resprouts following flood or fire damage. Shrubs are often positioned in the center of small washes and have clearly sustained repeated damage from flooding. Stems appear to ramify following damage. Flooding in the smaller washes probably occurs at least every 10 years. The relationship between this alliance and other similar ones, such as *Acacia greggii,* needs to be determined. Seeds are probably dispersed in water. Flowering and seed set is opportunistic, following rain and flooding (Desert Workshop, January 2000).

Many small washes in the Sonoran and Colorado Deserts are impacted by burro and OHV use. Impacts to this alliance have not been quantified.

This alliance is represented in JOTR by one association defined first in this project, the Desert-Lavender *(Hyptis emoryi)* Shrubland Association. In addition to the association described below, several unclassified, alliance-level samples were taken that suggest further variation. These include

*Hyptis emoryi/Sarcostemma cynanchoides* (JOTR: 60B-07-2)
*Hyptis emoryi – Acacia greggii* (JOTR: 20D-05-1)

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*Hyptis emoryi* Shrubland Association (Mapping Code: 28203)

| | |
|---|---|
| COMMON NAME | Desert-Lavender Shrubland Association |
| SYNONYM | *Ambrosia dumosa – Larrea tridentata* association (Leary 1977) |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Deciduous Shrubland (Scrub) |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Deciduous Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Intermittently Flooded Extremely Xeromorphic Deciduous Subdesert Shrubland |
| ALLIANCE | *Hyptis emoryi* Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Palustrine |

RANGE
Globally
This association is only described from Joshua Tree National Park. However, similar stands have been sampled in Anza-Borrego Desert State Park (Keeler-Wolf *et al.* 1998) and in the southern portion of the eastern Mojave Desert (Thomas *et al.* 2004).

JOTR
Stands of the *Hyptis emoryi* Shrubland Association occur in the central and eastern portions of the park and were sampled within the Cottonwood Basin, Fried Liver Wash, Clark's Pass, and Buzzard Springs 7.5 minute topographic quadrangles.

ENVIRONMENTAL DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Hyptis emoryi* Shrubland Association are found at low to mid elevations (1,500–2,000 ft.; 450–610 m) on convex, linear, concave, and undulating slopes of drainages on rocky highlands, washes, and arroyos. Soils are typically sandy (includes coarse, medium, and fine sand, and coarse, medium, and fine, loamy sand) and formed on sialic sediment, plutonic, and noncalcareous, metamorphic, parent material. The coarse fragment in this association is composed of 0–10 percent bedrock, 0–6 percent boulder, 0–20 percent stone, 5–25 percent cobble, 15–31 percent gravel, and 10–50 percent fines cover. Litter consists of 1–5 percent cover. This association experiences low levels of disturbance from competition from exotics (0–<1%).

Stands are common in narrow and steep, high energy, rocky washes throughout the mountain ranges in the eastern portions of the park (AIS). Some of the best stands occur in the Pinto Mountains (Leary 1977).

MOST ABUNDANT SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Shrub *Hyptis emoryi, Larrea tridentata*

CHARACTERISTIC SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Herbaceous *Chamaesyce* sp., *Mirabilis bigelovii, Stephanomeria* sp.
Shrub *Hyptis emoryi, Larrea tridentata, Bebbia juncea, Encelia farinosa*

VEGETATION DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Hyptis emoryi* Shrubland Association form a sparse to open shrubland with <1 percent cover at <1 cm tall, <1 percent cover at 1–25 cm tall, <1 percent cover at 25–50 cm tall, <1–7 percent cover at 50 cm to 1 m tall, 3–12 percent cover at 1–3 m tall, and 1–2 percent at 3–5 m tall. Total vegetative cover ranges from 8–18 percent.

This association is dominated by *Hyptis emoryi* and *Larrea tridentata* in the shrub layer. Characteristic shrub species include *Bebbia juncea* and *Encelia farinosa*. Characteristic herb species include *Chamaesyce* sp., *Mirabilis bigelovii,* and *Stephanomeria* sp. *Hymenoclea salsola; Allionia incarnata, Senna armata, Pleuraphis rigida, Simmondsia chinensis,* and *Ambrosia dumosa* are frequently present. *Acacia greggii, Aristida* sp., *Brandegea bigelovii, Eriogonum inflatum, Krameria grayi, Opuntia basilaris, Opuntia echinocarpa, Psorothamnus schottii, Krameria grayi,* rock lichen, *Lycium andersonii, Ditaxis lanceolata, Erioneuron pulchellum, Hibiscus denudatus, Perityle emoryi, Porophyllum gracile,* cryptobiotic crust, and moss are occasionally found contributing to minor cover.

OTHER NOTEWORTHY SPECIES
Evidence of tortoises was noted in one of five plots.

CONSERVATION RANK G4 S4

RANK JUSTIFICATION
This association is likely to be found throughout the northern Sonoran and adjacent southern Mojave Desert.

DATABASE CODE

COMMENTS
Globally

JOTR

Plots used for this description: JOTR: 26-24-1, 27B-12-2, 27B-12-7, 28B-13-2, 43-20-2, 53-08-10.

**Chuparosa *(Justicia californica)* Unique Stands (Mapping Code: 28170)**

The shrub *Justicia californica* forms occasional stands in the park. Two plots were sampled and do not provide enough information to define an alliance or association, one of which had a photo signature distinct enough to allow mapping. The plots are temporarily placed here until further information is available on their relationship to other alliances and associations.

*Justicia californica* - *Hyptis emoryi* (JOTR: 32-06-6) (Mapping Code: 28171)
*Justicia californica* - Undifferentiated (LONG: VMAL98-42)

**Teddy-Bear Cholla *(Opuntia bigelovii)* Shrubland Alliance**

This alliance of the arid Southwest grows on well-drained soils of bajadas and upland slopes. Stands of this alliance are found from sea level to 3,300 feet (1,000 m) of elevation. Stands are dominated by *Opuntia bigelovii. Larrea tridentata* is a very common associate. Other shrubs present may include *Pleuraphis rigida (= Hilaria rigida), Encelia farinosa, Fouquieria splendens,* and *Ambrosia dumosa*. Annuals are seasonally present.

This alliance is represented in JOTR by one association defined first in this project, the Teddy-Bear Cholla *(Opuntia bigelovii)* Shrubland Association.

*Opuntia bigelovii* Shrubland Association (Mapping Code: 29050)

| | |
|---|---|
| COMMON NAME | Teddy-Bear Cholla Shrubland Association |
| SYNONYM | *Ambrosia dumosa* - Mixed Shrub Type (Leary 1977) |
| PHYSIOGNOMIC CLASS | Shrubland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Shrubland |
| PHYSIOGNOMIC GROUP | Extremely Xeromorphic Evergreen Shrubland |
| PHYSIOGNOMIC SUBGROUP | Natural/Seminatural |
| FORMATION | Succulent Extremely Xeromorphic Evergreen Shrubland |
| ALLIANCE | *Opuntia bigelovii* Shrubland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 2 |
| USFWS WETLAND SYSTEM | Upland |

RANGE
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Opuntia bigelovii* Shrubland Association were sampled in the park within the Buzzard Springs and Hayfield 7.5 minute topographic quadrangles.

ENVIRONMENTAL DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Opuntia bigelovii* Shrubland Association are found at low elevations (1,500–1,900 ft.; 450–580 m) on gentle to moderate (<1-6 degrees), undulating and concave slopes of rocky highlands and upland, alluvial deposits. Soil textures range from coarse sand to moderately fine, silty, clay loam. This association typically occurs on sialic sediment, plutonic, and noncalcareous, metamorphic, parent material. Rock content in this association consists of 0–1 percent bedrock, 0–4 percent boulder, 0–4 percent stone, 5–20 percent cobble, 25–70 percent gravel, and 5–42 percent fines cover. Litter cover is 1–5 percent. These sites generally experience low levels of disturbance from competition from exotic species (0–<1%).

MOST ABUNDANT SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Shrub | *Opuntia bigelovii* |

CHARACTERISTIC SPECIES
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR

| | |
|---|---|
| Herbaceous | *Chamaesyce* sp., *Pectis papposa* |
| Shrub | *Opuntia bigelovii, Encelia farinosa, Larrea tridentata* |

VEGETATION DESCRIPTION
Globally
This association is only known from Joshua Tree National Park. Information about its global characteristics is not available without additional inventory.

JOTR
Stands of the *Opuntia bigelovii* Shrubland Association form a sparse to open shrubland with 0-1 percent cover at <1 cm tall, <1–1 percent cover at 1–25 cm tall, <1–1 percent cover at 25-50 cm

tall, 2–18 percent cover at 50 cm to 1 m tall, and <1-3 percent cover at 1–3 m tall. Total vegetative cover ranges from 4–26 percent.

This association is dominated by *Opuntia bigelovii*. Characteristic shrub species include *Chamaesyce* sp., *Encelia farinosa, Larrea tridentata*, and *Pectis papposa*. Often present are *Allionia incarnata, Hyptis emoryi, Opuntia echinocarpa, Krameria* sp., *Bebbia juncea*, and cryptobiotic crust.

OTHER NOTEWORTHY SPECIES
*Coryphantha alversonii* was found in one of three plots. *Coryphantha alversonii* is a List 4 plant in the CNPS Inventory of Rare and Endangered Plants of California (CNPS 2001). It is found in Imperial, Riverside, and San Bernardino Counties at low to high elevations (240–5,000 ft.; 73–1,500 m). (Syn: *Escobaria vivipara* var. *alversonii* in the Jepson Manual.)

CONSERVATION RANK G4 S3

RANK JUSTIFICATION
This association is local in the Sonoran Desert of Mexico, Arizona, and Southern California.

DATABASE CODE

COMMENTS
Globally

JOTR

Plots used for this description: JOTR: 39-02-2, 53-08-6, 53-08-9

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**Lotebush (*Ziziphus obtusifolia)* Unique Stands**

The shrub *Ziziphus obtusifolia* forms occasional stands in small drainages at the edge of the Colorado Desert. One stand was sampled in the park and is temporarily placed here until further information is available on its proper relationship to other alliances and associations.

*Ziziphus obtusifolia –Atriplex canescens* (JOTR: 32-08-4)

## Freshwater Wetland Vegetation

### Red Willow *(Salix laevigata)* Temporarily Flooded Alliance (Mapping Code: 15030, in part)

This alliance is not defined at the association level locally. The following general description will serve to distinguish the local stand(s):

| | |
|---|---|
| COMMON NAME | Red Willow Temporarily Flooded Alliance |
| SYNONYM | None |
| PHYSIOGNOMIC CLASS | Woodland |
| PHYSIOGNOMIC SUBCLASS | Deciduous Woodland |
| PHYSIOGNOMIC GROUP | Cold-Deciduous Woodland |
| PHYSIOGNOMIC SUBGROUP | Natural/Semi-natural |
| FORMATION | Temporarily flooded Cold-Deciduous Woodland |
| ALLIANCE | *Salix laevigata* Temporarily Flooded Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 1 |
| USFWS WETLAND SYSTEM | Wetland |

RANGE
Globally
The *Salix laevigata* Temporarily Flooded Alliance occurs throughout California and the intermountain West.

JOTR
The *Salix laevigata* Temporarily Flooded Alliance was sampled in the park on the Indian Cove 7.5 minute quadrangle.

ENVIRONMENTAL DESCRIPTION
Globally
The *Salix laevigata* Temporarily Flooded Alliance occupies temporarily flooded, saturated, freshwater habitats on floodplains; low-gradient depositions along rivers; and habitat along streams and meadow edges, from sea level to 5,600 feet (1,700 m).

JOTR

MOST ABUNDANT SPECIES
Globally

| | |
|---|---|
| Herbaceous | *Urtica dioica, Oenanthe sarmentosa* |
| *Shrub* | Baccharis pilularis, B. salicifolia, Salix *spp.,* Sambucus mexicana |
| Tree | *Salix laevigata, Alnus rhombifolia, Platanus racemosa, Populus fremontii* |

JOTR
Herbaceous *Xanthium strumarium, Datura wrightii*
Shrub *Artemisia dracunculus*
Tree *Salix laevigata*

CHARACTERISTIC SPECIES
Globally
Tree *Salix laevigata*

VEGETATION DESCRIPTION
Globally
*Salix laevigata* is sole or dominant shrub or tree in the canopy; *Alnus rhombifolia, Baccharis pilularis, B. salicifolia, Platanus racemosa, Populus fremontii, Salix* spp., and/or *Sambucus mexicana* may be present. If a shrubland, emergent trees may be present. Shrubs are < 15 m; the canopy continuous. Shrubs are sparse under any tree canopy. The ground layer is variable and may include high cover of large forbs such as *Urtica dioica* and *Oenanthe sarmentosa*.

JOTR

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G4 S3

RANK JUSTIFICATION
Stands of red willow are local and usually small in California, although the alliance ranges beyond the boundaries of California.

DATABASE CODE

COMMENTS
Globally
Willow stands may or may not be dominated by a single species. Stands of *Salix* have environmental conditions similar to Alder, Cottonwood, and other Willow alliances.

*Salix laevigata* is a fast growing Willow tree adapted to many riparian settings in the Western United States. It requires permanent moisture and is widely dispersed throughout the area by its copious, small seeds attached to cottony, filamentous hairs. It will resprout after physical stem damage, and individuals live for at least 90 years. Most natural flooding regimes maintain a matrix of young to medium aged stands; however, in flood-controlled situations, stabilized flooding regimes may enable dense stands of large, mature trees to develop, sometimes crowding riverbanks and forming arching canopies over the main watercourse.

JOTR
Many of the *Salix* in the one sampled stand in JOTR were dead.

One sample in JOTR suggested further variation than what is currently reported from the *Salix laevigata* Alliance.

*Salix laevigata/Artemisia dracunculus* (JOTR: 15-25-1)

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**Fremont Cottonwood *(Populus fremontii)* Temporarily Flooded Woodland Alliance (Mapping Code: 15040)**

This alliance is not defined at the association level locally. The following general description will serve to distinguish the local stand(s):

| | |
|---|---|
| COMMON NAME | Fremont Cottonwood Temporarily Flooded Woodland Alliance |
| SYNONYM | None |
| PHYSIOGNOMIC CLASS | Woodland |
| PHYSIOGNOMIC SUBCLASS | Deciduous Woodland |
| PHYSIOGNOMIC GROUP | Cold-Deciduous Woodland |
| PHYSIOGNOMIC SUBGROUP | Natural/Semi-natural |
| FORMATION | Temporarily Flooded Cold-Deciduous Woodland |
| ALLIANCE | *Populus fremontii* Temporarily Flooded Woodland Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 1 |
| USFWS WETLAND SYSTEM | Wetland |

RANGE
Globally
This alliance occurs in the central California coast, Southern California coast, Klamath Mountains, California coast ranges, Sierra Nevada foothills, Great Valley, Southern California mountains and valleys, Mojave Desert, Sonoran Desert, and Colorado Desert regions of California and in the western United States.

JOTR
This alliance was mapped in the northwest portion of the park.

ENVIRONMENTAL DESCRIPTION
Globally
This Alliance occupies temporarily flooded freshwater habitats on floodplains subject to high-intensity flooding; floodplains; low-gradient depositions along rivers; and along streams and meadow edges and river banks, from sea level to 7,700 feet (2,400 m).

JOTR

MOST ABUNDANT SPECIES
Globally
Tree *Populus fremontii*, *Prosopis pubescens* or *Salix* spp., *Acer negundo, Fraxinus latifolia, Juglans californica* and hybrids, *Platanus racemosa, Salix exigua, S. gooddingii, S. laevigata, S. lasiolepis, S. lucida* ssp. *lasiandra,* and/or *S. lutea*

JOTR
Tree *Populus fremontii*

CHARACTERISTIC SPECIES
Globally
Tree *Populus fremontii*

VEGETATION DESCRIPTION
Globally
*Populus fremontii* is dominant or important in the tree canopy. Trees are < 25 m; the canopy continuous or open. Shrubs and *Vitis californica* lianas are infrequent to common. The ground layer is variable.

JOTR

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G5S4

RANK JUSTIFICATION
This is a common riparian alliance of the West.

DATABASE CODE

COMMENTS
Globally
*Populus fremontii* may dominate or mix with other trees in wetland settings. Most stands have been eliminated, reduced in size and extent, and altered greatly, especially in areas supporting agriculture. Structure and composition of the remaining stands are changed as a result of hydrologic alternations, introduction of exotic species, grazing clearing, cutting for fence posts, fuel and wood projects, and other human impacts.

Trees are fast growing, short lived, and are intolerant of shade. Copious, wind-dispersed seed is produced in the spring and is viable for up to five days. Seeds germinate on moist alluvium and other recently disturbed sites. Seedlings establish in areas where subsurface water is available during the growing season. *P. fremontii* vegetatively regenerates by root suckers, but seed is the primary mode of reproduction. Trees damaged by cutting and fire resprout if the trees are not old.

*P. fremontii* is browse for livestock and wildlife and supplies cooler habitat in the summer. The fire interval was probably long in original stands. Those invaded by *Tamarix* species have a shorter fire interval of 10 to 20 years in Arizona (Ohmart *et al.* 1977).

JOTR
This alliance was observed in the park but not sampled.

---

**California Fan Palm *(Washingtonia filifera)* Seasonally Flooded Woodland Alliance (Mapping Code: 15112)**

This alliance is not defined at the association level locally. The following general description will serve to distinguish the local stand(s):

| | |
|---|---|
| COMMON NAME | California Fan Palm Seasonally Flooded Woodland Alliance |
| SYNONYM | None |
| PHYSIOGNOMIC CLASS | Woodland |
| PHYSIOGNOMIC SUBCLASS | Evergreen Woodland |
| PHYSIOGNOMIC GROUP | Temperate Broad-leaved Evergreen Woodland |
| PHYSIOGNOMIC SUBGROUP | Natural/Semi-natural |
| FORMATION | Seasonally Flooded Broad-leaved Evergreen Woodland |
| ALLIANCE | *Washingtonia filifera* Seasonally Flooded Alliance |
| CLASSIFICATION CONFIDENCE LEVEL | 1 |
| USFWS WETLAND SYSTEM | Wetland |

RANGE
Globally
The *Washingtonia filifera* Intermittently Flooded Woodland Alliance occurs in the Mojave, Colorado, and Sonoran Desert regions of California, in Arizona, and Baja California Norte, Mexico.

JOTR
This alliance was sampled at Fortynine Palms Oasis on the Queen Mountain 7.5 minute quadrangle and at Lost Palms Oasis on the Cottonwood Springs 7.5 minute quadrangle. It was also mapped at Cottonwood Springs.

ENVIRONMENTAL DESCRIPTION
Globally
This alliance occurs in intermittently flooded soils with fresh or mixosaline water chemistry and canyon waterways, often along fault lines.

JOTR

MOST ABUNDANT SPECIES
Globally
Herbaceous *Distichlis spicata*
Shrub *Salix* spp., *Atriplex canescens, A. hymenelytra, A. polycarpa, Baccharis emoryi, Encelia farinosa,* and/or *Suaeda moquinii*
Tree *Washingtonia filifera, Salix lasiolepis, Salix gooddingii, S. exigua, Platanus racemosa, Populus fremontii, Alnus rhombifolia, Prosopis glandulosa,* and/or *Fraxinus velutina*

JOTR
Herbaceous *Muhlenbergia rigens, Typha angustifolia*

Shrub *Salix exigua, Prosopis glandulosa*
Tree *Washingtonia filifera*

CHARACTERISTIC SPECIES
Globally
Herbaceous *Distichlis spicata*
Tree *Washingtonia filifera*

VEGETATION DESCRIPTION
Globally
*Washingtonia filifera* is the sole or dominant tree in the canopy. Trees are < 30 m in height, and the canopy is continuous or intermittent. Shrubs are occasional or absent. The ground layer is sparse. *Distichlis spicata* may form sparse turf.

JOTR

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G3 S2

RANK JUSTIFICATION
This alliance is only found as isolated stands at desert springs and oases. Its range includes Arizona and adjacent Baja California, Mexico. There are somewhat more than 75 stands naturally occurring in California (CNDDB 2004).

DATABASE CODE

COMMENTS
Globally
Vogl & McHargue (1966) report great floristic variation among *Washingtonia filifera* oases, however, canyon waterway oases differ consistently from those along fault lines in importance of other species besides *W. filifera*. Between 70 and 100 stands exist in California. All major *W.*

*filifera* sites have been mapped (CNDDB 2004). Variation in Anza-Borrego is defined by at least two associations.

The fan palm oases of the Colorado and adjacent Sonoran Deserts are well known and have been focal points since humans arrived in the desert more over 10,000 years ago. Natural disturbance patterns involved both flood and fire, although the latter was clearly frequently used by California Indians, and today, in a less directed way, by European immigrants for the entire known history of virtually all stands. *W. filifera* does not reproduce vegetatively, and it typically does not live for more than 150 years (Howard 1992). Seedlings require sunny, moist openings for germination. Occasional lightning fires and active burning by Indians opened up the understory for germination sites by killing other competing shrubs and trees. It did not typically kill individuals of *W. filifera* because their bark is extremely fire resistant. The death of the competing species also temporarily increased the flow of the springs or streams, affording better germination and growth of the *W.f.* seeds and seedlings (Howard 1992). Flash floods probably also created openings, allowing for germination sites. Lightning fires are an infrequent but major cause of natural fires in these stands (Howard 1992).

Many *Washingtonia filifera* oases have been destroyed by agricultural and urban development. Others have been eliminated due to loss of oases water sources. *W. filifera* is sensitive to any change in water level; either a lowering of water tables or the inundation of root systems may kill plants. Other phreatophytes competing for limited water resources can also greatly affect how much water will be available to palms. Increases of mesquite in the understory of some spring stands are probably an additional cause of the drop of water tables. *Tamarix* spp., with its extremely high evapotranspiration rate, can dry up or reduce the yield of oases seeps and springs. *Tamarix* is displacing *W. filifera* in some areas. Near the San Andreas Fault, palms receiving percolating water through rock fractures sometimes perish when the fault shifts, eliminating or relocating seeps. Outlying *W. filifera* oases are popular destinations for hikers and off-highway vehicle enthusiasts. Vegetation disturbance and vandalism are of continuing management concern.

JOTR
The stands at Cottonwood Spring may have been introduced. This may also be true at Twentynine Palms.

Several samples in JOTR suggested further variation than what is currently reported from the *Washingtonia filifera* Alliance

*Washingtonia filifera/Salix/Prosopis* (JOTR: 18B-04-1)
*Washingtonia filifera/Salix exigua/Muhlenbergia rigens* (JOTR: 34-06-3)

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# Appendix 1

## Crosswalk Between Vegetation Classification, Mapping Classification, Leary (1977) and Hogan (1977)

# Appendix 1—Crosswalk Between Vegetation Classification, Mapping Classification, Leary (1977) and Hogan (1977)

| **Vegetation Classification (Alliances in bold)** | **AIS Mapping Classification** | **Leary (1977)** | **Hogan (1977)** |
|---|---|---|---|
| **MONTANE WOODLAND AND SCRUB** | | | |
| **California Juniper *(Juniperus californica)* Wooded Shrubland Alliance** | | | |
| *Juniperus californica/Quercus cornelius-mulleri/Coleogyne ramosissima* Woodland Association | 21233 = *Quercus cornelius-mulleri – (Juniperus californica/Coleogyne ramosissima)* | Desert Woodland (table 2, column 13) | n/a |
| *Juniperus californica/Coleogyne ramosissima-Yucca schidigera* Woodland Association | 10021=*Juniperus californica/Coleogyne ramosissima – Yucca schidigera* | *Coleogyne ramosissima - Yucca schidigera - Juniperus californica* (table 2, column 7) | Desert Shrub Woodland community |
| *Juniperus californica*/(*Yucca schidigera)/Pleuraphis rigida* Woodland Association | 10033 = *Juniperus californica/(Coleogyne ramosissima – Yucca schidigera)* Super Association (Combines types 10021, 10025, & 10031); 10034 = *Juniperus californica/(Eriogonum fasciculatum/Achnatherum speciosum)* Super Association (10022 & 10023) | Desert Woodland (table 2, column 13) | Desert Shrub Woodland community |
| *Juniperus californica/Coleogyne ramosissima* Woodland Association | 10025 = *Juniperus californica/Coleogyne ramosissima* | Desert Woodland (table 2, column 13) | Desert Shrub Woodland community |

| **Vegetation Classification (Alliances in bold)** | **AIS Mapping Classification** | **Leary (1977)** | **Hogan (1977)** |
|---|---|---|---|
| *Juniperus californica/Nolina parryi* Woodland Association | 10033 = *Juniperus californica/(Coleogyne ramosissima – Yucca schidigera)* Super Association (Combines types 10021, 10025, & 10031); 10034 = *Juniperus californica/(Eriogonum fasciculatum/Achnatherum speciosum)* Super Association (10022 & 10023) | Desert Woodland (table 2, column 13) | Desert Shrub Woodland community |
| | 10029 = *Juniperus californica/Tetracoccus hallii* | *Yucca schidigera – Ambrosia dumosa* (?) | Desert Shrub Woodland community |
| | 10030 = *Juniperus californica/ Viguiera parishii – (Nolina bigelovii)* | *Yucca schidigera – Ambrosia dumosa* (?) | Desert Shrub Woodland community |
| | 10031 = *Juniperus californica/Yucca schidigera – (Tetracoccus hallii)* | *Yucca schidigera – Ambrosia dumosa* (?) | Desert Shrub Woodland community |
| | | *Juniperus californica* – mixed shrub (table 2, column 11) | |
| **Singleleaf Pinyon Pine (*Pinus monophylla)* Woodland Alliance** | | | |
| *Pinus monophylla/Quercus cornelius-mulleri* Woodland Association | 10161 = *Pinus monophylla – Quercus cornelius-mulleri* | Desert Woodland (table 2, column 13) | Chaparral-Woodland community |
| *Pinus monophylla/Juniperus californica/Achnatherum speciosum* Woodland Association | 10162 = *Pinus monophylla – (Juniperus californica) /Achnatherum speciosum* | Desert Woodland (table 2, column 13) | Chaparral-Woodland community |
| **Bigberry Manzanita *(Arctostaphylos glauca)* Shrubland Alliance** | | | Chaparral-Woodland community |

| **Vegetation Classification (Alliances in bold)** | **AIS Mapping Classification** | **Leary (1977)** | **Hogan (1977)** |
|---|---|---|---|
| **Muller's Oak (*Quercus cornelius-mulleri*) Shrubland Alliance** | | | Chaparral-Woodland community |
| *Quercus cornelius-mulleri/Eriogonum fasciculatum-Ericameria linearifolia* Shrubland Association | 21234 = *Quercus cornelius-mulleri – (Juniperus californica)* | Desert Woodland (table 2, column 13) | Chaparral-Woodland community |
| *Quercus cornelius-mulleri/Coleogyne ramosissima* Shrubland Association | 21233 = *Quercus cornelius-mulleri – (Juniperus californica/Coleogyne ramosissima)* | Desert Woodland (table 2, column 13) | Chaparral-Woodland community |
| **Rubber Rabbitbrush *(Ericameria nauseosa =Chrysothamnus nauseosus)* Shrubland Alliance** | | | n/a |
| **Round-Leaved Rabbitbrush *(Ericameria teretifolia =Chrysothamnus teretifolius)* Shrubland Alliance** | | | n/a |
| **Squaw False Willow (*Baccharis sergiloides*) Intermittently Flooded Shrubland Alliance** | | | n/a |
| **Antelope Bush *(Purshia tridentata)* Shrubland Alliance** | | | n/a |
| **Parry Nolina (*Nolina parryi)* Shrubland Alliance** | | | Chaparral-Woodland community |
| **Cheatgrass *Bromus tectorum* Annual Grassland Alliance** | | | n/a |

| **Vegetation Classification (Alliances in bold)** | **AIS Mapping Classification** | **Leary (1977)** | **Hogan (1977)** |
|---|---|---|---|
| **MOJAVEAN UPPER BAJADA SCRUB** | | | |
| **Joshua Tree (*Yucca brevifolia)* Wooded Shrubland Alliance** | | | |
| *Yucca brevifolia/Coleogyne ramosissima* Wooded Shrubland Association | 13012 = *Yucca brevifolia/Coleogyne ramosissima* | *Coleogyne ramosissima - Yucca schidigera - Yucca brevifolia (Y.s.-Y.b.- C.r* in table 2, column 6); *Yucca schidigera - Yucca brevifolia* - mixed shrub (not in table 2) | *Hilaria rigida-Coleogyne ramosissima* |
| *Yucca brevifolia/Juniperus californica/Coleogyne ramosissima* Wooded Shrubland Association | 13015 = *Yucca brevifolia – Juniperus californica/(Coleogyne ramosissima – Yucca schidigera – Ephedra nevadensis)* Super Association (13013, 13015, & 13017) | *Yucca schidigera - Yucca brevifolia - Juniperus californica - Coleogyne ramosissima* (not in table 2) | *Coleogyne ramosissima* community |
| *Yucca brevifolia/Juniperus californica/Ephedra nevadensis* Wooded Shrubland Association | 13015 = *Yucca brevifolia – Juniperus californica/(Coleogyne ramosissima – Yucca schidigera – Ephedra nevadensis)* Super Association (13013, 13015, & 13017) | *Yucca schidigera - Yucca brevifolia - Juniperus californica - Coleogyne ramosissima* (not in table 2): *Yucca schidigera - Yucca brevifolia - Juniperus californica* - mixed shrub | Desert Shrub Woodland community |
| *Yucca brevifolia/Larrea tridentata - Yucca schidigera Wooded Shrubland Association* | 13016 = *Yucca brevifolia/Larrea tridentata – (Yucca schidigera/Pleuraphis rigida)* Super Association (13011) | *Coleogyne ramosissima - Yucca schidigera - Yucca brevifolia (Y.s.-Y.b.-C.r* in table 2, column 6); *Yucca schidigera - Yucca brevifolia* - mixed shrub (not in table 2) | *Hilaria rigida-Coleogyne ramosissima* |

| **Vegetation Classification (Alliances in bold)** | **AIS Mapping Classification** | **Leary (1977)** | **Hogan (1977)** |
|---|---|---|---|
| *Yucca brevifolia/Larrea tridentata - Pleuraphis rigida* Wooded Herbaceous Association | 13016 = *Yucca brevifolia/Larrea tridentata – (Yucca schidigera/Pleuraphis rigida)* Super Association (13011) | *Yucca brevifolia – Hilaria rigida* (table 2, column 5) | *Hilaria rigida-Coleogyne ramosissima* |
| *Yucca brevifolia/Prunus fasciculata* Wooded Shrubland Association | | *Yucca brevifolia – Stipa speciosa* (table 2, column 12) | Desert Shrub Woodland community |
| **Joshua Tree (*Yucca brevifolia)* Wooded Herbaceous Alliance** | | | |
| *Yucca brevifolia/Pleuraphis rigida* Wooded Herbaceous Association | 13021 = *Yucca brevifolia/(Ephedra nevadensis – Grayia spinosa – Lycium* spp.*)/Pleuraphis rigida* Super Association | *Yucca brevifolia – Hilaria rigida* (table 2, column 5) [including *Yucca brevifolia – Hilaria rigida – Grayia spinosa* (not mapped), and *Yucca brevifolia – Hilaria rigida – Juniperus californica* (not in table 2)] | *Hilaria rigida-Coleogyne ramosissima* |
| **Blackbush (*Coleogyne ramosissima)* Shrubland Alliance** | 28023 = *Coleogyne ramosissima* – (mixed shrub) Super Association | *Coleogyne ramosissima - Yucca schidigera - Juniperus californica* (table 2, column 7) | *Coleogyne ramosissima* community |
| **California Buckwheat (*Eriogonum fasciculatum*) Shrubland Alliance** | | | *Stipa speciosa-Eriogonum fasciculatum* |
| **Desert Willow (*Chilopsis linearis)* Intermittently Flooded Shrubland Alliance** | | | n/a |
| *Chilopsis linearis* Shrubland Association | 15013 = *Chilopsis linearis/(Prunus fasciculata – Acacia greggii)* Super Association | | n/a |

| **Vegetation Classification (Alliances in bold)** | **AIS Mapping Classification** | **Leary (1977)** | **Hogan (1977)** |
|---|---|---|---|
| **Nevada Ephedra (*Ephedra nevadensis*) Shrubland Alliance** | 24010 = Nevada ephedra (*Ephedra nevadensis);* 24001 (24012) = *(Ephedra nevadensis – Pleurocoronis pluriseta – Encelia farinosa – Trixis californica – Bebbia juncea – Eriogonum fasciculatum – Lycium andersonii – Acacia greggii)* Low-Elevation Rocky Mountain Type | | n/a |
| ***California Ephedra (*Ephedra californica*) Intermittently Flooded Shrubland* Alliance** | | | |
| *Ephedra californica* Shrubland Association | | *Ambrosia dumosa* – mixed shrub (table 2, column 2) | *Hymenoclea salsola-Eriogonum californica-Eriogonum fasciculatum* |
| **Paper-Bag Bush (*Salazaria mexicana)* Shrubland Alliance** | 28140 = Paperbag Bush (*Salazaria mexicana*), 28141 = *(Salazaria mexicana)/Bromus madritensis – Bromus tectorum – Achnatherum speciosum* Postburn Type | | *Stipa speciosa-Eriogonum fasciculatum* |
| | 27001 = Dense rivulets within desert pavement – Includes: *Salazaria mexicana – Krameria* spp. *– Encelia farinosa – Hyptis emoryi – Eriogonum fasciculatum – Hymenoclea salsola – Acacia greggii – Tetracoccus hallii* | | |

| **Vegetation Classification (Alliances in bold)** | **AIS Mapping Classification** | **Leary (1977)** | **Hogan (1977)** |
|---|---|---|---|
| **Mojave Yucca *(Yucca schidigera)* Shrubland Alliance** | | | |
| *Yucca schidigera - Coleogyne ramosissima* Shrubland Association | 29032 = *Yucca schidigera – Coleogyne ramosissima* | *Coleogyne ramosissima - Yucca schidigera (Y.s.- C.r in* table 2, column 8) | *Coleogyne ramosissima* community |
| *Yucca schidigera - Larrea tridentata (- Simmondsia chinensis)* Shrubland Association | | *Yucca schidigera* – mixed shrub (table 2, column 4) | |
| *Yucca schidigera - Larrea tridentata- Ambrosia dumosa* Shrubland Association | 29033 = *Yucca schidigera – Larrea tridentata – (Ambrosia dumosa)* | *Yucca schidigera - Ambrosia dumosa* (table 2, column 3) | |
| *Yucca schidigera/Pleuraphis rigida* Shrubland Association | 29034 = *Yucca schidigera/Pleuraphis rigida* (Postfire) | *Yucca schidigera - Ambrosia dumosa* (table 2, column 3) | |
| | 29035 = *Yucca schidigera – Tetracoccus hallii* | | |
| **Desert Almond *(Prunus fasciculata)* Intermittently Flooded Shrubland Alliance** | | | |
| *Prunus fasciculata* Intermittently Flooded Shrubland Association | 32010 = Desert Almond *(Prunus fasciculata)* | | |
| **LOWER MOJAVE SCRUB** | | | |
| ***Creosote Bush (Larrea tridentata) Shrubland Alliance*** | | | |
| *Larrea tridentata* (Undifferentiated) Shrubland Association | 27022 = *Larrea tridentata* Clones, 27019 = *Larrea tridentata* Undifferentiated Playa and Sandy or Dune Top Type | *Larrea tridentata – Ambrosia dumosa* (table 2, column1) | n/a |

| **Vegetation Classification (Alliances in bold)** | **AIS Mapping Classification** | **Leary (1977)** | **Hogan (1977)** |
|---|---|---|---|
| *Larrea tridentata/Pleuraphis rigida* Shrubland Association | | *Larrea tridentata – Ambrosia dumosa* (table 2, column1) | *Hilaria rigida-Larrea tridentata* community |
| *Larrea tridentata - Hymenoclea salsola* Shrubland Association | 27011 = *Larrea tridentata – (Ambrosia dumosa) – Hymenoclea salsola* Low Energy Wash Type | *Larrea tridentata – Ambrosia dumosa* (table 2, column1) | *Cassia armata-Larrea tridentata* community |
| **Creosote Bush - Burro Bush (*Larrea tridentata - Ambrosia dumosa*) Shrubland Alliance** | 27030 = *Larrea tridentata*/*Ambrosia dumosa* | | |
| *Larrea tridentata - Ambrosia dumosa* Shrubland Association | 27011 = *Larrea tridentata – (Ambrosia dumosa) – Hymenoclea salsola* Low-Energy Wash Type, 27031 = *Larrea tridentata – Ambrosia dumosa* Generic – Fan & Slopes | *Larrea tridentata – Ambrosia dumosa* (table 2, column1) | *Ambrosia dumosa* community (with *Larrea* and *Hilaria*) |
| *Larrea tridentata - Ambrosia dumosa-Krameria grayi* Shrubland Association | | *Larrea tridentata – Ambrosia dumosa* (table 2, column1) | *Ambrosia dumosa* community (with *Larrea* and *Hilaria*) |
| *Larrea tridentata - Ambrosia dumosa-Psorothamnus schottii* Shrubland Association | 27047 = *Larrea tridentata – Ambrosia dumosa* – (*Ephedra californica– Senna armata – Hymenoclea salsola – Psorothamnus schottii*) Low Energy Wash Type | *Larrea tridentata – Ambrosia dumosa* (table 2, column1) | n/a |
| *Larrea tridentata - Ambrosia dumosa-Pleuraphis rigida* Shrubland Association | 27021 = *Larrea tridentata – (Ambrosia dumosa)/Pleuraphis rigida* Sandy Type | *Larrea tridentata – Ambrosia dumosa* (table 2, column 1) | *Ambrosia dumosa* community (with *Larrea* and *Hilaria*) |

| **Vegetation Classification (Alliances in bold)** | **AIS Mapping Classification** | **Leary (1977)** | **Hogan (1977)** |
|---|---|---|---|
| *Larrea tridentata - Ambrosia dumosa-Senna armata* Shrubland Association | 27047 = *Larrea tridentata – Ambrosia dumosa –* (*Ephedra californica– Senna armata – Hymenoclea salsola – Psorothamnus schottii*) Low-Energy Wash Type | *Larrea tridentata – Ambrosia dumosa* (table 2, column 1) | *Cassia armata-Larrea tridentata* community |
| *Larrea tridentata - Ambrosia dumosa-Yucca schidigera* Shrubland Association | 27045 = *Larrea tridentata – Ambrosia dumosa – Yucca schidigera – (Senna armata)* Toe Slopes & Steeper Fan Type | *Larrea tridentata – Ambrosia dumosa* (table 2, column 1) | *Ambrosia dumosa* community (with *Larrea* and *Hilaria*) |
| *Larrea tridentata - Ambrosia dumosa-Encelia farinosa* Shrubland Association | | *Larrea tridentata – Ambrosia dumosa* (table 2, column 1) | *Encelia farinosa-Eriogonum fasciculatum-Ambrosia dumosa* community |
| | 27043 = *Larrea tridentata – (Ambrosia dumosa) – Tetracoccus hallii – (Yucca schidigera)* | | *Ambrosia dumosa* community (with *Larrea* and *Hilaria*) |
| | 27046 = *Larrea tridentata – (Ambrosia dumosa – Viguiera parishii)* Higher-Elevation Type | | n/a |
| **Hall's Tetracoccus *(Tetracoccus hallii) Unique Stands*** | 28180 = Tetracoccus *(Tetracoccus hallii* | | n/a |
| ***Four-wing saltbush (Atriplex canescens)* Shrubland Alliance** | 28080 = Four-wing Saltbush *(Atriplex canescens)* | | n/a |

| **Vegetation Classification (Alliances in bold)** | **AIS Mapping Classification** | **Leary (1977)** | **Hogan (1977)** |
|---|---|---|---|
| **Cheesebush (*Hymenoclea salsola*) Shrubland Alliance** | 28110 = Cheesebush *(Hymenoclea salsola);* 27001 = Dense rivulets within desert pavement – Includes: *Salazaria mexicana – Krameria* spp. – *Encelia farinosa – Hyptis emoryi – Eriogonum fasciculatum – Hymenoclea salsola – Acacia greggii – Tetracoccus hallii* | | *Hymenoclea salsola-Ephedra californica-Eriogonum fasciculatum* |
| **Paniculate Rabbitbrush *(Ericameria paniculata =Chrysothamnus paniculatus)* Shrubland Alliance** | | | n/a |
| **Parish Viguiera (*Viguiera parishii)* Shrubland Alliance** | 28130 = Desert Sunflower *(Viguiera parishii)* | | |
| *Viguiera parishii/Eriogonum fasciculatum* Shrubland Association | 28133 = *Viguiera parishii – (Ephedra nevadensis – Eriogonum fasciculatum – Nolina bigelovii)* High-Elevation Rocky Mountain Types | *Ambrosia dumosa* – mixed shrub (table 2, column 2) | n/a |
| **Anderson's desert-thorn (*Lycium andersonii*) Shrubland Alliance** | | | |
| *Lycium andersonii – Simmondsia chinensis s– Pleuraphis rigida* Shrubland Association | 24001 (24012) = (*Ephedra nevadensis – Pleurocoronis pluriseta – Encelia farinosa – Trixis californica – Bebbia juncea – Eriogonum fasciculatum – Lycium andersonii – Acacia greggii)* Low-Elevation Rocky Mountain Type | *Ambrosia dumosa* – mixed shrub (table 2, column 2) | n/a |

| **Vegetation Classification (Alliances in bold)** | **AIS Mapping Classification** | **Leary (1977)** | **Hogan (1977)** |
|---|---|---|---|
| **Catclaw *(Acacia greggii)* Shrubland Alliance** | | | |
| *Acacia greggii - Prunus fasciculata* Shrubland Association | 36016 = *Acacia greggii – (Lycium cooperi – Prunus fasciculata)* High-Elevation Wash Type | | n/a |
| *Acacia greggii - Bebbia juncea* Shrubland Association | 36015 = *Acacia greggii – (Larrea tridentata Hymenoclea salsola – Peucephyllum schottii – Bebbia juncea – Ephedra californica)* Low-Elevation Wash Type | | n/a |
| *Acacia greggii - Hyptis emoryi* Shrubland Association | 36015 = *Acacia greggii – (Larrea tridentata Hymenoclea salsola – Peucephyllum schottii – Bebbia juncea – Ephedra californica)* Low-Elevation Wash Type | | n/a |
| | 36017 = *Acacia greggii – (Viguiera parishii – Eriogonum fasciculatum)* Upland slope type | | n/a |
| **Burro Bush *(Ambrosia dumosa)* Dwarf Shrubland Alliance** | 43013 = *Ambrosia dumosa – Senna armata – (Psorothamnus schottii)* Eastern Pediment Type | | |
| *Ambrosia dumosa - Pleuraphis rigida* Dwarf Shrubland Association | 43014 = *Ambrosia dumosa – (Eriogonum fasciculatum – Lycium andersonii/Pleuraphis rigida)* Western Mountain Type (Hexie Mountains) | *Ambrosia dumosa* – mixed shrub (table 2, column 2) | *Ambrosia dumosa* community (with *Larrea* and *Hilaria*) |

| Vegetation Classification (Alliances in bold) | AIS Mapping Classification | Leary (1977) | Hogan (1977) |
|---|---|---|---|
| **Big Galleta *(Pleuraphis rigida)* Grassland Alliance** | 59010 = Big Galleta *(Pleuraphis rigida)* | | |
| *Pleuraphis rigida - Atriplex canescens* Grassland Association | 59010 = Big Galleta *(Pleuraphis rigida)* | *Hilaria rigida – Oryzopsis hymenoides* | n/a |
| Common Mediterranean Grass *(Schismus barbatus)* Unique Stands | | | |
| **SONORAN DESERT WASH WOODLAND AND SCRUB** | | | |
| **Desert Willow (*Chilopsis linearis)* Intermittently Flooded Shrubland Alliance** | | | |
| *Chilopsis linearis* Shrubland Association | 15012 = *Chilopsis linearis – Psorothamnus spinosus – (Cercidium floridum/Acacia greggii)* | | n/a |
| **Blue Palo Verde (*Cercidium floridum*) Woodland Alliance** | 16013 = *Cercidium floridum/Larrea tridentata* | | n/a |
| *Cercidium floridum/Hyptis emoryi* Association | 16015 = *Cercidium floridum/Hyptis emoryi* (includes 16011, 16012, 16014) | *Larrea tridentata – Ambrosia dumosa* (table 2, column 1) | n/a |
| *Cercidium floridum/Chilopsis linearis* Association | | *Larrea tridentata – Ambrosia dumosa* (table 2, column 1) | n/a |
| **Ironwood *(Olneya tesota)* Woodland Association** | | | n/a |
| *Olneya tesota/Hyptis emoryi* Association | 16025 = *Olneya tesota – (Cercidium floridum/Hyptis emoryi)* Wash Type | | n/a |

| **Vegetation Classification (Alliances in bold)** | **AIS Mapping Classification** | **Leary (1977)** | **Hogan (1977)** |
|---|---|---|---|
| | 16024 = *Olneya tesota/(Larrea tridentata – Encelia farinosa)* Fan Type | | n/a |
| **Smoketree (*Psorothamnus spinosus)* Intermittently Flooded Shrubland Alliance** | | | |
| *Psorothamnus spinosus- Hyptis emoryi-Acacia greggii* Association | 16035 = *Psorothamnus spinosus*/(*Hyptis emoryi – Acacia greggii*) Narrow High-Energy Wash Type | *Larrea tridentata – Ambrosia dumosa* (table 2, column 1) | n/a |
| *Psorothamnus spinosus - Ephedra californica* Association | 16034 = *Psorothamnus spinosus*/*(Ephedra californica – Hymenoclea salsola)* Broad-Low Energy Sandy Wash Type | *Larrea tridentata – Ambrosia dumosa* (table 2, column 1) | n/a |
| **Mesquite (*Prosopis glandulosa)* Woodland Alliance, Shrubland Alliance Complex** | 16040 = Mesquite (*Prosopis glandulosa)* | | n/a |
| **Creosote Bush – Brittlebush (*Larrea tridentata - Encelia farinosa*) Shrubland Alliance** | | | |
| *Larrea tridentata - Encelia farinosa - Ambrosia dumosa* Shrubland Association | 27057 = *Larrea tridentata – Encelia farinosa (Ambrosia dumosa* – mixed shrub) Super Alliance | *Larrea tridentata – Ambrosia dumosa* (table 2, column 1) | n/a |
| *Larrea tridentata - Encelia farinosa* Shrubland Association | 27050 = Creosote bush *(Larrea tridentata)*/Brittlebush *(Encelia farinosa)* | *Larrea tridentata – Ambrosia dumosa* (table 2, column 1) | n/a |

| **Vegetation Classification (Alliances in bold)** | **AIS Mapping Classification** | **Leary (1977)** | **Hogan (1977)** |
|---|---|---|---|
| *Larrea tridentata - Encelia farinosa-Fouquieria splendens* Shrubland Association | 27056 = *Larrea tridentata – Encelia farinosa – Fouquieria splendens* | Southern bench | n/a |
| **Brittlebush *(Encelia farinosa)* Shrubland Alliance** | 28033 = *Encelia farinosa* Association | | |
| ***Desert Holly (Atriplex hymenelytra)* Shrubland Alliance** | 28070 = Desert Holly *(Atriplex hymenelytra)* | | |
| *Atriplex hymenelytra - Larrea tridentata-Ambrosia dumosa* Shrubland Association | | *Larrea tridentata – Ambrosia dumosa* (table 2, column 1) | n/a |
| **Desert Lavender *(Hyptis emoryi)* Intermittently Flooded Shrubland Alliance** | 28200 = Desert Lavender *(Hyptis emoryi);* 27001 = Dense rivulets within desert pavement – *Includes: Salazaria mexicana – Krameria* spp. – *Encelia farinosa – Hyptis emoryi – Eriogonum fasciculatum – Hymenoclea salsola – Acacia greggii – Tetracoccus hallii* | | n/a |
| *Hyptis emoryi* Shrubland Association | 28203 = *Hyptis emoryi* Association | *Larrea tridentata – Ambrosia dumosa* (table 2, column 1) | n/a |
| **Chuparosa *(Justicia californica)* Unique Stands** | 28170 = Chuparosa *(Justicia californica)* | | |
| | 28171 = *Justicia californica – Hyptis emoryi* | | n/a |
| **Teddy-Bear Cholla *(Opuntia bigelovii)* Shrubland Association** | | | |
| ***Opuntia bigelovii* Shrubland Association** | 29050 = Teddy-Bear Cholla *(Opuntia bigelovii)* | *Ambrosia dumosa* – mixed shrub (table 2, column 2) | n/a |

| Vegetation Classification (Alliances in bold) | AIS Mapping Classification | Leary (1977) | Hogan (1977) |
|---|---|---|---|
| **Lotebush (*Ziziphus obtusifolia)* Unique Stand** | | | n/a |
| **FRESHWATER WETLAND VEGETATION** | | | |
| **Red Willow *(Salix laevigata)* Temporarily Flooded Alliance** | | | |
| | 15030 = Mixed Willow | | |
| **Fremont Cottonwood *(Populus fremontii)* Temporarily Flooded Woodland Alliance** | 15040 = Fremont Cottonwood *(Populus fremontii)* | | n/a |
| **California Fan Palm *(Washingtonia filifera)* Seasonally Flooded Woodland Alliance** | 15112 = *Washingtonia filifera/Salix exigua/Muhlenbergia rigens* | | n/a |
| **Noncrosswalked Types** | | | |
| | | Granitic outcrop (table 2, columns 9 and 10) | |
| | 60000 = Annual Grassland | | |
| | 90100 – Desert Pavement | | |

# Appendix 2

## Relevé Field Form and Codes

# Appendix 2. Relevé Field Form and Codes

Note: The full relevé protocol can be viewed at the California Native Plant Society's Web site, http://www.cnps.org/programs/vegetation/PDFs/Releve_protocol.pdf. The protocol for this project was based on the CNPS protocol.

# JOSHUA TREE N.P. VEGETATION MAPPING FIELD FORM

(revised 10/3/00)

Page_____ of _____

**Cover Class Intervals: 1 (<1%), 2 (1–5%), 3 (>5–15%), 4 (>15–25%), 5 (>25–50%), 6 (>50–75%), 7 (>75%)**

*G=Ground (<0.5 m), S=Shrub (0.5-3.0 m), T=Tree (>3.0 m)*

***Layer***

| G | S | T | Vascular Plant Name or Moss/Lichen Cryptogamic Crust Cover | Final Species Determination | Cover Class | % |
|---|---|---|---|---|---|---|
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| | | | | | | |

Total Vegetation Cover (Class): _____ Total Tree_____ Total Shrub _____ Total Ground _____ Total Nonnative _____

%: _____ _____ _____ _____ _____

**(FILL OUT THE TOTALS PORTION IMMEDIATELY ABOVE ONLY ONE TIME PER FIELD FORM!)**

# JOSHUA TREE N.P. VEGETATION MAPPING FIELD FORM

(revised 10/03/00)
Page_____ of _____
***See code list for italicized fields***

POLYGON #: _____ RELEVÉ #: _____ AIRPHOTO #: _____Date: _____/ _____/ _____

Landowner (check one): BLM ____ NPS ___ DoD: Army___ Navy___Air Force___ Marines___ Private (owner if known) _____

State Lands: Generic _____ Department of Fish and Game _____ State Parks _____

GPS Unit Name: _____
USGS Quad: _____ 7.5 or 15' 7 (circle one) Air Photo #: _____

Contact Person: | Observer(s):

Elevation (ft.)_____ *Slope (code)* _____*Aspect (code)* _____ *Landform (code)* _____ *Microtopography (code)* _____

Selected Waypoint # : _____ UTMN _____ UTME _____

Actual Centroid of Plot: UTMN _____ UTME _____ Precision ∀ _____ m.

NVC Vegetation Group*:* _____
(Combined name from below 3 columns □)

| Leaf Phenology (of dominant stratum): | Leaf Type (of dominant stratum): | Physiognomic Class: |
|---|---|---|
| <u>Trees and Shrubs</u> | 1_____Broad-leaved | 1_____Forest |
| 1_____Evergreen | 2_____Needle-leaved | 2_____Woodland |
| 2_____Cold-deciduous | 3_____Microphyllous | 3_____Shrubland |
| 3_____Drought-deciduous | 4_____Graminoid | 4_____Dwarf Shrubland |
| 4_____Mixed evergreen-cold-deciduous | 5_____Broad-leaved herbaceous | 5_____Herbaceous (including grassland and forb) |
| 5_____Mixed evergreen-drought-deciduous | 6_____Pteridophyte | 6_____Nonvascular |
| <u>Herbs</u> | 7_____Extremely xeromorphic | 7_____Sparsely Vegetated |
| 6_____Annual | 8_____Mixed broad and needle-leaved | |
| 7_____Perennial | 9_____Hydromorphic | |

## Vegetation Description

Preliminary Vegetation Name_____ Other same type polygons (Yes or No)
_____(Mark on Xerox of photo)

| Adjacent Vegetation: (Indicate preliminary name by listing of major species & indicate location on Xerox of photo.) | |
|---|---|
| | |
| | |
| | |
| | |

*Impact Codes* _____ _____ _____ _____ _____ _____ _____ _____
(List codes in order, with most significant first.)

Intensity _____ _____ _____ _____ _____ _____ _____ _____
1. Light 2. Moderate 3. Heavy (List beneath each impact code.)

Leaf Phenology: Ground _____ Shrub _____ Tree _____ 7□ <u>Designate</u> (Early, Peak, Late)

Plot Shape (square, rectangle, triangle, circle, entire stand) _____ **NOTE:** All desert shrub and grassland plots should be 1000$m^2$ (Circle Diameter=35.6m).

All dense scrub and wetland herb/graminoid plots should be 400$m^2$ (CircleDiameter=22.8m).

Plot size (length of rectangle edges or if circle-radius) _ (m.)

Is plot representative of Polygon? Yes or No (Circle one) If **no**, why not?_____

**Height Classes for Vegetation Strata & Cover Estimates** (see cover class intervals-**below** )

| Name of Strata | Moss/Lichen | 0-25 cm. | 25-50 cm. | 0.5-1 m. | 1-3 m. | 3-5 m. | 5-10 m. | 10-20 m. | 20-30 m. | >30 m. |
|---|---|---|---|---|---|---|---|---|---|---|
| Cover Class | | | | | | | | | | |
| percent Estimate | | | | | | | | | | |

**Cover Class Intervals: 1 (<1%), 2 (1–5%), 3 (>5–15%), 4 (>15–25%), 5 (>25–50%), 6 (>50–75%), 7 (>75%)**

**Coarse fragments and soils information** (See cover class intervals-**above** )

**Cover Class:** Basal area of living plants _____ Fines _____ Bedrock _____ Gravel _____ Cobble _____ Stone _____ Boulder _____ Litter _____
<3mm, <76mm 76mm-25cm >25-61cm >61cm Organic matter includes duff & fallen wood covering ground (subtract living plant stems)

**(Optional) %:** _____ _____ _____ _____ _____ _____ _____ _____

**Soil Texture:** _____ **Rock/Sediment Composition:** _____

Community Type (circle one): Wetland/Upland If Community Type=W (*See Artificial Keys to Cowardin Systems and Names.*)

Cowardin System _____ Subsystem _____ Class _____Channel form (if riverine)_____
(Straight, Meandering, Braided)

**Site Location and Plot Description**

**Photographs** *Include chalkboard with sample # and stadia for scale.*

**Site History**

**Unknown Specimens** *List code, identification notes (e.g., genus, condition of specimen) of unknowns.*

| **Additional Comments** |
| --- |
| |
| |
| **Sensitive Species** *List species observed and GPS UTM=s. Estimate size and extent of local population(s).* |
| |

# Appendix 3

## NPS Vegetation Mapping Program Joshua Tree National Park—Final Mapping Classification

# Appendix 3. USGS—NPS Vegetation Mapping Program Joshua Tree National Park—Final Mapping Classification

This is a hierarchical summary of the relationship of the vegetation classification to the mapping classification, based on analysis of 556 plots assigned by Todd Keeler-Wolf & AIS-DFG-NPS Classification-Mapping Meeting in 2001.

Five-digit map unit codes have been assigned to all bona fide associations or alliances. However, not all of these were deemed mappable. **Boldface** indicates mapped Association or Alliance types.

In some cases, multiple association mapping units (MAMU) have been identified. These are indicated as such in parenthesis. These use associations that cross alliance types. Super Associations use associations within the same alliance.

Types indicated by an ***** are new associations or alliances based on the analysis of data collected for this study.

**FORMATION/ALLIANCE/ASSOCIATION**

**Tree-Dominated Alliances/Associations**

10000 = Rounded-crowned temperate or subpolar needle-leaved evergreen woodland

**10020 = California Juniper**

**10021 = *Juniperus californica/Coleogyne ramosissima - Yucca schidigera***

*Juniperus californica/Achnatherum speciosum* (10022)

*Juniperus californica/Eriogonum fasciculatum* (10023)

*Juniperus californica - Quercus cornelius-mulleri* (10024 - Use 21234 MAMU)

**10025 = *Juniperus californica/Coleogyne ramosissima***

*Juniperus californica* - undifferentiated/*Encelia farinosa* (10026)

******Juniperus californica – Prunus fasciculatum*

***10029 = *Juniperus californica/Tetracoccus hallii***

***10030 = *Juniperus californica/Viguiera parishii – (Nolina bigelovii)***

***10031 = *Juniperus californica/Yucca schidigera – (Tetracoccus hallii)***

*****Juniperus californica/Nolina parryi*

**Mapping Units**

**10033 = *Juniperus californica/(Coleogyne ramosissima – Yucca schidigera)* Super Association** (includes 10021 & 10031)

**10034 = *Juniperus californica/(Eriogonum fasciculatum/Achnatherum speciosum)* Super Association (includes 10022 & 10023)**

**10160 = Singleleaf Pinyon**

**10161 = *Pinus monophylla - Quercus cornelius-mulleri***

10162 = *Pinus monophylla - Juniperus californica/Achnatherum speciosum*

13000 = Succulent extremely xeromorphic evergreen woodland

**13010 = Joshua Tree**

*Yucca brevifolia/Larrea tridentata – Yucca schidigera/Pleuraphis rigida* (13011)

**13012 = Yucca brevifolia/Coleogyne ramosissima**

*Yucca brevifolia - Juniperus californica/Coleogyne ramosissima* (13013)

*Yucca brevifolia/Prunus fasciculatum* (13014)

*****Yucca brevifolia – Juniperus californica/Ephedra nevadensis*

*****Yucca brevifolia – Larrea tridentata – Yucca schidigera*

*****Yucca brevifolia – Juniperus californica/Yucca schidigera*

*****Yucca brevifolia – Atriplex canescens*

**Mapping Units**

**13015 = *Yucca brevifolia – Juniperus californica/(Coleogyne ramosissima – Yucca schidigera – Ephedra nevadensis)* Super Association (13013, 13015, & 13017)**

**13016 = *Yucca brevifolia/Larrea tridentata – (Yucca schidigera/Pleuraphis rigida)* Super Association (13011 & 13016)**

**13021 = *Yucca brevifolia/(Ephedra nevadensis – Grayia spinosa – Lycium* spp.)/*Pleuraphis rigida* Super Association**

15000 = Temporarily flooded cold-deciduous woodland

15010 = Desert Willow

*Chilopsis linearis – Psorothamnus spinosa* (15011)

*****Chilopsis linearis – Prunus fasciculatum*

*****Chilopsis linearis – Acacia greggii*

*****Chilopsis linearis – Brandegea bigelovii*

**Mapping Units**

**15012 = *Chilopsis linearis – Psorothamnus spinosus - (Cercidium floridum/Acacia greggii)* MAMU**

**15013 = *Chilopsis linearis/(Prunus fasciculatum – Acacia greggii)* Super Association**

**15030 = Mixed Willow**

**15040 = Fremont Cottonwood**

*Populus fremontii - Washingtonia filifera* (no plots) (15041)

*Populus fremontii/Salix spp.* (no plots) (15042)

15060 = *Ziziphus obtusifolia* (not mappable at alliance level)

15110 = Seasonally flooded temperate broad-leaf evergreen woodland

15110 = California Fan Palm

***15112 = *Washingtonia filifera/Salix exigua/Muhlenbergia rigens***

16000 = Thorn extremely xeromorphic deciduous woodland

**16010 = Blue Palo Verde**

*Cercidium floridum/Hymenoclea salsola* (16011)

*Cercidium floridum/Justicia californica* (16012)
**16013 = *Cercidium floridum/Larrea tridentata***
*Cercidium floridum – Psorothamnus spinosus* (16014)
******Cercidium floridum/Tetracoccus hallii*
***16015 = *Cercidium floridum/Hyptis emoryi* (includes 16011, 16012, 16014)**

16020 = Ironwood
*Olneya tesota/Fouquieria splendens/Larrea tridentata* (16021)
*Olneya tesota/Encelia farinosa/Hymenoclea salsola* (16022)
*Olneya tesota/Cercidium floridum* (16023)
******Olneya tesota/Hyptis emoryi*
**Mapping Units**
**16024 = *Olneya tesota/(Larrea tridentata - Encelia farinosa)* Fan Type; includes 16021 16022)**
**16025 = *Olneya tesota - (Cercidium floridum/Hyptis emoryi)* Wash Type; includes 16023)**

16030 = Smoke Tree
*Psorothamnus spinosus/Hymenoclea salsola* (16031)
*Psorothamnus spinosus - Acacia greggii* (16032)
*Psorothamnus spinosus - Chilopsis linearis* (16033 - Use 15015)
******Psorothamnus spinosus/Ephedra californica*
******Psorothamnus spinosus/Eriogonum fasciculatum*
******Psorothamnus spinosus/Hyptis emoryi – Acacia greggii* (includes 16031)
**Mapping Units**
**16034 = *Psorothamnus spinosus/(Ephedra californica – Hymenoclea salsola)***
**Broad Low-Energy Sandy Wash Type**
**16035 = *Psorothamnus spinosus/(Hyptis emoryi– Acacia greggii)***
**Narrow High-Energy Wash Type**

**16040 = Mesquite (Map to Alliance Level)**
16041 = *Prosopis glandulosa/Isomeris arborea*
16042 = *Prosopis glandulosa/Atriplex canescens*

16050 = Indigo Bush
16051 = *Psorothamnus schottii – Larrea tridentata a/ Ambrosia dumosa (*moved to *Larrea)*

**Shrub-Dominated Alliances/Associations**

21000 = Sclerophyllous temperate broad-leaved evergreen shrubland
21210 = Bigberry Manzanita
21211 = *Arctostaphylos glauca – Quercus cornelius-mulleri*
21220 = Jojoba
21230 = Muller Oak Alliance
*Quercus cornelius-mulleri/Coleogyne ramosissima* (21232)
******Quercus cornelius-mulleri – Juniperus californica/Coleogyne ramosissima*

**Mapping Units**
**21233 = *Quercus cornelius-mulleri – (Juniperus californica/Coleogyne ramosissima)* MAMU**
**21234 = *Quercus cornelius-mulleri – (Juniperus californica)* MAMU**

22000 = Temporarily flooded temperate broad-leaved evergreen shrubland
22020 = Arrow-Weed
*Pluchea sericea* (no plots) (22021)

23000 = Needle-leaved evergreen shrubland
23010 = Desert Fir
*Peucephyllum schottii/Gutierrezia microcephala* (23011)

24000 = Microphyllous evergreen shrubland
**Mapping Units**
**24001 = *(Ephedra nevadensis – Pleurocoronis pluriseta – Encelia farinosa - Trixis californica – Bebbia juncea – Eriogonum fasciculatum – Lycium andersonii – Acacia greggii)* Low-Elevation Rocky Mountain Type**

24010 = Nevada Ephedra (not mappable at alliance level)
*Ephedra nevadensis* (24011)
**Ephedra nevadensis – Viguiera parishii*

*24020 = California Ephedra (not mappable at alliance level)
**Ephedra californica – Hymenoclea salsola*
**Ephedra californica – Viguiera parishii/Pleuraphis rigida*

27000 = Broad-leaved and microphyllous evergreen extremely xeromorphic subdesert shrubland
27001 = *(Salazaria mexicana – Krameria* spp.*– Encelia farinosa – Hyptis emoryi – Eriogonum fasciculatum – Hymenoclea salsola – Acacia greggii – Tetracoccus hallii)* rivulets within desert pavement

**27010 = Creosote bush**
*Larrea tridentata/Pleuraphis rigida* (Wash Type) (27012)
*Larrea tridentata/Hymenoclea salsola* (27013)
*Larrea tridentata - Coleogyne ramosissima/Ephedra nevadensis -Eriogonum fasciculatum/Encelia farinosa* (27014)
*Larrea tridentata/Viguiera parishii - Eriogonum fasciculatum* (27015)
*Larrea tridentata - Yucca schidigera/Ephedra californica* (27016)
*Larrea tridentata* (Undifferentiated) often with annuals (27017)
*Larrea tridentata/Encelia farinosa* (27018)
**27019 = Larrea Tridentata Undifferentiated Playa and Sandy or Dune Top Type**
*Larrea tridentata/Pleuraphis rigida* (Dune Top) (27021)
***27022 = Larrea Tridentata Clones***
*Larrea tridentata/(Bebbia juncea - Trixis californica - Pleurocoronis pluriseta – Viguiera parishii)* (27023)
**Larrea tridentata – Ephedra californica*/cryptobiotic crust
**Larrea tridentata – Senna armata – Ephedra californica*
**Larrea tridentata – Justicia californica*

**Larrea tridentata – Psorothamnus schottii*
**Larrea tridentata/Brandegea bigelovii*
**Larrea tridentata – Tetracoccus hallii*
**Larrea tridentata – Lycium andersonii*
**Larrea tridentata – Viguiera parishii*

**Mapping Units**
**27011 = *Larrea tridentata – (Ambrosia dumosa) – Hymenoclea salsola* Low-Energy Wash Type (includes types 27012, 27013, 27037)**
**27021 = *Larrea tridentata – (Ambrosia dumosa)/Pleuraphis rigida* Sandy Type (includes types 27021)**

27030 = Creosote Bush/White Bursage

**27031 = *Larrea tridentata – Ambrosia dumosa* Generic – Fans & Slopes**

*Larrea tridentata - Ambrosia dumosa* with *Atriplex hymenelytra* (27032)
*Larrea tridentata - Ambrosia dumosa - Lycium andersonii* (27033)
*Larrea tridentata - Ambrosia dumosa - Krameria grayi* (27034)
*Larrea tridentata - Ambrosia dumosa - Encelia farinosa* (27035)
*Larrea tridentata - Ambrosia dumosa - Ephedra californica* (27036)
*Larrea tridentata - Ambrosia dumosa - Hymenoclea* salsola (27037)
*Larrea tridentata - Ambrosia dumosa - Pleuraphis rigida* (27038)
*Larrea tridentata - Ambrosia dumosa - Senna armata* (27039)
*Larrea tridentata - Ambrosia dumosa* (Generic – Slope) (27041) (Include with 27031)
**27043 = *Larrea tridentata – (Ambrosia dumosa) - Tetracoccus hallii – (Yucca schidigera)* (Use as MAMU)**
*Larrea tridentata - Ambrosia dumosa - Yucca schidigera* (27044)
**Larrea tridentata - Ambrosia dumosa* Sparse
**Larrea tridentata - Ambrosia dumosa - Psorothamnus schottii*
**Larrea tridentata - Ambrosia dumosa - Viguiera parishii*
**Larrea tridentata – Ambrosia dumosa – Petalonyx thurberi*

**Mapping Units**
27045 = *Larrea tridentata – Ambrosia dumosa – Yucca schidigera – (Senna armata)* Toe Slopes & Steeper Fans Type
**27046 = *Larrea tridentata – (Ambrosia dumosa – Viguiera parishii)* Higher-Elevation Type**
**27047 = *Larrea tridentata – Ambrosia dumosa – (Ephedra californica – Senna armata – Hymenoclea salsola – Psorothamnus schottii)* Low-Energy Wash Type**

27050 = Creosote Bush/Brittlebush

*Larrea tridentata - Encelia farinosa* (Generic - Slope) (27051)
*Larrea tridentata - Encelia farinosa with Ambrosia dumosa* (Slope) (27052)
*Larrea tridentata - Encelia farinosa* (Generic – Fan) (27053)
*Larrea tridentata - Encelia farinosa with Ambrosia dumosa* (Fan) (27042)
*Larrea tridentata - Encelia farinosa with Hymenoclea salsola* (27054)
**Larrea tridentata – Encelia farinosa – Ambrosia dumosa*

***27056 = *Larrea tridentata – Encelia farinosa – Fouquieria splendens***
**Larrea tridentata – Encelia farinosa – Bebbia juncea*
**Mapping Units**
**27057 = *Larrea tridentata – Encelia farinosa* – *(Ambrosia dumosa* – mixed shrub) Super Alliance**

28000 = Facultatively deciduous extremely xeromorphic subdesert shrubland

28020 = Blackbush
*Coleogyne ramosissima -Yucca schidigera/Ambrosia dumosa* (28021)
*Coleogyne ramosissima/Pleuraphis rigida - Eriogonum fasciculatum - Hymenoclea salsola* (28022)
**Coleogyne ramosissima/Pleuraphis rigida*
**Coleogyne ramosissima – Lycium andersonii*
**Coleogyne ramosissima – Tetracoccus hallii – Ambrosia dumosa*
**Mapping Units**
**28023 = *Coleogyne ramosissima* – (mixed shrub) Super Association**

28030 = Brittlebush
*Encelia farinosa - Ambrosia dumosa* (28031)
*Encelia farinosa - Peucephyllum schottii* (28032)
**Encelia farinosa – Ambrosia dumosa – Lycium andersonii*
**Encelia farinosa – Ambrosia dumosa – Fagonia laevis*
**28033 = *Encelia farinosa* Association** (Includes 28031, 28032)

28060 = California Buckwheat (not mappable at Alliance Level)
*Eriogonum fasciculatum –Undifferentiated* (28061)
*Eriogonum fasciculatum - Salazaria mexicana* (28062)

**28070 = Desert holly**
*Atriplex hymenelytra – Larrea tridentata - Ambrosia dumosa* (28071)

**28080 = Four-wing saltbush**
*Atriplex canescens/Bromus madritensis* (28082)
**Atriplex canescens/Achnatherum speciosum*

28100 = Ocotillo (not mappable at alliance level)
*Fouquieria splendens* (no plots) (28101)

8110 = Cheesebush (28113)
*Hymenoclea salsola - Ephedra californica* (28111)
*Hymenoclea salsola - Senna armata* (28112)
**Hymenoclea salsola – Salazaria mexicana*
**Hymenoclea salsola – Larrea tridentata*
**Hymenoclea salsola – Senna armata*
**Hymenoclea salsola – Psorothamnus armata*
**Hymenoclea salsola – Tetracoccus hallii*

28120 = Paniculate Rabbitbrush (not mappable at alliance level)
*Ericameria paniculata – Acacia greggii* (28121)

28130 = Desert sunflower (28131)
*Viguiera parishii - Encelia farinosa* (28132)
**Viguiera parishii – Ephedra nevadensis*

*Viguiera parishii – Eriogonum fasciculatum*

**Mapping Units**

**28133 = *Viguiera parishii – (Ephedra nevadensis – Eriogonum fasciculatum – Nolina bigelovii)* High-Elevation Rocky Eastern Mountain Type**

28140 = Paper-Bag Bush (not mappable at alliance level) (28141)

**Mapping Units**

**28141 = *(Salazaria mexicana)/Bromus madritensis – Bromus tectorum – Achnatherum speciosum* Postburn Type**

28150 = Spiny Menodora (not mappable at alliance level) (28151)

28160 = Mock-Heather Scrub (alliance removed)

*Ericameria cooperi – Ericameria cuneata - Chrysothamnus teretifolius - Salazaria mexicana -Brickellia arguta - Acamptopappus sphaerocephalus/Poa secunda* (moved to 28220) (28161)

28170 = Chuparosa Unique Stands

**28171 = *Justicia californica – Hyptis emoryi***

**28180 = Tetracoccus *hallii* Unique Stands**

*Tetracoccus hallii - Lycium andersonii* (28181)

*Tetracoccus hallii - Larrea tridentata/Ambrosia dumosa* (Slope) (28182)

*28190 = Anderson's Wolfberry *(Lycium andersonii)* (alliance not mappable)

*28200 = Desert Lavender (alliance not mappable – See *Acacia greggii* Alliance)

**Hyptis emoryi/Sarcostemma cynanchoides*

**Hyptis emoryi – Acacia greggii*

***28203 = *Hyptis emoryi* Association**

*28210 = Rubber Rabbitbrush *(Ericameria nauseosa)* (alliance not mappable)

***28220 = Round-leaved Rabbitbrush *(Ericameria teretifolia)*** (Postburn 10 Years – "Mock Heather")

29000 = Succulent extremely xeromorphic evergreen shrubland

29030 = Mojave Yucca

*Yucca schidigera - Ephedra nevadensis* (29031)

**Yucca schidigera – Coleogyne ramosissima*

**Yucca schidigera – Eriogonum fasciculatum*

**Yucca schidigera – Larrea tridentata – (Simmondsia chinensis)*

**Yucca schidigera – Larrea tridentata – Ambrosia dumosa*

**Yucca schidigera/Pleuraphis rigida*

**Yucca schidigera – Tetracoccus hallii*

**Yucca schidigera – Larrea tridentata – Senna armata*

**Mapping Units**

**29032 = *Yucca schidigera – Coleogyne ramosissima***

**29033 = *Yucca schidigera – Larrea tridentata – (Ambrosia dumosa)***

**29034 = *Yucca schidigera/Pleuraphis rigida* (Postfire)**

**29035 = *Yucca schidigera – Tetracoccus hallii***

29040 = Parry Nolina (alliance not mappable)

*Nolina parryi/Hesperostipa* (29041)

*Nolina parryi - Coleogyne ramosissima* (29042)

**29050 = Teddy-Bear Cholla** (29051)

*Opuntia bigelovii* association

32000 = Intermittently flooded cold-deciduous shrubland

**32010 = Desert Almond**

*Prunus fasciculatum – Salazaria mexicana* (32011)

*Prunus fasciculatum - Rhus trilobata* (32012)

**Prunus fasciculatum – Purshia tridentata*

32020 = Desert Apricot (alliance removed)

36000 = Extremely xeromorphic deciduous subdesert shrubland without succulents

36010 = Catclaw Acacia (generally mapped to alliance level)

*Acacia greggii - Prunus fasciculatum* (36011)

*Acacia greggii - Hyptis emoryi* (36012)

*Acacia greggii - Larrea tridentata* (36013)

*Acacia greggii - Hymenoclea salsola* (36014)

**Acacia greggii – Peucephyllum schottii*

**Acacia greggii – Tetracoccus hallii*

**Acacia greggii – Bebbia juncea*

**Acacia greggii – Ephedra californica*

**Acacia greggii – Chilopsis linearis*

**Acacia greggii – Lycium cooperi*

**Acacia greggii – Viguiera parishii*

**Acacia greggii – Yucca schidigera – Viguiera parishii*

**Acacia greggii – Eriogonum fasciculatum/Nolina bigelovii*

**Mapping Units**

**36015 = *Acacia greggii – (Hymenoclea salsola – Larrea tridentata - Peucephyllum schottii – Bebbia juncea – Ephedra californica)* Low-Elevation Wash Type**

**36016 = *Acacia greggii – (Lycium cooperi – Prunus fasciculatum)* High-Elevation Wash Type**

**36017 = *Acacia greggii – (Viguiera parishii – Eriogonum fasciculatum)* Upland Slope Type**

43000 = Caespitose drought deciduous dwarf shrubland

43010 = White Bursage (Alliance not mappable)

*Ambrosia dumosa* association (43011)

*Ambrosia dumosa/Pleuraphis rigida* (43012)

**Ambrosia dumosa – Eriogonum fasciculatum*

**Ambrosia dumosa – Senna armata*/cryptobiotic crust

**Mapping Units**

**43013 = *Ambrosia dumosa – Senna armata – (Psorothamnus schottii)* Eastern Pediment Type**

**43014 = *Ambrosia dumosa – (Eriogonum fasciculatum – Lycium andersonii/Pleuraphis rigida)* Western Mountain Type**

**Herbaceous-Dominated Alliances/Associations**

59000 = Medium tall temperate grassland with a sparse xeromorphic shrub layer
- **59010 = Big Galleta**
  - **Pleuraphis rigida/Hymenoclea salsola*
  - **Pleuraphis rigida/Atriplex canescens*
  - **Pleuraphis rigida/Lycium cooperi*
  - **Pleuraphis rigida/Ephedra nevadensis*

**60000 = Annual Grassland**
- **60001 = *Bromus tectorum* fire plot**

**Miscellaneous Classes**

90000 = Nonvegetated (i.e., less than 2 percent shrub cover)
- **90100 = Desert Pavement (Annuals)**
- **90200 = Rock Outcrops**
- **90300 = Dunes**
- **90400 = Playa**
- **90500 = Wash**
- **90600 = Disturbed/Built-Up**
- **90900 = Water**

95000 = Exotic vegetation

Land Use
- **100 = Urban/Built-Up**
- **110 = Residential**
- **120 = Commercial**
- **130 = Industrial**
- **140 = Transportation/Utility/Communications**
- **150 = Recreation**
- **200 = Agriculture**
- **300 = Mining**
- **400 = National Park Facilities**
  - **401 = Administration/Headquarters/Research Facilities**
  - **402 = Campgrounds**
  - **403 = Picnic Areas**
  - **404 = Parking Areas**
  - **405 = Residential**
  - **406 = Barrow Pit**
  - **407 = Mining**
  - **408 = Well/Pump/Guzzler**
  - **409 = Colorado River Aqueduct**
  - **410 = Levees**
  - **411 = Exhibit Areas**

**800 = Water**
**900 = Vacant**

Other map attributes:

**Height**
1 = <0.5 meters
2 = 0.5 – 2 meters
3 = 2 – 5 meters
4 = 5 – 15 meters
5 = 15 – 35 meters
9 = Not Applicable

**Absolute Crown Density**
1 = Closed/Continuous: >60 percent
2 = Discontinuous: 40 percent–60 percent
3 = Dispersed: 25–40 percent
4 = Sparse: 10 percent–25 percent
5 = Rare: 2 percent–10 percent
9 = Not Applicable

# PHOTO-INTERPRETATION REPORT

# USGS-NPS VEGETATION AND INVENTORY AND MAPPING PROGRAM

# JOSHUA TREE NATIONAL PARK

**December 20, 2004**

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# Table of Contents


**Section** **Page**

**I. INTRODUCTION ..... 4**

**II. SUMMARY OF MAPPING EFFORT AT JOSHUA TREE NATIONAL PARK ..... 5**

**III. VEGETATION MAPPING ..... 6**

Initial Project Planning Meeting ..... 6

Development of Photo-interpretation Mapping Procedures ..... 6

Development of Photo-interpretation Mapping Criteria ..... 7

Aerial Photography Acquisition ..... 8

Pilot Area Mapping / Classification Development ..... 8

Field Reconnaissance ..... 9

Photo-interpretation of Vegetation ..... 9

Quality Control of Photo-interpretation ..... 10

Photo-interpretation Field Verification ..... 10

**IV. DATA CONVERSION ..... 11**

Data Automation ..... 11

Data Rectification ..... 11

Polygon Attribute Assignment ..... 11

Digital Orthophoto Quarter-Quad (DOQQ) Notes ..... 11

Code Verification and Edit Plot Quality Assurance ..... 11

Final Quality Assurance of the Vegetation Map ..... 12

**V. APPENDICES ..... 13**

Developing Ecological Zones / Biophysical Units for Joshua Tree National Park ..... 13

Joshua Tree National Park - Final Mapping Classification ..... 14

## I. INTRODUCTION

The National Park Service (NPS), in conjunction with the Biological Resources Division (BRD) of the U.S. Geological Survey (USGS), has implemented a program to "develop a uniform hierarchical vegetation methodology" at a national level. An element of the Inventory and Monitoring Program program is the creation of a Geographic Information System (GIS) database for the parks under NPS management. The purpose of the data is to document the state of vegetation within the National Park Service region. Aerial Information Systems, Inc. (AIS) was subcontracted by Environmental Systems Research Institute (ESRI), the prime contractor, to complete the vegetation photo-interpretation (PI) and automation for the program. NPS also contracted NatureServe (formally The Nature Conservancy or TNC) to support the development of the National Vegetation Classification System.

Several parks representing different regions, environmental conditions, and vegetation types, were chosen by USGS-NPS to be part of the prototype phase of the program. The initial goal of the prototype phase is to "develop, test, refine, and finalize the standards and protocols" to be used during the production phase of the project. The program includes the development of a standardized vegetation classification system for each park and the establishment of photo-interpretation, field sampling, and accuracy assessment procedures. This report outlines and describes the project timeline, photo-interpretation methodologies, mapping criteria and data conversion procedures implemented in creating the final vegetation layer for Joshua Tree National Park.

In 1936, approximately 825,000 acres of desert habitat in California was set aside as Joshua Tree National Monument. The monument was elevated to park status in October 1994 as part of the Desert Protection Bill. Joshua Tree National Park represents both the higher elevation Mojave Desert ecosystem and the warmer Colorado Desert ecosystem. Currently, Joshua Tree National Park contains 794,000 acres of land including 585,000 acres of wilderness.

## II. SUMMARY OF THE MAPPING EFFORT AT JOSHUA TREE NATIONAL PARK

**1996** - Initial project planning meeting and Park tour
AIS field reconnaissance trip for Malapai Hill area

**1997** - Pilot area mapping - Malapai Hill quadrangle

**1998** - New CIR aerial photographs acquired (June – November)

**1999** - Review and evaluation of Park vegetation classification
Preliminary photo-interpretation performed to aid field sampling

**2000** - AIS conducts vegetation field sampling (300 plots)

**2001** - Vegetation classification for JOTR developed
Aerial photo-interpretation initiated

**2002** - Vegetation photo-interpretation completed

**2003** - Data automation and rectification commences

**2004** - Final vegetation coverage and photo-interpretation report completed

## III. VEGETATION MAPPING

One of the most important mandates of the Inventory and Monitoring Program is the consistent capture and classification of vegetation types through mapping and field sampling methods. Mapping criteria and procedures developed during the prototype parks are being tested and revised.

The first two parks mapped - Assateague Island National Seashore and Tuzigoot National Monument utilized a vegetation layer mapping approach. Layer mapping consists of photo-interpretation of multiple canopies of vegetation that are visible on the aerial photography. Canopies are normally defined by the structure of the vegetation (trees, shrubs, or herbaceous growth). Where possible, individual plant species are interpreted for each layer of vegetation. These data layers are then aggregated up into the appropriate alliance or community as defined by NatureServe. Subsequent parks, including the Nebraska grassland parks, Rock Creek Park, Isle Royale National Park and Congaree Swamp National Monument involved mapping an initial photo signature type describing multiple vegetation canopies. These photo signature types are then translated into a natureServe community type or alliance. Height, density and in some instances, pattern are additionally assigned to each polygon. In some instances mapping unit types are retained to further describe at a more detailed level the attributes visible on the aerial photography for each polygon. In other situations mapping units are used to address more general levels where an alliance or association is not discernable on the aerial photography.

### Initial Project Planning Meeting

Meetings were held in May 1996 at Joshua Tree National Park (JOTR) to bring together the project team members from the National Biological Service (NBS), USGS, ESRI, AIS, and NatureServe. These meetings focused primarily on discussing the Vegetation Inventory and Mapping Program, existing park data, logistics, and park specific issues.

During the meetings, imagery, basemaps, and other pertinent collateral materials were discussed and evaluated. Included in this inventory were the following data items:

- Color Infrared (CIR) Digital Orthophoto Quarter-Quads (DOQQ) would be available for the Park in April 1997.
- Technical Report #2 - Investigation of the Vegetational Communities of Joshua Tree National Monument, California, Patrick James Leary, June 1977.
- Geologic data is available for the Park at a scale of 1:250,000.
- Digital Elevation Model (DEM's) have been developed for selected quadrangles within Joshua Tree National Park.

The logistics for fieldwork at Joshua Tree National Park were discussed as part of the project strategy. The Park was able to provide transportation and a vegetation specialist to accompany AIS during field reconnaissance and verification trips.

### Development of Photo-interpretation Mapping Procedures

The normal process in vegetation mapping is to conduct an initial field reconnaissance, map the vegetation units through photo-interpretation, and then conduct field verification. The field reconnaissance visit serves two major functions.

First, the photo-interpreter keys the signature on the aerial photos to the vegetation on the ground at each signature site. Second, the photo-interpreter becomes familiar with the flora,

vegetation communities and local ecology that occur in the study area. Park and/or NatureServe field biologists that are familiar with the local vegetation and ecology of the park are present to help the photo-interpreter understand these elements and their relationship with the geography of the Park.

Upon completion of the field reconnaissance, photo-interpreters delineate vegetation units on frosted mylar sheets that overlay the 9”x9” aerial photographs. This effort is conducted in accordance with the NatureServe vegetation classification and criteria for defining each community or alliance. The mapping is then followed by a final field verification session designed to confirm that the vegetation units were mapped correctly. Any outstanding photo-interpretation related questions are also addressed during the visit.

## Development of Photo-interpretation Mapping Criteria

From the onset of the Vegetation Inventory and Monitoring Program, a standardized program-wide mapping criterion has been used. The mapping criterion contains a set of documented working decision rules used to facilitate the maintenance of accuracy and consistency of the photo-interpretation. This criterion assists the user in understanding the characteristics, definition and context for each vegetation community.

Additional criteria specific to mapping at Joshua Tree National Park is described in the following three sections:

### Park Specific Mapping Criteria

During the initial planning meeting, Park staff discussed the need for an accurate vegetation map to assist in programs targeting desert tortoise habitat, fire monitoring, vegetation succession, highway construction, and abandoned mines.

### TNC Classification, Key, and Descriptions

The assignment of alliance and community associations to the vegetation is based on criteria formulated by NatureServe. In 1996, NatureServe provided AIS with a tentative mapping community classification derived from existing vegetation plot data and series level information from A Manual of California Vegetation, John O. Sawyer and Todd Keeler-Wolf, California Native Plant Society (CNPS), 1995. This classification was used as the basis in developing a photo-interpretation signature type listing used during the preliminary mapping task.

### Mapping Classification and Descriptions

The photo-interpretation mapping descriptions are an important tool for maintaining consistency in the vegetation mapping. Field data collected during the reconnaissance effort were analyzed and compared with the aerial photos and a consistent correlation between the photo signatures and vegetation types were noted.

As the vegetation classification was further developed, the mapping descriptions were modified to accommodate the classification revisions. The mapping descriptions provide a sample of the photo signature correlated to the appropriate vegetation community. The descriptions also incorporate other useful information to assist the photo-interpreter (elevation, zone, soil, aspect, slope position, steepness, geology, hydrology, fire history, distribution, and notes on similar vegetation types).

## Aerial Photography Acquisition

The pilot project used existing aerial photography from two sources to provide coverage of the Malapai Hill, California quadrangle. A new set of aerial photographs was acquired in 1998 to provide complete stereo coverage of the Park.

**Pilot Area – Malapai Hill Quadrangle:**

- Color infrared photography (CIR)
- Flight date – May 15, 1995
- Nominal scale – 1:20,000
- Approximate photo size – 9" x 9"

- Natural color photography
- Flight date – April 1993
- Nominal scale – 1:24,000
- Approximate photo size – 9" x 9"

**Joshua Tree National Park:**

- Color infrared photography (CIR)
- Flight dates – June thru November 1998
- Nominal scale – 1:12,000
- Approximate photo size – 9" x 9"

General flight line indexes were created for the pilot area and the Park aerial photography. These indexes were used for quick reference to photo locations and as a tool to display the status of mapping and automation tasks.

## Pilot Area Mapping / Classification Development

Photo-interpretation of vegetation traditionally takes place after the vegetation classification has been developed. For Joshua Tree National Park, the classification existed in a preliminary format based on A Manual of California Vegetation. The initial mapping of vegetation for the pilot area, Malapai Hill quadrangle, highlighted the need for additional field samples to verify and describe the plant communities in the draft classification.

The Park staff was funded to collect vegetation field data in the Malapai Hill area. In order to assist the vegetation field crews in collecting data for the rest of the Park, AIS created a biophysical units model (see Appendix I). The biophysical units (defined by ecological zones) were used to generate optimal locations for vegetation plot sampling. Using the model, 300 aerial photographs representing diverse regions of the Park were selected for sampling. Preliminary vegetation map units were delineated on each photo and potential field sample sites were selected. Using the California Native Plant Society (CNPS) releve protocol, 300 vegetation plots were sampled to provide additional data for the development of the Joshua Tree National Park vegetation classification.

In 2001, the new plot data was incorporated into the vegetation classification. At this time, AIS was able to create the mapping classification (see Appendix II) and to begin aerial photo-interpretation for the remaining areas of the Park.

## Field Reconnaissance

Prior to the field reconnaissance, several in-house preparations were performed in order to facilitate a more organized trip. Field routes were planned to accommodate a variety of factors including: maximizing the number of vegetation communities and elevation zones visited, responding to recommendations of Park staff, addressing time constraint considerations, and accessibility. Photos along selected routes were prepared with a frosted mylar field overlay. Locational features (trails and place names) were drafted onto the overlays to aid in navigation.

Each photo was reviewed under a stereoscope to choose field transect sites representing different signatures types, geographic variables (% slope, aspect, shape of the slope, elevation), and other abiotic variables noted on the photography. Field check sites and associated notations were drafted onto the field overlays. Multiple sites were chosen to provide alternatives if one or more sites proved inaccessible. The field photographs (CIR prints), overlays and associated topographic sheets were arranged in packets for the field team.

The field reconnaissance effort was conducted to establish relationships between the photo signatures evident on the aerial photographs and habitats on the ground. The field trip involved both driving and hiking to view a variety of vegetation types. During the field visit, the photo-interpreter worked with the Park field biologists to identify the plant species, preliminary vegetation communities, and the associated photo signature.

Field site numbers were annotated directly onto the photo field overlay, thereby correlating the field site to a specific location and photo signature. A field notebook was used to record pertinent information (canopy dominance, understory species present, abiotic features, disturbance history) for each site visited. Color ground photos (35mm) were taken at selected locations and later compared to the aerial photographs and the field site notes. Additional field sites included areas in transit, particularly those between initially selected sites, areas of noteworthy or unusual significance, and other vegetation types the photo-interpreter or ecologist deemed important.

## Photo-interpretation of Vegetation

Photo-interpretation is the process of identifying map units based on their photo signature. All land cover features have a photo signature. These signatures are defined by the color, texture, tone and pattern they represent on the aerial photography. By observing the context and extent of the photo signatures associated with specific vegetation types, the photo-interpreter is able to identify and delineate the boundaries between plant communities or signature units. At Joshua Tree National Park, training with the photo signatures proved to be particularly difficult since three sets of aerial photography were utilized over the course of the project. Additional collateral sources (existing vegetation maps, supplemental photography, soil data, etc.) can be of great utility to the photo-interpreter. Understanding the relationship between the vegetation and the context in which they appear is useful in the interpretation process. Familiarity with regional differences also aids interpretation by establishing a context for a specific area.

Approximately 1000 aerial photographs were needed to provide full photo coverage for photo-interpretation of the Park. In the western region of the study area with steep terrain the photo-interpretation was completed on every photo. For flatter zones in the east (Pinto Basin area) mapping was done on every other photograph.

Each photo was prepared with a 9”x9” frosted mylar overlay for the photo signature delineations. Photo overlays were then pin-registered to the photos and project labels were affixed to each overlay identifying the photo number, status of work, and photo interpreter responsible for that task. Study area boundaries were drafted onto each photo overlay, defining the area within the photograph to be interpreted. The study area boundaries were edge matched to adjacent photos to ensure complete coverage.

Using a mirror stereoscope, with a 3X lens, photo signature units were delineated onto the mylar overlays. These initial photo delineations were based on a number of signature characteristics including color, tone, texture, relative height and density. Attribute codes (mapping classification types, height and density) were assigned to each polygon. The map units and codes were edge matched to the adjoining photo overlays.

The availability of CIR Digital Orthophoto Quarter-Quads (DOQQ’s) from the Park gave the photo-interpreter an additional source of information for refining some of the vegetation communities. During the data rectification phase, some map unit delineations were modified to represent photo signatures that were evident on the DOQQ imagery.

Land use activities within the Park were also identified during the mapping of the vegetation units. The land use codes were drafted onto the photo overlay in a different color.

**Quality Control of the Photo-interpretation**

A separate quality control step was performed for each photo upon completion of the photo-interpretation. A senior photo-interpreter reviewed each photo for map unit delineation, PI signature code, height code, and density code accuracy. Each photo overlay was checked for completeness, consistency, and adherence to the mapping criteria and guidelines

**Photo-interpretation Field Verification**

A field verification trip was conducted for this mapping effort. The field verification focused primarily on checking and/or refining photo signature units and substantiating the mapping type coded to polygons.

Preparation for the field verification involved choosing representative areas for community types to review in the field. Additional sites with questionable photo signatures were also visited. Although AIS chose specific areas of focus, sections of the park in the vicinity of selected routes were also checked for both line and label accuracy.

## IV. DATA CONVERSION

The following section outlines the data automation procedures required to convert the hand-drafted vegetation map units to a digital format rectified to the Digital Orthophoto Quarter-Quad (DOQQ) base.

### Data Automation

Data automation was conducted using semi-photogrammetric software package. The first step of the procedure involved the creation of control points. Locational points identified both on the DOQQ imagery and the aerial photography were identified and input into an ARC/INFO point coverage.

The MDSD software used to capture the vegetation linework automatically georeferences the data into real world coordinates. By using the control points generated in the previous step each photo is registered to the DOQQ. Once each photo has been georeferenced the lines were then digitized. The digitized lines were stored in a file format which ARC/INFO can read. These files were then converted to a coverage using ARC/INFO.

### Data Rectification

Coverage linework from each aerial photo was rectified to the DOQQ and connected to the adjacent photo coverage. Map sheets were checked for open polygons, data registration, and any spatial edgematch problems between photos. Registration quality depended on the accuracy, quantity, and distribution of the control points. Spatial refinement to approximately 1:4,000 was performed in an ARCEDIT session using various user-defined tools. Lines depicting boundaries representing minimal ecotones (for example – land use interface, water bodies, life-form interface) were refined even closer.

### Polygon Attribute Assignment

During the data rectification step, label points were created and coded for each map unit. The vegetation mapping type, height, density and land use type codes were input for each polygon (see Appendix II for Mapping Classification). Codefind and code frequency programs were run to check for code validity.

### Digital Orthophoto Quarter-Quad (DOQQ) Notes

Joshua Tree National Park provided Color Infrared (CIR) Digital Orthophoto Quarter-Quad (DOQQ) images as the project base. One obvious data shift was noted between the images for Keys View SE and Malapai Hill SW.

### Code Verification and Edit Plot Quality Assurance

An edit plot of the converted spatial data was produced for each DOQQ and compared to the aerial photo overlays. Each plot was checked for cartographic quality of the arcs defining the polygon features and the accuracy of the label assignments. Line and code changes were noted directly on the edit plot. All plots were edgematched to verify line and code accuracy across map sheets. Processors conducted interactive ARCEDIT sessions to make the necessary corrections to the coverages.

**Final Quality Assurance of the Vegetation Map**

The individual coverages created for each DOQQ were then joined as one complete vegetation coverage for the Park. This final vegetation layer was examined by a senior photo-interpreter. Final checks were conducted to test for invalid codes, check for missing or extra lines, look for edgematch problems, verify the registration of linework to the DOQQ base, and to review the distribution of species mapped within the Park.

## V. APPENDICES

## APPENDIX I

# DEVELOPING ECOLOGICAL ZONES AND BIOPHYSICAL UNITS FOR JOSHUA TREE NATIONAL PARK

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**KEY WORDS**: Biophysical Units, Ecological Zones, Vegetation Mapping, Vegetation Plots

### ABSTRACT

The creation of accurate vegetation maps is an integral component of natural resource management and conservation in national parks. Defining ecologically unique zones and biophysical units is prerequisite to the development of a vegetation layer. Several techniques are used to create vegetation maps including satellite imaging and photo interpretation. All methods require the collection of field data to delimit and verify community types. The objectives of this paper are to provide a method for defining ecological zones and biophysical units which can then be applied to generate vegetation plot locations.

### METHODS

Vegetation communities change along various gradients. Changes in vegetation along an altitudinal gradient are possibly the most noticeable because of the unidirectional, multilevel changes that occur over such a short distance. Therefore, in mountainous areas such as Joshua Tree National Park it is sensual to divide ecological zones by elevation.

All GIS layers were projected into UTM Zone 11, NAD27. All layers were either originally created at 30 meter resolution or resampled to 30 m resolution.

Selecting Photos:

1. Calculated Distance from road to each photo
2. Calculated the number of BPU's in each zone
3. Calculated the number of existing plots in each BPU
4. Tallied the number of unsampled BPU's in each zone
5. Selected BPU's which had been sampled and set them = to no data
6. Used BPU's that had not been sampled as a mask and map calculated the BPU map by itself. This produced a map showing only those BPU's that had no samples.
7. Calculated the number of unique (unsampled) BPU's in each photo.
8. Constructed a map showing the richness of unsampled BPU's within each photo
9. Determined the number of photos to select from each zone based on A) The land area occupied by unsampled BPU's and B) The # of unsampled BPU's. Calculated percentages of each and then took the average.
10. Ordered photos within each zone from the highest number of BPU's to the lowest # of BPU's and selected those that were within 3km from the nearest road
11. Determined how many BPU's would not be sampled via this strategy in each zone and then added photos (irregardless of distance from road) to each zone until all BPU's were sampled.

**APPENDIX II**

# USGS - NPS VEGETATION MAPPING PROGRAM
# JOSHUA TREE NATIONAL PARK - FINAL MAPPING CLASSIFICATION

Updated May 22, 2001: Based on analysis of 600 plots done by Todd Keeler-Wolf & AIS-DFG-NPS Classification-Mapping Meeting

Note: Multiple association mapping units (MAMU) use associations, which cross alliance types; Super associations use associations within the same alliance.

*Italicized types are no longer associations*

**Bold** Indicates Mapped Association or Alliance Types

Types indicated by an * are potential new associations or alliances based on the analysis

---

## FORMATION / ALLIANCE / ASSOCIATION

**Tree-Dominated Series/Associations**

10000 = Rounded-crowned temperate or subpolar needle-leaved evergreen woodland

**10020 = California juniper**

**10021 = Juniperus californica / Coleogyne ramosissima - Yucca schidigera**

Juniperus californica / Achnatherum (10022)

Juniperus californica / Eriogonum fasciculatum (10023)

Juniperus californica - Quercus cornelius-mulleri (10024 - Use 21234 MAMU)

**10025 = Juniperus californica / Coleogyne ramosissima**

Juniperus californica - undifferentiated / Encelia farinosa (10026)

*Juniperus californica – Prunus fasciculatum

***10029 = Juniperus californica / Tetracoccus hallii**

***10030 = Juniperus californica / Viguiera parishii – (Nolina bigelovii)**

***10031 = Juniperus californica / Yucca schidigera – (Tetracoccus hallii)**

*Juniperus californica / Nolina parryi

**-Mapping Units**

**10033 = Juniperus californica / (Coleogyne ramosissima – Yucca schidigera) Super Association** (includes 10021 & 10031)

**10034 = Juniperus californica / (Eriogonum fasciculatum / Achnatherum speciosum) Super Association (includes 10022 & 10023)**

**10160 = Singleleaf pinyon**

**10161 = Pinus monophylla - Quercus cornelius-mulleri**

10162 = Pinus monophylla - Juniperus californica / Achnatherum speciosum

13000 = Succulent extremely xeromorphic evergreen woodland

**13010 = Joshua tree**

Yucca brevifolia / Larrea tridentata – Yucca schidigera / Pleuraphis rigida (13011)

**13012 = Yucca brevifolia / Coleogyne ramosissima**

Yucca brevifolia - Juniperus californica / Coleogyne ramosissima (13013)

Yucca brevifolia / Prunus fasciculatum (13014)

*Yucca brevifolia – Juniperus californica / Ephedra nevadensis

*Yucca brevifolia – Larrea tridentata – Yucca schidigera

*Yucca brevifolia – Juniperus californica / Yucca schidigera

*Yucca brevifolia – Atriplex canescens

**-Mapping Units**

**13015 = Yucca brevifolia – Juniperus californica / (Coleogyne ramosissima – Yucca schidigera – Ephedra nevadensis) Super Association (13013, 13015, & 13017)**

**13016 = Yucca brevifolia / Larrea tridentata – (Yucca schidigera / Pleuraphis rigida) Super Association (13011 & 13016)**

**13021 = Yucca brevifolia / (Ephedra nevadensis – Grayia spinosa – Lycium spp.) / Pleuraphis rigida Super Association**

15000 = Temporarily flooded cold-deciduous woodland

15010 = Desert Willow

Chilopsis linearis – Psorothamnus spinosa (15011)

*Chilopsis linearis – Prunus fasciculatum

*Chilopsis linearis – Acacia greggii
*Chilopsis linearis – Brandegea bigelovii
**-Mapping Units**
**15012 = Chilopsis linearis – Psorothamnus spinosus - (Cercidium floridum / Acacia greggii) MAMU**
**15013 = Chilopsis linearis / (Prunus fasciculatum – Acacia greggii) Super Association**

**15030 = Mixed Willow**

**15040 = Fremont cottonwood**

*Populus fremontii - Washingtonia filifera (no plots) (15041)*
*Populus fremontii / Salix spp. (no plots) (15042)*

15060 = Ziziphus (Not Mappable at Alliance Level)

15110 = Seasonally flooded temperate broad-leaf evergreen woodland

15110 = California Fan Palm

***15112 = Washingtonia filifera / Salix exigua / Muhlenbergia rigens**

16000 = Thorn extremely xeromorphic deciduous woodland

**16010 = Blue palo verde**

*Cercidium floridum / Hymenoclea salsola (16011)*
*Cercidium floridum / Justicia californica (16012)*
**16013 = Cercidium floridum / Larrea tridentata**
*Cercidium floridum – Psorothamnus spinosa (16014)*
*Cercidium floridum / Tetracoccus hallii
***16015 = Cercidium floridum / Hyptis emoryi (includes 16011,16012 16014)**

16020 = Ironwood

*Olneya tesota / Fouquieria splendens / Larrea tridentata (16021)*
*Olneya tesota / Encelia farinosa / Hymenoclea salsola (16022)*
Olneya tesota / Cercidium floridum (16023)
*Olneya tesota / Hyptis emoryi
-**Mapping Units**
**16024 = Olneya tesota / (Larrea tridentata - Encelia farinosa) Fan Type; includes 16021 16022)**
**16025 = Olneya tesota - (Cercidium floridum / Hyptis emoryi) Wash Type; includes 16023)**

16030 = Smoke tree

*Psorothamnus spinosa / Hymenoclea salsola (16031)*
Psorothamnus spinosa - Acacia greggii (16032)
Psorothamnus spinosa - Chilopsis linearis (16033 - Use 15015)
*Psorothamnus spinosa / Ephedra californica
*Psorothamnus spinosa / Eriogonum fasciculatum
*Psorothamnus spinosa / Hyptis emoryi – Acacia greggii (Includes 16031)
**-Mapping Units**
**16034 = Psorothamnus spinosa / (Ephedra californica – Hymenoclea salsola)**
**Broad low energy sandy wash type**
**16035 = Psorothamnus spinosa / (Hyptis emoryi– Acacia greggii)**
**Narrow high-energy wash type**

**16040 = Mesquite (Map to Alliance Level)**

16041 = Prosopis glandulosa / Isomeris arborea
16042 = Prosopis glandulosa / Atriplex canescens

16050 = Indigo bush

*16051 = Psorothamnus schottii – Larrea tridentata a/ Ambrosia dumosa (moved to Larrea)*

**<u>Shrub-Dominated Series/Associations</u>**

21000 = Sclerophyllous temperate broad leaved evergreen shrubland

21210 = Bigberry manzanita

21211 = Arctostaphylos glauca – Quercus cornelius-mulleri

21220 = Jojoba

21230 = Muller Oak Alliance

Quercus cornelius-mulleri / Coleogyne ramosissima (21232)
*Quercus cornelius-mulleri – Juniperus californica / Coleogyne ramosissima
**-Mapping Units**

**21233 = Quercus cornelius-mulleri – (Juniperus californica / Coleogyne ramosissima) MAMU**

**21234 = Quercus cornelius-mulleri – (Juniperus californica) MAMU**

22000 = Temporarily flooded temperate broad-leaved evergreen shrubland

22020 = Arrow-weed

*Pluchea sericea (No Plots) (22021)*

23000 = Needle-leaved evergreen shrubland

23010 = Desert fir

Peucephyllum schottii / Gutierrezia microcephala (23011)

24000 = Microphyllous evergreen shrubland

**-Mapping Units**

**24001 = (Ephedra nevadensis – Pleurocoronis pluriseta – Encelia farinosa - Trixis californica – Bebbia juncea – Eriogonum fasciculatum – Lycium andersonii – Acacia greggii) low elevation rocky mountain type**

24010 = Nevada ephedra (Not mappable at alliance level)

Ephedra nevadensis (24011)

*Ephedra nevadensis – Viguiera parishii

*24020 = California ephedra (Not mappable at alliance level)

*Ephedra californica – Hymenoclea salsola

*Ephedra californica – Viguiera parishii / Pleuraphis rigida

27000 = Broad-leaved and microphyllous evergreen extremely xeromorphic subdesert shrubland

27001 = (Salazaria mexicana – Krameria spp.– Encelia farinosa – Hyptis emoryi – Eriogonum fasciculatum – Hymenoclea salsola – Acacia greggii – Tetracoccus hallii) rivulets within Desert Pavement

**27010 = Creosote bush**

Larrea tridentata / Pleuraphis rigida (Wash Type) (27012)

Larrea tridentata / Hymenoclea salsola (27013)

*Larrea tridentata - Coleogyne ramosissima / Ephedra nevadensis - Eriogonum fasciculatum / Encelia farinosa (27014)*

Larrea tridentata / Viguiera parishii - Eriogonum fasciculatum (27015)

Larrea tridentata - Yucca schidigera / Ephedra californica (27016)

Larrea tridentata (Undifferentiated) often with annuals (27017)

*Larrea tridentata / Encelia farinosa (27018)*

**27019 = Larrea tridentata Undifferentiated Playa and Sandy or Dune Top Type**

*Larrea tridentata / Pleuraphis rigida (Dune Top) (27021)*

***27022 = Larrea tridentata Clones***

*Larrea tridentata / (Bebbia juncea - Trixis californica - Pleurocoronis pluriseta – Viguiera parishii) (27023)*

*Larrea tridentata – Ephedra californica / cryptobiotic crust

*Larrea tridentata – Senna armata – Ephedra californica

*Larrea tridentata – Justicia californica

*Larrea tridentata – Psorothamnus schottii

*Larrea tridentata / Brandegea bigelovii

*Larrea tridentata – Tetracoccus hallii

*Larrea tridentata – Lycium andersonii

*Larrea tridentata – Viguiera parishii

**-Mapping Units**

**27011 = Larrea tridentata – (Ambrosia dumosa) – Hymenoclea salsola Low Energy Wash Type (Includes types 27012, 27013, 27037)**

**27021 = Larrea tridentata – (Ambrosia dumosa) / Pleuraphis rigida Sandy Type (Includes types 27021)**

27030 = Creosote bush / White bursage

**27031 = Larrea tridentata – Ambrosia dumosa Generic – Fans & Slopes**

*Larrea tridentata - Ambrosia dumosa with Atriplex hymenelytra (27032)*

Larrea tridentata - Ambrosia dumosa - Lycium andersonii (27033)

Larrea tridentata - Ambrosia dumosa - Krameria grayi (27034)

Larrea tridentata - Ambrosia dumosa - Encelia farinosa (27035)

Larrea tridentata - Ambrosia dumosa - Ephedra californica (27036)

Larrea tridentata - Ambrosia dumosa - Hymenoclea salsola (27037)

Larrea tridentata - Ambrosia dumosa - Pleuraphis rigida (27038)

Larrea tridentata - Ambrosia dumosa - Senna armata (27039)

*Larrea tridentata - Ambrosia dumosa (Generic – Slope) (27041) (Include with 27031)*

**27043 = Larrea tridentata – (Ambrosia dumosa) - Tetracoccus hallii – (Yucca schidigera) (Use as MAMU)**

Larrea tridentata - Ambrosia dumosa - Yucca schidigera (27044)

*Larrea tridentata - Ambrosia dumosa Sparse

*Larrea tridentata - Ambrosia dumosa – Psorothamnus schottii

*Larrea tridentata - Ambrosia dumosa - Viguiera parishii

*Larrea tridentata – Ambrosia dumosa – Petalonyx thurberi

-**Mapping Units**

27045 = Larrea tridentata – Ambrosia dumosa – Yucca schidigera – (Senna armata) Toe-slopes & Steeper Fans Type

**27046 = Larrea tridentata – (Ambrosia dumosa – Viguiera parishii) Higher Elevation Type**

**27047 = Larrea tridentata – Ambrosia dumosa – (Ephedra californica – Senna armata – Hymenoclea salsola – Psorothamnus schottii) Low Energy Wash Type**

27050 = Creosote bush / Brittlebush

*Larrea tridentata - Encelia farinosa (Generic - Slope) (27051)*

*Larrea tridentata - Encelia farinosa with Ambrosia dumosa (Slope) (27052)*

*Larrea tridentata - Encelia farinosa (Generic – Fan) (27053)*

*Larrea tridentata - Encelia farinosa with Ambrosia dumosa (Fan) (27042)*

*Larrea tridentata - Encelia farinosa with Hymenoclea salsola (27054)*

*Larrea tridentata – Encelia farinosa – Ambrosia dumosa

***27056 = Larrea tridentata – Encelia farinosa – Fouquieria splendens**

*Larrea tridentata – Encelia farinosa – Bebbia juncea

**- Mapping Units**

**27057 = Larrea tridentata – Encelia farinosa – (Ambrosia dumosa – mixed shrub) Super Alliance**

28000 = Facultatively deciduous extremely xeromorphic subdesert shrubland

28020 = Black bush

*Coleogyne ramosissima -Yucca schidigera / Ambrosia dumosa (28021)*

*Coleogyne ramosissima / Pleuraphis rigida - Eriogonum fasciculatum - Hymenoclea salsola (28022)*

*Coleogyne ramosissima / Pleuraphis rigida

*Coleogyne ramosissima – Lycium andersonii

*Coleogyne ramosissima – Tetracoccus hallii – Ambrosia dumosa

**- Mapping Units**

**28023 = Coleogyne ramosissima – (mixed shrub) Super Association**

28030 = Brittlebush

Encelia farinosa - Ambrosia dumosa (28031)

*Encelia farinosa - Peucephyllum schottii (28032)*

*Encelia farinosa – Ambrosia dumosa – Lycium andersonii

*Encelia farinosa – Ambrosia dumosa – Fagonia laevis

**28033 = Encelia farinosa Association** (Includes 28031, 28032)

28060 = California buckwheat (Not Mappable at Alliance Level)

*Eriogonum fasciculatum –Undifferentiated (28061)*

*Eriogonum fasciculatum - Salizaria mexicana (28062)*

**28070 = Desert holly**

Atriplex hymenelytra – Larrea tridentata - Ambrosia dumosa (28071)

**28080 = Fourwing saltbush**

Atriplex canescens / Bromus madritensis (28082)

*Atriplex canescens / Achnatherum speciosum

28100 = Ocotillo (Not Mappable at Alliance Level)

*Fouquieria splendens (No Plots) (28101)*

28110 = Cheesebush (28113)

*Hymenoclea salsola - Ephedra californica (28111)*

*Hymenoclea salsola - Senna armata (28112)*

*Hymenoclea salsola – Salizaria mexicana

*Hymenoclea salsola – Larrea tridentata

*Hymenoclea salsola – Senna armata

*Hymenoclea salsola – Psorothamnus armata

*Hymenoclea salsola – Tetracoccus hallii

28120 = Paniculate Rabbitbrush (Not mappable at alliance level)

Chrysothamnus paniculatus – Acacia greggii (28121)

28130 = Desert sunflower (28131)
Viguiera parishii - Encelia farinosa (28132)
*Viguiera parishii – ephedra nevadensis
*Viguiera parishii – Eriogonum fasciculatum
**-Mapping Units**
**28133 = Viguiera parishii – (Ephedra nevadensis – Eriogonum fasciculatum – Nolina bigelovii) high elevation rocky eastern mountains type**
28140 = Paper-bag bush (Not mappable at alliance level) (28141)
-Mapping Units
28141 = (Salazaria mexicana) / Bromus madritensis – Bromus tectorum – Achnatherum speciosum Post-Burn type
28150 = Spiny Menodora (Not mappable at alliance level) (28151)
28160 = Mock-heather scrub (Alliance removed)
*Ericameria cooperi – Ericameria cuneata - Chrysothamnus teretifolius - Salizaria mexicana -Brickellia arguta - Acamptopappus sphaerocephalus / Poa secunda (Moved to 28220) (28161)*
28170 = Chuparosa
**28171 = Justicia californica – Hyptis emoryi**
**28180 = Tetracoccus**
*Tetracoccus hallii - Lycium andersonii (28181)*
*Tetracoccus hallii - Larrea tridentata / Ambrosia dumosa (Slope) (28182)*
*28190 = Anderson's Lycium (Alliance not mappable)
*28200 = Desert Lavender (Alliance not mappable – See Acacia greggii Alliance)
*Hyptis emoryi / Sarcostemma cynanchoides
*Hyptis emoryi – Acacia greggii
***28203 = Hyptis emoryi Association**
*28210 = Rubber Rabbitbrush (Alliance not mappable)
***28220 = Round-leaved Rabbitbrush** (Post burn 10 years – "Mock Heather")
29000 = Succulent extremely xeromorphic evergreen shrubland
29030 = Mojave yucca
Yucca schidigera - Ephedra nevadensis (29031)
*Yucca schidigera – Coleogyne ramosissima
*Yucca schidigera – Eriogonum fasciculatum
*Yucca schidigera – Larrea tridentata – (Simmondsia chinensis)
*Yucca schidigera – Larrea tridentata – Ambrosia dumosa
*Yucca schidigera / Pleuraphis rigida
*Yucca schidigera – Tetracoccus hallii
*Yucca schidigera – Larrea tridentata – Senna armata
**-Mapping Units**
**29032 = Yucca schidigera – Coleogyne ramosissima**
**29033 = Yucca schidigera – Larrea tridentata – (Ambrosia dumosa)**
**29034 = Yucca schidigera / Pleuraphis rigida (Post Fire)**
**29035 = Yucca schidigera – Tetracoccus hallii**
29040 = Parry Nolina (Alliance not mappable)
Nolina parryi / Heterostipa (29041)
Nolina parryi - Coleogyne ramosissima (29042)
**29050 = Teddy-bear cholla** (29051)
32000 = Intermittently flooded cold deciduous shrubland
**32010 = Desert almond**
Prunus fasciculatum – Salizaria mexicana (32011)
Prunus fasciculatum - Rhus trilobata (32012)
*Prunus fasciculatum – Purshia tridentata
32020 = Desert apricot (Alliance Removed)
36000 = Extremely xeromorphic deciduous subdesert shrubland without succulents
36010 = Catclaw acacia (Generally mapped to alliance level)
Acacia greggii - Prunus fasciculatum (36011)
Acacia greggii - Hyptis emoryi (36012)
*Acacia greggii - Larrea tridentata (36013)*
*Acacia greggii - Hymenoclea salsola (36014)*
*Acacia greggii – Peucephyllum schottii
*Acacia greggii – Tetracoccus hallii
*Acacia greggii – Bebbia juncea
*Acacia greggii – Ephedra californica

*Acacia greggii – Chilopsis linearis
*Acacia greggii – Lycium cooperi
*Acacia greggii – Viguiera parishii
*Acacia greggii – Yucca schidigera – Viguiera parishii
*Acacia greggii – Eriogonum fasciculatum / Nolina bigelovii

**-Mapping Units**

**36015 = Acacia greggii – (Hymenoclea salsola – Larrea Tridentata - Peucephyllum schottii – Bebbia juncea – Ephedra californica) Low elevation wash type**

**36016 = Acacia greggii – (Lycium cooperi – Prunus fasciculatum) High elevation wash type**

**36017 = Acacia greggii – (Viguiera parishii – Eriogonum fasciculatum) Upland slopes type**

43000 = Caespitose drought deciduous dwarf shrubland

43010 = White bursage (Alliance not mappable)

Ambrosia dumosa association (43011)
Ambrosia dumosa / Pleuraphis rigida (43012)
*Ambrosia dumosa – Eriogonum fasciculatum
*Ambrosia dumosa – Senna armata / cryptobiotic crust

**-Mapping Units**

**43013 = Ambrosia dumosa – Senna armata – (Psorothamnus schottii) Eastern pediment type**

**43014 = Ambrosia dumosa – (Eriogonum fasciculatum – Lycium andersonii / Pleuraphis rigida) Western mountain type**

**Herbaceous-Dominated Series/Associations**

59000 = Medium-tall temperate grassland with a sparse xeromorphic shrub layer

**59010 = Big galleta**

*Pleuraphis rigida / Hymenoclea salsola
*Pleuraphis rigida / Atriplex canescens
*Pleuraphis rigida / Lycium cooperi
*Pleuraphis rigida / Ephedra nevadensis

**60000 = Annual grassland**

**60001 = Bromus tectorum fire plot**

**Miscellaneous Classes**

90000 = Non-Vegetated (i.e., less than 2% shrub cover)

**90100 = Desert Pavement (Annuals)**
**90200 = Rock Outcrops**
**90300 = Dunes**
**90400 = Playa**
**90500 = Wash**
**90600 = Disturbed / Built-up**
**90900 = Water**

95000 = Exotic vegetation

**Land Use**

**100 = Urban/Built Up**
**110 = Residential**
**120 = Commercial**
**130 = Industrial**
**140 = Transportation/Utility/Communication**
**150 = Recreation**
**200 = Agriculture**
**300 = Mining**
**400 = National Park Facilities**
**401 = Administration/Headquarters/Research Facilities**
**402 = Campgrounds**
**403 = Picnic Areas**
**404 = Parking Areas**
**405 = Residential**
**406 = Barrow Pit**
**407 = Mining**

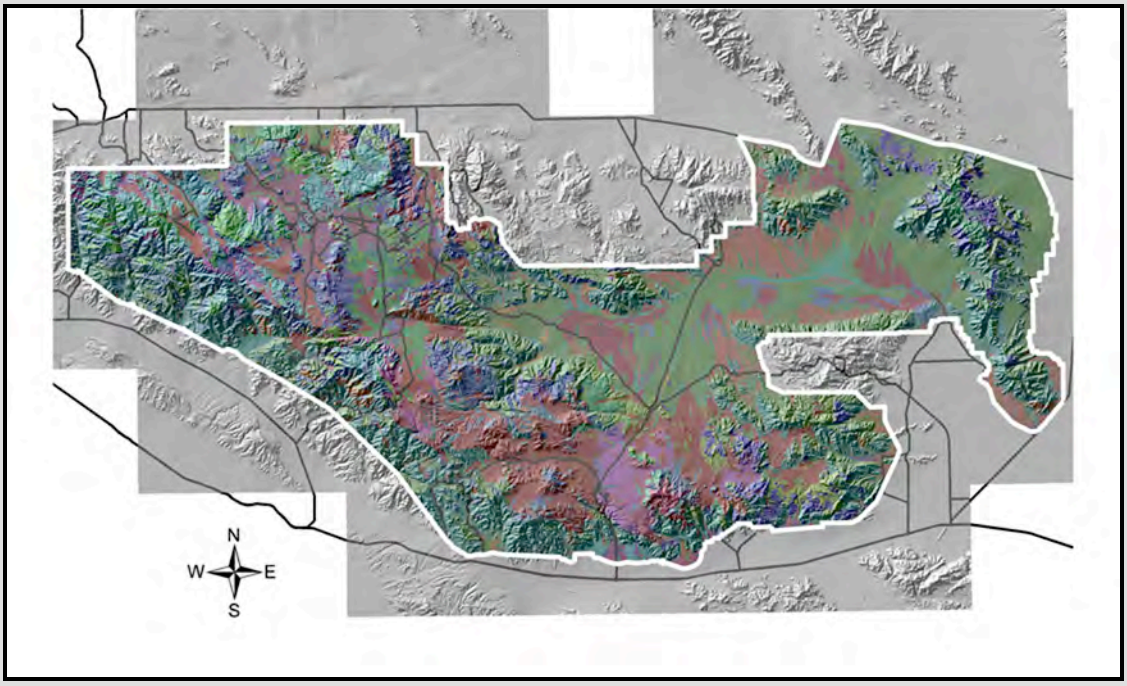
**408 = Well/Pump/Guzzler**
**409 = Colorado River Aqueduct**
**410 = Levees**
**411 = Exhibit Areas**
**800 = Water**
**900 = Vacant**

**Height**
1 = <0.5 meters
2 = 0.5 – 2 meters
3 = 2 – 5 meters
4 = 5 – 15 meters
5 = 15 – 35 meters
9 = not applicable

**Absolute Crown Density**
1 = Closed / Continuous: >60%
2 = Discontinuous: 40% - 60%
3 = Dispersed: 25 – 40%
4 = Sparse: 10% - 25%
5 = Rare: 2% - 10%
9 = Not Applicable



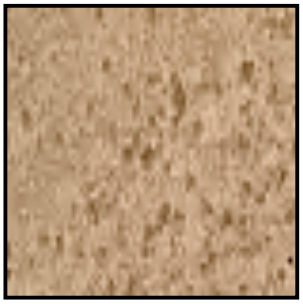
**USGS – NPS VEGETATION MAPPING PROGRAM**
**JOSHUA TREE NATIONAL PARK**
**MAPPING CLASSIFICATION**
**November 17, 2004**

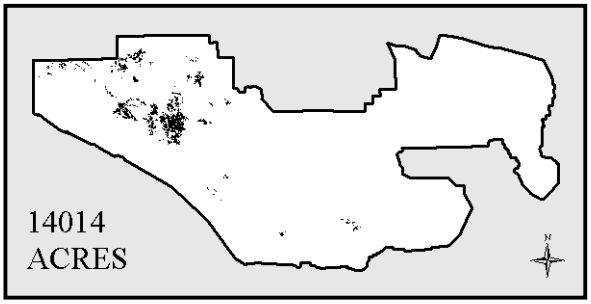


# California Juniper Alliance



**10021 = *Juniperus californica / Coleogyne ramosissima – Yucca schidigera***



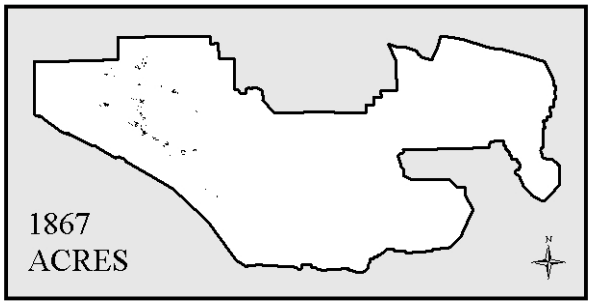



General Observations – Found in western part of the park. Occurring most frequently on gently sloping upper portions of fans, near the base of mountains.
Zone – Zone 2
Taxa – Open stand of JUNCAL generally ranging from 1 - 15% absolute cover over a shrub and succulent cover of CORA and YUSC usually over 10% absolute cover.
Elevation – 3500 to 4500 feet
Soil – Usually depositional, occasionally on poor developed soils.
Aspect – Generally north trending
Shape – Neutral to concave
Slope Position – upper portions of fans and low to mid slopes.
Steepness – Gentle to moderately steep
Geology –
Hydrology – Upland
Fire –
Frequency -
Note – The following similar map units may be confused with this type:

- 10025 – *Juniperus californica / Coleogyne ramosissima* is usually found on more mesic slopes and fans.

**10025 = *Juniperus californica / Coleogyne ramosissima***



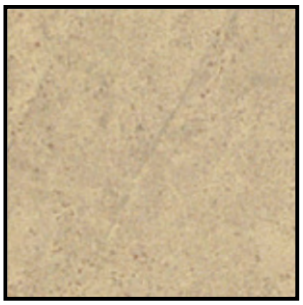


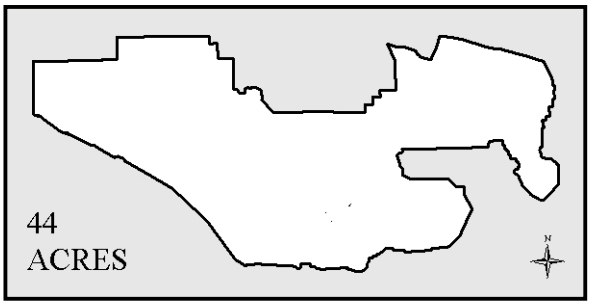

General Observations –Occurring most frequently on gently sloping upper portions of fans near the base of mountains.
Zone – Zone 2
Taxa – Open stand of JUNCAL generally ranging from 1-15% absolute cover over a shrub cover of CORA usually over 10% absolute cover.
Elevation – 3000 to 5000 feet

Soil – Usually depositional, occasionally on poor developed soils.
Aspect -Variable
Shape – Neutral to concave
Slope Position –Upper portions of fans and low to mid slopes.
Steepness –Gentle to moderately steep
Geology -
Hydrology -Upland
Fire –
Frequency -
Note – The following similar map units may be confused with this type:

- 10021 – *Juniperus californica / Coleogyne ramosissima – Yucca schidigera* is usually found on hotter and drier slopes and fans.

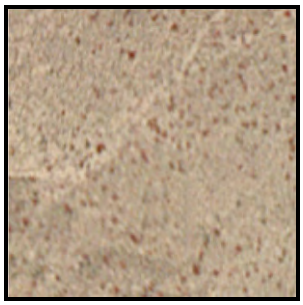
**10029 = *Juniperus californica / Tetracoccus hallii***

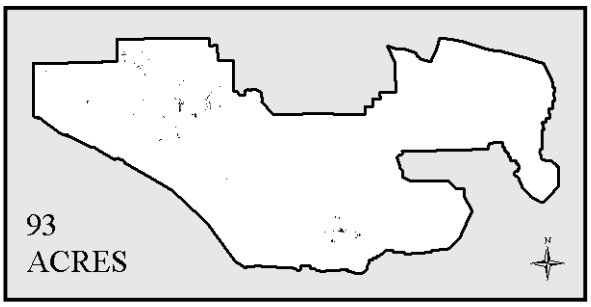





General Observations – Noted in the Eagle Mountains in the vicinity of Cottonwood Springs.
Zone – Western portions of Zone 6
Taxa – Emergent JUNCAL as a sparse emergent (minimum 1-5%) over a moderately sparse shrub understory of TEHA and associated shrubs.
Elevation – 3000 to 4000 feet
Soil –Usually depositional, occasionally on poor developed soils.
Aspect -Variable
Shape – Neutral to concave
Slope Position –Upper portions of fans and low to mid slopes.
Steepness –Gentle to moderately steep.
Geology -
Hydrology – Upland
Fire –
Frequency -
Note –

**10030 = *Juniperus californica/ Viguiera parishii – (Nolina bigelovii)***

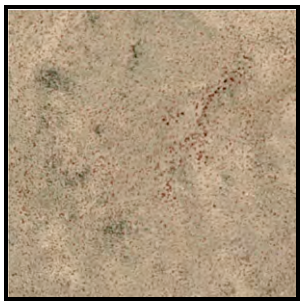


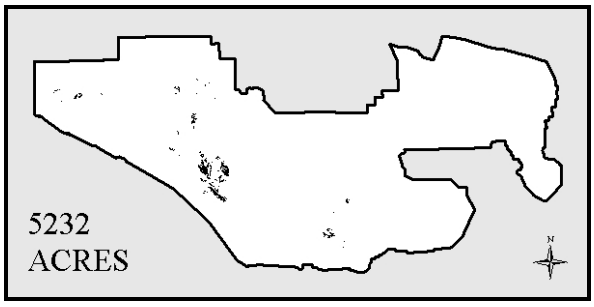



General Observations – Observed in the Coxcomb Mountains in the northeastern portion of the Park and near Lost Palms Oasis Trail.
Zone – Higher portions of Zone 8 and possibly Zone 7
Taxa – Extremely sparse JUNCAL (1-5%) as emergent to sparse understory cover (5-15%) of VIPA and other shrubs. Note: NOBI can have relative cover <1%.
Elevation – Above 4000 feet
Soil – Extremely rocky poorly developed soil
Aspect – Generally north trending
Shape – Neutral to concave but highly complex
Slope Position – Mid to upper slopes
Steepness – Moderate to very steep
Geology -
Hydrology - Upland
Fire –
Frequency – Uncommon; polygons are generally small in size. Limited, in extent, due to low precipitation in the eastern portion of the park and to the highest elevations.
Note – The following similar map units may be confused with this type:

- 28133 – *Viguiera parishii – (Ephedra nevadensis – Eriogonum fasciculatum – Nolina bigelovii)* has no visible JUNCAL.
- Areas around Jumbo Rocks may contain a minor component of QUCO.

**10031 = *Juniperus californica / Yucca schidigera – (Tetracoccus hallii)***



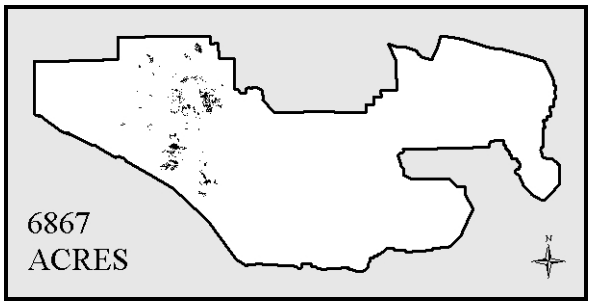


General Observations – Found mostly in the southwestern part of the park. Occurring most frequently on fans and gentle sloping upper portions of fans.
Zone – Zones 1 and 2
Taxa – Sparse JUNCAL (1-5%) with understory of YUSC and possibly TEHA
Elevation – 3500 to 5000 feet
Soil – Usually depositional
Aspect – Variable
Shape - Variable
Slope Position – Low to mid slopes
Steepness -Gentle
Geology -
Hydrology -Upland
Fire –
Frequency – Fairly common
Note – The following similar map units may be confused with this type:

- 10021 – *Juniperus californica / Coleogyne ramosissima – Yucca schidigera* is usually found on North facing slopes and concavities.

**10033 = *Juniperus californica / (Coleogyne ramosissima – Yucca schidigera)* Super Association (Combines types 10021, 10025, & 10031)**



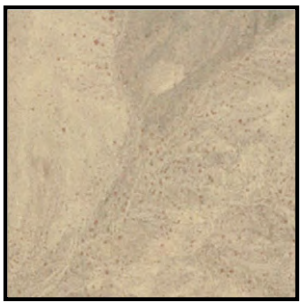


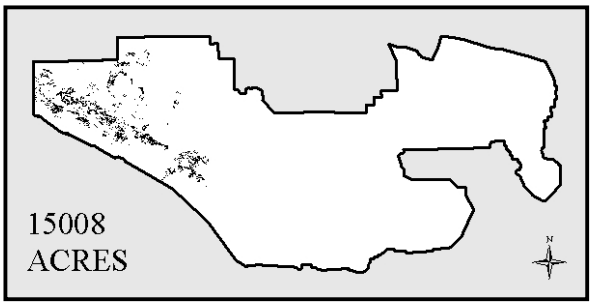

General Observations – Found in the Western portion of the park.
Zone – Occurring most frequently in Zone 2 on gently sloping upper portions of fans near the base of mountains.
Taxa – Open stands of JUNCAL generally ranging from 1-15% absolute cover over a shrub and succulent cover of CORA and/or YUSC usually over 10% absolute cover.
Elevation – 3500 to 4500 feet
Soil – Usually depositional, occasionally on poorly developed soils
Aspect - Variable
Shape – Complex & variable
Slope Position – Upper portions of fans; occasionally on low to mid slopes
Steepness – Gentle to moderately steep
Geology -
Hydrology - Upland
Fire –
Frequency – Common in the western portion of the park; polygons often extensive

Note – The following similar map units may be confused with this type:

- Super Association 10034 – *Juniperus californica / (Eriogonum fasciculatum / Achnatherum speciosum)* is found on much steeper sites generally south facing in the Little San Bernardino Mountains.
- This code is used when CORA signature is not clear because of soil or geology, but is in the CORA environment.

**10034 = *Juniperus californica / (Eriogonum fasciculatum / Achnatherumspeciosum)* Super Association (10022 & 10023)**






General Observations – Observed near ridges and slopes of the Little San Bernardino Mountains.
Zone – Zones 1 and 2.
Taxa – Sparse JUNCAL (1-5%) with understory cover of ACHSPE and ERFA.
Elevation – 3500 to 4500 feet
Soil –Usually depositional
Aspect – Mostly south trending; locally north trending at lower elevations
Shape - Variable
Slope Position –Mid to upper slopes
Steepness –Moderate to very steep
Geology -
Hydrology -Upland
Fire –
Frequency – Common in the Little San Bernardino Mountains
Note – The following map units may be confused with this type:

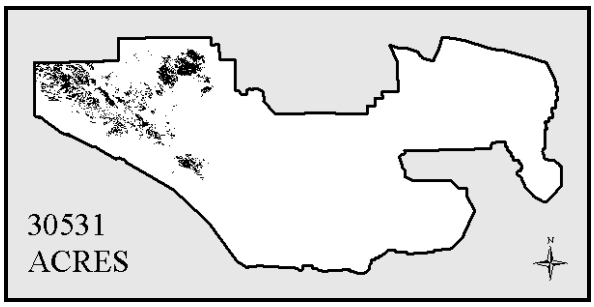
- 21234 – *Quercus Cornelius-mulleri – (Juniperus californica)* is generally found in more mesic areas.

# Singleleaf Pinyon Alliance



**10161 = *Pinus monophylla – Quercus cornelius-mulleri***

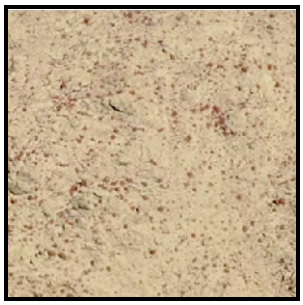


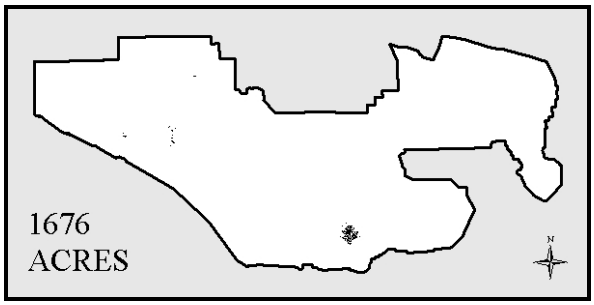



General Observations – Noted on north trending slopes above Lower Covington Flats in the Little San Bernardino Mountains.
Zone – Found exclusively in Zone 3
Taxa – Sparse to moderately closed stands (generally 5-40% cover) of PIMO over an open cover of QUCO. JUNCAL may be present in small amounts.
Elevation – Generally over 4500 feet, locally as small stands on lower elevation more protected sites
Soil –Well to poorly developed soils.
Aspect – Northerly trending
Shape – Neutral to concave
Slope Position – Lower to mid slopes
Steepness – Moderately to very steep
Geology – Granitic and calcareous
Hydrology - Upland
Fire – Much of the existing Pinyon within the park has been burned within the past five years; many acres were this type.
Frequency – Common and fairly extensive in Zone 3; reduced substantially by fire
Note – The following map units may be confused with this type:

- 10162 – *Pinus monophylla – Juniperus californica / Achnatherum speciosum* is generally found in slightly drier settings at high elevations generally east of type 10161. Type 10162 is probably less extensive and restricted to the highest elevations in the middle and eastern portions of the park.
- Likes North facing, rockier soils that are fairly steep.

**10162 = *Pinus monophylla – (Juniperus californica) / Achnatherum speciosum***






General Observations – Noted on Queen Mountain and associated slopes.
Zone – Zones 3, 7 and isolated locations in Zone 8
Taxa – Sparse stands (generally 3-25% but locally down to 1% in Coxcomb Mountains) of PIMO in association with or without a JUNCAL tall shrub layer over an extremely sparse understory of small shrubs & grasses primarily consisting of Ericameria spp. & ACHSPE.
Elevation – Generally over 4000 feet, but locally on protected slopes to 3500 feet
Soil –Well to poorly developed soils.
Aspect – Northerly trending
Shape – Concave to neutral
Slope Position – Upper slopes
Steepness – Generally steep
Geology – Granitic and calcareous
Hydrology - Upland
Fire – Extensively burned in the vicinity of Quail Mountain
Frequency – Fairly common, but polygons less extensive than type 10161; Restricted to the highest elevations in the Eagle, Cottonwood; Coxcomb Mtn. Stands noted as 10160.
Note - The following map units may be confused with this type:

- 10161 – *Pinus monophylla – Quercus cornelius-mulleri* generally has a higher canopy cover and is found in wetter locations usually in the western portion of the park.
- This type is generally not very rocky with gentle slopes; QUCO is less common on flatter or less rocky substrate.

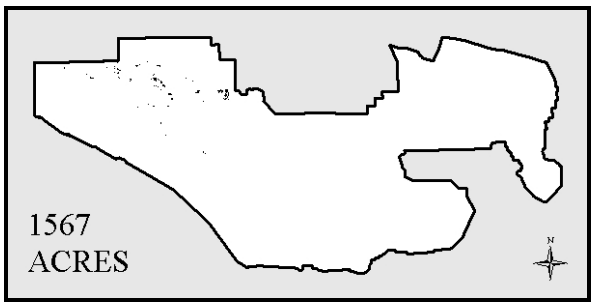
13000 = Succulent extremely xeromorphic evergreen woodland

# Joshua Tree Alliance



**13012 = *Yucca brevifolia / Coleogyne ramosissima***

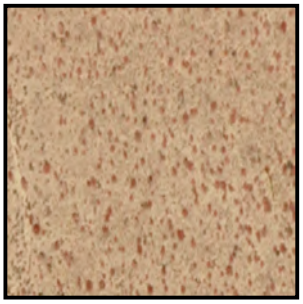


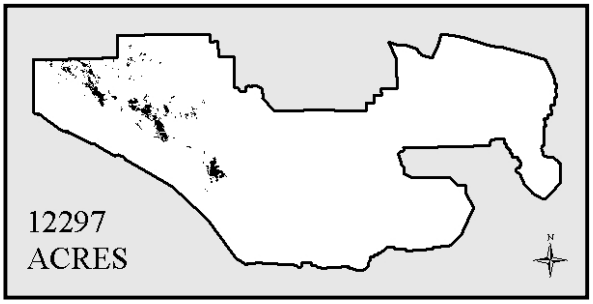



General Observations –Occurring most frequently on fans and upper gentle portions of fans.
Zone - Zone 2
Taxa – YUBR in sparse to open stands (1-5%) over an open canopy of CORA dominant shrubs of about 5-20% absolute cover
Elevation – 3000 to 5000 feet
Soil – Well developed with caliche associated with CORA.
Aspect - Variable
Shape - Neutral
Slope Position – Fans and upper fans
Steepness – Flat to gentle slopes
Geology – Some pediment surface may be present
Hydrology – Upland
Fire – Much of this type has undergone recent burning in the Covington Flats area
Frequency –
Note - The following map units may be confused with this type:

- 13016 – *Yucca brevifolia / Larrea tridentata – (Yucca schidigera / Pleuraphis rigida)* Super Association is generally found on slightly lower elevations and has a sparser yucca canopy
- 13015 – *Yucca brevifolia / Juniperus californica / (Coleogyne ramosissima – Yucca schidigera – Ephedra nevadensis)* is found upslope of this type on slightly steeper settings closer to mountain toe-slopes.

**13015 = *Yucca brevifolia – Juniperus californica / (Coleogyne ramosissima – Yucca schidigera – Ephedra nevadensis)* Super Association (13013, 13015, & 13017)**



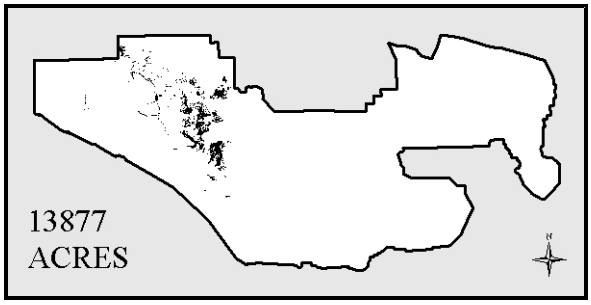


General Observations – Observed during field in the Upper Covington Flats area.
Zone – Upper elevations of Zone 2
Taxa – Open stands of YUBR and JUNCAL from 3-15% cover over an open layer of CORA dominant shrubs. Other species including EPNE, YUSC and Lycium spp. may be present in the shrub layer.
Elevation – 4500 to 5500 (the highest YUBR association)
Soil –Less well developed than other YUBR types.
Aspect -Variable
Shape -
Slope Position - Upper fans often near toe slopes
Steepness – Flat to gentle slopes
Geology –
Hydrology -Upland
Fire –Less extensive than other YUBR types; found generally at higher elevations.
Frequency –
Note –The following similar map units may be confused with this type:

- 13012 – *Yucca brevifolia / Coleogyne ramosissima* Association does not have a JUNCAL presence in the canopy layer and is generally found down slope from this type.

**13016 = *Yucca brevifolia / Larrea tridentata – (Yucca schidigera / Pleuraphis rigida)* Super Association (13011)**





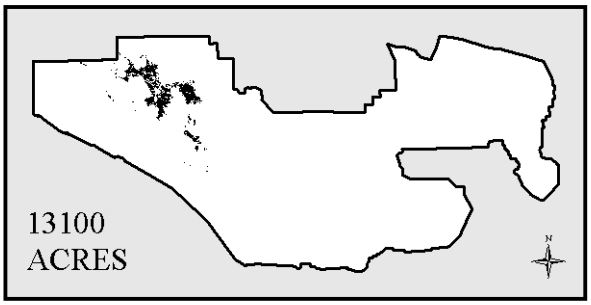

General Observations –Noted on Geology Tour Road in the lower portions of Queen Valley.
Zone – Uppermost portions of Zone 1 and into Zone 2.
Taxa – Extremely sparse emergent layer of YUBR under 5% cover over an open shrub layer dominated by LATR. PLRI may dominate in sandier settings; YUSC may also be a component to the understory layer.
Elevation –3500 to 4500 feet
Soil –Generally well developed, often sandy.
Aspect -
Shape -
Slope Position -
Steepness – Nearly level
Geology - Bajadas

Hydrology - Upland
Fire –
Frequency – Common and extensive; the lowest elevation YUBR type.
Note – The following similar map units may be confused with this type:

- 13012 – *Yucca brevifolia / Coleogyne ramosissima* Association is found at higher elevations and has a slightly higher canopy cover.
- 13021 – *Yucca brevifolia / (Ephedra nevadensis – Grayia spinosa – Lycium spp.) / Pleuraphis rigida* Association will have a shrub layer without visible LATR.

**13021 = *Yucca brevifolia / (Ephedra nevadensis – Grayia spinosa – Lycium spp.) / Pleuraphis rigida* Super Association**






General Observations – Mostly occurring at higher elevation valley floors and low energy washes. Observed in Lost Horse Valley and Black Rock Valley.
Zone – Zones 1 and 2
Taxa – Sparse YUBR under 5% cover over open shrub layer of EPNE, GRSP, Lycium spp. and associated shrubs.
Elevation – 3000 to 5000 feet
Soil – Well developed
Aspect -Variable
Shape -
Slope Position – Flat to gently sloping
Steepness - Gentle
Geology – Valley floors and low energy washes
Hydrology - Upland
Fire –
Frequency –
Note -

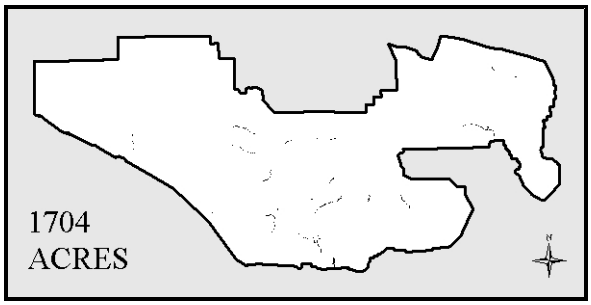
15000 = Temporarily flooded cold-deciduous woodland

# Desert Willow Alliance



**15012 = *Chilopsis linearis – Psorothamnus spinosus – (Cercidium floridum / Acacia greggii)* MAMU**






General Observations – Noted in major washes with wide floodplains in the vicinity of Cottonwood Springs
Zone - Limited primarily to the eastern portions of Zone 1
Taxa – CHLI as co-dominant to PSSP, usually with associated individuals of ACGR. CEFL may be present in the canopy layer. Canopy density is highly variable, but generally under 15%

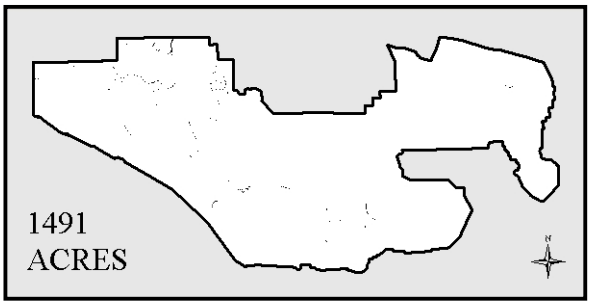
Diagnostic species in riparian types are irregularly distributed and generally extremely sparse with extensive portions of the wash corridor lacking species which define the alliance.

Elevation – 1500 to 3500 feet; representing a transition zone between high elevation wash types and lower Colorado Desert washes
Soil - Unconsolidated
Aspect -
Shape -
Slope Position -
Steepness - Gentle
Geology – Granitic and calcareous
Hydrology – Temporarily or intermittently flooded, active high energy large washes.
Fire –
Frequency – Uncommon; overlap between CHLI & PSSP is probably narrow
Note – The following similar map units may be confused with this type:

- 15013 *Chilopsis linearis – (Prunus fasciculata – Acacia greggii)* Super association is generally found at higher elevations and often has an extremely dense canopy of CHLI.
- Cercidium, Olneya types are restricted to the lower elevations south of the Little San Bernardino Mountains and in Big Wash.
- Psorothamnus types are generally sparser canopy cover and do not contain the dark signatures of CHLI although large individuals of ACGR may be confused with desert willow.
- Poly can be extended to include associated species.

**15013 = *Chilopsis linearis / (Prunus fasciculata – Acacia greggii)* Super Association**





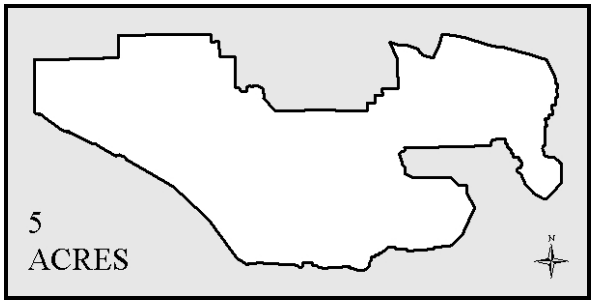

General Observations –Noted in major washes in Fortynine Palms Canyon and Johnny Lang Canyon.
Zone – Limited primarily to Northern portions of Zone 1.
Taxa – Canopy layer of CHLI generally under 15% with PRFA and ACGR

Diagnostic species in riparian types are irregularly distributed and generally extremely sparse with extensive portions of the wash corridor lacking species which define the alliance.

Elevation – 3000 to 4000 feet
Soil - Unconsolidated
Aspect -
Shape -
Slope Position -
Steepness - Gentle
Geology – Granitic and calcareous
Hydrology – Temporarily or intermittently flooded, active high energy washes.
Fire –
Frequency – Fairly common
Note -

**15030 = Mixed Willow**





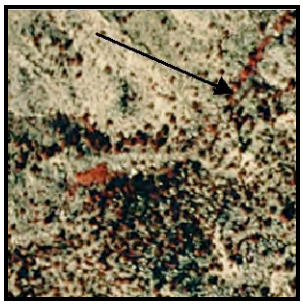

General Observations – Found in Willow Hole area.
Zone – Zone 2
Taxa – Canopy of SAGO and/or SALA with high-density ground cover.

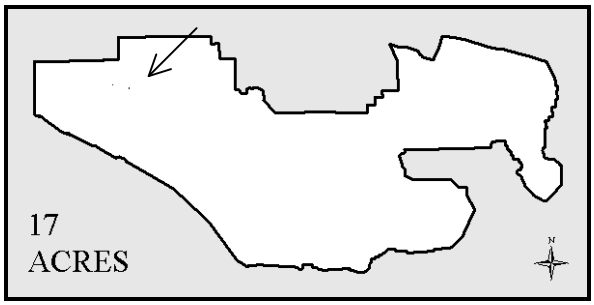
Elevation – 3000 to 4000
Soil - Unconsolidated
Aspect -
Shape -
Slope Position -
Steepness - Gentle
Geology - Granitic
Hydrology – Temporarily or intermittently flooded canyons.
Fire –
Frequency –
Note –

# Freemont Cottonwood Alliance



**15040 = Fremont cottonwood (*Populus fremontii*)**






General Observations – Usually found with WAFI, or down the wash from a WAFI oasis.
Zone – Zones 1 and 6
Taxa – Canopy layer of POFR usually as a co-dominant with WAFI. Canopy density is highly variable.
Elevation – 2500 to 3500 feet
Soil - Unconsolidated
Aspect -
Shape -
Slope Position -
Steepness - Gentle
Geology – Granitic
Hydrology – Temporarily flooded canyons
Fire –
Frequency – Uncommon
Note – Several stands noted may be lumped into *Washingtonia filifera* Associations unless polygons can be split to a finer level such as lower portions of Cottonwood Springs.

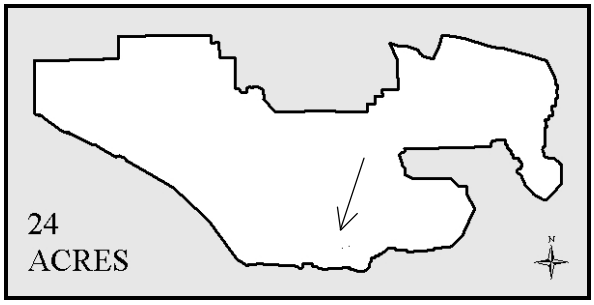
15110 = Seasonally flooded temperate broad-leaf evergreen woodland

# California Fan Palm Alliance



**15112 = *Washingtonia filifera / Salix exigua / Muhlenbergia rigens***





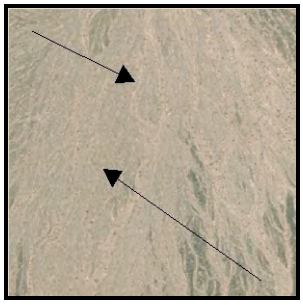

General Observations – Locations observed at Fortynine Palms Oasis, Cottonwood Springs, and Lost Palms Oasis.
Zone – Zones 1 and 5
Taxa – Canopy layer of WAFI with SAEX and MURI understory. Canopy density is highly variable.
Elevation – Usually found below 3500 feet
Soil - Unconsolidated
Aspect -
Shape -
Slope Position -
Steepness – Gentle to Moderately steep
Geology – Usually clustered around seeps and springs
Hydrology – Seasonally flooded
Fire –
Frequency – Uncommon; known stands have been documented
Note –

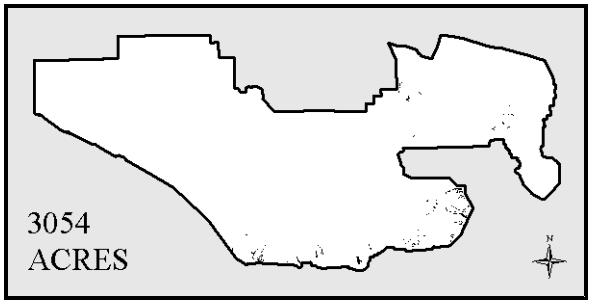
16000 = Thorn extremely xeromorphic deciduous woodland

# Blue Palo Verde Alliance



**16013 = *Cercidium floridum / Larrea tridentate***






General Observations – Observed at lower elevations mainly in the southeastern portion of the Park especially along small tributaries of Big Wash. Noted in a few locations in the Pinto Wells area (Leary).
Zone – Almost exclusively in Zone 9
Taxa – Sparse small individuals of CEFL as a co-dominant with LATR.

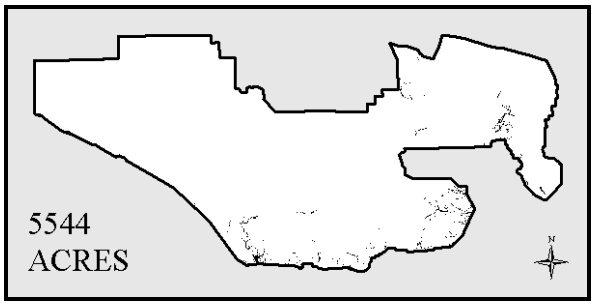
Diagnostic species in riparian types are irregularly distributed and generally extremely sparse with extensive portions of the wash corridor lacking species which define the alliance.

Elevation – Below 2500 feet
Soil - Unconsolidated
Aspect – Variable
Shape - Neutral
Slope Position - Low
Steepness – Slight to moderate
Geology – Small tributaries that do not flood regularly and along terraces of some major washes
Hydrology – Riparian edge
Fire –
Frequency – Uncommon and polygons often small or too narrow to map
Note – The following similar map units may be confused with this type:

- 16015 – *Cercidium floridum – Hyptis emoryi* found in more active portion of washes.

**16015 = *Cercidium floridum / Hyptis emoryi* (includes 16011, 16012, 16014)**






General Observations – Observed in large active washes coming down off the Little San Bernardino Mountains into the Colorado Desert and in tributaries of Big Wash, East of Coxcomb Mountains.
Zone – Frequent in Zone 9 and the lower portions of Zone 1 and 6
Taxa – Extremely sparse to open stands of CEFL in association with PSSP, HYEM & ACGR over a sparse shrub layer of HYSA. Diagnostic species in riparian types are irregularly distributed and generally extremely sparse with extensive portions of the wash corridor lacking species which define the alliance.

Elevation – Below 2500 feet, but seen up to 3200' near Fried Liver Wash.
Soil - Unconsolidated
Aspect - Variable
Shape - Neutral
Slope Position -
Steepness - Gentle
Geology – Active large washes
Hydrology – Riparian – intermittently flooded washes and arroyos, usually on a regular annual cycle
Fire –
Frequency – Common; polygons often extensive
Note – The following similar map units may be confused with this type:

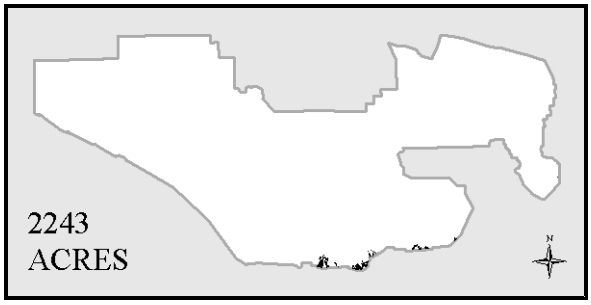
- 16013 – *Cercidium floridum / Larrea tridentata* generally found adjacent to this type.

# Ironwood Alliance



**16024 = *Olneya tesota* / *(Larrea tridentata – Encelia farinosa)* Fan Type**





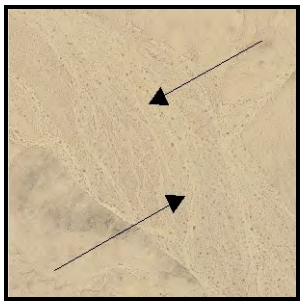

General Observations – Observed on fans South of Cottonwood.
Zone – Zones 6 and 9.
Taxa – Canopy can include OLTE and/or CEFL possibly with understory of LATR, ENFA, OPBI and FOSP.

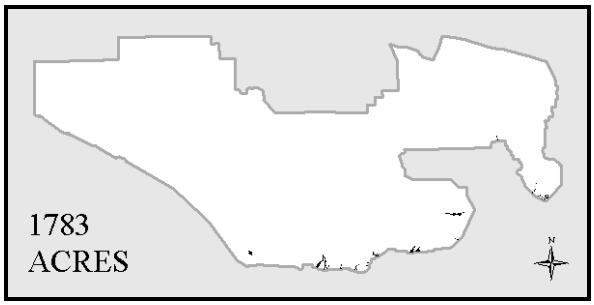
Diagnostic species in riparian types are irregularly distributed and generally extremely sparse with extensive portions of the wash corridor lacking species which define the alliance.

Elevation – Below 2500 feet
Soil – Well developed
Aspect – Generally south trending
Shape – Neutral
Slope Position – Lower portion of fans
Steepness – Even to slight steepness
Geology -
Hydrology – Found on fans, adjacent to washes
Fire –
Frequency –
Note – The following similar map units may be confused with this type:

- 16025 = *Olneya tesota – (Cercidium floridum / Hyptis emoryi)* Wash Type found in more active portions of washes, look for visible CEFL.

**16025 = *Olneya tesota – (Cercidium floridum / Hyptis emoryi)* Wash Type**





General Observations –Observed in Big Wash and East of Coxcomb Mountains.
Zone – Zone 9
Taxa – OLTE canopy with a possibility of CEFL with an understory of HYEM and HYSA. Canopy density is highly variable.

Diagnostic species in riparian types are irregularly distributed and generally extremely sparse with extensive portions of the wash corridor lacking species which define the alliance.

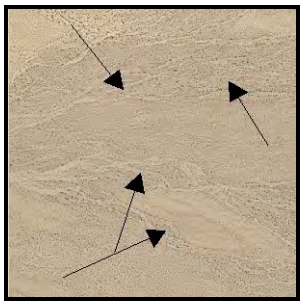
Elevation – Below 2500 feet
Soil - Unconsolidated
Aspect - Variable
Shape - Neutral
Slope Position -
Steepness - Gentle
Geology -
Hydrology – Temporarily flooded washes
Fire –
Frequency –
Note – The following similar map units may be confused with this type:

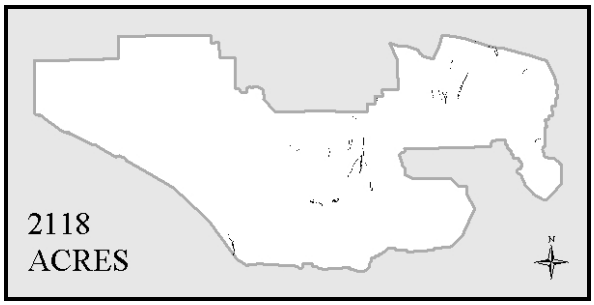
- 16024 = *Olneya tesota* / *(Larrea tridentata – Encelia farinosa)* Fan Type is generally found adjacent to this type.

# Smoketree Alliance



**16034 = *Psorothamnus spinosus* / (Ephedra californica – Hymenoclea salsola) broad low energy sandy wash type**



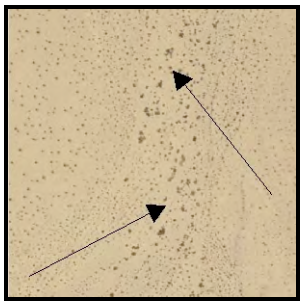


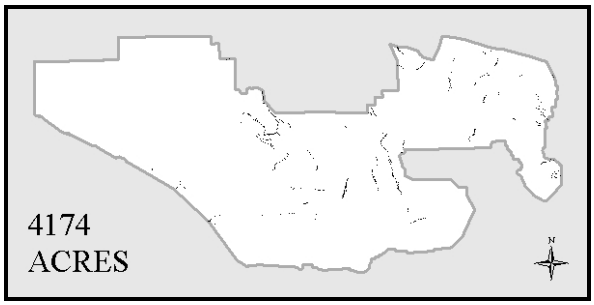

General Observations – Found in major washes (Smoke Tree Wash) with wide floodplains.
Zone – Zones 4, 5 and 6
Taxa – Canopy of PSSP with understory of EPCA and/or HYSA. Canopy density is highly variable.

Diagnostic species in riparian types are irregularly distributed and generally extremely sparse with extensive portions of the wash corridor lacking species which define the alliance.
Elevation – Below 2500 feet
Soil - Unconsolidated
Aspect - Variable
Shape - Neutral
Slope Position -
Steepness - Gentle
Geology – Granitic
Hydrology – Low energy, temporarily or intermittently flooded washes
Fire –
Frequency – Fairly common, polygons will be extensive.
Note – The following similar map units may be confused with this type:

- 16035 – *Psorothamnus spinosus / (Hyptis emoryi – Acacia greggii)* found in narrow high-energy washes, look for visible ACGR.

**16035 = *Psorothamnus spinosus* / (*Hyptis emoryi – Acacia greggii*)**
**Narrow high-energy wash type**






General Observations - Observed in narrow washes at base of the mountains and continuing onto the fan.
Zone – Zones 4, 5 and 6
Taxa – Canopy of PSSP with understory of HYEM and ACGR.

Diagnostic species in riparian types are irregularly distributed and generally extremely sparse with extensive portions of the wash corridor lacking species which define the alliance.

Elevation – Below 3000 feet
Soil – Fairly Rocky
Aspect - Variable
Shape - Neutral
Slope Position –
Steepness - Gentle to Moderately steep
Geology – Granitic and calcareous
Hydrology – High energy, temporarily or intermittently flooded washes
Fire –
Frequency – Fairly common, polygons will be restricted to narrow washes
Note – The following similar map units may be confused with this type:

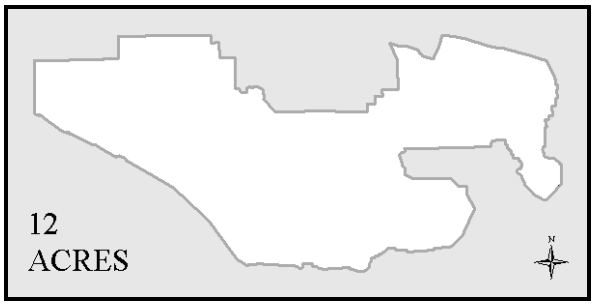
- 16034 = *Psorothamnus spinosus* / (Ephedra californica – Hymenoclea salsola) found in broad washes.

# Mesquite Alliance



**16040 = Mesquite (*Prosopis glandulosa*, Map to Alliance Level)**






General Observations – Can be found in isolated locations in the western part of the park and in the Eagle, Coxcomb, and Pinto Mountains and in Rattlesnake Canyon (Leary). Found in and adjacent to washes.
Zone – Primarily found in Zones 4 & 9
Taxa – Dense continuous stands of PRGL usually over 40% associated with ISAR and /or ATCA.
Diagnostic species in riparian types are irregularly distributed and generally extremely sparse with extensive portions of the wash corridor lacking species which define the alliance.

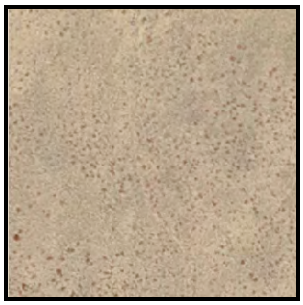
Elevation – 2000 to 3000
Soil -
Aspect - Variable
Shape - Concave
Slope Position – Low slope of wash banks
Steepness – Locally moderate to steep
Geology -
Hydrology – Temporarily flooded, high energy washes.
Fire –
Frequency – Fairly common with polygons restricted to canyons and isolated portions of the park.
Note -

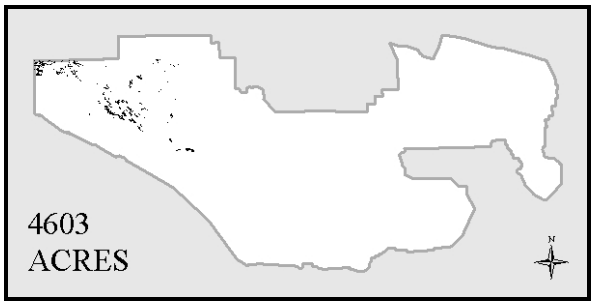
21000 = Sclerophyllous temperate broad leaved evergreen shrubland

# Muller Oak Alliance



**21233 = *Quercus cornelius-mulleri – (Juniperus californica / Coleogyne ramosissima)* MAMU**



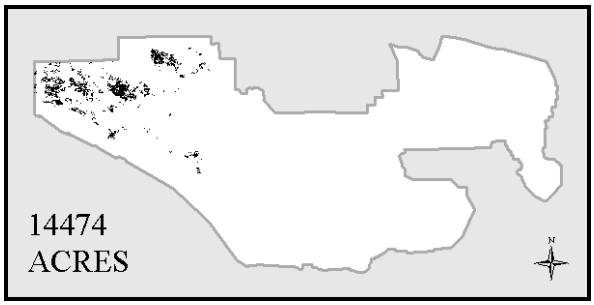



General Observations – Found in western part of the park in pinyon/juniper areas. Observed in Covington Flats area and in Little San Bernardino Mountains.
Zone – Zones 2 and 3
Taxa – Sparse QUCO canopy with or without JUNCAL that can have dense dominantly CORA shrub layer.
Elevation – Above 3500 feet
Soil -
Aspect – Generally trending south/southeast
Shape – Neutral to concave
Slope Position – Mid slope
Steepness – Moderately steep
Geology -
Hydrology – Upland
Fire – Many areas near Covington Flats have been burned within the last 5 years.
Frequency – Fairly common
Note – The following similar map units may be confused with this type:

- 21234 *Quercus cornelius-mulleri – (Juniperus californica)* MAMU will not have any visible CORA.

**21234 = *Quercus cornelius-mulleri – (Juniperus californica)* MAMU**






General Observations – Found in western part of the park in pinyon/juniper areas. Observed in Covington Flats area and in Little San Bernardino Mountains.
Zone – Zones 2 and 3

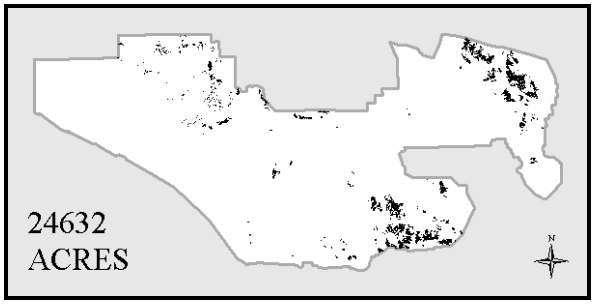
Taxa – Sparse QUCO canopy with or without JUNCAL. May contain a minor component of PIMO.
Elevation – Above 3500 feet
Soil -
Aspect – Generally trending south/southeast
Shape – Neutral to concave
Slope Position – Mid slope
Steepness – Moderately steep
Geology -
Hydrology – Upland
Fire – Many areas near Covington Flats have been burned within the last 5 years.
Frequency – Very common in the Little San Bernardino Mountains
Note – The following similar map units may be confused with this type:

- 21233 *Quercus cornelius-mulleri – (Juniperus californica / Coleogyne ramosissima)* MAMU will have visible CORA.

24000 = Microphyllous evergreen shrubland

**24001 (24012) = (*Ephedra nevadensis – Pleurocoronis pluriseta – Encelia farinosa – Trixis californica – Bebbia juncea – Eriogonum fasciculatum – Lycium andersonii – Acacia greggii)* low elevation rocky mountain type**






General Observations – Most common Ephedra in the Park Occurs mainly in rocky situations at lower elevations excluding the higher peaks in the Little San Bernardino Mountains (Leary).
Zone – Primarily in Zones 3, 6, and 8
Taxa – Extremely sparse to sparse shrub layer, dominated by EPNE with or without PLPL, TRCA, ENFA, BEJU, ERFA, LYAN and ACGR
Elevation – Below 3000 feet
Soil – Rocky
Aspect –Variable
Shape - Variable
Slope Position – Low to upper slopes
Steepness – Moderately steep to steep
Geology – Bouldery
Hydrology – Upland
Fire –
Frequency – Common

Note – The following similar map units may be confused with this type:

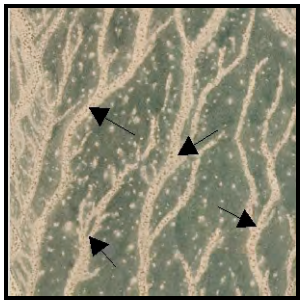
- 28133 - *Viguiera parishii (Ephedra californica – Eriogonum fasciculatum – Nolina bigelovii)* is generally found in higher elevations.

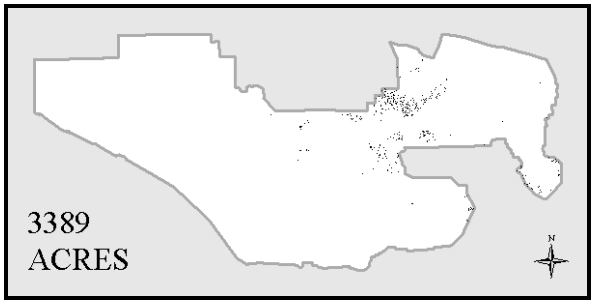
**24010 = Nevada ephedra (*Ephedra nevadensis*, not mappable at alliance level)**

**24012 = See 24001**

27000 = Broad-leaved and microphyllous evergreen extremely xeromorphic sub-desert shrubland

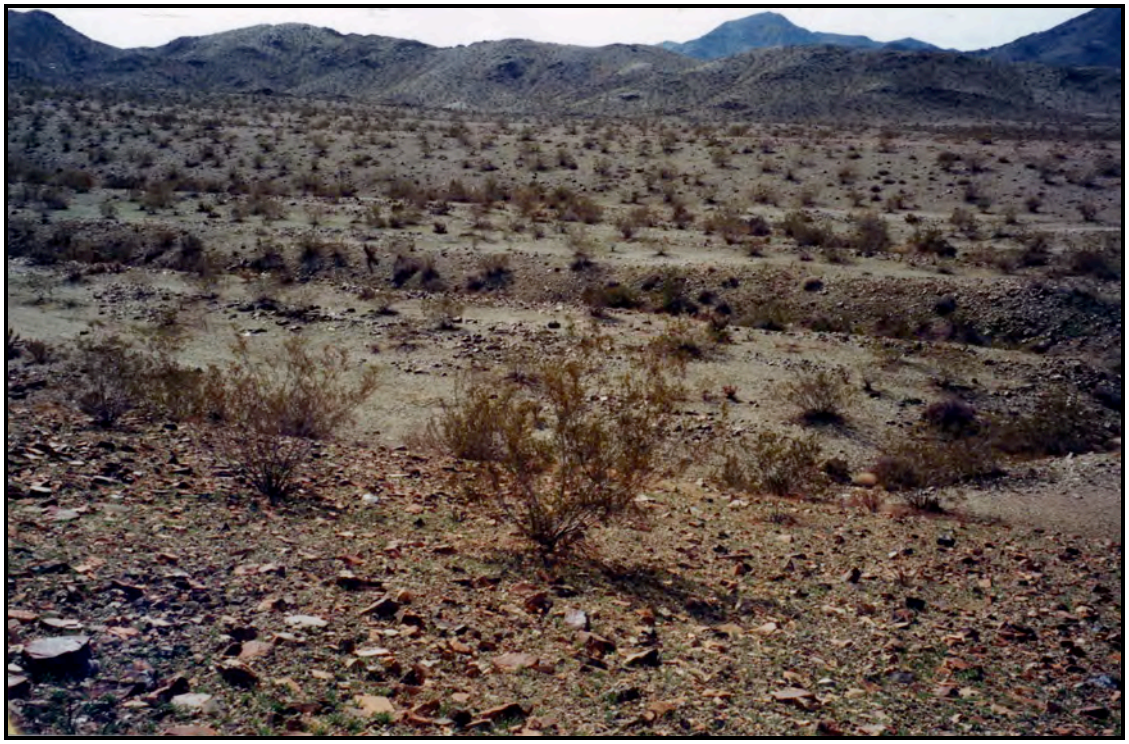
**27001 = Dense rivulets within desert pavement – Includes: *Salazaria mexicana – Krameria spp. – Encelia farinosa – Hyptis emoryi – Eriogonum fasciculatum – Hymenoclea salsola – Acacia greggii – Tetracoccus hallii***





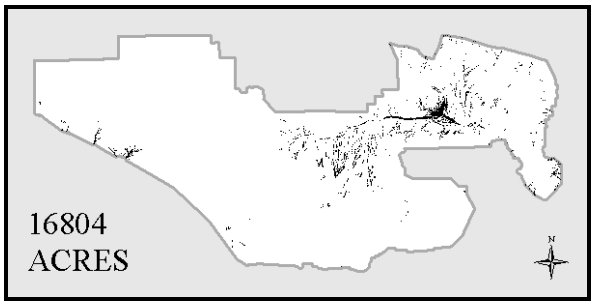

General Observations – Found in small rivulets between desert pavement types.
Zone – Zone 4
Taxa – A combination of plants, usually containing about 1-3% of each species.
Elevation – Below 2000 feet
Soil –
Aspect – Variable
Shape – Even
Slope Position –
Steepness – Gentle
Geology –
Hydrology – Low energy, rivulets resulting from sheet runoff of the adjacent pavement surfaces
Fire –
Frequency – Fairly common
Note – Often these types occur below minimum mapping unit (MMU) between desert pavements.

# Creosote Bush Alliance



**27011 = *Larrea tridentata – (Ambrosia dumosa) – Hymenoclea salsola* Low Energy Wash Type**



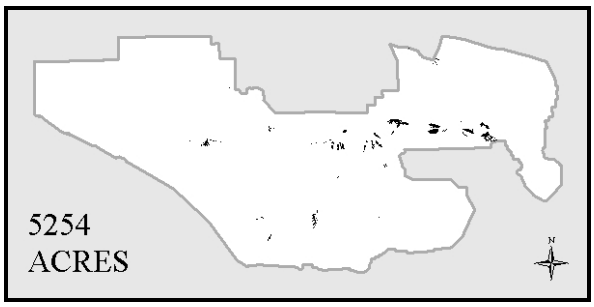



General Observations – Generally found where washes dissipate into the fan. This type is usually found in the Pinto Basin and Eastern portions of the Park.
Zone – Zones 1 and 4
Taxa – LATR with HYSA (3-5%) cover that may or may not include AMDU.
Elevation – Below 3000 feet
Soil – Sand or sandy soils
Aspect - Variable
Shape – Even
Slope Position -
Steepness - Gentle
Geology – Granitic
Hydrology – Low energy, temporarily flooded washes.
Fire –
Frequency –
Note - The following similar map units may be confused with this type:

- 27047 – *Larrea tridentata – Ambrosia dumosa – (Ephedra californica – Senna armata – Hymenoclea salsola – Psorothamnus schottii)* Low Energy Wash Type. May be difficult to separate. Species composition more diverse with a higher presence of PSSC.

**27019 = *Larrea tridentata* Undifferentiated Playa and Sandy or Dune Top Type**





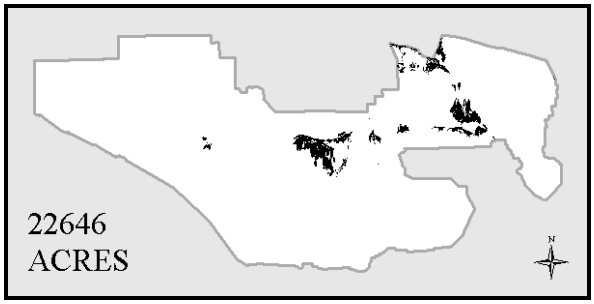

General Observations – Associated with several small depressions that are not alkaline.
Zone – Primarily in Zone 4

Taxa – Sandy type usually sparse LATR often found with annuals. Playa type usually dense with annual understory component
Elevation – Below 3000 feet
Soil - Sandy
Aspect -
Shape -
Slope Position -
Steepness – Flat
Geology -
Hydrology – Playas may have been temporarily flooded.
Fire –
Frequency – Playa type fairly uncommon. Sandy type fairly common with extensive polygons.
Note – The following similar map units may be confused with this type:

- 27021 - *Larrea tridentata – (Ambrosia dumosa) / Pleuraphis rigida* Sandy Type will have visible PLRI.

**27021 = *Larrea tridentata* – *(Ambrosia dumosa) / Pleuraphis rigida* Sandy Type**



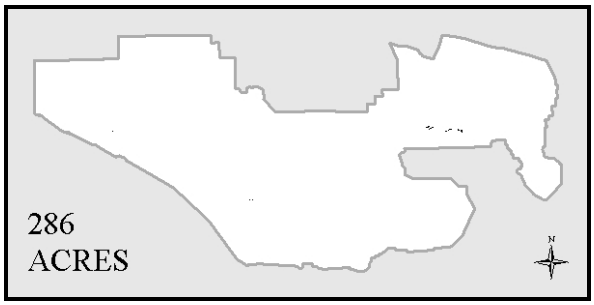



General Observations – This type is found in Sandy or Dune areas.
Zone – Zone 4
Taxa – LATR with PLRI cover of 3-5%. May include AMDU and annuals.
Elevation – Below 4000 feet
Soil - Sandy
Aspect -
Shape -
Slope Position -
Steepness – Flat to gently sloping
Geology -
Hydrology – Upland
Fire –
Frequency – Fairly common
Note – The following similar map units may be confused with this type:

- 27019 *Larrea tridentata* Undifferentiated Playa and Sandy or Dune Top Type has no visible PLRI.
- Type can be associated with disturbance areas.

**27022 = *Larrea tridentata* Clones**






General Observations – Possibly observed in field in Little San Bernardino Mountains, on ridge top east of East Deception Canyon.
Zone -
Taxa – Cover is highly variable. Usually large individuals that grow in a circular pattern.
Elevation – Below 3000 feet
Soil – Usually Sandy
Aspect -
Shape -
Slope Position -
Steepness -
Geology -
Hydrology – Upland
Fire –
Frequency – Very uncommon
Note – Clones are remnants of plants established more than 11,000 years ago (Plant Species Guide, Kumi), may occur below minimum mapping unit (MMU).

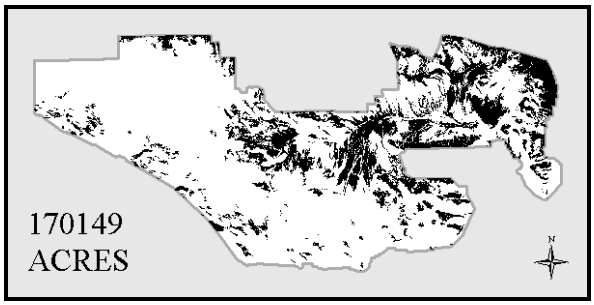
# Creosote bush/White bursage Alliance



**27030 = Creosote bush *(Larrea tridentata)* / White bursage *(Ambrosia dumosa)***

**27031 = *Larrea tridentata – Ambrosia dumosa* Generic – Fan & Slopes**



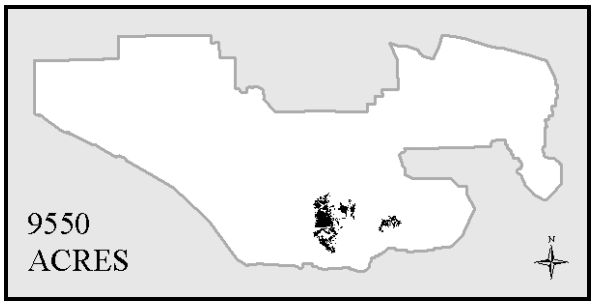



General Observations – The most common type in the Park. Best developed stands are found in the Pinto Basin and east of the Coxcomb Mountains.
Zone – Zones 1 and 4
Taxa – LATR with AMDU dominant shrub layer. Cover density is highly variable.
Elevation – Below 3500 feet
Soil –Well developed soils
Aspect – North trending
Shape – Variable
Slope Position – Lower to mid slopes and lower to upper fans.
Steepness – Gentle to moderately steep
Geology -
Hydrology – Upland
Fire –
Frequency – Very common; Polygons can be extensive.
Note – The following similar map units may be confused with this type:

- 27057 – *Larrea tridentata – Encelia farinosa (Ambrosia dumosa* – mixed shrub) found on south facing slopes and pediment surfaces at base of mountains.

**27043 = *Larrea tridentata – (Ambrosia dumosa) – Tetracoccus hallii – (Yucca schidigera)* (Use MAMU)**



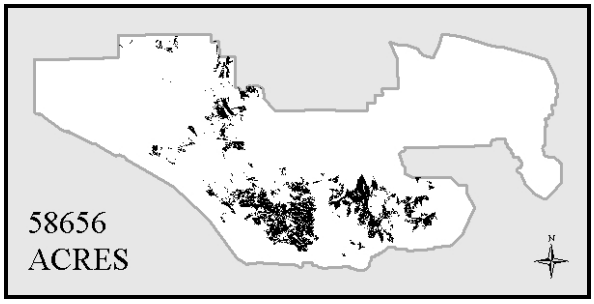



General Observations – Occurring mainly in and around the Cottonwood Springs area

Zone – Zone 6
Taxa – Shrub cover of LATR with a co-dominant of TEHA (3-5%) and may or may not have AMDU.
Elevation – 2500 to 3500 feet
Soil -
Aspect -
Shape -
Slope Position – Upper fans and lower slopes
Steepness – Gentle to moderately steep
Geology -
Hydrology – Upland
Fire –
Frequency –
Note – TEHA only occurs around the Eagle Mountains.

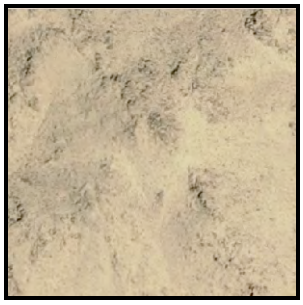
**27045 = *Larrea tridentata – Ambrosia dumosa – Yucca schidigera – (Senna armata)***
**Toe-slopes & Steeper Fan Type**

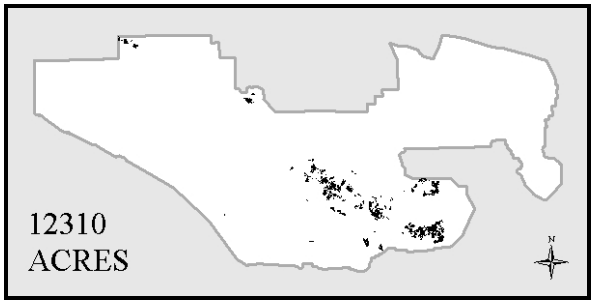





General Observations – Generally found on upper portions of LATR – AMDU fans.
Zone – Zones 1 and 4
Taxa – LATR with AMDU (3-5%) dominant shrub layer and succulents with 1-3% YUSC
Elevation –2500 to 4500 feet
Soil – Well developed soils
Aspect - Variable
Shape - Neutral
Slope Position – Fan to mid slope
Steepness – Gentle to Moderately steep.
Geology -
Hydrology – Upland
Fire –
Frequency – Common
Note –

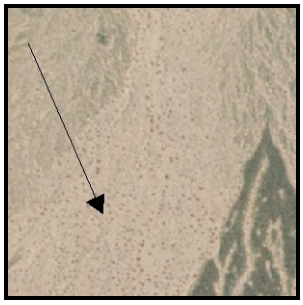
**27046 = *Larrea tridentata – (Ambrosia dumosa – Viguiera parishii)* Higher Elevation Type**

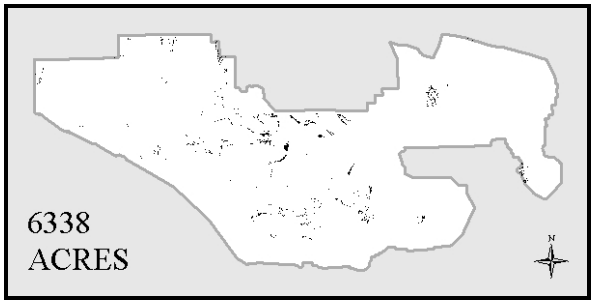





General Observations – Mostly found on the rocky slopes of the Coxcomb Mountains.
Zone – Zones 2 and 5
Taxa – Sparse and small LATR on rocky slopes with the possibility of AMDU – VIPA dominant shrub layer.
Elevation – 2500 to 4000 feet
Soil -Rocky
Aspect – Generally North/Northwest trending
Shape -
Slope Position – Mid to upper slopes.
Steepness – Moderate to steep.
Geology -
Hydrology – Upland
Fire –
Frequency –
Note -

**27047 = *Larrea tridentata – Ambrosia dumosa* – (*Ephedra californica– Senna armata – Hymenoclea salsola – Psorothamnus schottii*) Low Energy Wash Type**






General Observations – Generally found in wider floodplain, low energy washes.
Zone – Zone 1
Taxa – LATR with AMDU and can include EPCA, SEAR, HYSA and PSSC.
Elevation – 2500 to 4000 feet
Soil - Sandy
Aspect -

Shape - Variable
Slope Position -
Steepness - Gentle
Geology – Granitic
Hydrology – Low energy, temporarily or intermittently flooded washes.
Fire –
Frequency –
Note – The following similar map units may be confused with this type:

- 27011 – *Larrea tridentata (Ambrosia dumosa) – Hymenoclea salsola* Low Energy Wash Type. May be difficult to separate out, possible key out on the presence of PSSC.
- 36015 – *Acacia greggii (Hymenoclea salsola – Psorothamnus schottii – Bebbia juncea – Ephedra californica)* look for visible ACGR.

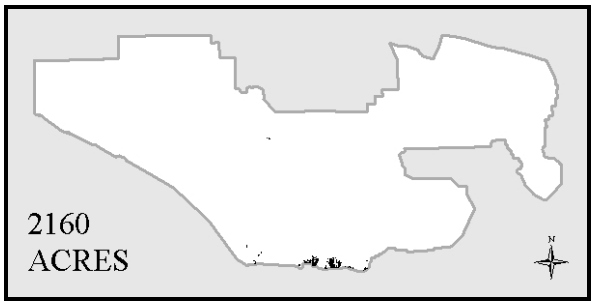
# Creosote bush/Brittlebush Alliance



**27050 = Creosote bush *(Larrea tridentata)* / Brittlebush *(Encelia farinosa)***

**27056 = *Larrea tridentata – Encelia farinosa – Fouquieria splendens***



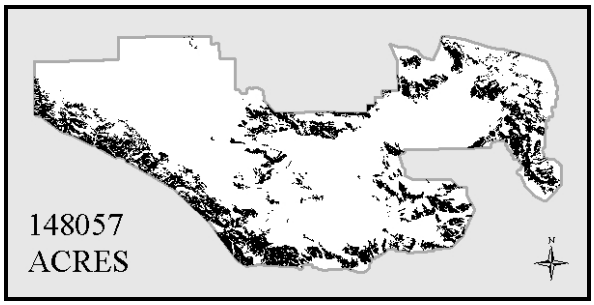



General Observations – Generally found on upper portions of Fans in the Colorado Desert.
Zone – Zone 9
Taxa – LATR with ENFA dominant shrub layer and succulents with 1-3% FOSP
Elevation – Below 3500 feet
Soil -
Aspect – South/southwest trending
Shape - Variable
Slope Position – Upper portions of fans.
Steepness - Gentle
Geology -
Hydrology – Upland
Fire –
Frequency – Very uncommon
Note – The following similar mapping units may be confused with this type:

- 27057 – *Larrea tridentata /Encelia farinosa (Ambrosia dumosa)* this type will be without visible FOSP

**27057 = *Larrea tridentata – Encelia farinosa (Ambrosia dumosa* – mixed shrub) Super Alliance**






General Observations – Generally occurring on Southern slopes of the Mountains and pediment surfaces of the toe slopes. Best developed on southern slopes of the Little San Bernardino Mountains. Elsewhere locally on hot dry exposures in mountain ranges east of the Hexies

Zone – Zones 1, 4, and 5
Taxa – LATR with ENFA and/or AMDU
Elevation – Below 3500 feet
Soil – Well developed
Aspect – South/southwest trending
Shape - Variable
Slope Position – Lower to mid slopes and upper fans
Steepness – Gentle to moderately steep
Geology -
Hydrology – Upland
Fire –
Frequency – Very common
Note – The following similar mapping units may be confused with this type:

- 27031 – *Larrea tridentata – Ambrosia dumosa* found on north facing slopes and extensively on fans.
- 27056 – *Larrea tridentata - Encelia farinosa - Fouquieria splendens* look for visible FOSP

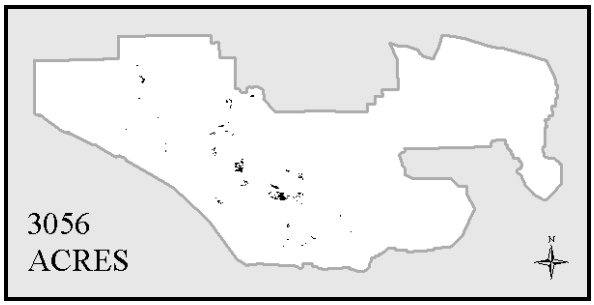
28000 = Facultatively deciduous extremely xeromorphic sub-desert shrubland

# Blackbush Alliance



**28023 = *Coleogyne ramosissima* – (mixed shrub) Super Association**






General Observations – Most pure stands are located in the western part of the park, on the North slopes of the Hexie Mountains.
Zone – Zone 2
Taxa – Mostly CORA with or without YUSC and can have VIPA, AMDU, SAME, EPNE and other associated shrubs.
Elevation – 3500 to 5500 feet
Soil – Well developed soils
Aspect – Northerly trending
Shape – Generally concave
Slope Position – Lower to upper slopes
Steepness – Gentle to moderately steep
Geology -
Hydrology – Upland
Fire –
Frequency – Pure stands of CORA are fairly uncommon
Note – The following similar map units may be confused with this type:

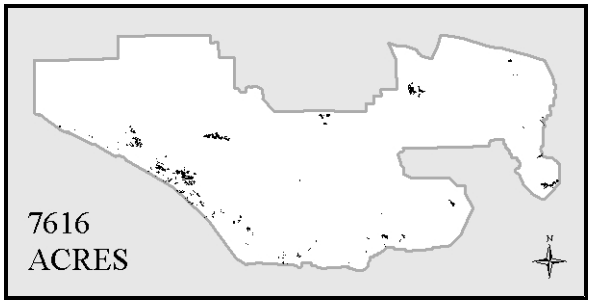
- 29032 *Yucca schidigera – Coleogyne ramosissima* type will have a much higher percent (3-5%) cover of YUSC.

# Brittlebush Alliance



**28033 = *Encelia farinosa* Association**

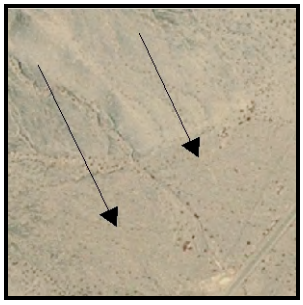


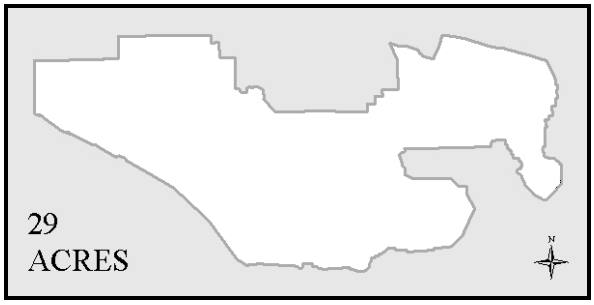



General Observations – Often found in driest, hottest portions of the Park on south facing slopes.
Zone – Zone 5 and 9
Taxa – ENFA 1 – 3% cover with very minor component of LATR or AMDU
Elevation – 1500 to 3500 feet
Soil – Rocky
Aspect – South trending
Shape - Convex
Slope Position – Low to mid slope
Steepness – Moderate to steep
Geology -
Hydrology – Upland
Fire –
Frequency – Uncommon
Note – The following similar map units may be confused with this type:

- 27057 – *Larrea tridentata – Encelia farinosa (Ambrosia dumosa* – mixed shrub) look for the presence of LATR.

**28070 = Desert Holly *(Atriplex hymenolytra)***

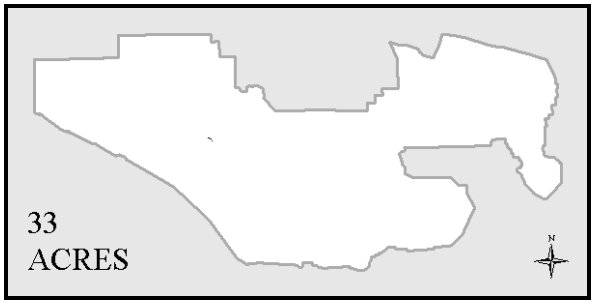





General Observations – Observed in the field in the Southeast portion of the park adjacent to Highway 177. Leary observed one isolated spot southwest of Pinto Wells on volcanic tuft.
Zone – Zone 4
Taxa – ATHY (3-5%) cover and may include LATR and AMDU.
Elevation – 500 to 1500 feet
Soil -
Aspect – South/Southwest trending
Shape - Neutral
Slope Position – Lower slopes
Steepness - Gentle
Geology – Possibly volcanic
Hydrology – Upland
Fire –
Frequency – Very uncommon
Note – Only stands of ATHY that have been identified in the field are delineated, photo interpretation signature not established.

**28080 = Fourwing saltbush *(Atriplex canescens)***






General Observations – Occurring usually in areas of poor drainage in mid to upper elevations in the western portions of the park (Leary). A significant stand exists in Pleasant Valley, Malapai Hill (Plant Species Guide, Kumi)
Zone – Zone 2
Taxa – ATCA (3-5%) cover with various annuals
Elevation – Above 1500 feet

Soil – Poorly drained, non-alkaline soils and dry lakebeds on the desert floor
Aspect - Variable
Shape - Even
Slope Position –
Steepness -
Geology -
Hydrology – Temporarily or intermittently flooded drainages.
Fire –
Frequency – Uncommon
Note –

**28110 = Cheesebush *(Hymenoclea salsola)***

General Observations – Common throughout the park. Occurs mainly in and along watercourses. Respectable stands found in Queen and Pleasant Valleys. (Plant Specie Guide, Kumi)
Zone – Zones 1 and 9
Taxa – HYSA (3-5%) with a minor component of LATR
Elevation – Below 5000 feet
Soil - Sandy
Aspect - Variable
Shape - Even
Slope Position -
Steepness - Gentle
Geology – Granitic
Hydrology – Temporarily flooded, low energy washes.
Fire –
Frequency – Uncommon
Note – Difficult to map, usually occurs below minimum mapping unit (MMU).

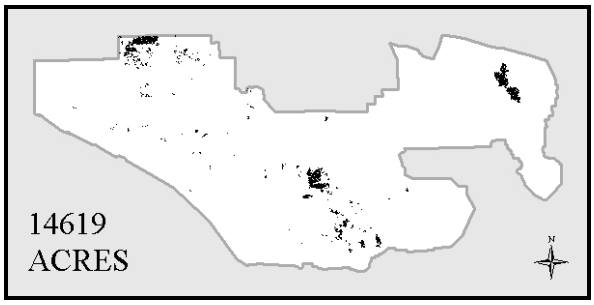
# Desert Sunflower Alliance



**28130 = Desert Sunflower *(Viguiera parishii)***

**28133 = *Viguiera parishii – (Ephedra nevadensis – Eriogonum fasciculatum – Nolina bigelovii)* high elevation rocky mountain types**






General Observations - Commonly found in rocky slopes and canyons. Western stands may be replaced with NOPA.
Zone – Zones 2, 6 and 8
Taxa – VIPA, EPNE, ERFA, and PLPL as the dominant shrub layer with NOBI at less than 1% (NOBI a presence type indicator species).
Elevation – 2500 to 4500 feet
Soil - Rocky
Aspect – Generally northerly but variable.
Shape - Variable
Slope Position – Mid to Upper slopes
Steepness – Moderate to steep
Geology -
Hydrology – Upland
Fire –
Frequency – Fairly common
Note – The following similar map units may be confused with this type:

- 24001 (24012) = (*Ephedra nevadensis – Pleurocoronis pluriseta – Encelia farinosa – Trixis californica – Bebbia juncea – Eriogonum fasciculatum – Lycium andersonii – Acacia greggii)* low elevation rocky mountain type is generally found in lower elevations and is associated with more "boulder" type environments.

**28140 = Paperbag Bush (Salazaria mexicana)**

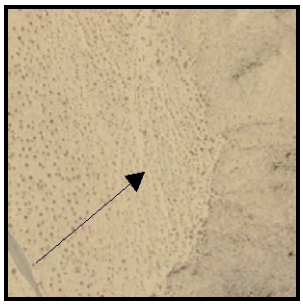
**28141 = *(Salazaria mexicana) / Bromus madritensis – Bromus tectorum – Achnatherum speciosum Post-burn type***

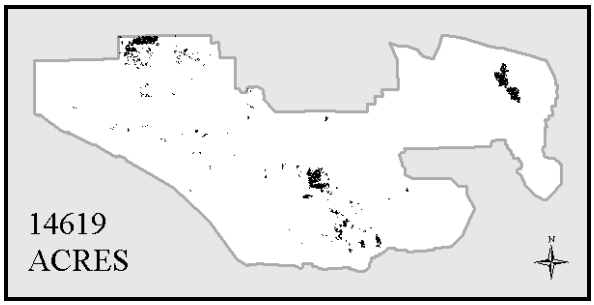
General Observations – Observed in Covington Flat post-burn areas.
Zone – Zone 2
Taxa –
Elevation – Above 2000 feet
Soil – Developed soils

Aspect - Variable
Shape - Even
Slope Position -
Steepness -
Geology -
Hydrology – Upland
Fire – Associated with Post-burn areas
Frequency –
Note – Replaces 60001 – *Bromus tectorum* fire plot type.

**28170 = Chuparosa *(Justicia californica)***

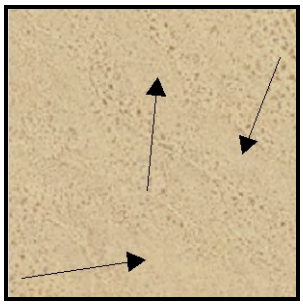
**28171 = *Justicia californica – Hyptis emoryi***

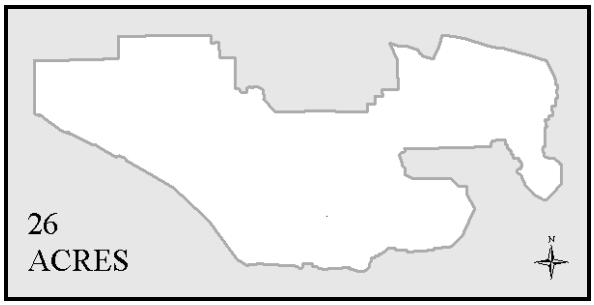





General Observations – Observed North of the Cholla Gardens and South of Cottonwood.
Zone – Zone 1
Taxa – JUSCAL and HYEM (3-5%) with shrub layer of HYSA and annuals.
Elevation – 1500 to 2500 feet
Soil - Sandy
Aspect – Southerly trending
Shape - Variable
Slope Position -
Steepness - Gentle
Geology -
Hydrology – Temporarily flooded washes
Fire –
Frequency –
Note –

**28180 = Tetracoccus *(Tetracoccus hallii)***





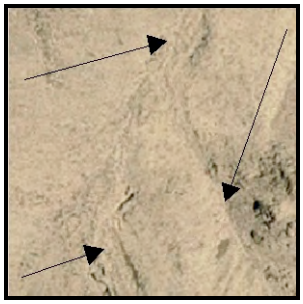

General Observations – Observed primarily on the flats west and northwest of Eagle Mountains, towards Cottonwood Springs and Smoke Tree Wash (Leary).
Zone – Zone 6
Taxa – TEHA (3-5%) with mixed shrubs and succulents.
Elevation – 2500 to 4000 feet
Soil – Well developed soils
Aspect - Variable
Shape - Even
Slope Position -
Steepness - Gentle
Geology -
Hydrology – Upland
Fire –
Frequency –
Note –

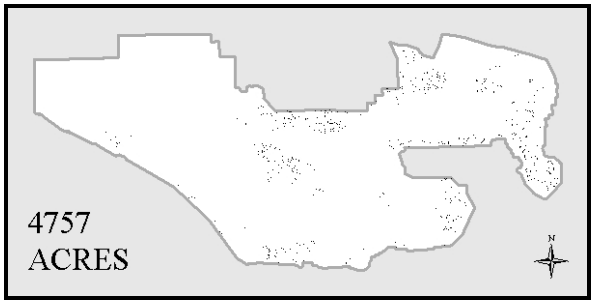
# Desert Lavender Alliance



**28200 = Desert Lavender *(Hyptis emoryi)***

**28203 = *Hyptis emoryi* Association**






General Observations – Common in narrow and steep, high energy, rocky washes throughout the mountain ranges in the eastern portions of the park. Some of the best stands occur in the Pinto Mountains (Leary).
Zone – Zone 4
Taxa – HYEM (1-5%) may include minor components of ACGR and LATR

Diagnostic species in riparian types are irregularly distributed and generally extremely sparse with extensive portions of the wash corridor lacking species which define the alliance.

Elevation – 2500 to 3500 feet
Soil - Rocky
Aspect - Variable
Shape -
Slope Position -
Steepness – Occupies narrow washes with moderate to steep gradients
Geology -
Hydrology – High energy, temporarily flooded washes and arroyos.
Fire –
Frequency – Very common
Note –

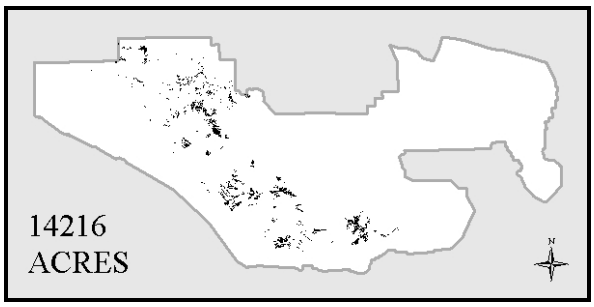
29000 = Succulent extremely xeromorphic evergreen shrubland

# Mojave Yucca Alliance



**29032 = *Yucca schidigera – Coleogyne ramosissima***



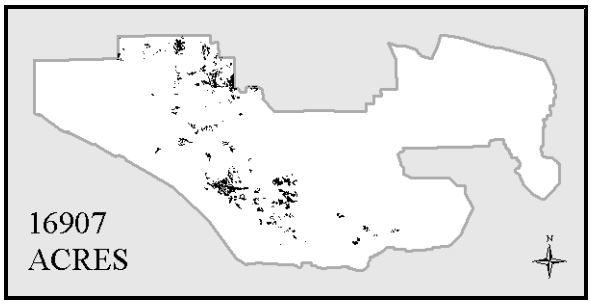



General Observations – Observed in areas North of Pinkham Canyon Road.
Zone – Zone 1
Taxa – YUSC (3-5%) with CORA dominant shrub layer.
Elevation – 3000 to 4500 feet
Soil – Developed soils
Aspect – Northerly trending
Shape – Generally concave
Slope Position – Low to mid slopes
Steepness – Gentle to moderately steep
Geology -
Hydrology – Upland
Fire –
Frequency – Common
Note – The following similar map units may be confused with this type:

- 28023 *Coleogyne ramosissima* will have a much lower percentage of YUSC (< 3%).

**29033 = *Yucca schidigera – Larrea tridentata – (Ambrosia dumosa)***



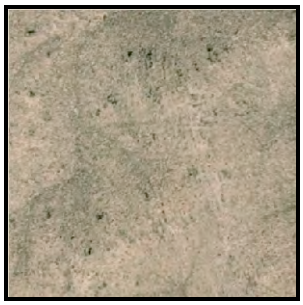


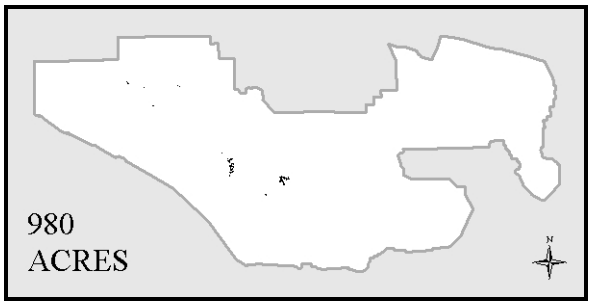

General Observations – Found mostly near Hexie Mountains and North of the Little San Bernardino Mountains.
Zone – Zones 1 and 2
Taxa – YUSC (3-5%) with LATR (1-3%)
Elevation – 2500 to 4500 feet
Soil – Developed to rocky soils
Aspect - Variable

Shape - Variable
Slope Position –Low to mid slopes
Steepness – Moderately steep
Geology -
Hydrology – Upland
Fire –
Frequency – Common
Note – The following similar map units may be confused with this type:

- 27045 *Larrea tridentata – Ambrosia dumosa – Yucca schidigera* will have a much lower percentage of YUSC (<3%).

**29034 = *Yucca schidigera / Pleuraphis rigida*** (Post Fire)

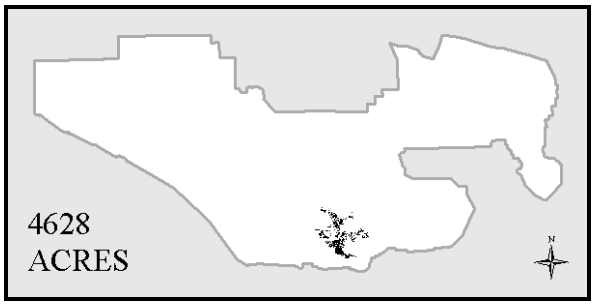





General Observations – Observed in the Little San Bernardino Mountains, often in post-burn areas.
Zone – Zones 1 and 2
Taxa – YUSC (3-5%) with mixed shrub layer and annuals.
Elevation – 2500 to 4500 feet
Soil – Well developed soils
Aspect - Variable
Shape - Variable
Slope Position –Low to mid slopes
Steepness – Moderately steep
Geology -
Hydrology – Upland
Fire –Associated with post-fire areas
Frequency – Fairly uncommon
Note –

**29035 = *Yucca schidigera – Tetracoccus hallii***






General Observations – Observed in Cottonwood Spring area on hillsides and small areas along the Conejo Well Trail.
Zone – Zone 6
Taxa – Consistent layer of YUSC with nearly equal amounts of TEHA.
Elevation – 2500 to 4000 feet
Soil – poorly developed soils
Aspect - Variable
Shape -
Slope Position – Low to mid slope
Steepness – Gentle to moderately steep
Geology -
Hydrology – Upland
Fire –
Frequency – Fairly uncommon
Note – The following similar map units may be confused with this type:

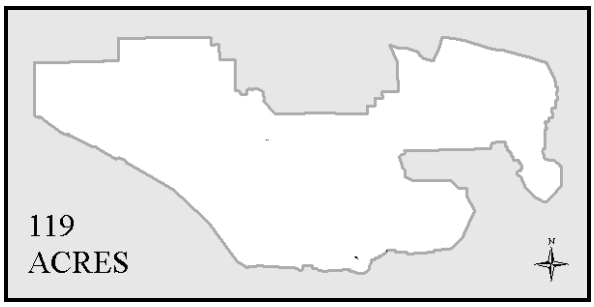
- 29032 – *Yucca schidigera* - *Coleogyne ramosissima* signature will be grayer, with round-crowned shrubs.
- 27043 - *Larrea tridentata – (Ambrosia dumosa) – Tetracoccus hallii – (Yucca schidigera)* will have LATR over 2%.

# Teddy-Bear cholla Alliance



**29050 = Teddy Bear Cholla *(Opuntia bigelovii)***






General Observations - Occurs along the southern flank of the Little San Bernardino Mountains in dense, isolated populations on low elevation stony slopes and fans (Leary). An isolated stand was observed in the field near the town of Hayfield.
Zone – Zones 1, 4 and 9
Taxa – OPBI (3-5%) with mixed shrub layer and other succulents.
Elevation – 2000 to 3000
Soil -
Aspect – Generally south trending
Shape -
Slope Position –Low to mid slopes
Steepness – Gentle to moderately steep
Geology -
Hydrology – Upland
Fire –
Frequency – Very uncommon type
Note – This type is associated with disturbance areas.

32000 = Intermittently flooded cold deciduous shrubland

**32010 = Desert almond *(Prunus fasciculata)***

General Observations – Occurs primarily in broad, sandy washes in the Coxcomb, Eagle, and Hexie Mountains and is most abundant in the western Pinto Mountains and the northwest portion of the Little San Bernardino's (Leary).
Zone – Zone 1
Taxa -
Elevation – 2000 to 4000 feet
Soil - Sandy
Aspect -
Shape -
Slope Position -
Steepness - Gentle
Geology – Granitic and calcareous

Hydrology – Temporarily flooded washes
Fire –
Frequency –
Note –

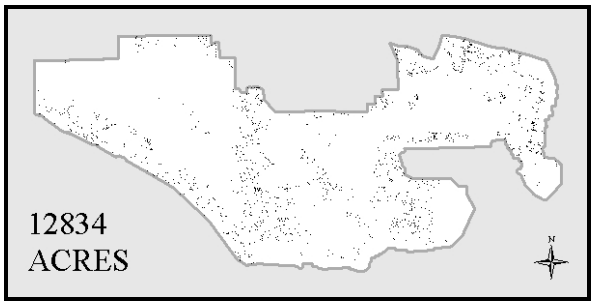
36000 = Extremely xeromorphic deciduous sub-desert shrubland without succulents

# Catclaw Acacia Alliance



**36015 = *Acacia greggii – (Larrea tridentata Hymenoclea salsola – Peucephyllum schottii – Bebbia juncea – Ephedra californica)* Low elevation wash type**





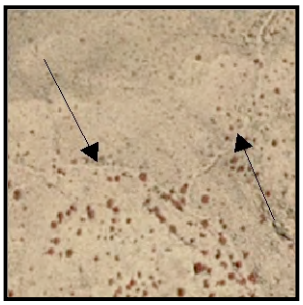

General Observations – Generally found at base of mountains in high energy washes and continuing into the fan.
Zone – Zone 5
Taxa – ACGR (3-5%) with mixed shrubs and often with annuals.

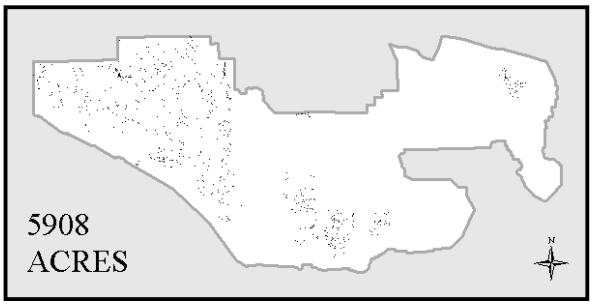
Diagnostic species in riparian types are irregularly distributed and generally extremely sparse with extensive portions of the wash corridor lacking species which define the alliance.

Elevation – 1500 to 3000 feet
Soil - Sandy
Aspect - Variable
Shape -
Slope Position -
Steepness – Gentle to moderately steep
Geology – Granitic and calcareous
Hydrology – Temporarily or intermittently flooded washes.
Fire –
Frequency – Common
Note – The following similar map units may be confused with this type:

- 27047 - *Larrea tridentata – Ambrosia dumosa (Ephedra californica – Senna armata – Hymenoclea salsola – Psorothamnus schottii)* will have a more diverse species composition without visible ACGR.
- 36016 – *Acacia greggii – (Lycium cooperi – Prunus fasciculata)* High Elevation wash type. Usually found at higher elevations in western portion of Park.

**36016 = Acacia greggii – (Lycium cooperi – Prunus fasciculata) High elevation wash type**





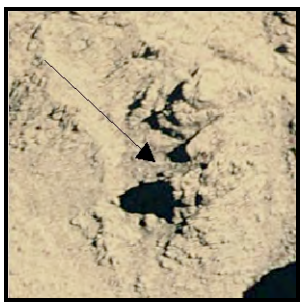

General Observations – Often found in the west, isolated pockets are found in the east at higher elevations.
Zone – Zones 2 and 6
Taxa – ACGR (3-5%) with dense LYCO and PRFA along banks of wash.

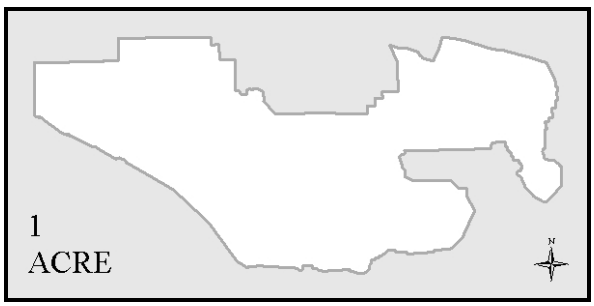
Diagnostic species in riparian types are irregularly distributed and generally extremely sparse with extensive portions of the wash corridor lacking species which define the alliance.

Elevation – 2500 to 5000 feet
Soil - Unconsolidated
Aspect - Variable
Shape -
Slope Position -
Steepness - Gentle
Geology – Granitic and calcareous
Hydrology – high energy, temporarily flooded washes and arroyos.
Fire –
Frequency – Common
Note – The following similar map units may be confused with this type:

- 36015 - *Acacia greggii – (Hymenoclea salsola – Larrea tridentata – Bebbia juncea – Ephedra californica)* is generally found at a lower elevation.

**36017 = *Acacia greggii – (Viguiera parishii – Eriogonum fasciculatum)* Upland slope type**





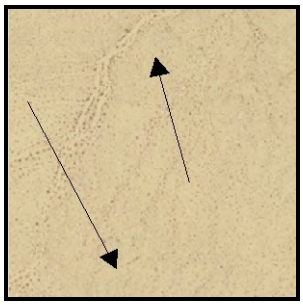
General Observations – Generally found on rocky slopes.
Zone -
Taxa – ACGR with mixed shrubs that may include VIPA and ERFA.
Elevation – 2500 to 4500
Soil - Rocky
Aspect - Variable
Shape -
Slope Position -
Steepness -
Geology – Granitic and calcareous
Hydrology – Upland, rocky or large bouldery slopes
Fire –
Frequency –
Note – Unable to distinguish ACGR in upland areas

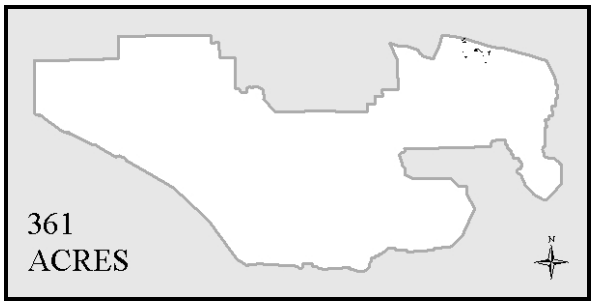
43000 = Caespitose drought deciduous dwarf shrubland

# White bursage Alliance



**43013 = *Ambrosia dumosa – Senna armata – (Psorothamnus schottii)* Eastern Pediment Type**

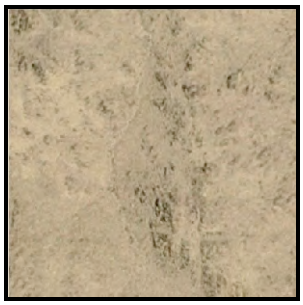


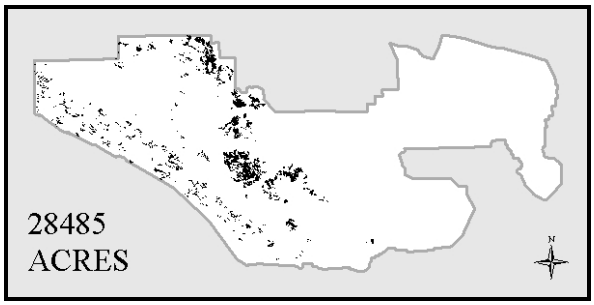



General Observations – Generally found in the East on pediment surfaces that are slightly rocky.
Zone – Zones 4 and 5
Taxa – A diverse shrub layer dominated by AMDU.
Elevation – 1500 – 2500 feet.
Soil – from developed to rocky soils
Aspect – Northerly trending
Shape - Variable
Slope Position – Mid to upper slope
Steepness – Gentle to moderately steep
Geology -
Hydrology – Upland
Fire –
Frequency – fairly uncommon
Note – The following similar map units may be confused with this type:

- 24001 (24012) = (*Ephedra nevadensis – Pleurocoronis pluriseta – Encelia farinosa – Trixis californica – Bebbia juncea – Eriogonum fasciculatum – Lycium andersonii – Acacia greggii)* low elevation rocky mountain type is generally found on steeper, more rocky slopes.

**43014 = *Ambrosia dumosa – (Eriogonum fasciculatum – Lycium andersonii / Pleuraphis rigida)* Western Mountain Type. (Hexie Mountains)**






General Observations – Generally found in Hexie Mountains on well-developed soils.

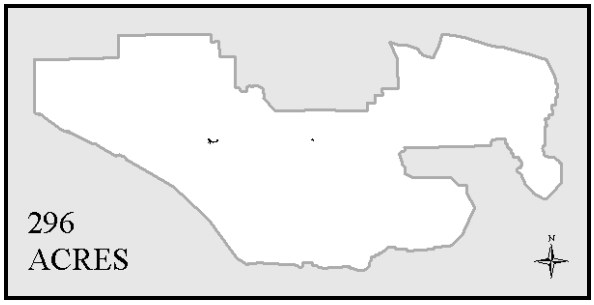
Zone – Zones 1 and 2
Taxa – A diverse shrub layer dominated by AMDU.
Elevation – 2500 to 4500 feet
Soil – well developed soils
Aspect – variable
Shape - variable
Slope Position – Mid to upper slope
Steepness – moderately steep
Geology -
Hydrology – Upland
Fire –
Frequency – fairly common in Hexie Mountains
Note – The following similar map units may be confused with this type:

- 28133 - *Viguiera parishii – (Ephedra nevadensis – Eriogonum fasciculatum – Pleurocoronis pluriseta - Nolina bigelovii)* high elevation rocky eastern mountain type is generally found on rockier slopes.

59000 = Medium-tall temperate grassland with a sparse xeromorphic shrub layer

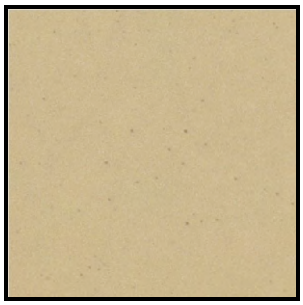
**59010 = Big galleta *(Pleuraphis rigida)***

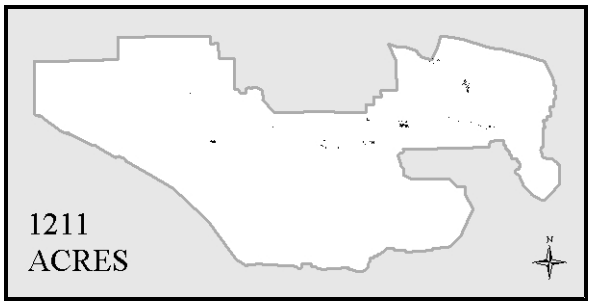





General Observations – Most common bunch grass occurring in the Park, generally occurs where it is too sandy for LATR.
Zone – Zones 1 and 4
Taxa – PLRI (3-5%) with annuals.
Elevation – 1500 to 3500
Soil - Sandy
Aspect - Variable
Shape - Even
Slope Position -
Steepness - Flat
Geology -
Hydrology – Upland
Fire –
Frequency – Uncommon
Note –This type is usually associated with disturbance areas. Usually found below minimum mapping unit (MMU).

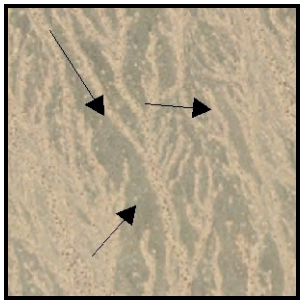
**60000 = Annual Grassland**

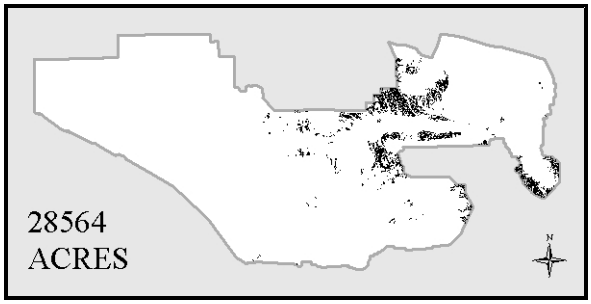





General Observations – This type was used for playas and smooth pediment surfaces without a shrub layer.
Zone – Zone 4
Taxa -
Elevation – 1500 to 3500 feet
Soil -
Aspect - Variable
Shape - Even
Slope Position –
Steepness - Gentle
Geology -
Hydrology – Upland
Fire –
Frequency –
Note –

**90100 – Desert Pavement**






General Observations – Highly dissected pavement surface that may include a 27001 (SAME – Krameria sp. – ENFA – HYEM - ERFA – HYSA – ACGR) complex that is not mappable due to minimum mapping unit (MMU).
Zone – Zone 4
Taxa – Pavement surface containing less than 2% of vegetation
Elevation – Below 2000 feet
Soil – Rocky
Aspect – Variable
Shape – Even

Slope Position –
Steepness – Gentle
Geology –
Hydrology – Upland
Fire –
Frequency – Fairly common
Note – If pavement surface vegetation exceeds 2% cover, then a vegetated code will be used.

# Appendix H: Summary of JOTR Map Classes and Thematic Accuracy Assessment Observations

**Table H1.** Sample contingency table for USNVC association level map classes.

| MAP CLASS # | 10161 | 21234 | 28023 | 10031 | 10025 | 10032 | 28181 | 28134 | 28133 | 13015 | 13012 | 13016 | 13021 | 29032 | 29033 | 29034 | 29051 | 28033 | 27044 | 27034 | 27047 | 27046 | 27045 | 27031 | 27057 | 27056 | 27059 | 27023 | 27021 | 27019 | 15013 | 28203 | 16024 | 16025 | 16015 | 16013 | 16035 | 36015 | 36016 | 32013 | 28083 | ROW TOTALS ($n_{i+}$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10161 | 16 | 7 | | | 2 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 26 |
| 21234 | 5 | 7 | | | 2 | 1 | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | 1 | | | 17 |
| 28023 | | | 8 | | 3 | | | 9 | 2 | | 1 | 1 | | | 1 | | | | | | | 2 | | | 1 | | | | | | | | | | | | | | | | | 28 |
| 10031 | | | | 6 | 11 | | | | 1 | 2 | | 1 | | | 3 | | | | | | 1 | | 2 | | | | | | | | | | | | | | | | | | | | 27 |
| 10025 | 3 | 3 | 4 | 5 | 64 | 4 | | | | 14 | 2 | | | 3 | | | | | | | | 1 | | | | 1 | | | | | | | | | | | | | | 1 | 1 | | 106 |
| 10032 | 3 | | | | 12 | 6 | | | 1 | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 24 |
| 28181 | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| 28134 | | | 1 | 1 | | | | 4 | 3 | | | | | 1 | | | | 1 | | | | 2 | 1 | | 1 | | 2 | | | | | | | | | | 1 | | | | | 18 |
| 28133 | | | 2 | | 4 | | | | 4 | | | | | 1 | | | | | | | | 2 | 1 | | 2 | | | | | | | | | | | | 1 | | | | | 17 |
| 13015 | 1 | | | 2 | | | | | | 17 | 1 | 2 | 9 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 32 |
| 13012 | | | 3 | | | | | | | | 10 | 5 | 4 | | 1 | 1 | | | | | 1 | | | | | | | | | | | | | | 1 | | | | 1 | | | | 27 |
| 13016 | | | | | | | | 1 | | | 3 | 20 | | | 1 | | | | | | | | | | | | | 3 | | | | | | | | | | | | | | | 28 |
| 13021 | | | 1 | | | | | | | 1 | 2 | 3 | 16 | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | 24 |
| 29032 | | | 1 | | 1 | | | | | 2 | 3 | 1 | | 1 | 6 | | | | | | | 1 | 2 | | | | | | | | | | | | | | | | | | | 18 |
| 29033 | | | 1 | 7 | 2 | | 6 | 1 | | 1 | | | | 4 | 4 | 1 | | 1 | | | | 2 | 1 | 1 | 2 | | 1 | | | | | | | | | | | | | | | 35 |
| 29034 | | | 1 | | | | | 3 | 1 | 1 | | 5 | 3 | | 4 | 2 | | 2 | | | | | | | | | 1 | | | | | | | | | | | | | 2 | | 25 |
| 29051 | | | | | | | | | | | | | | | | | 21 | | | | | | | 1 | | | | | | | | | | | 1 | | 2 | | | | | 25 |
| 28033 | | | | | | | | 1 | | | | | | | | | | 3 | | | | | | | 4 | | | | | | | | | | | | 1 | | | | | 9 |
| 27044 | | | | | | | | | | | | | | | | | | | | | 1 | | | 1 | | | | | 8 | | | | | | | | | | | | | 10 |
| 27034 | | | | | | | | 2 | | | | | | | | | | 2 | | 7 | 2 | | | 3 | 7 | | 1 | | | 1 | 1 | | | | | | | | | | | 26 |
| 27047 | | | | | | | | | | | | | 1 | | 1 | | | | | 24 | | 6 | 6 | | | | 2 | 3 | | 7 | | | | | | | 1 | | | | | 51 |
| 27046 | | | | | | | | | | | | | | | | | | 1 | | | 1 | 5 | 1 | 1 | 8 | | 3 | | | | | | | | | | | | | | | 20 |
| 27045 | | | | 2 | 1 | | 2 | 1 | | | | | | | 1 | | | | | | 2 | 1 | 35 | 1 | 1 | | | | 1 | | | | | | | | | | | | | 48 |
| 27031 | | | | | | | | 6 | | | | | | | | | | | | | 9 | | 2 | 15 | 1 | | | | 1 | 7 | | | | | | | | | | | 6 | 47 |
| 27057 | | | | | | | | | | | | | | | | | | 2 | | | | | 1 | | 6 | 1 | | | | | | 1 | 1 | | | | | | | | | 12 |
| 27056 | | | | | | | | | | | | | | | | | 1 | | | | 9 | | | | 5 | 8 | | | | | | | 5 | | | 1 | | | | | | 29 |
| 27059 | | | | | 1 | | | | | | | | | | | | | | | | | 1 | | 1 | 5 | 1 | | | | 1 | | 2 | | | | | 1 | | | | 13 |
| 27023 | | | | | | | | | | | | | | | | | | | | | | | | 4 | | | | | | | | | | | | | | | | | | 4 |
| 27021 | | | | | | | | | | | | | | | | | | | | | 5 | | | 8 | | | | | 12 | 1 | | | | | | | | | | | | 26 |
| 27019 | | | | | | | 1 | | | | | 1 | | | | | | | | | 4 | | 1 | 7 | | | | | 4 | 10 | | | | | | | | | | | | 28 |
| 15013 | | | | | | | | | | | | | | | | | | | | | 2 | | | | | | | | | | 13 | | | 1 | | | | 2 | 5 | | | 23 |
| 28203 | | | | | | | | | | | | | | | | | | | | | | | | | 2 | | 1 | | | | | 9 | | | | | 2 | 1 | | | | 15 |
| 16024 | | | | | | | | | | | | | | | | | | | | | 1 | | | | 1 | 2 | | | | | | | 14 | 7 | 1 | 2 | | | | | | 28 |
| 16025 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 4 | 20 | 4 | | | | | | 29 |
| 16015 | | | | | | | | | | | | | | | | | | | | | 3 | | | | | | | | | | | | 1 | 4 | 2 | 25 | 7 | 6 | 1 | 2 | | | 51 |
| 16013 | | | | | | | | | | | | | | | | | | 1 | | | | | | | 1 | 2 | | | | | | | | 4 | 3 | 6 | 11 | | | | | | 28 |
| 16035 | | | | | | | | | | | | | | | | | 1 | | | | 19 | | | 3 | | 1 | | | | | | | 3 | | | 3 | 8 | 7 | | | | 45 |
| 36015 | | | | | | | | | | | | | | | 1 | | | | | | 9 | | | 1 | 4 | | | | | 1 | | | | | | | | 1 | | | | 17 |
| 36016 | | | | 1 | | | | | | | | 1 | 1 | | | | | | | | 1 | | 4 | 1 | | | | | | | 1 | | | | | | | 6 | 11 | | | 27 |
| 32013 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 28083 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 6 | 6 |
| COLUMN TOTALS | 28 | 17 | 22 | 24 | | | 10 | 28 | 12 | 40 | 22 | 40 | 34 | 10 | 23 | 5 | 23 | 13 | 0 | 0 | 99 | 19 | 57 | 54 | 51 | 15 | 10 | 0 | 31 | 25 | 15 | 24 | 32 | 33 | 41 | 24 | 17 | 21 | 21 | 3 | 12 | GRAND TOTAL: 1070 |

**Table H2.** Population contingency table and users and producers accuracies for USNVC association level map classes. Overall accuracy = 41.0%.

| MAP CLASS # | 10161 | 21234 | 28023 | 10031 | 10025 | 10032 | 28181 | 28134 | 28133 | 13015 | 13012 | 13016 | 13021 | 29032 | 29033 | 29034 | 29051 | 28033 | 27044 | 27034 | 27047 | 27046 | 27045 | 27031 | 27057 | 27056 | 27059 | 27023 | 27021 | 27019 | 15013 | 28203 | 16024 | 16025 | 16015 | 16013 | 16035 | 36015 | 36016 | 32013 | 28083 | USER ACCURACY |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10161 | 2.23% | 0.79% | 0.00% | 0.00% | 0.05% | 0.03% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 72.1% |
| 21234 | 0.44% | 0.62% | 0.00% | 0.00% | 0.18% | 0.09% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.09% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.09% | 0.00% | 0.00% | 41.2% |
| 28023 | 0.00% | 0.00% | 0.09% | 0.00% | 0.03% | 0.00% | 0.00% | 0.10% | 0.02% | 0.00% | 0.01% | 0.01% | 0.00% | 0.00% | 0.01% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.02% | 0.00% | 0.00% | 0.01% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 28.6% |
| 10031 | 0.00% | 0.00% | 0.00% | 0.15% | 0.33% | 0.00% | 0.00% | 0.00% | 0.03% | 0.06% | 0.00% | 0.03% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 24.9% |
| 10025 | 0.17% | 0.14% | 0.14% | 0.02% | 2.73% | 0.05% | 0.00% | 0.00% | 0.00% | 0.43% | 0.04% | 0.00% | 0.00% | 0.01% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.03% | 0.00% | 0.00% | 0.00% | 0.00% | 0.13% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.03% | 0.00% | 0.00% | 69.4% |
| 10032 | 0.05% | 0.00% | 0.00% | 0.00% | 0.20% | 0.10% | 0.00% | 0.00% | 0.02% | 0.03% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 25.0% |
| 28181 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 100.0% |
| 28134 | 0.00% | 0.00% | 0.20% | 0.20% | 0.00% | 0.00% | 0.00% | 0.79% | 0.60% | 0.00% | 0.00% | 0.00% | 0.00% | 0.20% | 0.00% | 0.00% | 0.00% | 0.20% | 0.00% | 0.00% | 0.00% | 0.40% | 0.20% | 0.00% | 0.20% | 0.00% | 0.40% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.20% | 0.00% | 0.00% | 22.2% |
| 28133 | 0.00% | 0.00% | 0.24% | 0.00% | 0.48% | 0.00% | 0.00% | 0.00% | 0.48% | 0.00% | 0.00% | 0.00% | 0.00% | 0.12% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.24% | 0.12% | 0.00% | 0.24% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.12% | 0.00% | 0.00% | 23.5% |
| 13015 | 0.05% | 0.00% | 0.00% | 0.10% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.83% | 0.05% | 0.10% | 0.44% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 53.1% |
| 13012 | 0.00% | 0.00% | 0.02% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.05% | 0.03% | 0.02% | 0.00% | 0.01% | 0.01% | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.00% | 0.00% | 37.0% |
| 13016 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.06% | 0.00% | 0.00% | 0.18% | 1.21% | 0.00% | 0.00% | 0.06% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.18% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 71.4% |
| 13021 | 0.00% | 0.00% | 0.07% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.07% | 0.15% | 0.22% | 1.20% | 0.00% | 0.00% | 0.07% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 66.7% |
| 29032 | 0.00% | 0.00% | 0.07% | 0.00% | 0.07% | 0.00% | 0.00% | 0.00% | 0.00% | 0.15% | 0.22% | 0.07% | 0.00% | 0.07% | 0.45% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.07% | 0.15% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 5.6% |
| 29033 | 0.00% | 0.00% | 0.03% | 0.18% | 0.05% | 0.00% | 0.15% | 0.13% | 0.00% | 0.13% | 0.00% | 0.00% | 0.00% | 0.31% | 0.41% | 0.13% | 0.00% | 0.13% | 0.00% | 0.00% | 0.00% | 0.25% | 0.13% | 0.13% | 0.25% | 0.00% | 0.13% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 16.1% |
| 29034 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.00% | 0.00% | 0.00% | 0.02% | 0.01% | 0.00% | 0.02% | 0.01% | 0.00% | 0.01% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.00% | 8.0% |
| 29051 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 100.0% |
| 28033 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.10% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.29% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.38% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.10% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 33.3% |
| 27044 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.00% | 0.00% | 0.00% | 0.01% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.0% |
| 27034 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.06% | 0.00% | 0.00% | 0.06% | 0.00% | 0.00% | 0.00% | 0.00% | 0.51% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.0% |
| 27047 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.00% | 0.01% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.62% | 0.00% | 0.10% | 0.21% | 0.00% | 0.00% | 0.00% | 0.00% | 0.12% | 0.02% | 0.00% | 0.16% | 0.00% | 0.00% | 0.00% | 0.01% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 49.1% |
| 27046 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.09% | 0.00% | 0.00% | 0.09% | 0.43% | 0.09% | 0.09% | 0.69% | 0.00% | 0.26% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 25.0% |
| 27045 | 0.00% | 0.00% | 0.00% | 0.09% | 0.05% | 0.00% | 0.09% | 0.48% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.48% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.09% | 0.48% | 7.19% | 0.05% | 0.05% | 0.00% | 0.00% | 0.00% | 0.48% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 75.6% |
| 27031 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 10.93% | 0.00% | 2.43% | 6.09% | 1.21% | 0.00% | 0.00% | 0.00% | 1.21% | 3.65% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 23.8% |
| 27057 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 3.39% | 0.00% | 0.00% | 0.00% | 1.69% | 0.00% | 10.16% | 1.69% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 1.69% | 1.69% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 50.0% |
| 27056 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.00% | 0.00% | 0.00% | 0.10% | 0.00% | 0.00% | 0.05% | 0.08% | 0.00% | 0.00% | 0.00% | 0.00% | 0.05% | 0.00% | 0.00% | 0.01% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 27.6% |
| 27059 | 0.00% | 0.00% | 0.00% | 0.24% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.24% | 0.00% | 0.24% | 1.22% | 0.24% | 0.00% | 0.00% | 0.00% | 0.24% | 0.00% | 0.00% | 0.49% | 0.00% | 0.00% | 0.00% | 0.00% | 0.24% | 0.00% | 0.00% | 0.00% | 0.0% |
| 27023 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.0% |
| 27021 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.70% | 0.00% | 0.00% | 1.12% | 0.00% | 0.00% | 0.00% | 0.00% | 1.68% | 0.14% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 46.2% |
| 27019 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.02% | 0.00% | 0.00% | 0.00% | 0.00% | 0.02% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.10% | 0.00% | 0.02% | 0.17% | 0.00% | 0.00% | 0.00% | 0.00% | 0.10% | 0.24% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 35.7% |
| 15013 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.02% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.00% | 0.00% | 56.5% |
| 28203 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 60.0% |
| 16024 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.00% | 0.00% | 0.00% | 0.01% | 0.02% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.16% | 0.08% | 0.01% | 0.02% | 0.00% | 0.00% | 0.00% | 0.00% | 50.0% |
| 16025 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.03% | 0.13% | 0.03% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 69.0% |
| 16015 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.03% | 0.01% | 0.16% | 0.04% | 0.03% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 53.1% |
| 16013 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.02% | 0.00% | 0.00% | 0.00% | 0.03% | 0.02% | 0.05% | 0.08% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 37.1% |
| 16035 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.00% | 0.00% | 0.00% | 0.08% | 0.00% | 0.00% | 0.01% | 0.00% | 0.01% | 0.00% | 0.00% | 0.00% | 0.01% | 0.00% | 0.00% | 0.01% | 0.04% | 0.04% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 19.1% |
| 36015 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.00% | 0.00% | 0.00% | 0.01% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 5.9% |
| 36016 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 40.7% |
| 32013 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.0% |
| 28083 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 100.0% |
| | 75.8% | 39.9% | 10.1% | 20.4% | 61.9% | 38.3% | 0.4% | 47.4% | 41.6% | 48.4% | 7.4% | 70.4% | 71.4% | 10.5% | 28.3% | 3.9% | 41.1% | 7.0% | 0.0% | 0.0% | 4.8% | 19.9% | 59.3% | 74.5% | 70.1% | 4.1% | 0.0% | 0.0% | 39.2% | 5.5% | 93.6% | 0.0% | 8.0% | 52.2% | 61.5% | 31.9% | 51.3% | 0.2% | 2.9% | 0.0% | 3.7% | |

**PRODUCER ACCURACY**

**Table H3.** Sample contingency table for USNVC alliance level map classes.

| MAP CLASS # | 10160 | 15040 | 15030 | 15110 | 21230 | 60010 | 28020 | 10020 | 59010 | 28140 | 28180 | 28130 | 13010 | 29030 | 28110 | 29050 | 28030 | 27030 | 27050 | 27010 | 15010 | 28200 | 28171 | 16010 | 16040 | 16030 | 36010 | 32010 | 28210 | 28080 | 60020 | 90100 | ROW TOTALS ($n_{i+}$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **10160** | 16 | | | | 7 | | | 3 | | | | | | | | | | | | | | | | | | | | | | | | | **26** |
| **15040** | | | 2 | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | **3** |
| **15030** | | | 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | **4** |
| **15110** | | | | 4 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | **5** |
| **21230** | 5 | | | | 7 | | | 3 | | | | | | | | | | | | 1 | | | | | | | 1 | | | | | | **17** |
| **60010** | 1 | | | | 8 | | 1 | | | | | 2 | | | | | | | 1 | | | | | | | | 1 | 2 | | | | | **16** |
| **28020** | | | | | | | 8 | 3 | | | | 11 | 2 | 1 | | | | 2 | 1 | | | | | | | | | | | | | | **28** |
| **10020** | 7 | | | | 14 | | 4 | 109 | | 1 | | 2 | 24 | 6 | | | | 4 | 1 | | | | | | | | 1 | 2 | | | | | **175** |
| **59010** | | | | | | | | | 16 | | | | | | | | | 5 | | | | | | | | | | | | 9 | | | **30** |
| **28140** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | **0** |
| **28180** | | | | | | | | | | | 1 | | | 3 | | | | 1 | | | | | | | | | | | | | | | **5** |
| **28130** | | | | | | | 3 | 5 | | | | 11 | | 2 | | | 1 | 6 | 5 | | | | | | | | 2 | | | | | | **35** |
| **13010** | 1 | | | | 1 | | 4 | 2 | 4 | 3 | | 1 | 99 | 6 | | | | 1 | | 3 | | | | 1 | | | 10 | 3 | | | | | **139** |
| **29030** | | | | | | | 3 | 10 | | 1 | 6 | 5 | 16 | 22 | | | 3 | 7 | 4 | | | | | | | | | 2 | | | | | **79** |
| **28110** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | **0** |
| **29050** | | | | | | | | | | | | | | | | 21 | | 1 | | | | | | 3 | | | | | | | | | **25** |
| **28030** | | | | | | | | | | | | 1 | | | | | 3 | | 4 | | | | | 1 | | | | | | | | | **9** |
| **27030** | | | | | | | | 3 | | | 2 | 9 | 1 | 2 | 1 | | 3 | 137 | 21 | 23 | 1 | 7 | | | | 1 | | | | 6 | | 6 | **223** |
| **27050** | | | | | | | | 1 | | | | | | | | 1 | 2 | 12 | 26 | 1 | | 3 | | 7 | | | 1 | | | | | 1 | **55** |
| **27010** | | | | | | | | | | | 1 | | 1 | | | | | 29 | | 27 | | | | | | | | | | | | 1 | **59** |
| **15010** | | | | | | | | | | | | | | | 1 | | | 2 | | | 13 | | | 1 | | | 7 | | | | | | **24** |
| **28200** | | | | | | | | | | | | | | | 1 | | | | 3 | | | 9 | | | | 2 | 1 | | | | | 1 | **17** |
| **28171** | | | | | | | | | | | | | | | | | | 1 | 1 | | | | | 28 | | | | | | | | | **30** |
| **16010** | | | | | | | | | | | | | | | 3 | | 1 | 4 | 6 | | | 2 | | 114 | | 6 | 3 | | | | | | **139** |
| **16040** | | | | | | | | | | | | | | | | | | | | | | | | | 5 | | | | | | | | **5** |
| **16030** | | | | | | | | | | | | | | | 1 | 1 | | 22 | 2 | | | 3 | | 3 | | 8 | 7 | | | | | 2 | **49** |
| **36010** | | | | | | | | 1 | | | | | 2 | 1 | 6 | | | 16 | 4 | 1 | 1 | | | | | | 18 | | | | | | **50** |
| **32010** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | **0** |
| **28210** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | **1** |
| **28080** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 6 | | | **6** |
| **60020** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | **0** |
| **90100** | | | | | | | | | | | | | | | | | | 3 | 3 | 6 | | | | 4 | | | | | | | | 8 | **24** |
| **Col. TOTAL** | **30** | **0** | **6** | **4** | **38** | **0** | **23** | **140** | **20** | **5** | **10** | **42** | **145** | **43** | **13** | **23** | **13** | **253** | **82** | **62** | **15** | **24** | **0** | **162** | **5** | **17** | **53** | **9** | **1** | **21** | **0** | **19** | **G. Total: 1278** |

**Table H4.** Population contingency table and users and producers accuracies for USNVC alliance level map classes. Overall accuracy = 60.9%.

| MAP CLASS # | 10160 | 15040 | 15030 | 15110 | 21230 | 60010 | 28020 | 10020 | 59010 | 28140 | 28180 | 28130 | 13010 | 29030 | 28110 | 29050 | 28030 | 27030 | 27050 | 27010 | 15010 | 28200 | 28171 | 16010 | 16040 | 16030 | 36010 | 32010 | 28210 | 28080 | 60020 | 90100 | USER ACCURACY |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10160 | 2.23% | 0.00% | 0.00% | 0.00% | 0.79% | 0.00% | 0.00% | 0.08% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 72.1% |
| 15040 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.0% |
| 15030 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 100.0% |
| 15110 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 80.0% |
| 21230 | 0.44% | 0.00% | 0.00% | 0.00% | 0.62% | 0.00% | 0.00% | 0.26% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.09% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.09% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 41.2% |
| 60010 | 0.05% | 0.00% | 0.00% | 0.00% | 0.43% | 0.00% | 0.05% | 0.00% | 0.00% | 0.00% | 0.00% | 0.11% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.05% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.05% | 0.11% | 0.00% | 0.00% | 0.00% | 0.00% | 0.0% |
| 28020 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.09% | 0.03% | 0.00% | 0.00% | 0.00% | 0.12% | 0.02% | 0.01% | 0.00% | 0.00% | 0.00% | 0.02% | 0.01% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 28.6% |
| 10020 | 0.22% | 0.00% | 0.00% | 0.00% | 0.15% | 0.00% | 0.14% | 3.58% | 0.00% | 0.02% | 0.00% | 0.05% | 0.59% | 0.02% | 0.00% | 0.00% | 0.00% | 0.04% | 0.13% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.03% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 72.1% |
| 59010 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.02% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.00% | 0.00% | 53.3% |
| 28140 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.0% |
| 28180 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 20.0% |
| 28130 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.44% | 0.67% | 0.00% | 0.00% | 0.00% | 1.87% | 0.00% | 0.32% | 0.00% | 0.00% | 0.20% | 0.95% | 0.83% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.32% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 33.3% |
| 13010 | 0.05% | 0.00% | 0.00% | 0.00% | 0.01% | 0.00% | 0.09% | 0.10% | 0.09% | 0.09% | 0.00% | 0.06% | 4.59% | 0.16% | 0.00% | 0.00% | 0.00% | 0.01% | 0.00% | 0.18% | 0.00% | 0.00% | 0.00% | 0.01% | 0.00% | 0.00% | 0.06% | 0.02% | 0.00% | 0.00% | 0.00% | 0.00% | 83.4% |
| 29030 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.10% | 0.31% | 0.00% | 0.00% | 0.15% | 0.14% | 0.61% | 1.39% | 0.00% | 0.00% | 0.14% | 0.73% | 0.38% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.00% | 0.00% | 0.00% | 0.00% | 34.9% |
| 28110 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.0% |
| 29050 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 84.0% |
| 28030 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.10% | 0.00% | 0.00% | 0.00% | 0.00% | 0.29% | 0.00% | 0.38% | 0.00% | 0.00% | 0.00% | 0.00% | 0.10% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 33.3% |
| 27030 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.14% | 0.00% | 0.00% | 0.09% | 0.49% | 0.01% | 0.48% | 0.01% | 0.00% | 0.09% | 29.01% | 2.22% | 6.00% | 0.00% | 0.16% | 0.00% | 0.00% | 0.00% | 0.01% | 0.00% | 0.00% | 0.00% | 0.01% | 0.00% | 1.41% | 72.3% |
| 27050 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.24% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 3.39% | 2.28% | 13.46% | 0.24% | 0.00% | 2.18% | 0.00% | 1.76% | 0.00% | 0.00% | 0.24% | 0.00% | 0.00% | 0.00% | 0.00% | 1.69% | 52.8% |
| 27010 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.02% | 0.00% | 0.02% | 0.00% | 0.00% | 0.00% | 0.00% | 2.12% | 0.00% | 2.16% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 49.9% |
| 15010 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.02% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 54.2% |
| 28200 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 52.9% |
| 28171 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.0% |
| 16010 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.02% | 0.00% | 0.01% | 0.03% | 0.06% | 0.00% | 0.00% | 0.02% | 0.00% | 0.88% | 0.00% | 0.03% | 0.01% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 84.1% |
| 16040 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 100.0% |
| 16030 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.00% | 0.09% | 0.01% | 0.00% | 0.00% | 0.01% | 0.00% | 0.01% | 0.00% | 0.04% | 0.04% | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 17.8% |
| 36010 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.00% | 0.00% | 0.02% | 0.01% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 19.5% |
| 32010 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.0% |
| 28210 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 100.0% |
| 28080 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 100.0% |
| 60020 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.0% |
| 90100 | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.23% | 0.23% | 0.45% | 0.00% | 0.00% | 0.00% | 0.30% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.60% | 33.3% |
| PRODUCER ACCURACY | 74.4% | 0.0% | 37.7% | 100.0% | 31.0% | 0.0% | 9.5% | 66.1% | 17.4% | 0.0% | 0.4% | 63.7% | 78.5% | 58.3% | 0.0% | 41.1% | 7.0% | 81.7% | 75.7% | 23.7% | 93.6% | 0.0% | 0.0% | 28.8% | 100.0% | 51.3% | 0.9% | 0.0% | 100.0% | 1.9% | 0.0% | 16.2% | |

**Table H5.** Sample contingency table for USNVC group level map classes.

| GROUP | Great Basin Pinyon-Juniper Woodland Group | Southwestern North American Warm Desert Riparian Group | California Mesic North-Slope Chaparral Group | Mediterranean California Naturalized Annual & Perennial Grassland Group | North American Warm Desert Alkaline Scrub & Herb Playa & Wet Flat Group | Mojave Mid-Elevation Mixed Desert Scrub Group | Sonoran – Mojave Creosotebush – White Bursage Desert Scrub Group | Sonoran-Coloradan Semi-Desert Wash Woodland / Scrub Group | Warm Semi-Desert Shrub & Herb Wash-Arroyo Group | Intermountain Semi-Desert Shrubland & Steppe Group | Intermountain Shadscale-Saltbush Scrub Group | North American Warm Desert Dunes & Sand Flats Group | North American Warm Semi-Desert Cliff, Scree & Pavement Group | ROW TOTALS ($n_{i+}$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Great Basin Pinyon-Juniper Woodland Group | 16 | | 7 | | | 3 | | | | | | | | **26** |
| Southwestern North American Warm Desert Riparian Group | | 10 | 1 | | | | | | 1 | | | | | **12** |
| California Mesic North-Slope Chaparral Group | 5 | | 7 | | | 3 | 1 | | 1 | | | | | **17** |
| Mediterranean California Naturalized Annual & Perennial Grassland Group | 1 | | 8 | | | 5 | 1 | | 3 | | | | | **18** |
| North American Warm Desert Alkaline Scrub & Herb Playa & Wet Flat Group | | | | | 3 | | | | | | 1 | | | **4** |
| Mojave Mid-Elevation Mixed Desert Scrub Group | 8 | | 15 | | | 394 | 44 | 1 | 20 | | 9 | | 1 | **492** |
| Sonoran – Mojave Creosotebush – White Bursage Desert Scrub Group | | | | | 3 | 21 | 312 | 23 | 1 | | 6 | | 10 | **376** |
| Sonoran-Coloradan Semi-Desert Wash Woodland / Scrub Group | | | | | | | 49 | 184 | 18 | | | | 3 | **254** |
| Warm Semi-Desert Shrub & Herb Wash-Arroyo Group | | | | | | 4 | 27 | 1 | 18 | | | | | **50** |
| Intermountain Semi-Desert Shrubland & Steppe Group | | | | | | | | | | 1 | | | | **1** |
| Intermountain Shadscale-Saltbush Scrub Group | | | | | | | | | | | 6 | | | **6** |
| North American Warm Desert Dunes & Sand Flats Group | | | | | | | | | | | | | | **0** |
| North American Warm Semi-Desert Cliff, Scree & Pavement Group | 1 | | | | | | 12 | 4 | | | | | 8 | **25** |
| **COLUMN TOTALS ($n_{+j}$)** | **31** | **10** | **38** | **0** | **6** | **430** | **446** | **213** | **62** | **1** | **22** | **0** | **22** | **GRAND TOTAL: 1281** |

**Table H6.** Population contingency table and users and producers accuracies for USNVC group level map classes. Overall accuracy = 82.0%.

| GROUP | Great Basin Pinyon-Juniper Woodland Group | Southwestern North American Warm Desert Riparian Group | California Mesic North-Slope Chaparral Group | Mediterranean California Naturalized Annual & Perennial Grassland Group | North American Warm Desert Alkaline Scrub & Herb Playa & Wet Flat Group | Mojave Mid-Elevation Mixed Desert Scrub Group | Sonoran – Mojave Creosotebush – White Bursage Desert Scrub Group | Sonoran-Coloradan Semi-Desert Wash Woodland / Scrub Group | Warm Semi-Desert Shrub & Herb Wash-Arroyo Group | Intermountain Semi-Desert Shrubland & Steppe Group | Intermountain Shadscale-Saltbush Scrub Group | North American Warm Desert Dunes & Sand Flats Group | North American Warm Semi-Desert Cliff, Scree & Pavement Group | USER ACCURACY |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Great Basin Pinyon-Juniper Woodland Group | 2.2278% | 0.0000% | 0.7860% | 0.0000% | 0.0000% | 0.0780% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 72.1% |
| Southwestern North American Warm Desert Riparian Group | 0.0000% | 0.0000% | 0.0011% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0012% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0% |
| California Mesic North-Slope Chaparral Group | 0.4401% | 0.0000% | 0.6161% | 0.0000% | 0.0000% | 0.2641% | 0.0880% | 0.0000% | 0.0880% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 41.2% |
| Mediterranean California Naturalized Annual & Perennial Grassland Group | 0.0539% | 0.0000% | 0.4316% | 0.0000% | 0.0000% | 0.1618% | 0.0539% | 0.0000% | 0.1618% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0% |
| North American Warm Desert Alkaline Scrub & Herb Playa & Wet Flat Group | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0014% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0005% | 0.0000% | 0.0000% | 75.0% |
| Mojave Mid-Elevation Mixed Desert Scrub Group | 0.2706% | 0.0000% | 0.1526% | 0.0000% | 0.0000% | 15.871% | 3.6341% | 0.0052% | 0.4446% | 0.0000% | 0.0111% | 0.0000% | 0.0031% | 77.8% |
| Sonoran – Mojave Creosotebush – White Bursage Desert Scrub Group | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0056% | 1.5972% | 61.659% | 4.2067% | 0.2435% | 0.0000% | 0.0112% | 0.0000% | 3.2064% | 86.9% |
| Sonoran-Coloradan Semi-Desert Wash Woodland / Scrub Group | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.2271% | 1.0151% | 0.0526% | 0.0000% | 0.0000% | 0.0000% | 0.0113% | 77.7% |
| Warm Semi-Desert Shrub & Herb Wash-Arroyo Group | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0026% | 0.0293% | 0.0004% | 0.0078% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 19.5% |
| Intermountain Semi-Desert Shrubland & Steppe Group | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0011% | 0.0000% | 0.0000% | 0.0000% | 100.0% |
| Intermountain Shadscale-Saltbush Scrub Group | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0004% | 0.0000% | 0.0000% | 100.0% |
| North American Warm Desert Dunes & Sand Flats Group | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0% |
| North American Warm Semi-Desert Cliff, Scree & Pavement Group | 0.0338% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.9018% | 0.3006% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.6012% | 32.7% |
| PRODUCER ACCURACY | 73.6% | 0.0% | 31.0% | 0.0% | 19.6% | 88.3% | 92.6% | 18.4% | 0.8% | 100.0% | 1.8% | 0.0% | 15.7% | |

**Table H7.** Sample contingency table for USNVC macrogroup level map classes.

| MACROGROUP | Intermountain Singleleaf Pinyon-Western Juniper Woodland | Warm Mediterranean & Desert Riparian, Flooded & Swamp Forest | California Chaparral | California Annual & Perennial Grassland | Warm Semi-Desert & Mediterranean Alkaline-Saline Wetland | Mojave-Sonoran Semi-Desert Scrub | North American Warm-Desert Xero-Riparian | Great Basin & Intermountain Semi-Desert Shrubland & Steppe | Great Basin Saltbrush Scrub | North American Warm Semi-Desert Cliff, Scree & Rock Vegetation | ROW TOTALS ($n_{i+}$) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Intermountain Singleleaf Pinyon-Western Juniper Woodland** | 16 | | 7 | | | 3 | | | | | **26** |
| **Warm Mediterranean & Desert Riparian, Flooded & Swamp Forest** | | 10 | 1 | | | | 1 | | | | **12** |
| **California Chaparral** | 5 | | 7 | | | 4 | 1 | | | | **17** |
| **California Annual & Perennial Grassland** | 1 | | 8 | | | 6 | 3 | | | | **18** |
| **Warm Semi-Desert & Mediterranean Alkaline-Saline Wetland** | | | | | 3 | | | | 1 | | **4** |
| **Mojave-Sonoran Semi-Desert Scrub** | 8 | | 15 | | 3 | 771 | 45 | | 15 | 11 | **868** |
| **North American Warm-Desert Xero-Riparian** | | | | | | 80 | 221 | | | 3 | **304** |
| **Great Basin & Intermountain Semi-Desert Shrubland & Steppe** | | | | | | | | 1 | | | **1** |
| **Great Basin Saltbrush Scrub** | | | | | | | | | 6 | | **6** |
| **North American Warm Semi-Desert Cliff, Scree & Rock Vegetation** | 1 | | | | | 12 | 4 | | | 8 | **25** |
| **COLUMN TOTALS ($n_{+j}$)** | **31** | **10** | **38** | **0** | **6** | **876** | **275** | **1** | **22** | **22** | **GRAND TOTAL: 1281** |

**Table H8.** Population contingency table and users and producers accuracies for USNVC macrogroup level map classes. Overall accuracy = 87.3%.

| MACROGROUP | Intermountain Singleleaf Pinyon-Western Juniper Woodland | Warm Mediterranean & Desert Riparian, Flooded & Swamp Forest | California Chaparral | California Annual & Perennial Grassland | Warm Semi-Desert & Mediterranean Alkaline-Saline Wetland | Mojave-Sonoran Semi-Desert Scrub | North American Warm-Desert Xero-Riparian | Great Basin & Intermountain Semi-Desert Shrubland & Steppe | Great Basin Saltbrush Scrub | North American Warm Semi-Desert Cliff, Scree & Rock Vegetation | USER ACCURACY |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Intermountain Singleleaf Pinyon-Western Juniper Woodland | 2.2278% | 0.0000% | 0.7860% | 0.0000% | 0.0000% | 0.0780% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 72.1% |
| Warm Mediterranean & Desert Riparian, Flooded & Swamp Forest | 0.0000% | 0.0000% | 0.0011% | 0.0000% | 0.0000% | 0.0000% | 0.0012% | 0.0000% | 0.0000% | 0.0000% | 0.0% |
| California Chaparral | 0.4401% | 0.0000% | 0.6161% | 0.0000% | 0.0000% | 0.3521% | 0.0880% | 0.0000% | 0.0000% | 0.0000% | 41.2% |
| California Annual & Perennial Grassland | 0.0539% | 0.0000% | 0.4316% | 0.0000% | 0.0000% | 0.2158% | 0.1618% | 0.0000% | 0.0000% | 0.0000% | 0.0% |
| Warm Semi-Desert & Mediterranean Alkaline-Saline Wetland | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0014% | 0.0000% | 0.0000% | 0.0000% | 0.0005% | 0.0000% | 75.0% |
| Mojave-Sonoran Semi-Desert Scrub | 0.2706% | 0.0000% | 0.1526% | 0.0000% | 0.0056% | 82.761% | 4.9000% | 0.0000% | 0.0223% | 3.2095% | 90.6% |
| North American Warm-Desert Xero-Riparian | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.2590% | 1.0759% | 0.0000% | 0.0000% | 0.0113% | 79.9% |
| Great Basin & Intermountain Semi-Desert Shrubland & Steppe | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0011% | 0.0000% | 0.0000% | 100.0% |
| Great Basin Saltbrush Scrub | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0004% | 0.0000% | 100.0% |
| North American Warm Semi-Desert Cliff, Scree & Rock Vegetation | 0.0338% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.9018% | 0.3006% | 0.0000% | 0.0000% | 0.6012% | 32.7% |
| PRODUCER ACCURACY | 73.6% | 0.0% | 31.0% | 0.0% | 19.6% | 97.9% | 16.5% | 100.0% | 1.8% | 15.7% | |

**Table H9.** Sample contingency table for USNVC formation level (and unvegetated) map classes.

| FORMATION | Cool Temperate Forest Formation | Temperate Flooded & Swamp Forest Formation | Mediterranean Scrub Formation | Mediterranean Grassland & Forb Meadow Formation | Salt Marsh Formation | Warm Desert Scrub & Grassland Formation | Cool Semi-Desert Scrub & Grassland Formation | Warm Semi-Desert Cliff, Scree, & Rock Vegetation Formation | Unvegetated - Built-Up | Unvegetated - Water | ROW TOTALS ($n_{i+}$) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Cool Temperate Forest Formation** | 16 | | 7 | | | 3 | | | | | **26** |
| **Temperate Flooded & Swamp Forest Formation** | | 10 | 1 | | | 1 | | | | | **12** |
| **Mediterranean Scrub Formation** | 5 | | 7 | | | 5 | | | | | **17** |
| **Mediterranean Grassland & Forb Meadow Formation** | 1 | | 8 | | | 9 | | | | | **18** |
| **Salt Marsh Formation** | | | | | 3 | | 1 | | | | **4** |
| **Warm Desert Scrub & Grassland Formation** | 8 | | 15 | | 3 | 1117 | 15 | 14 | | | **1172** |
| **Cool Semi-Desert Scrub & Grassland Formation** | | | | | | | 7 | | | | **7** |
| **Warm Semi-Desert Cliff, Scree, & Rock Vegetation Formation** | 1 | | | | | 16 | | 8 | | | **25** |
| **Unvegetated - Built-Up** | | | | | | 9 | | | 5 | | **14** |
| **Unvegetated - Water** | | | | | | | | | | 3 | **3** |
| **COLUMN TOTALS ($n_{+j}$)** | **31** | **10** | **38** | **0** | **6** | **1151** | **23** | **22** | **5** | **3** | **1293** |

**Table H10.** Population contingency table and users and producers accuracies for USNVC formation level (and unvegetated) map classes. Overall accuracy (formations only) = 92.5%.

| FORMATION | Cool Temperate Forest Formation | Temperate Flooded & Swamp Forest Formation | Mediterranean Scrub Formation | Mediterranean Grassland & Forb Meadow Formation | Salt Marsh Formation | Warm Desert Scrub & Grassland Formation | Cool Semi-Desert Scrub & Grassland Formation | Warm Semi-Desert Cliff, Scree, & Rock Vegetation Formation | Unvegetated - Built-Up | Unvegetated - Water | ROW TOTALS ($n_{i+}$) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Cool Temperate Forest Formation | 2.2278% | 0.0000% | 0.7860% | 0.0000% | 0.0000% | 0.0780% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 72.1% |
| Temperate Flooded & Swamp Forest Formation | 0.0000% | 0.0000% | 0.0011% | 0.0000% | 0.0000% | 0.0012% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0% |
| Mediterranean Scrub Formation | 0.4401% | 0.0000% | 0.6161% | 0.0000% | 0.0000% | 0.4401% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 41.2% |
| Mediterranean Grassland & Forb Meadow Formation | 0.0539% | 0.0000% | 0.4316% | 0.0000% | 0.0000% | 0.3776% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0% |
| Salt Marsh Formation | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0014% | 0.0000% | 0.0005% | 0.0000% | 0.0000% | 0.0000% | 75.0% |
| Warm Desert Scrub & Grassland Formation | 0.2706% | 0.0000% | 0.1526% | 0.0000% | 0.0056% | 88.996% | 0.0223% | 3.2207% | 0.0000% | 0.0000% | 96.0% |
| Cool Semi-Desert Scrub & Grassland Formation | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0015% | 0.0000% | 0.0000% | 0.0000% | 100.0% |
| Warm Semi-Desert Cliff, Scree, & Rock Vegetation Formation | 0.0338% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 1.2024% | 0.0000% | 0.6012% | 0.0000% | 0.0000% | 32.7% |
| Unvegetated - Built-Up | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0010% | 0.0000% | 0.0000% | 0.0006% | 0.0000% | 35.7% |
| Unvegetated - Water | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0000% | 0.0008% | 100.0% |
| COLUMN TOTALS ($n_{+j}$) | 73.6% | 0.0% | 31.0% | 0.0% | 19.6% | 97.7% | 6.2% | 15.7% | 100.0% | 100.0% | |

**Table H11.** Sample contingency table for USNVC class level (and unvegetated) map classes.

| CLASS | Forest & Woodland Class | Shrubland & Grassland Class | Xeromorphic Scrub & Herb Vegetation (Semi-Desert) Class | Nonvascular & Sparse Vascular Rock Vegetation Class | Unvegetated | ROW TOTALS ($n_{i+}$) |
|---|---|---|---|---|---|---|
| **Forest & Woodland Class** | 26 | 8 | 4 | | | **38** |
| **Shrubland & Grassland Class** | 6 | 18 | 15 | | | **39** |
| **Xeromorphic Scrub & Herb Vegetation (Semi-Desert) Class** | 8 | 18 | 1139 | 14 | | **1179** |
| **Nonvascular & Sparse Vascular Rock Vegetation Class** | 1 | | 16 | 8 | | **25** |
| **Unvegetated** | | | 9 | | 8 | **17** |
| **COLUMN TOTALS ($n_{+j}$)** | **41** | **44** | **1183** | **22** | **8** | **1298** |

**Table H12.** Population contingency table and users and producers accuracies for USNVC class level (and unvegetated) map classes. Overall accuracy 92.9%.

| CLASS | Forest & Woodland Class | Shrubland & Grassland Class | Xeromorphic Scrub & Herb Vegetation (Semi-Desert) Class | Nonvascular & Sparse Vascular Rock Vegetation Class | Unvegetated | ROW TOTALS ($n_{i+}$) |
|---|---|---|---|---|---|---|
| **Forest & Woodland Class** | **2.2278%** | 0.7871% | 0.0792% | 0.0000% | 0.0000% | 72.0% |
| **Shrubland & Grassland Class** | 0.4940% | **1.0491%** | 0.8182% | 0.0000% | 0.0000% | 44.4% |
| **Xeromorphic Scrub & Herb Vegetation (Semi-Desert) Class** | 0.2706% | 0.1582% | **89.0198%** | 3.2207% | 0.0000% | 96.1% |
| **Nonvascular & Sparse Vascular Rock Vegetation Class** | 0.0338% | 0.0000% | 1.2024% | **0.6012%** | 0.0000% | 32.7% |
| **Unvegetated** | 0.0000% | 0.0000% | 0.0010% | 0.0000% | **0.0014%** | 57.0% |
| **COLUMN TOTALS ($n_{+j}$)** | 73.6% | 52.6% | 97.7% | 15.7% | 100.0% | |

Revised January 2007

# Accuracy Assessment Form
# USGS-NPS Vegetation Mapping Program

**1. PLOT (WAYPOINT) #: JOTR - _____ - _____ 2. DATE: _____**

**3. OBSERVER (DETERMINING ASSOCIATION) _____**

**4. Observer (assisting) _____**

**5. ACCURACY OF NAVIGATION (METERS) _____**

**6. How determined: _____**

**7. UTM EASTING _____ 8. UTM NORTHING _____**

**9. UTM Zone 11 10. Datum NAD83**

**11. Reason for offset of GPS Position from waypoint (if applicable):**
**Mosaicing situation (see #16)_____ Physical constraints in reaching waypoint: _____**

**Explain (as needed): _____**

**12. VEGETATION ASSOCIATION (primary call): _____**

**_____**

**13. Other possible associations for primary call (complexing scenario) (if applicable):**

**_____**

**14. Explanation for #14 (if applicable): _____**

**_____**

**_____**

**15. Other Associations present in plot and %age of each: (mosaicing scenario) (if applicable)**

**Primary cell association: _____ %age of plot: _____**

**2nd association present: _____ %age of plot: _____**

**3rd association present: _____ %age of plot: _____**

**16. Dominant/characteristic species in tree layer (~ 1-5 species, where layer is present)**

**17. Dominant/characteristic species in shrub layer (~ 1-10 species, where layer is present)**

**18. Dominant/characteristic species in herbaceous layer (up to 5 species, where layer is present)**

**19. Other comments (if needed)**

## Classification

A classification and key were produced to identify all vegetation types detected in the fieldwork for this project based on consistent patterns of species composition, abundance, and habitat/environmental factors. The classification follows a standard floristic hierarchy of the U.S. National Vegetation Classification System (Grossman *et al*. 1998) and A Manual of California Vegetation (Sawyer and Keeler-Wolf 1995), which have naming conventions for alliances and associations. An alliance is the generic unit in the floristic classification. It is based on the dominant (or diagnostic) species of the stand, which are usually of the uppermost and/or dominant height stratum. An association is the most basic, fundamental unit of classification. Associations are subdivisions of alliances based on constant patterns of additional species within an overall pattern of alliance dominance. Associations are typically geographically more specific than alliances, and they tend to be locally distributed and indicative of a certain environment or ecosystem in a local setting.

In the naming of alliances and associations, species in the uppermost stratum are listed first and species differing in strata are separated with a slash (*e.g., Yucca brevifolia/Pleuraphis rigida*), while species in the same stratum are separated with a dash (*e.g., Larrea tridentata–Ambrosia dumosa)*. Because the levels above alliance and association currently are being reevaluated, a conservative approach was taken for the formation and other upper levels of the classification and in keeping with current revisions of the national hierarchy.

## Developing the Key

The key provides general choices and information on the physiognomy of the vegetation and the different environments based on species composition and ecological setting. This approach in the key was chosen (1) to reduce the length and redundancy common to dichotomous keys and (2) because such a guide can be easily used by nonbotanists/plant ecologists. It can be used as a stand-alone product, allowing anyone with some basic ecology background and knowledge of the main characteristic plant species to identify the vegetation. The vegetation key is written from two perspectives: (1) a field team attempting to identify vegetation and (2) an office team attempting to place field samples into the proper category. Thus, heavy reliance is placed on correct identification of characteristic plant species and of estimation of cover of these species.

The key is first broken into major units based on dominant plant life form—trees, shrubs, and herbs. Trees are categorized into three sections: coniferous, broadleaf evergreen and deciduous, and microphyllous. Shrubs are also categorized into three sections: shrublands of wet to moist localities, moderately tall shrublands of drier localities, and dwarf shrublands. Herbs are categorized into perennial grass and annual grass-dominated types. Since the vast majority of vegetation in this project area is shrubby, the shrubland sections are the most complicated.

## Description Writing

Following the analysis of field data and development of the classification and key, brief alliance-level descriptions were written and based on available literature. Association-level descriptions

were written in two formats, depending on the sample size: (1) Associations with only one sample are described in a brief description of species and environmental composition, with comparison to existing references; (2) ssociations represented by two or more samples are described using the currently available template provided by NatureServe. The two primary writers were Sau San and Diana Hickson (California Department of Fish and Game). Todd Keeler-Wolf (California Department of Fish and Game) edited all the descriptions. When writing the descriptions, the following standards were set:

1. Dominant or codominant species: Must be in at least 80 percent of the samples, with at least 30 percent relative cover in all samples.
2. Characteristic/Diagnostic species: Must be present in at least 80 percent of the samples, with no restriction on cover.
3. Abundant species: Must be present in at least 50 percent of the samples, with an average of at least 30 percent relative cover in all samples.
4. Often/Usually occurring species: Must be present in at least 50 percent of the samples, with no restriction on cover.
5. Minimum sample size for description: n=3. Descriptions of associations with fewer than three samples were attempted if (a) the association was sampled and described by previous authors, or (b) the vegetation was confirmed as distinctive and repeatable based on field reconnaissance or by photointerpretation signature.
6. Open: Used to describe individual layers of vegetation (tree, shrub, herb, or subdivisions of them) where the cover is generally less than 33 percent absolute cover.
7. Intermittent: Used to describe individual layers of vegetation (tree, shrub, herb, or subdivisions of them) where there is 33–66 percent absolute cover.
8. Continuous: Used to describe individual layers of vegetation (tree, shrub, herb, or subdivisions of them) where there is greater than 66 percent absolute cover.
9. Relative cover: Refers to the amount of the surface of the plot or stand sampled that is covered by one species (or physiognomic group) as compared to (relative to) the amount of surface of the plot or stand covered by all species (in that group). Thus, 50 percent relative cover means that half of the total cover of all species or physiognomic groups is composed of the single species or group in question. Relative cover values are proportional numbers and, if added, total 100 percent for each stand (sample).
10. Absolute cover: Refers to the actual percentage of the ground (surface of the plot or stand) that is covered by a species or group of species. For example, *Pinus monophylla* covers between five and 10 percent of the stand. Absolute cover of all species or groups in a stand or plot, if added, may total greater or less than 100 percent, because it is not a proportional number.
11. Stand: The basic physical unit of vegetation in a landscape. It has no set size. Some vegetation stands, such as wetland seeps, are very small, and some, such as desert or forest types, may be several square kilometers in size. A stand is defined by two main unifying characteristics:
    a. It has *compositional* integrity. Throughout the site, the combination of species is similar. The stand is differentiated from adjacent stands by a discernible boundary that may be abrupt or gradual.

   b. It has *structural* integrity. It has a similar history or environmental setting, affording relatively similar horizontal and vertical spacing of plant species. For example, a hillside forest formerly dominated by the same species but that has burned on the upper part of the slope and not the lower is divided into two stands. Likewise, a sparse woodland occupying a slope with shallow rocky soils is considered a different stand from an adjacent slope of a denser woodland/forest with deep, moister soil and the same species.
12. Woody plant: Any species of plant that has noticeably woody stems. It does not include herbaceous species with woody, underground portions such as tubers, roots, or rhizomes.
13. Tree: A single-stemmed, woody plant that normally grows to be greater than five meters tall.
14. Shrub: Normally a multistemmed woody, plant that is between 0.2 meters and five meters tall. Definitions are blurred at low and the high ends of the height scales.
15. Herbaceous plant: Any species of plant that has no main woody stem development and includes grasses, forbs, and perennial species that die back seasonally.
16. Forest: In the National Vegetation Classification, a forest is defined as a tree-dominated stand of vegetation with 60 percent or greater cover of trees.
17. Woodland: In the National Vegetation Classification, a woodland is defined as a tree-dominated stand of vegetation with between 25 and 60 percent cover of trees.
18. Sparsely wooded: Refers to stands with conspicuous trees (generally at least 10 percent absolute cover), but less than 25 percent cover may occur over shrubs as the dominant canopy (sparsely wooded shrubland) or herbaceous (sparsely wooded) cover.
19. Rare and endangered plants: Listed as per CNPS (2003) Online Inventory of Rare and Endangered Plants.
20. Conservation rank: Listed by the state Nature Conservancy Heritage Programs, these are the "Global" and "State" ranks, as seen below.
   a. G1 and S1: Fewer than six viable occurrences worldwide and/or 2,000 acres
   b. G2 and S2: six–20 viable occurrences worldwide and/or 2,000–10,000 acres
   c. G3 and S3: 21–100 viable occurrences worldwide and/or 10,000–50,000 acres
   d. G4 and S4: Greater than 100 viable occurrences worldwide and/or greater than 50,000 acres
21. Sample(s): Listed by their survey numbers from the vegetation databases and indicated using the following: Relevé samples begin with the alpha code "JOTR" for the 300 plots collected specifically for this project, "MDEI" for the 74 plots collected by the Mojave Desert Ecosystem Initiative crews in 1998, "Long" for the Bret Long crew's 74 plots collected in 1997, and "Watts" for the 115 plots collected by the Watts team in the Malapai Hill Quadrangle in 1996.

## Lessons Learned

This National Park Service vegetation project was the first in California to utilize an overlapping crew of photointerpreters and field data collectors. There were clear, positive benefits to this in that the photointerpretation/field sampling team gleaned a detailed and intimate understanding of the vegetation and corresponding environmental cues. This was very useful in interpreting the often subtle and indistinct vegetation patterns that show up in the aerial photographs.

This project also made use of several data sets that were collected sequentially in support of other mapping or overlapping data needs. The value of the Long and MDEI data on a plot-by-plot basis was equivalent to the larger JOTR data set. However, the Watts data was less useful, primarily as a result of the small plot size and the relatively inflexible random plot selection process. Clearly, the JOTR data set was the most useful because of its full allocation across the entire park, relying as it did on an environmentally driven, randomly stratified sample allocation.

Several new types of vegetation were described in this project. The sampling of the Colorado Desert portion of the park was particularly useful. Due to the paucity of previous data analysis of vegetation from the eastern California portion of the Colorado Desert, many new types were described in this area. This data will provide valuable perspective when new field data collected from the Bureau of Land Management (BLM) Northern and Eastern Colorado Desert Plan (NECO 2003) become analyzed later this year, as planned by the California Native Plant Society (Julie Evens, personal communication, February 2005).

One final point of interest is the relationship of the Joshua Tree (*Yucca brevifolia*) in the current National Vegetation Classification System. Presently, there is a sparsely wooded shrubland alliance defined by *Yucca brevifolia* and a wooded herbaceous alliance defined by *Yucca brevifolia*. Some evidence from the data in this study suggests that there may, indeed, be Joshua Tree alliance; however, there is also likely to be a series of associations within the Blackbush (*Coleogyne ramosissima*) and the Creosote Bush (*Larrea tridentata*) alliances that are defined by Joshua Tree. In other words, despite the fact that the Joshua Tree is taller, it may be less significant than the shrubs with which it occurs, and further analysis may determine that the so-named *Yucca brevifolia/Coleogyne ramosissima* association and other similar situations may be better thought of as Joshua Tree associations of a shrub alliance (e.g., *Coleogyne ramosissima/Yucca brevifolia* association).

## KEY TO THE VEGETATION TYPES OF JOSHUA TREE NATIONAL PARK

How to Use the Key

This is not a dichotomous key; there are often more than two choices for each section. Read all options in each list to choose the best match for your vegetation stand. The key will direct you first to the life forms: tree, shrub, and herbaceous, then lead you through more specific lists based on dominant/characteristic or presence/absence of significant species.

Due to the high diversity of the vegetation communities in the area, this is a complex key. You will need to collect plant composition data that includes not only those species that are dominant but also those "indicator," or characteristic species, whose presence may cause the plot to key to another vegetation type.

**If there is a species present in high cover for which no type exists in the key,** there are two options. First, the plot can key to another species that is present in high cover. For example, a plot with 35 percent cover toyon and 30 percent holly-leaved cherry would key to holly-leaved cherry, since there is no toyon type defined in the study area. If this is not a reasonable option, the plot can be designated "unable to key." Plots that are unable to key may be candidates for new vegetation types.

**Estimating cover using actual percentages, rather than cover classes,** is preferable, because it gives the fullest picture of the vegetation present. It enables later review of the data to confirm choice of plant community and may help to describe new vegetation types and answer future management or research questions. If a less rigorous and faster approach is needed, for example, if the project is not primarily a vegetation project, the following cover classes are compatible with the key and may be used:

**1. <1 percent**
**2. 1–5 percent**
**3a. 6–15 percent**
**3b. 16–25 percent**
**4. 26–50 percent**
**5. 51–75 percent**
**6. 76–100 percent**

### *Using percent Cover Data to Arrive at a Plant Vegetation Type*

All references to percent cover in the key are to absolute cover unless specified in a particular section as relative cover.

**Absolute cover:** The actual percentage of the surface area of the plot that is covered by a species or physiognomic group (trees, shrubs, herbaceous), as in "creosote bush covers 10 percent of the plot." Absolute cover of all species or physiognomic groups, when added together, may total greater than 100 percent, because this is not a proportional number and plants

can overlap each other. For example, a plot could have 25 percent tree cover, 40 percent shrub cover, and 50 percent herbaceous cover.

**Relative cover:** The percentage of the surface area of the plot that is covered by one species or physiognomic group (trees, shrubs, herbaceous) as compared or relative to the amount of surface of the plot covered by all species or groups. Thus, 50 percent relative cover means that half of the total proportion of cover of all species or physiognomic groups is composed of the single species or group in question. Relative cover values are a proportional number that, when added together, total 100 percent for each plot. For example, a Creosote bush–burro bush vegetation plot with 5 percent cover creosote bush and 5 percent cover burro bush estimated using absolute cover would translate to 50 percent relative cover of creosote bush and 50 percent relative cover of burro bush.

Terms and Concepts Used Throughout the Key

**Dominance by layer:** Tree, shrub, and herbaceous layers are considered physiognomically distinct. A vegetation type is considered to belong to a certain physiognomic group if it is dominated by one layer. Layers are prioritized in order of height. The tallest layer, if it meets a criterion in the "characterized" definitions (see below) is said to dominate, and the type is usually named at the alliance level by the characteristic species of the tallest layer.

**Dominant: >50 percent relative cover.** Dominance refers to the preponderance of vegetation cover in a stand of uniform composition and site history. It may refer to cover of an individual species (as in "dominated by Douglas-fir", or it may refer to dominance by a physiognomic group, as in "dominated by shrubs." Dominance refers to the relative cover of one species or physiognomic group as compared to another species or physiognomic group. Anything more than 50 percent relative cover is said to dominate a stand, however, see "dominance by layer.

**Strongly dominant: 60 percent+ relative cover.** A species in the dominant life form has 60 percent or greater relative cover.

**Codominant: Each species has 30 percent–60 percent relative cover.** Codominance refers to two or more species in a stand with near equal cover . In general, codominance can occur among species that have between 30 and 60 percent relative cover each.

**Significant: 1 percent–5 percent absolute cover.** A species is considered significant if it makes up 1 to 5 percent absolute cover.

**Important: >1 percent absolute cover.** A species is considered important if it has greater than 1 percent absolute cover. This term is contrasted with dominant to mean that the species is always present in greater than 1 percent cover but not always dominant.

**Tree-characterized vegetation:** Due to the arid nature of JTNP, the absolute cover for tree vegetation in any plot may be quite low (<10%) in comparison to that found in other parks. Therefore our definition for "tree-characterized" vegetation is as follows: trees are evenly distributed throughout the stand, providing a consistent (even if sparse) structural component. Additionally, one or both of the following criteria are met: (1) Trees influence the distribution or population dynamics of other plant species; (2) Trees play an important role in ecological processes within the stand.

**Shrub-characterized vegetation:** Shrubs (including dwarf-shrubs) are evenly distributed throughout the stand, providing a consistent (even if sparse) structural component, and one or both of the following criteria are met: (1) Shrubs influence the distribution or population dynamics of other plant species; (2) Shrubs play an important role in ecological processes within the stand.

**Herb-characterized vegetation:** Herbs are evenly distributed throughout the stand, providing a consistent (even if sparse) structural component, and play an important role in ecological processes within the stand.

**Nonvascular vegetation:** Nonvascular organisms provide a consistent (even if sparse) structural component and play an important role in ecological processes within the stand.

**Sparse vegetation:** Neither vascular plants nor nonvascular organisms provide a consistent **structural component or play an important role in ecological processes on the site.**

Other Important Terms

**Alliance**: Plant communities based on dominant/diagnostic species of uppermost or dominant stratum. Part of the USNVC hierarchy.

**Association:** The most botanically detailed plant community designation based on dominant species and multiple co- or subdominant indicator species from any strata. Part of the USNVC system.

**Diagnostic species:** A species typically found in the dominant stratum of a vegetation association and lending its name to that association.

**Shrub:** A multi-stemmed plant with noticeably woody stems that is between 0.2 and 5 meters tall. *Juniperus californica* (in JTNP) is often less than the 3 m but is treated as a tree in this key.

**Subshrub:** A multi-stemmed plant with noticeably woody stems less than 0.5 meters tall.

**Tree:** Woody perennials that are regularly over 3m in height including "shrub" species that may be taller than 3m such as *Prosopsis glandulosa*, *Tamarix* spp., and *Juniperus californica*.

*Quercus* spp., *Chilopsis linearis*, *Psorothamnus spinosus*, and *Fouquieria splendens* are species that may frequently be 3 or more meters tall but are treated as shrubs in this key.

**Plant community nomenclature:** Species separated by "-" are within the same stratum; species separated by "/" are in different strata. The number at the end of some plant community names is the Mapping Code used for labeling plant community polygons for the associated GIS-based plant community map.

**Stand:** The basic physical unit of plant communities in a landscape. It has no set size. Some vegetation stands are very small, such as certain wetland types, and some may be several square kilometers in size, such as certain forest types. A stand is defined by two main unifying characteristics:

1. It has compositional integrity. Throughout the stand, the combination of species is similar. The stand is differentiated from adjacent stands by a discernible boundary that may be abrupt or occur indistinctly along an ecological gradient.

2. It has structural integrity. It has a similar history or environmental setting that affords relatively similar horizontal and vertical spacing of plant species. For example, a hillside forest originally dominated by the same species that burned on the upper part of the slopes but not the lower would be divided into two stands. Likewise, a sparse woodland occupying a slope with very shallow rocky soils would be considered a different stand from an adjacent slope with deeper, moister soil and a denser woodland or forest of the same species.

The structural and compositional features of a stand are often combined into a term called homogeneity. For an area of vegetated ground to meet the requirements of a stand, it must be homogeneous at the scale being considered. The associated plant community mapping project had a Minimum Mapping Unit (MMU) of 0.5 hectares.

Key to Main Vegetation Divisions

**I.** Vegetation characterized by trees including shrub species *Prosopsis glandulosa*, *Tamarix* spp., and *Juniperus californica*. (*Quercus* spp. *Chilopsis linearis*, *Psorothamnus spinosus*, and *Fouquieria splendens* are treated as shrubs). Trees are evenly distributed throughout the stand and provide a consistent (even if sparse) structural component over denser subcanopies of shrub and herbaceous species. Absolute tree cover is generally >/=1% with the exception of the Joshua Tree (*Yucca brevifolia*), which may be evenly distributed within a plot and yet still not make up 1% cover.

**Division A: Tree Vegetation**

**II.** Vegetation dominated by shrubs (including *Quercus* spp. *Chilopsis linearis*, *Psorothamnus spinosus*, and *Fouquieria splendens)* or subshrubs. Trees, if present, are not evenly distributed across the stand and generally form less than 1 percent cover. This division is categorized into three sections: (1) shrublands of wet to moist localities including springs, seasonally flooded stream channels, and so forth; (2) moderately tall shrublands (shrub canopy ranging from >0.5 m to 4 m) of drier localities from intermittently flooded desert washes to dry uplands; and (3) dwarf shrublands where the average height of shrubs is 0.5 m or less.

**Division B: Shrub Vegetation**

**III.** Vegetation characterized by herbaceous species including grasses, grass-like plants, and broad-leaved, herbaceous species.

Two sections are included: (1) perennial grasslands and (2) annual grasslands.

**Division C: Herbaceous Vegetation**

## Division A: Tree Vegetation

Tree species are present and evenly distributed throughout the stand, although the cover may be low. Woody perennials that are regularly over 3m in height including shrub species such as *Prosopsis glandulosa*, *Tamarix* spp., and *Juniperus californica which are* often taller than 3m. *Quercus* spp., *Chilopsis linearis*, *Psorothamnus spinosus*, and *Fouquieria splendens* are are treated as shrubs in this key.

**I.** Stands characterized by coniferous evergreen trees including *Pinus monophylla* and *Juniperus californica*.

**II.** Stands characterized by nonconiferous trees including broad-leaf evergreen or deciduous species.

**III.** Stands characterized by thorny, extremely xeromorphic trees including Blue Palo Verde (*Cercidium floridum,* also known as *Parkinsonia florida*) and Ironwood (*Olneya tesota*).

### Section I

**I.** Stands characterized by coniferous evergreen trees including *Pinus monophylla* and *Juniperus californica*.

**Needle-Leaved Evergreen Woodland**

**IA.** *Pinus monophylla* >=1 percent and generally less than 25 percent cover. *Juniperus californica* may be present. *Pinus monophylla* occurs over a sparse to relatively dense cover of shrubs. Restricted to cool, relatively moist sites of the upper elevations mostly in Little San Bernardino Mountains, but isolated stands in Coxcomb Mountains

**IB.** The short tree (or large shrub) layer is characterized by California Juniper (*Juniperus californica*) with no other tree species equaling or exceeding cover of *J. californica*, though other species (*Pinus monophylla, Yucca brevifolia*) may be present in small amounts (usually <1 percent cover).

**IC.** Single-Leaf Pinyon (*Pinus monophylla*) and/ or California Juniper (*Juniperus californica*) is/ are present, but vegetation characterized by Muller or Desert Scrub Oak (*Quercus cornelius-mulleri)*. Oak spp. (*Quercus* spp.) is > or + 2 percent cover and is not exceeded by any tree cover such as California Juniper or Single-Leaf Pinyon Pine.

## IA. Single-Leaf Pinyon *(Pinus monophylla)* Wooded Shrubland Alliance

Two associations have been described from JOTR.

**IA.1.** Sparse to moderately closed stands (>=1% cover) of PIMO over an open cover of QUCO. JUNCAL may be present in small amounts. QUCO cover does not exceed that of PIMO or JUNCAL.
**101=Singleleaf Pinyon Pine/Muller's Oak (*Pinus monophylla/Quercus cornelius-mulleri)* Woodland Association** 10161

**IA.2**. Sparse stands (1-25%) of PIMO in association with or without a JUNCAL tall shrub layer over an extremely sparse understory of small shrubs & grasses primarily consisting of Ericameria spp. & ACHSPE. QUCO does not have a regular presence.
**102=Singleleaf Pinyon Pine/(California Juniper)/Desert Needlegrass *(Pinus monophylla/(Juniperus californica)/Achnatherum speciosum)* Woodland Association** (stands noted as 10160)

## IB. California Juniper *(Juniperus californica)* Woodland Alliance

This alliance is represented by six different associations in JOTR.

**IB.3.a.** Open stand of JUNCAL generally ranging from 1 - 15% absolute cover over a shrub and succulent cover of CORA and YUSC.
**103=California Juniper/ Blackbrush- Mojave Yucca (*Juniperus californica / Coleogyne ramosissima – Yucca schidigera)* Woodland Association** 10021

**IB.3.b**. Open stand of JUNCAL generally ranging from 1-15% absolute cover over a shrub cover of CORA.
**104= California Juniper/ Blackbrush *(Juniperus californica / Coleogyne ramosissima)* Woodland Association** 10025

**IB.3.c.** Sparse JUNCAL (1-5%) with understory of YUSC and possibly TEHA.
**105=California Juniper/ Mojave Yucca- Tetracoccus (*Juniperus californica / Yucca schidigera – (Tetracoccus hallii)*) Woodland Association** 10031

**IB.3.d.** Sparse JUNCAL (1-5%) with understory cover of ACHSPE and ERFA
**107=California Juniper/ (California Buckwheat/ Desert Needlegrass*) (Juniperus californica / (Eriogonum fasciculatum / Achnatherum speciosum))* Super Association** 10034 {*Juniperus californica/Achnatherum speciosum* 10022 **&** *Juniperus californica/Eriogonum fasciculatum* 10023}

**IB.3.e.** Emergent JUNCAL as a sparse emergent (minimum 1-5%) over a moderately sparse shrub understory of TEHA and associated shrubs.
**108=California Juniper/ Tetracoccus (*Juniperus californica / Tetracoccus hallii)* Woodland Association** 10029

**IB.3.f.** Extremely sparse JUNCAL (1-5%) as emergent to sparse understory cover (5-15%) of VIPA and other shrubs. Note: **Nolina spp.** can have relative cover <1%.
**109=California Juniper/ Desert Sunflower-(Beargrass) (*Juniperus californica/ Viguiera parishii – (Nolina spp.))* Woodland Association** *10030*

**IC. Muller Oak (*Quercus cornelius-mulleri*) Shrubland Alliance**

Two associations have been defined locally.

**IC.a.** Sparse QUCO canopy with or without JUNCAL over a scattered, shorter shrub layer characterized by Linear-Leafed Goldenbush (*Ericameria linearifolia*) and California Buckwheat (*Eriogonum fasciculatum*). May contain a minor component of PIMO. Common on slopes of higher mountains.
**162= Muller Oak- (California Juniper) *Quercus cornelius-mulleri – (Juniperus californica)* Shrubland Association** MAMU 21234

**IC.b..**) Sparse QUCO canopy with or without JUNCAL. May have a dense and dominant CORA shrub layer. Often on on upper fans and relatively linear hillslopes of the upper elevations.
**163= Muller Oak- (California Juniper/ Blackbush) *Quercus cornelius-mulleri – (Juniperus californica/Coleogyne ramosissima)* Shrubland Association** 21233

**II.** Stands characterized by nonconiferous trees including broad-leaf evergreen or deciduous species.
**Broad-Leaved Woodland and Forest**

**IIA.** Stands characterized by tall monocot trees of Southwest Desert affinities.

**IIB.** Stands characterized by widespread winter-deciduous, broad-leaved (including pinnate-leaved, e.g., *Prosopis*) species of trees or tall shrubs usually associated with places that remain moist throughout the growing season.

**IIA.** Stands characterized by the California Fan Palm (*Washingtonia filifera*), associated with springs and moist canyon bottoms. Other riparian tree species (*Populus fremontii, Salix spp.*) may be present or codominant. Deer grass (Muhlenbergia rigens) understory may also be present
**110=California Fan Palm (*Washingtonia filifera*) Alliance** 15112

**IIA.2.** Stands characterized by the evenly distributed Joshua Tree (*Yucca brevifolia*), (YUBR cover may be <1%). *Yucca brevifolia* and *Juniperus californica* may both codominate in the tree. If *Pinus monophylla* and *Yucca brevifolia* codominate, then use *Pinus monophylla* alliance. Dominant understory species include *Coleogyne ramosissima, Opuntia ramosissima,* and

*Pleuraphis rigida*. Common in shallow, upland soils throughout the mid and upper elevations of the park.

**Joshua Tree *(Yucca brevifolia)* Wooded Shrubland Alliance**

Four associations have been tentatively defined from the park.

**IIA.2.a.** YUBR in sparse to open stands. CORA is dominant in the shrub layer. (5-20% absolute cover).
**111=Joshua Tree/Blackbush *(Yucca brevifolia/Coleogyne ramosissima)* Wooded Shrubland Association** 13012

**IIA.2.b.** Open stands of YUBR and JUNCAL from 3-15% cover over an open layer of CORA dominant shrubs. Other species including EPNE, YUSC and Lycium spp. may be present in the shrub layer.
**112=Joshua Tree/California Juniper/(Blackbush- Mojave Yucca-Nevada Ephedra) *(Yucca brevifolia/Juniperus californica/(Coleogyne ramosissima*- Yucca Schidigera-Ephedra nevadensis*)* )Wooded Shrubland Association** 13015

**IIA.2.c**. Extremely sparse emergent layer of YUBR over an open shrub layer dominated by LATR. PLRI may dominate in sandier settings; YUSC may also be a component to the understory layer.
**113=Joshua Tree/Creosote Bush – (Mojave Yucca/ Big Galletta) *(Yucca brevifolia/Larrea tridentata – (Yucca schidigera/ Pleuraphis rigida))* Wooded Shrubland Association** 13016

**IIA.2.d.** Sparse YUBR cover over an open shrub layer of EPNE, GRSP, Lycium spp. and associated shrubs.
**114=Joshua Tree/ (Nevada ephedra- Grayia- Lycium spp.)/ Big Galleta (*Yucca brevifolia / (Ephedra nevadensis – Grayia spinosa – Lycium spp.)) / Pleuraphis rigida* Super Association** 13021

**IIB.** Stands characterized by widespread winter-deciduous, broad-leaved (including pinnate-leaved, e.g., *Prosopis*) species of trees usually associated with places that remain moist throughout the growing season.

**IIB.1.** Associated with alkaline wetlands and dune margins locally in the eastern portion of the park. Dense continuous stands of PRGL usually over 40% associated with ISAR and /or ATCA.Diagnostic species in riparian types are irregularly distributed and generally extremely sparse with extensive portions of the wash corridor lacking species which define the alliance.
**115= Honey Mesquite (*Prosopis glandulosa*) Woodland Alliance (no associations defined for the park)** 16040

**IIB.2.** The broad-leaved deciduous tree Fremont Cottonwood (*Populus Fremontii)* is conspicuous and the dominant tree throughout the stand. Associated with springs scattered throughout the park, may be mixed with Willow (Salix) species at lower cover. Canopy layer of POFR usually as a co-dominant with WAFI. Canopy density is highly variable.
**116=Fremont Cottonwood (*Populus fremontii*) Woodland Alliance (no associations defined for this project)** 15040

**IIB.3.** Red Willow (*Salix laevigata*) or other Salix spp. are the dominant species in stands, usually associated with permanent moisture in canyons and at springs, occasional throughout the park.
**117=Mixed (*Salix sp.*) Forest Alliance** 15030

**Section III**

**III.** Stands characterized by thorny, extremely xeromorphic trees including Blue Palo Verde (*Cercidium floridum,* also known as *Parkinsonia florida*) and Ironwood (*Olneya tesota*).

**IIIA.** Stands characterized by Blue Palo Verde (*Cercidium floridum*) as solely dominant in the sparse tree layer. If Ironwood (*Olneya tesota*) is present, it is significantly less in cover in the tree layer than *C. floridum.* Characteristic of washes in the lower-elevation (Colorado Desert) portion of the park.
**Blue Palo Verde (*Cercidium floridum*) Extremely Xeromorphic Evergreen Shrubland Alliance**

**IIIA.1**. Extremely sparse to open stands of CEFL in association with PSSP, HYEM & ACGR over a sparse shrub layer of HYSA. Diagnostic species in riparian types are irregularly distributed and generally extremely sparse with extensive portions of the wash corridor lacking species which define the alliance.
**118= Blue Palo Verde/Desert Lavender (*Cercidium floridum /Hyptis emoryi*) Association 16015** (includes: *Cercidium floridum/Hymenoclea salsola* (16011), *Cercidium floridum/Justicia californica* (16012), and *Cercidium floridum – Psorothamnus spinosus* (16014)).

**IIIA.2**.
**119= Blue Palo Verde (Cercidium floridum)** 16010

**IIIA.3**.
Sparse small individuals of CEFL as a co-dominanat with LATR.
**120= Blue Palo Verde/ Creosote Bush (Cercidium floridum/ Larrea tridentate)** 16013

**IIIA.4.** CHLI as co-dominant to PSSP, usually with associated individuals of ACGR. CEFL may be present in the canopy layer. Canopy density is highly variable, but

generally under 15%. CEFL, PSSP, and ACGR do not individually exceed CHLI in cover.
**134= Desert Willow- Smoketree- (Blue Palo Verde/ Catclaw) (*Chilopsis linearis – Psorothamnus spinosus – (Cercidium floridum / Acacia greggii))* Association** 15012

**IIIB.** Stands characterized by the short tree Desert Ironwood (*Olneya tesota*) strongly dominating an emergent tree layer, often mixed with other tall shrubs. If *Cercidium floridum* is present, it is in substantially lower cover in both tree and shrub layers. Associated with washes and bajadas, with occasional sheet flow in the Colorado Desert portion of the Park.
**Desert Ironwood (*Olneya tesota*) Extremely Xeromorphic Evergreen Woodland Alliance (provisional new alliance)**

**IIIB.1.** Characterized by the presence of Desert Lavender (*Hyptis emoryi*) in the understory. OLTE canopy. A possibility of CEFL with an understory of HYEM and HYSA. Canopy density is highly variable.
**121=Desert Ironwood/Desert Lavender (*Olneya tesota- (Cercidium floridum /Hyptis emoryi*)) Xeromorphic Woodland Association 16025**

**IIIB.2.** Canopy can include OLTE and/or CEFL possibly with understory of LATR, ENFA, OPBI and FOSP.
**122= Desert Ironwood/ (Creosote-Brittlebush) (*Olneya tesota /(Larrea tridentata – Encelia farinosa))* Association** Fan Type 16024

**Division B: Shrub Vegetation**

Vegetation characterized by shrubs of various heights. Trees if present, are usually <1 percent cover and not evenly scattered throughout the stand. This division is categorized into three sections: (1) shrublands of wet to moist localities including springs, seasonally flooded stream channels, and so forth; (2) moderately tall shrublands (shrub canopy ranging from >0.5 m to 4 m) of drier localities from intermittently flooded desert washes to dry uplands; and (3) dwarf shrublands where the average height of shrubs is 0.5 m or less.

- **I.** Stands characterized by shrubs of localities remaining wet to moist through the growing season. **Not mapped**
- **II.** Stands characterized by a canopy or emergent layer of moderately tall to dwarf shrubs, ranging in a variety of settings from the higher mountains to the lowest portions of the park. This key is based on species composition and contains the largest number of choices in the entire key. A stand is most easily identified if you proceed through all of the choices until you reach a description that fits the characteristics of dominance specified. It is categorized into two subsections, one with Creosote Bush as a common and characteristic component and the other without Creosote Bush as a common and characteristic component.

**Section I**
**Not mapped.**

**Section II**

**II.** Stands characterized by a canopy or emergent layer of moderately tall to dwarf shrubs, ranging from the higher mountains to the lowest portions of the park. This key is based on species composition and contains the largest number of choices in the entire key. A stand is most easily identified if you proceed through all of the choices until you reach a description that fits the characteristics of dominance specified. It is categorized into two subsections, one with Creosote Bush as a common and characteristic component and the other without Creosote Bush as a common and characteristic component.

**IIA.** Creosote Bush (*Larrea tridentata*) is a characteristic tall shrub (generally >= 1 percent and evenly distributed across the stand). No shrub with cover greater than *Larrea tridentata* with the following exceptions: *Ambrosia dumosa*, *Encelia farinosa, Krameria* spp. *Bebbia juncea, Ericameria teretifolia* or *Acamptopappus sphaerocephalus*. *Ephedra nevadensis* may have higher cover, but no more than three times. Go to IIA.1.

**IIB.** Creosote Bush (*Larrea tridentata*), if present, generally not one of the shrub species producing the greatest cover (however, it may be present and even conspicuous). Shrubs other than *Ambrosia dumosa*, *Encelia farinosa, Krameria* spp. *Bebbia juncea, Ericameria teretifolia* or *Acamptopappus sphaerocephalus*.are typically dominant.

**Subsection IIA.**

**IIA.1.** *Ambrosia dumosa* present (>=1 percent cover), may have higher cover than *Larrea tridentata.* If *Encelia farinosa* is present, go to IIA.2. Widespread on all but the hottest and most rocky, sandy, or alkaline areas of the middle and lower elevations.
**Creosote Bush - Burro Bush *(Larrea tridentata-Ambrosia dumosa)* Shrubland Alliance**

**IIA.2** *Encelia farinosa* present (>=1 percent cover), may have higher cover than *Larrea tridentata*. *Ambrosia dumosa* may be present but at generally low cover (usually less than *Encelia*). Widespread on hot (southerly exposure) mountain slopes and upper bajadas.
**Creosote Bush - Brittlebush *(Larrea tridentata-Encelia farinosa)* Shrubland Alliance**

**IIA.3.** Associated shrubs other than *Ambrosia dumosa* or *Encelia farinosa* may or may not be present. Except for shrubs listed above in Subsection IIA, cover of each associated shrub species is less than *Larrea tridentata.*
**Creosote Bush *(Larrea tridentata)* Shrubland Alliance**.

### IIA.1. Creosote Bush - Burro Bush *(Larrea tridentata-Ambrosia dumosa)* Shrubland Alliance

The *Larrea tridentata - Ambrosia dumosa* Shrubland Alliance is one of the most diverse alliances in the Mojave and Northern Sonoran deserts. It is represented in JOTR by seven associations. In addition to these identified below, there are several other variations that have not been substantiated. These will only be keyable to the alliance level in the following key:

**IIA.1.a.** Simple, widespread associations. LATR with AMDU dominant shrub layer. No other shrubs common or characteristic. Cover density is highly variable. Fan & Slopes.
**123=Larrea tridentata – Ambrosia dumosa Shrubland Association Generic – Fan & Slopes** 27031

**IIA.1.b.** Simple, widespread associations. LATR with AMDU dominant shrub layer. No other shrubs common or characteristic. Cover density is highly variable. Low Energy Wash Type.
**124=Larrea tridentata – (Ambrosia dumosa) – Hymenoclea salsola Shrubland Association-Low Energy Wash Type** 27011

**IIA.1.c.** LATR with AMDU. Can include EPCA, SEAR, HYSA and PSSC.
**125=Larrea tridentata – Ambrosia dumosa – (Ephedra californica– Senna armata – Hymenoclea salsola – Psorothamnus schottii) Low Energy Wash Type** 27047

**IIA.1.d**. YUBR and AMDU accompanied by Big Galleta (*Pleuraphis rigida*). Generally present on sandy fans and lower bajadas and occasionally at the edges of sand sheets and dunes.
**126=Creosote Bush – (Burro Bush) - Big Galleta (*Larrea tridentata – (Ambrosia dumosa) - Pleuraphis rigida)* Shrubland Association** 27021

**IIA.1.e.** LATR with AMDU dominant shrub layer, YUSC and possibly SEAN.
**127=Creosote Bush - Burro Bush - Mojave Yucca- (Spiny Senna) (*Larrea tridentata - Ambrosia dumosa - Yucca schidigera– (Senna armata))* Shrubland Association** 27045

**IIA.1.f.** Shrub cover of LATR with a co-dominant of TEHA. May or may not have AMDU.
**128=Creosote Bush-(BurroBush)-Tetracoccus-(Mojave Yucca) [Larrea tridentata – (Ambrosia dumosa) – Tetracoccus hallii – (Yucca schidigera)] Shrubland Association** 27043

**IIA.1.g.** Sparse and small LATR on rocky slopes with the possibility of a AMDUand/ or VIPA dominant shrub layer.
**129= Creosote Bush-(Burro Bush- Desert Sunflower) (*Larrea tridentata – (Ambrosia dumosa – Viguiera parishii))* Higher Elevation Type** 27046

### IIA.2 Creosote Bush - Brittlebush *(Larrea tridentata- Encelia farinosa)* Shrubland Alliance

The *Larrea tridentata - Encelia farinosa* Shrubland Alliance is represented by two associations in JOTR.

**IIA.2.a.** LATR with ENFA and AMDU all >1 percent cover. Brittlebush exceeds or equals Burro Bush in cover. Common at lower elevations on neutral, rocky slopes or on steep, south facing slopes at mid elevations throughout the park.
**130=Creosote Bush – Brittlebush - Burro Bush (*Larrea tridentata - Encelia farinosa - Ambrosia dumosa)* Association** 27057

**IIA.2.b.** . LATR with ENFA are both codominant, with FOSP as emergent and evenly spaced, though low in cover. Locally distributed on lower fans in Pinto Basin and perhaps elsewhere in the Colorado Desert portion of the park.
**131=Creosote Bush – Brittlebush - Ocotillo *(Larrea tridentata - Encelia farinosa - Fouquieria splendens)* Shrubland Association** 27056

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### IIA.3. Creosote Bush *(Larrea tridentata)* Shrubland Alliance.

There are three associations identified in the park, along with several single sample variants that, at this point, can only be keyed to the alliance level.

**IIA.3.a**. Creosote Bush is the sole dominant shrub, with little else in the shrub layer, except possibly some annuals. A monoculture associated with lower bases of fans and bajadas that may be sandy or have had past disturbance (at least, in other parts of the Mojave Desert).
**132=*Larrea tridentata* Undifferentiated Playa and Sandy or Dune Top Type** 27019

**IIA.3.b** LATR with PLRI evenly distributed in the understory. May include AMDU and annuals. Generally in sandy areas at lower elevations at the bases of bajadas and adjacent to sand fields.
**126=Creosote Bush – (Burro Bush) - Big Galleta (*Larrea tridentata – (Ambrosia dumosa) - Pleuraphis rigida)* Shrubland Association** 27021

**IIA.3.c.** LATR is the sole dominant shrub with an even distribution of HYSAcover that may or may not include AMDU. Generally associated with minor washes and disturbed areas in middle to lower elevations of the park.
**124=Creosote Bush – (Burro Bush) – Cheesebush (Larrea tridentata – (Ambrosia dumosa) – Hymenoclea salsola) Shrubland Association Low Energy Wash Type** 27011

**IIA.3.d.** LATR is the sole dominant shrub. Cover is highly variable. Usually large individuals that grow in a circular pattern.
**133=Larrea tridentata Clones** 27022

**IIA.3.e.** Sparse and small LATR on rocky slopes with the possibility of AMDU – VIPA dominant shrub layer.
**129=*Larrea tridentata – (Ambrosia dumosa – Viguiera parishii)* Higher Elevation Type** 27046

**IIA.3.f.** Shrub cover of LATR with a co-dominant of TEHA (3-5%) and may or may not have AMDU and/ or YUSC.
**128=Creosote Bush-(BurroBush)-Tetracoccus-(Mojave Yucca) [Larrea tridentata – (Ambrosia dumosa) – Tetracoccus hallii – (Yucca schidigera)] Shrubland Association** 27043

**Subsection IIB.**

**IIB.1.** Stands characterized (1 percent or higher cover) by the small tree or large shrub Desert Willow *(Chilopsis linearis)*. No other tree-sized or tall shrub species equals or exceeds *Chilopsis linearis* cover. Known from washes at mid to low elevations throughout the park.
**Desert Willow *(Chilopsis linearis)* Intermittently Flooded Shrubland Alliance**

**IIB.1.a.** CHLI as co-dominant to PSSP, usually with associated individuals of ACGR. CEFL may be present in the canopy layer. Canopy density is highly variable. No other tree-sized or tall shrub species equals or exceeds *Chilopsis linearis* cover.
**134= Desert Willow- Smoketree- (Blue Palo Verde/ Catclaw) (*Chilopsis linearis – Psorothamnus spinosus – (Cercidium floridum / Acacia greggii))* Association** 15012

**IIB.1.b.** Canopy layer of CHLI generally under 15% with PRFA and ACGR No other tree-sized or tall shrub species equals or exceeds *Chilopsis linearis* cover.
**135= Desert Willow*/ (Desert Almond-Catclaw) (Chilopsis linearis / (Prunus fasciculata – Acacia greggii)* ) Super Association** 15013

**IIB.2**. HYSA >1% cover (greater cover than other shrubs) and with a minor component of LATR. Found commonly in wash and/ or disturbed environments. Currently, no associations are defined in the park. Stands are variable in composition ranging from monospecific to stands with the following species present: *Petalonyx thurberi, Eriogonum plumatella, Salazaria mexicana*, *Larrea tridentata*, *Senna armata*, *Psorothamnus armata*, *and Tetracoccus hallii.*
**136=Cheesebush *(Hymenoclea salsola)* Shrubland Alliance** 28110

**IIB.3.** Paper-Bag Bush) (*Salazaria mexicana*) >=2 percent cover, with no other shrub species exceeding it in cover**.** Usually in washes, burned areas or disturbed uplands. This alliance is not defined at the association level locally. *(Salazaria mexicana) / Bromus madritensis – Bromus tectorum – Achnatherum speciosum) Post-burn type*
**137=Bladder-Sage *(Salazaria mexicana)* Shrubland Alliance** 28140

**IIB.4.** Mojave Yucca (*Yucca schidigera)* >=2 percent cover. Other shrub species present may include *Eriogonum fasciculatum*, *Ephedra nevadensis*, *Larrea tridentata, Ambrosia dumosa, Tetracoccus hallii*, and *Senna armata.*. Widespread in the middle elevations of the park, usually on upper fans and hillslopes.
**Mojave Yucca *(Yucca schidigera)* Shrubland Alliance**

Four associations have been defined locally.

**IIB.4.a.** YUSC with CORA dominant in the shrub layer. On pediments and hillslopes near the upper-elevation range of the alliance.
**138=Mojave Yucca - Blackbush *(Yucca schidigera - Coleogyne ramosissima)* Shrubland Association** 29032

**IIB.4.b.** Mojave yucca is 2 percent or greater cover but may codominate with LATR. AMDU may be present. Common on bajadas and gentle hillslopes at the lower-elevation extent of the alliance near the transition with the Creosote Bush-Burro Bush alliance.

**139=Mojave Yucca - Creosote Bush – (Burro Bush) *(Yucca schidigera - Larrea tridentata – (Ambrosia dumosa))* Shrubland Association** 29033

**IIB.4.c.** YUSC (3-5%) with mixed shrub layer, annuals and Big Galleta grass (*Pleuraphis rigida*). Usually on upper bajadas with a relatively sandy substrate.
**140=Mojave Yucca/Big Galleta (*Yucca schidigera/Pleuraphis rigida)* Shrubland Association** 29034

**IIB.4.d.** Consistent layer of YUSC with nearly equal amounts of TEHA.
**141= Mojave Yucca- Tetracoccus *(Yucca schidigera – Tetracoccus hallii)* Shrubland Association** 29035

**IIB.5.** Mostly CORA with or without YUSC and can have VIPA, AMDU, SAME, EPNE and other associated shrubs.
**142=Blackbush *(Coleogyne ramosissima)* Shrubland Alliance** 28023

**IIB.6.** Burro Bush (*Ambrosia dumosa*) >1 percent cover, and no other species with equal or higher cover. Occasional on lower, sandy flats or on hillslopes, usually at lower elevations. May occur on edges of washes.
**Burro Bush *(Ambrosia dumosa)* Dwarf Shrubland Alliance**

**IIB.6. a.** A diverse shrub layer dominated by AMDU.
**143=*Ambrosia dumosa – (Eriogonum fasciculatum – Lycium andersonii / Pleuraphis rigida)* Western Mountain Type** 43014

**IIB.6. b.** A diverse shrub layer dominated by AMDU.
**144=*Burro Bush-Senna -Indigo Bush (Ambrosia dumosa – Senna armata – (Psorothamnus schottii))* Eastern Pediment Type** 43013

**IIB.7.** ENFA is dominant (at least >1%), and no other species have equal or higher cover, except possibly *Lycium andersonii*. A very minor component of LATR or AMDU Occasional on hot, rocky slopes at lower elevations in the park. In the few stands sampled, *Ambrosia dumosa*, and *Fagonia laevis* have also been noted as associated species. No associations have been defined locally.
**145=Brittlebush *(Encelia farinosa)* Shrubland Association** 28033

**IIB.8.** A saltbush species (*Atriplex* spp.) provides >= half of all shrub cover.

**IIB.8.a.** ATCA (3-5%) with highest shrub cover. Annuals present. Typically of low-lying playa edges, dune aprons, or edges of alkaline wetlands from low- to mid-elevation zones. This alliance is not defined at the association level locally.
**146=Four-Wing Saltbush *(Atriplex canescens)* Shrubland Alliance** 28080

**IIB.8.b.** Desert Holly *(Atriplex hymenelytra)* >1 percent cover, and no other species with equal or higher cover. May occur on hot, rocky slopes, dry bajadas, alkaline badlands or playa edges.
**Desert Holly *(Atriplex hymenelytra)* Shrubland Alliance**

This alliance is represented in the park by one association. ATHY (3-5%) cover and may include LATR and AMDU.
**147=Desert Holly *(Atriplex hymenolytra)*** 28070

**IIB.9.** Catclaw (*Acacia greggii*) >=2 percent cover. No other single, tall shrub species with greater cover, but *Prunus fasciculata* or *Hyptis emoryi* may be equal or slightly greater cover than *Acacia.* Smaller shrubs, such as *Ericameria paniculata* or *Hymenoclea salsola,* can have higher cover but no more than twice the cover of *Acacia greggii.* Occurs in washes and arroyos, as well as upland valleys and bouldery slopes. In addition

to the following described associations, this alliance may also include the following shrub species in some stands that have as yet been undefined at the association level: *Peucephyllum schottii, Tetracoccus hallii, Ephedra californica*, *Chilopsis linearis*, *Ephedra nevadensis*, *Lycium cooperi, Viguiera parishii*, *Yucca schidigera, Nolina bigelovii,* and *Eriogonum fasciculatum.*

**Catclaw *(Acacia greggii)* Shrubland Alliance**

This alliance is represented in the park by three associations, all defined first in this project.

**IIB.9.a.** ACGR with dense LYCO and PRFA along banks of wash.
**148=Acacia greggii – (Lycium cooperi – Prunus fasciculata) High elevation wash type Shrubland Association** 36016

**IIB.9.b.** ACGR is dominant with Sweetbush *(Bebbia juncea)* as a common short shrub along with other mixed shrubs and often with annuals. Generally of rocky washes at lower elevations.
**149=*Acacia greggii – (Larrea tridentate- Hymenoclea salsola – Peucephyllum schottii – Bebbia juncea – Ephedra californica)*** Low elevation wash type **Shrubland Association** 36015

**IIB.9.c.** ACGR with mixed shrubs that may include VIPA and ERFA.
**151= *Acacia greggii – (Viguiera parishii – Eriogonum fasciculatum)*** Upland slope type 36017

**IIB.10.** Desert Almond (*Prunus fasciculata*) >=2 percent cover. Must be 25 percent or more of total vegetative cover of stand. *Gutierrezia sarothrae* may have higher cover. If *Prunus fasciculata* co-occurs with other tall shrubs, such as *Acacia greggii*, it must have twice the cover of other species to make the alliance definition. Typically of washes and arroyos at the mid and upper elevations of the park, but may occur on wash terraces and in valleys. The following species are common associates: *Salazaria mexicana*, *Ericameria teretifolia, Yucca schidigera*, *Rhus trilobata*, and *Purshia tridentata*.

**Desert Almond (*Prunus fasciculata)* Shrubland Alliance**

A single, broadly defined association has been identified from the park.

PRFA (25 percent or more of total vegetative cover of stand). If PRFA co-occurs with other tall shrubs, such as ACGR, it must have twice the cover of other species.
**152=Desert Almond *(Prunus fasciculata)* Intermittently Flooded Shrubland Association** 32010

**IIB.11**. Smoketree (*Psorothamnus spinosus*) >=2 percent cover. No other species with greater or equal cover. Of low-elevation, active washes, mostly in southern and central portion of mapping area. Some of the upper-elevation examples of these stands may

have California Buckwheat (*Eriogonum fasciculatum*). The Desert Willow (*Chilopsis linearis*) may occasionally occur in some stands.

**Smoketree *(Psorothamnus spinosus)* Intermittently Flooded Shrubland Alliance**

This alliance is represented in JOTR by two associations.

**IIB.11.a.** Canopy of PSSP with understory of HYEM and ACGR.Diagnostic species in riparian types are irregularly distributed and generally extremely sparse with extensive portions of the wash corridor lacking species which define the alliance.

**153=Smoketree - Desert-Lavender - Catclaw Association *(Psorothamnus spinosus/ Hyptis emoryi - Acacia greggii)* Association** 16035

**IIB.11.b.** Canopy of PSSP with understory of EPCA and/or HYSA. Canopy density is highly variable.

**154=Smoketree/Desert Tea Association *(Psorothamnus spinosus /( Ephedra californica- Hymenoclea salsola))* Association** 16034

**IIB.1.a.** CHLI as co-dominant to PSSP, usually with associated individuals of ACGR. CEFL may be present in the canopy layer. Canopy density is highly variable. No other tree-sized or tall shrub species equals or exceeds *Chilopsis linearis* cover.

**134= Desert Willow- Smoketree- (Blue Palo Verde/ Catclaw) (*Chilopsis linearis – Psorothamnus spinosus – (Cercidium floridum / Acacia greggii))* Association** 15012

**IIB.12.** Extremely sparse shrub layer dominated by EPNE, with or without PLPL, TRCA, ENFA, BEJU, ERFA, LYAN and/ or ACGR.

**155=*(Ephedra nevadensis – Pleurocoronis pluriseta – Encelia farinosa – Trixis californica – Bebbia juncea – Eriogonum fasciculatum – Lycium andersonii – Acacia greggii) low elevation rocky mountain type*** 24001 (24012)

**IIB.13.** Rubber Rabbitbrush (*Ericameria nauseosa*) >=2 percent. *Ericameria nauseosa* must have 25 percent or greater relative cover in the shrub layer. Occasional in upper-elevation zones, usually in areas with fire or flood history. This alliance is not defined at the association level locally.

**156=Rubber Rabbitbrush (Ericameria nauseosa) Shrubland Alliance** 28210

**IIB.14**. Round-Leaf Rabbitbrush (*Ericameria teretifolia*) >=2 percent cover. No other species with greater or equal cover. Usually of disturbed uplands**,** in the upper elevations of the park often adjacent to *Juniperus californica* stands**.** This alliance is not defined at the association level locally.

**157=Round-Leaf Rabbitbrush (Ericameria teretifolia) Shrubland Alliance** 28220

**IIB.15.** Vegetation characterized by Desert Lavender (*Hyptis emoryi)*. Other shrub species are not in high cover, but may include *Acacia greggii* and *Sarcostemma cynanchoides.* In rocky washes of upper bajadas and low-elevation canyons throughout the park.
**Desert Lavender *(Hyptis emoryi)* Intermittently Flooded Shrubland Alliance**

This alliance is represented in the park by one broadly defined association.

HYEM may include minor components of ACGR and LATR
**158=Desert-Lavender *(Hyptis emoryi)* Shrubland Association** 28203

**IIB.16.** Stands dominated by Teddy-Bear Cholla (*(Opuntia bigelovii).* Local in Pinto Basin on rocky fans.
**Teddy-Bear Cholla (*Opuntia bigelovii*) Shrubland Alliance**

The alliance is represented locally by a single association. OPBI with mixed shrub layer and other succulents
**159=Teddy-Bear Cholla *(Opuntia bigelovii)* Shrubland Association** 29050

**IIB.17.** Desert Sunflower or Parish Viguiera (*Viguiera parishii*) with >=2 percent cover. No other species with greater or equal cover. Stands typically occur on rocky hillslopes just above the *Larrea tridentata-Ambrosia dumosa* zone or, rarely, in washes.
**Parish Viguiera (*Viguiera parishii)* Shrubland Alliance**

This alliance is represented in the park by one association.

VIPA, EPNE, ERFA (the most common associate and may codominate), and PLPL are in the dominant shrub layer with NOBI at less than 1% (NOBI a presence type indicator species).Other species include: HYEM, and ENFA**.**
**160=*Viguiera parishii – (Ephedra nevadensis – Eriogonum fasciculatum – Nolina bigelovii)* high elevation rocky mountain types** 28133

**IIB.18**. Dense rivulets between desert pavement types. A combination of plants, usually containing about 1-3% of the listed species.
**161= *Salazaria mexicana- Krameria spp. – Encelia farinosa – Hyptis emoryi – Eriogonum fasciculatum – Hymenoclea salsola – Acacia greggii – Tetracoccus hallii*** 27001

**IIB.19.** Vegetation characterized by Muller or Desert Scrub Oak (*Quercus cornelius-mulleri).* The oak is >= 2 percent cover and is not exceeded by any tree cover such as California Juniper or Single-Leaf Pinyon Pine.
**Muller Oak (*Quercus Cornelius-mulleri*) Shrubland Alliance**

Two associations have been defined locally.

**IIB.19.a.** Sparse QUCO canopy with or without JUNCAL over a scattered, shorter shrub layer characterized by Linear-Leafed Goldenbush (*Ericameria linearifolia*) and California Buckwheat (*Eriogonum fasciculatum*). May contain a minor component of PIMO. Common on slopes of higher mountains.
**162= Muller Oak- (California Juniper) *Quercus cornelius-mulleri – (Juniperus californica)* Shrubland Association** MAMU 21234

**IIB.19.b.** Sparse QUCO canopy with or without JUNCAL. May have a dense and dominant CORA shrub layer. Often on on upper fans and relatively linear hillslopes of the upper elevations.
**163= Muller Oak- (California Juniper/ Blackbush) *Quercus cornelius-mulleri – (Juniperus californica/Coleogyne ramosissima)* Shrubland Association** 21233

**IIB.20.** Stands dominated by TEHA with mixed shrubs and succulents. Stands are generally centered in the southern-central portion of the park from low-elevation wash margins near the Eagle Mine to rocky uplands in the vicinity of Cottonwood Springs. Insufficient information exists to define an alliance, so these stands are considered unique at this point.
**164=Hall's Tetracoccus *(Tetracoccus hallii)* Unique Stands** 28180

**IIB.21.** Stands are dominated by the JUSCAL and HYEM with shrub layer of HYSA and annuals. Occasional stands associated with low-elevation washes at the southern portion of the park near other stands of Colorado Desert wash vegetation (*Olneya tesota* and *Cercidium floridum* Alliance stands or *Hyptis emoryi* stands). So far, not described elsewhere and currently treated as unique stands.
**165=Chuparosa *(Justicia californica)* Unique Stands** 28171

**Division C**: **Herbaceous Vegetation**

Two sections are included: (1) perennial grasslands and (2) annual grasslands.

**Section I**
**I.** Stands dominated by perennial grasses.
**Perennial Grasslands**

**IA.** Big Galleta Grass (*Pleuraphis rigida*) >=2 percent. This species occurs in low, sandy areas and occasionally uplands at mid elevations, often with emergent shrubs such as *Yucca schidigera* and *Ephedra nevadensis*. As an alliance in the park, it is generally uncommon in upland areas, such as upper bajadas, sandy washes, and intermontane valleys, and somewhat more common in low, sandy areas. In addition to the association described below, several stands include several shrubs such as *Hymenoclea salsola*, *Lycium cooperi,* and *Ephedra nevadensis* in total lower

cover than the grass cover. Other unclassified stands suggest a relatively pure association with little other perennial cover but Big Galleta.
**Big Galleta *(Pleuraphis rigida)* Herbaceous Alliance**

This alliance is represented in the park by one association. It is characteristic of low flats adjacent to sandy playas, such as Pleasant Valley, and characterized by the presence of scattered shrubs of Four-wing Saltbush. Most common bunch grass occurring in the Park, generally occurs where it is too sandy for LATR.

> **166=Big Galleta -Four-wing *(Pleuraphis rigida - Atriplex canescens)* Grassland Association** 59010 (mapped at alliance level; includes associations: **Pleuraphis rigida/Hymenoclea salsola, *Pleuraphis rigida/Atriplex canescens, *Pleuraphis rigida/Lycium cooperi, *Pleuraphis rigida/Ephedra nevadensis)*

**Section II**
**II.** Stands dominated by annual grasses, locally in all cases, these species are nonnatives. Stands fluctuate, depending on annual variation in timing and amount of precipitation.
No perennial species (either shrubs or herbs) totaling greater than 10 percent absolute cover.
**Annual Grasslands**

**IIA.** Vegetation dominated by Cheatgrass (*Bromus tectorum*). Occasional in postburn situations, mostly at mid and upper elevations and associated with former stands of *Yucca brevifolia, Pinus monophylla, Coleogyne ramosissima,* and *Juniperus californica* alliances.
**167=Cheatgrass (*Bromus tectorum*) Annual Herbaceous Alliance** 60001

**<u>Unmapped Alliances and Assocations</u>**

**a. Joshua Tree/Desert Almond *(Yucca brevifolia/Prunus fasciculata)* Wooded Shrubland Association**
**b. Blue Palo Verde/Desert Willow (*Cercidium floridum/Chilopsis linearis)* Association**
**c. Blue Palo Verde-Desert Ironwood *(Cercidium floridum* = *Parkinsonia florida* *- Olneya tesota*) Woodland Alliance**
**d. Narrow-Leaf Willow (*Salix exigua*) Deciduous Shrubland Alliance**
**e. False Willow (*Baccharis sergiloides*) Intermittently Flooded Shrubland Alliance**
**f. Creosote Bush - Burro Bush - White Rhatany (*Larrea tridentata - Ambrosia dumosa - Krameria grayi)* Shrubland Association**
**g. Creosote Bush-Burro Bush-Brittlebush Shrubland Association**
**h. Tamarisk *(Tamarix* spp.*)* Seminatural Flooded Shrubland Alliance**
**i. Mojave Yucca - Creosote Bush – (Jojoba) *[Yucca schidigera - Larrea tridentata (- (Simmondsia chinensis))]* Shrubland Association**
**j. Andersons Desert Thorn**
**k. Desert False Willow *(Baccharis sergiloides)* Intermittently Flooded Shrubland Alliance**
**l. Paniculate Rabbitbrush *(Ericameria paniculata)* Intermittently Flooded Shrubland**
**m. Alliance Spiny Hop-Sage *(Grayia spinosa)* Shrubland Alliance**
**n. Parry Beargrass *Nolina parryi* Shrubland Alliance**

**o. Antelope Bush *(Purshia tridentata)* Shrubland Alliance**
**p. Bigberry Manzanita (*Arctostaphylos glauca*) Shrubland Alliance**
**q. Lotebush (*Ziziphus obtusifolia)* Unique Stands (one plot)**
**r. Desert Needlegrass *(Achnatherum speciosum)* Herbaceous Alliance**
**s. Cheatgrass (Bromus tectorum) Annual Herbaceous Alliance**
**t. Red Brome (*Bromus madritensis* ssp. *rubens*) Annual Herbaceous Alliance**

The following mapping unit was deleted because even though it has been mapped, there is no way to distinguish it from the associations that make up this Super Association.

> **IB.3.d.** Open to sparse stand of JUNCAL ranging from 1 - 15% absolute cover over a shrub and succulent cover of CORA, and/ or YUSC, and/or TEHA.
> This Super Association combines types 10021**(*Juniperus californica / Coleogyne ramosissima – Yucca schidigera)* Woodland Association**, 10025*(**Juniperus californica / Coleogyne ramosissima)* Woodland Association** , and 10031**(*Juniperus californica / Yucca schidigera – (Tetracoccus hallii)*) Woodland Association**
>
> **106=California Juniper/ Blackbush- Mojave Yucca (*Juniperus californica / (Coleogyne ramosissima – Yucca schidigera))* Super Association.** 10033

PROTOCOL FOR COMBINED
VEGETATION RELEVÉ AND RAPID ASSESSMENT SAMPLING FORM
(April, 29 2009)

## Introduction

This protocol describes the methodology for both the relevé and rapid assessment vegetation sampling techniques as recorded in the combined relevé and rapid assessment field survey form dated June 17, 2008. The same environmental data are collected for both techniques. However, the relevé sample is plot-based, with each species in the plot and its cover being recorded. The rapid assessment sample is based not on a plot but on the entire stand, with 12-20 of the dominant or characteristic species and their cover values recorded. For more background on the relevé and rapid assessment sampling methods, see the relevé and rapid assessment protocols at www.cnps.org.

## Selecting stands to sample:

To start either the relevé or rapid assessment method, a stand of vegetation needs to be defined. A stand is the basic physical unit of vegetation in a landscape. It has no set size. Some vegetation stands are very small, such as alpine meadow or tundra types, and some may be several square kilometers in size, such as desert or forest types. A stand is defined by two main unifying characteristics:

1) It has compositional integrity. Throughout the site, the combination of species is similar. The stand is differentiated from adjacent stands by a discernable boundary that may be abrupt or indistinct.
2) It has structural integrity. It has a similar history or environmental setting that affords relatively similar horizontal and vertical spacing of plant species. For example, a hillside forest originally dominated by the same species that burned on the upper part of the slopes, but not the lower, would be divided into two stands. Likewise, sparse woodland occupying a slope with very shallow rocky soils would be considered a different stand from an adjacent slope with deeper, moister soil and a denser woodland or forest of the same species.

The structural and compositional features of a stand are often combined into a term called homogeneity. For an area of vegetated ground to meet the requirements of a stand, it must be homogeneous (uniform in structure and composition throughout).

Stands to be sampled may be selected by evaluation prior to a site visit (*e.g.,* delineated from aerial photos or satellite images), or they may be selected on site during reconnaissance to determine extent and boundaries, location of other similar stands, etc..

Depending on the project goals, you may want to select just one or a few representative stands of each homogeneous vegetation type for sampling (*e.g.,* for developing a classification for a vegetation mapping project), or you may want to sample all of them (*e.g.,* to define a rare vegetation type and/or compare site quality between the few remaining stands).

*For the rapid assessment method, you will collect data based on the entire stand.*

**Selecting a plot to sample within in a stand (for relevés only):**

Because many stands are large, it may be difficult to summarize the species composition, cover, and structure of an entire stand. We are also usually trying to capture the most information with the least amount of effort. Thus, we are typically forced to select a representative portion to sample.

When sampling a vegetation stand, the main point to remember is to select a sample that, in as many ways possible, is representative of that stand. This means that you are not randomly selecting a plot; on the contrary, you are actively using your own best judgment to find a representative example of the stand.

Selecting a plot requires that you see enough of the stand you are sampling to feel comfortable in choosing a representative plot location. Take a brief walk through the stand and look for variations in species composition and in stand structure. In many cases in hilly or mountainous terrain look for a vantage point from which you can get a representative view of the whole stand. Variations in vegetation that are repeated throughout the stand should be included in your plot. Once you assess the variation within the stand, attempt to find an area that captures the stand's common species composition and structural condition to sample.

***Plot Size***

All relevés of the same type of vegetation to be analyzed in a study need to be the same size. Plot shape and size are somewhat dependent on the type of vegetation under study. Therefore, general guidelines for plot sizes of tree-, shrub-, and herbaceous communities have been established. Sufficient work has been done in temperate vegetation to be confident the following conventions will capture species richness:

Herbaceous communities: 100 sq. m plot
Shrublands: 400 sq. m plot
Forest and woodland communities: 1000 sq. m plot

***Plot Shape***

A relevé has no fixed shape, though plot shape should reflect the character of the stand. If the stand is about the same size as a relevé, you need to sample the entire stand. If we are sampling streamside riparian or other linear communities, our plot dimensions should not go beyond the community's natural ecological boundaries. Thus, a relatively long, narrow plot capturing the vegetation within the stand, but not outside it would be appropriate. Species present along the edges of the plot that are clearly part of the adjacent stand should be excluded.

If we are sampling broad homogeneous stands, we would most likely choose a shape such as a circle (which has the advantage of the edges being equidistant to the center point) or a square (which can be quickly laid out using perpendicular tapes).

**Definitions of fields in the protocol**

**Relevé or Rapid Assessment** (Circle One).

**LOCATIONAL/ENVIRONMENTAL DESCRIPTION**

**Polygon/Stand #:** Number assigned either in the field or in the office prior to sampling. It is usually denoted with a four-letter abbreviation of the sampling location and then a four-number sequential number of that locale (*e.g.* CARR0001 for Carrizo sample #1). The maximum number of letters/numbers is eight.

**Air photo #:** Leave blank for this project

**Date:** Date of the sampling.

**Name(s) of surveyors:** The full names of each person assisting should be provided for the first field form for the day. On successive forms, initials of each person assisting can be recorded. Please note: The person recording the data on the form should circle their name/initials.

**GPS waypoint #:** The waypoint number assigned by a Global Positioning System (GPS) unit when marking and storing a waypoint for the sample location. Stored points should be downloaded in the office to serve as a check on the written points and to enter into a GIS.

*For relevé plots, take the waypoint in the southwest corner of the plot or in the center of a circular plot.*

**GPS name:** The name/number assigned to each GPS unit. This can be the serial number if another number is not assigned.

**Datum: (NAD 83)** The default GPS datum for this project is NAD 83. If you are using another datum for some reason, denote it here.

**Bearing, left axis at SW pt (note in degrees) of Long or Short side:** For square or rectangular plots: from the SW corner (=GPS point location), looking towards the plot, record the bearing of the axis to your left. If the plot is a rectangle, indicate whether the left side of the plot is the long or short side of the rectangle by circling "long" or "short" side (no need to circle anything for circular or square plots). If there are no stand constraints, W/E should run along the short side while N/S should run along the long side of the rectangle.

**UTM coordinates:** Easting (UTME) and northing (UTMN) location coordinates using the Universal Transverse Mercator (UTM) grid. Record using a GPS unit.

**UTM zone:** Universal Transverse Mercator zone. Zone 10 is for California west of the 120$^{th}$ longitude, zone 11 is for California east of 120$^{th}$ longitude

**Error: ±** The accuracy of the GPS location, when taking the UTM field reading. Please denote feet (ft) or meters (m). If your GPS does not determine error, insert N/A in this field.

**Is GPS within stand? Yes / No** Circle"Yes" to denote that the GPS waypoint was taken directly within or at the edge of the stand being assessed for a rapid assessment, or circle "No" to

denoted the waypoint was taken at a distance from the stand (such as with a binocular view of the stand).
**If No, cite from waypoint to stand, distance (note in meters) & bearing ( note in degrees):** An estimate of the number of feet or meters (please circle appropriate), the compass bearing from the waypoint of GPS to the stand.

**Elevation:** Recorded from the GPS unit or USGS topographic map. Please denote feet (ft) or meters (m).

**Photograph #s:** Write the name or initials of the camera owner, JPG/frame number, and direction of photos (note the roll number if using film). *Take four photos in the main cardinal directions (N, E, S, W) clockwise from the north, from the GPS location.* If additional photos are taken in other directions, please note this information on the form.

**Stand Size:** Estimate the size of the entire stand in which the sample is taken. As a measure, one acre is about 4000 square meters, or 208 feet by 208 feet.

**Plot Size:** If this is a relevé, circle the size of the plot.

**Plot Shape:** Denote the length and width of the plot and include measurement units (i.e., ft or m). If it is a circular plot, enter radius (or just check).

**Exposure:** (Enter actual º and circle general category): Read degree slope from compass (or estimate), using degrees from north, adjusted for declination. Average the reading over entire stand, even if you are sampling a relevé plot, since your plot is representative of the stand. "Variable" may be selected if the same, homogenous stand of vegetation occurs across a varied range of slope exposures. Select "all" if stand is on top of a knoll that slopes in all directions or if the same, homogenous stand of vegetation occurs across all ranges of slope.

**Steepness:** (Enter actual º and circle general category): Read degree aspect from a compass or clinometer (or estimate). Make sure to average the reading across entire stand even if you are sampling in a relevé plot.

**Topography:** First assess the broad (macro) topographic feature or general position of the stand in the surrounding watershed, that is, the stand is at the bottom, lower (1/3 of slope), middle (1/3 of slope), upper (1/3 of slope), or at the top. Circle all of the positions that apply. Then, assess the local (micro) topographic features or the lay of the area (*e.g.,* surface is flat or concave). Circle only one of the microtopographic descriptors.

**Geology:** Geological parent material of site. If exact type is unknown, use a more general category (*e.g.,* igneous, metamorphic, sedimentary). *See code list for types.*

**Soil Texture:** Record soil texture that is characteristic of the site (*e.g.,* coarse loamy sand, sandy clay loam). *See soil texture key and code list for types.*

**Upland or Wetland/Riparian** (circle one): Indicate if the stand is in an upland or a wetland. Note that a site need not be officially delineated as a wetland to qualify as such in this context (*e.g.,* seasonally wet meadow).

**% Surface cover (abiotic substrates).** It is helpful to imagine "mowing off" all of the live vegetation at the base of the plants and removing it – you will be estimating what is left covering

the surface. **The total should sum to 100%.** Note that non-vascular cover (lichens, mosses, cryptobiotic crusts) is not estimated in this section.

**% Water**: Estimate the percent surface cover of running or standing water, ignoring the substrate below the water.

**% BA Stems**: Percent surface cover of the plant basal area, *i.e.*, the basal area of stems at the ground surface. Note that for most vegetation types BA is 1-3% cover.

**% Litter**: Percent surface cover of litter, duff, or wood on the ground.

**% Bedrock**: Percent surface cover of bedrock.

**% Boulders:** Percent surface cover of rocks > 60 cm in diameter.

**% Stone:** Percent surface cover of rocks 25-60 cm in diameter.

**% Cobble:** Percent surface cover of rocks 7.5 to 25 cm in diameter.

**% Gravel:** Percent surface cover of rocks 2 mm to 7.5 cm in diameter.

**% Fines:** Percent surface cover of bare ground and fine sediment (e.g. dirt) < 2 mm in diameter.

**% Current year bioturbation:** Estimate the percent of the sample or stand exhibiting soil disturbance by fossorial organisms (any organism that lives underground). Do not include disturbance by ungulates. Note that this is a separate estimation from surface cover.

**Past bioturbation present?** Circle "Y"(yes) if there is evidence of bioturbation from previous years.

**% Hoof punch:** Note the percent of the sample or stand surface that has been punched down by hooves (cattle or native grazers) in wet soil.

**Site history, stand age, and comments**: Briefly describe the stand age/seral stage, disturbance history, nature and extent of land use, and other site environmental and vegetation factors. Examples of disturbance history: fire, landslides, avalanching, drought, flood, animal burrowing, or pest outbreak. Also, try to estimate year or frequency of disturbance. Examples of land use: grazing, timber harvest, or mining. Examples of other site factors: exposed rocks, soil with fine-textured sediments, high litter/duff build-up, multi-storied vegetation structure, or other stand dynamics.

**Type / level of disturbance** (use codes): List codes for potential or existing impacts on the stability of the plant community. Characterize each impact each as L (=Light), M (=Moderate), or H (=Heavy). For invasive exotics, divide the total exotic cover (e.g. 25% Bromus diandrus + 8% Bromus madritensis + 5% Centaurea melitensis = 38% total exotics) by the total % cover of all the layers went added up (e.g. 15% tree + 5% low tree + 25% shrub + 40% herbs = 85% total) and multiply by 100 to get the % relative cover of exotics (e.g. 38% total exotics/85% total cover = 45% relative exotic cover). L = 0-33% *relative* cover of exotics; M =34-66% relative cover, and H = > 66% relative cover. *See code list for impacts.*

## II. HABITAT AND VEGETATION DESCRIPTION *per California Wildlife-Habitat Relationships (CWHR)*

For CWHR, identify the size/height class of the stand using the following tree, shrub, and/or herbaceous categories. These categories are based on functional life forms.

**Tree DBH:** Record tree size classes when the tree canopy closure exceeds 10 percent of the total cover (except in desert types), or if young tree density indicates imminent tree dominance. Size class is based on the average diameter at breast height (dbh) of each trunk (standard breast height is 4.5ft/137cm). You can record tree size class by circling the main size class(es), When

marking the main size class, make sure to estimate the mean diameter of all trees over the entire stand, and weight the mean if there are some larger tree dbh's. The "**T6 multi-layered**" dbh size class contains a multi-layered tree canopy (with a size class T3 and/or T4 layer growing under a T5 layer and a distinct height separation between the classes) exceeding 60% total cover. Stands in the T6 class need also to contain at least 10% cover of size class 5 (>24" dbh) trees growing over a distinct layer with at least 10% combined cover of trees in size classes 3 or 4 (>11-24" dbh).

**Shrub** (mark one)**:** Record shrub size classes when shrub canopy closure exceeds 10 percent (except in desert types). You can record shrub size class by circling the class that is predominant in the survey. Shrub size class is based on the average amount of crown decadence (dead standing vegetation on live shrubs when looking across the crowns of the shrubs).

**Herb** (mark one)**:** Record herb height when herbaceous cover exceeds 2 percent. You can record herb class by the size class that is predominant in the survey (**H1 or H2**). *This height class is based on the average plant height at maturity.*

***Overall cover of vegetation***

Provide an estimate of cover for the following categories below (based on functional life forms). Record a specific number for the total aerial cover or "bird's-eye view" looking from above for each category, estimating cover for the living plants only. Litter/duff should not be included in these estimates. The porosity of the vegetation should be taken into consideration when estimating percent cover (how much of the sky can you see when you are standing under the canopy of a tree, or how much light passes through the canopy of the shrub layer?).

To come up with a specific number estimate for percent cover, first use to the following CWHR cover intervals as a reference aid to get a generalized cover estimate: <2%, 2-9%, 10-24%, 25-39%, 40-59%, 60-100%. While keeping these intervals in mind, you can then refine your estimate to a specific percentage for each category below.

**% Total Non-Vasc cover:** The total cover of all lichens and bryophytes (mosses, liverworts, hornworts) on substrate surfaces including downed logs, rocks and soil, but not on standing or inclined trees.

**% Total Vasc Veg cover:** The total cover of all vascular vegetation taking into consideration the porosity, or the holes, in the vegetation. This is an estimate of the absolute vegetation cover, disregarding overlap of the various tree, shrub, and/or herbaceous layers and species.

**%Overstory Conifer/Hardwood Tree:** The total foliar cover (considering porosity) of all live tree species (>5 m tall) that are specifically in the overstory or are emerging, disregarding overlap of individual trees. Estimate conifer and hardwood covers separately. Please note: These cover values should not include the coverage of recruits of overstory tree species (the only place that seedlings and saplings should be considered is in the species list in the "U" stratum category).

**%Low-Medium Tree:** The total foliar cover (considering porosity) of all live understory low to medium height tree species, disregarding overlap of individual trees and shrubs. This category only includes tree species that typically do not make up the overstory canopy. Please note: These cover values should not include the coverage of recruits of overstory tree species (the only place that seedlings and saplings should be considered is in the species list in the "U" stratum category).

**%Shrub:** The total foliar cover (considering porosity) of all live shrub species disregarding overlap of individual shrubs.

**%Herbaceous:** The total cover (considering porosity) of all herbaceous species, disregarding overlap of individual herbs.

**Modal height for conifer/hardwood tree, shrub, and herbaceous categories**: Provide an estimate of height for each category listed. Record an average height value per each category by estimating the mean height for each group. Please use the following height intervals to record a height class: 01=<1/2m, 02=1/2-1m, 03=1-2m, 04=2-5m, 05=5-10m, 06=10-15m, 07=15-20m, 08=20-35m, 09=35-50m, 10=>50m.

***Species list and coverage***

**For rapid assessments,** list the 10-20 species that are dominant or that are characteristically consistent throughout the stand. These species may or may not be abundant, but they should be constant representatives in the survey. When different layers of vegetation occur in the stand, make sure to list species from each stratum. As a general guide, make sure to list at least 1-2 of the most abundant species per stratum.

**For relevés, list all species present in the plot, using the second species list page if necessary.**

For both sample types, provide the stratum where:
**T= Overstory tree.** A woody perennial plant that has a single trunk.
**U= Understory tree**. Trees species that grow under the overstory trees. Note: this also includes seedlings and saplings of trees that may be in the overstory.
**S = Shrub.** A perennial, woody plant that is multi-branched and doesn't die back to the ground every year.
**H= Herb.** An annual or perennial that dies down to ground level every year.
**N= Non-vascular**. Includes mosses, liverworts, hornworts, and algae.

Be consistent and don't break up a single species into two separate strata. The only time it would be appropriate to do so is when you have a tree that is in the overstory (T) and it is also recruiting in the understory (U). Here is a list of a few species that can be ambiguous:

*Juniperus californicus* = Understory tree (U)
*Quercus wislizeni* = If it is regenerating after a fire or disturbance call it an understory tree (U). Otherwise call it a Tree (T).
*Sambucus nigra* subsp. *Canadensis* = Shrub (S)
*Aesculus californica* = Understory tree (U)
*Phoradendron* spp. = Shrub (S)

If a species collection is made, it should be indicated in the collection column with a "C" (for collected). If the species is later keyed out, the data sheet needs to be updated with the proper species name. If the specimen is then thrown out, the "C" in the collection column should be erased. If the specimen is kept but is still not confidently identified, add a "U" to the "C" in the collection column (CU = collected and unconfirmed). In this case the unconfirmed species epithet should be put in parentheses [e.g *Hordeum (murinum)*]. If the specimen is kept and is confidently identified, add a "C" to the existing "C" in the collection column (CC = Collected and confirmed).

Use Jepson Manual nomenclature.

Provide the % absolute aerial cover for each species listed. When estimating, it is often helpful to think of coverage in terms of the following cover intervals at first:

<1%, 1-5%, >5-15%, >15-25%, >25-50%, >50-75%, >75%.

Keeping these classes in mind, then refine your estimate to a specific percentage. All species percent covers may total over 100% because of overlap.

For rapid assessments, make sure that the major non-native species occurring in the stand also are listed in the space provided in the species list with their strata and % cover. For relevés, all non-native species should be included in the species list.

**Unusual species:** List species that are locally or regionally rare, endangered, or atypical (*e.g.,* range extension or range limit) within the stand. This species list will be useful to the Program for obtaining data on regionally or locally significant populations of plants.

Include the percent cover of snags (standing dead) of trees and shrubs. Note their species, if known, in the "Stand history, stand age and comments" section.

**INTERPRETATION OF STAND**

**Field-assessed vegetation alliance name:** Name of alliance or habitat following the CNPS classification system (Sawyer and Keeler-Wolf 1995). Please use scientific nomenclature, *e.g., Quercus agrifolia* forest. An alliance is based on the dominant or diagnostic species of the stand, and is usually of the uppermost and/or dominant height stratum. A dominant species covers the greatest area. A diagnostic species is consistently found in some vegetation types but not others.

Please note: The field-assessed alliance name may not exist in present classification, in which case you can provide a new alliance name in this field. If this is the case, also make sure to state that it is not in the MCV under the explanation for "Confidence in alliance identification."

**Field-assessed association name** (optional): Name of the species in the alliance and additional dominant/diagnostic species from any strata, as according to CNPS classification. In following naming conventions, species in differing strata are separated with a slash, and species in the uppermost stratum are listed first (*e.g., Quercus douglasii/Toxicodendron diversilobum*). Species in the same stratum are separated with a dash (*e.g., Quercus lobata-Quercus douglasii)*.

Please note: The field-assessed association name may not exist in present classification, in which you can provide a new association name in this field.

**Adjacent Alliances:** Identify other vegetation types that are directly adjacent to the stand being assessed by noting the dominant species (or known type). Also note the distance away in meters from the GPS waypoint and the direction in degrees aspect that the adjacent alliance is found (e.g., *Amsinckia tessellata* 50m, 360°/N *Eriogonum fasciculatum* 100m, 110° ).

**Confidence in Identification: (L, M, H)** With respect to the "field-assessed alliance name", note whether you have L (=Low), M (=Moderate), or H (=High) confidence in the interpretation of this alliance name.

**Explain:** Please elaborate if your "Confidence in Identification" is low or moderate. Low confidence can occur from such things as a poor view of the stand, an unusual mix of species that does not meet the criteria of any described alliance, or a low confidence in your ability to identify species that are significant members of the stand.

**Phenology:** Indicate early (E), peak (P) or late (L) phenology for each of the strata.

**Other identification problems or mapping issues:** Discuss any further problems with the identification of the assessment or issues that may be of interest to mappers. Note if this sample represents a type that is likely too small to map, and if so, how much of the likely mapping unit would be comprised of this type. For example: "this sample represents the top of kangaroo rat precincts in this general area, which are surrounded by vegetation represented by CARR000x; this type makes up 10% of the mapping unit."

# CALIFORNIA NATIVE PLANT SOCIETY FIELD FORM CODE LIST (revised 3/0107)

## MACRO TOPOGRAPHY

00 Bench
01 Ridge top (interfluve)
02 Upper 1/3 of slope
03 Middle 1/3 of slope
04 Lower 1/3 of slope (lowslope)
05 Toeslope (alluvial fan/bajada)
06 Bottom/plain
07 Basin/wetland
08 Draw
09 Other
10 Terrace (former shoreline or floodplain)
11 Entire slope
12 Wash (channel bed)
13 Badland (complex of draws & interfluves)
14 Mesa/plateau
15 Dune/sandfield
16 Pediment
17 Backslope (cliff)

## MICRO TOPOGRAPHY

01 Convex or rounded
02 Linear or even
03 Concave or depression
04 Undulating pattern
05 Hummock or Swale pattern
06 Mounded
07 Other

## SITE IMPACTS

01 Development
02 ORV activity
03 Agriculture
04 Grazing
05 Competition from exotics
06 Logging
07 Insufficient population/stand size
08 Altered flood/tidal regime
09 Mining
10 Hybridization
11 Groundwater pumping
12 Dam/inundation
13 Other
14 Surface water diversion
15 Road/trail construction/maint.
16 Biocides
17 Pollution
18 Unknown
19 Vandalism/dumping/litter
20 Foot traffic/trampling
21 Improper burning regime
22 Over collecting/poaching
23 Erosion/runoff
24 Altered thermal regime
25 Landfill
26 Degrading water quality
27 Wood cutting
28 Military operations
29 Recreational use (non ORV)
30 Nest parasitism
31 Non-native predators
32 Rip-rap, bank protection
33 Channelization (human caused)
34 Feral pigs
35 Burros
36 Rills
37 Phytogenic mounding
38 Sudden oak death syndrome (SODS)

## PARENT MATERIAL

| | |
|---|---|
| **IGTU** | **Igneous (type unknown)** |
| MIIG | Mixed igneous |
| ULTU | Ultramafic (type unknown) |
| VOLC | General igneous extrusives |
| ANDE | Andesite |
| ASHT | Ash (of any origin) |
| BASA | Basalt |
| DIAB | Diabase |
| OBSI | Obsidian |
| PUMI | Pumice |
| PYFL | Pyroclastic flow |
| RHYO | Rhyolite |
| VOFL | Volcanic flow |
| VOMU | Volcanic mud |
| INTR | General igneous intrusives |
| DIOR | Diorite |
| GABB | Gabbro |
| GRAN | Granitic (generic) |
| MONZ | Monzonite |
| PERI | Peridotite |
| QUDI | Quartz diorite |
| **METU** | **Metamorphic (type unknown)** |
| MIME | Mixed metamorphic |
| GREE | Greenstone |
| BLUE | Blue schist |
| FRME | Franciscan melange |
| GNBG | Gneiss/biotite gneiss |
| HORN | Hornfels |
| MARB | Marble |
| PHYL | Phyllite |
| SCHI | Schist |
| SESC | Semi-schist |
| SLAT | Slate |
| **ULTU** | **Ultramafic (type unknown)** |
| SERP | Serpentine |
| **SETU** | **Sedimentary (type unknown)** |
| BREC | Breccia (non-volcanic) |
| CACO | Calcareous conglomerate |
| CALU | Calcareous (origin unknown) |
| CASA | Calcareous sandstone |
| CASH | Calcareous shale |
| CASI | Calcareous siltstone |
| CHER | Chert |
| CONG | Conglomerate |
| DOLO | Dolomite |
| FANG | Fanglomerate |
| LIME | Limestone |
| MISE | Mixed sedimentary |
| SAND | Sandstone |
| SHAL | Shale |
| SILT | Siltstone |
| CLAL | Clayey alluvium |
| DUNE | Sand dunes |
| GLTI | Glacial till, mixed origin, moraine |
| GRAL | Gravelly alluvium |
| LALA | Large landslide (unconsolidated) |
| LOSS | Loess |
| MIAL | Mixed alluvium |
| SAAL | Sandy alluvium |
| SIAL | Silty alluvium |
| MIRT | Mix of two or more rock types |
| OTHE | Other than on list |

## SOIL TEXTURE

| | |
|---|---|
| COSA | Coarse sand |
| MESN | Medium sand |
| FISN | Fine sand |
| COLS | Coarse, loamy sand |
| MELS | Medium to very fine, loamy sand |
| MCSL | Moderately coarse, sandy loam |
| MESA | Medium to very fine, sandy loam |
| MELO | Medium loam |
| MESL | Medium silt loam |
| MESI | Medium silt |
| MFCL | Moderately fine clay loam |
| MFSA | Moderately fine sandy clay loam |
| MFSL | Moderately fine silty clay loam |
| FISA | Fine sandy clay |
| FISC | Fine silty clay |
| FICL | Fine clay |
| SAND | Sand (class unknown) |
| LOAM | Loam (class unknown) |
| CLAY | Clay (class unknown) |
| UNKN | Unknown |
| PEAT | Peat |
| MUCK | Muck |

## DOMINANT VEGETATION GROUP

***Trees:***

| | |
|---|---|
| TBSE | Temperate broad-leaved seasonal evergreen forest |
| TNLE | Temperate or subpolar needle-leafed evergreen forest |
| CDF | Cold-deciduous forest |
| MNDF | Mixed needle-leafed evergreen-cold deciduous. forest |
| TBEW | Temperate broad-leaved evergreen woodland |
| TNEW | Temperate or subpolar needle-leaved evergreen woodland |
| EXEW | Extremely xeromorphic evergreen woodland |
| CDW | Cold-deciduous woodland |
| EXDW | Extremely xeromorphic deciduous woodland |
| MBED | Mixed broad-leaved evergreen-cold deciduous woodland |
| MNDW | Mixed needle-leafed evergreen-cold deciduous woodland |

***Shrubs:***

| | |
|---|---|
| TBES | Temperate broad-leaved evergreen shrubland |
| NLES | Needle-leafed evergreen shrubland |
| MIES | Microphyllus evergreen shrubland |
| EXDS | Extremely xeromorphic deciduous shrubland |
| CDS | Cold-deciduous shrubland |
| MEDS | Mixed evergreen-deciduous shrubland |
| XMED | Extremely xeromorphic mixed evergreen-deciduous shrubland |

***Dwarf Shrubland:***

| | |
|---|---|
| NMED | Needle-leafed or microphyllous evergreen dwarf shrubland |
| XEDS | Extremely xeromorphic evergreen dwarf shrubland |
| DDDS | Drought-deciduous dwarf shrubland |
| MEDD | Mixed evergreen cold-deciduous dwarf shrubland |

***Herbaceous:***

| | |
|---|---|
| TSPG | Temperate or subpolar grassland |
| TGST | Temperate or subpolar grassland with sparse tree |
| TGSS | Temperate or subpolar grassland with sparse shrublayer |
| TGSD | Temperate or subpolar grassland with sparse dwarf shrub layer |
| TFV | Temperate or subpolar forb vegetation |
| THRV | Temperate or subpolar hydromorphic rooted vegetation |
| TAGF | Temperate or subpolar annual grassland or forb vegetation |

***Sparse Vegetation*:**

| | |
|---|---|
| SVSD | Sparsely vegetated sand dunes |
| SVCS | Sparsely vegetated consolidated substrates |

**Simplified Key to Soil Texture**
(Adapted from Brewer and McCann 1982)

Place about three teaspoons of soil in the palm of your hand. Take out any particles ≥ 3 mm in size.

**A.** Does soil remain in ball when squeezed in your hand palm?

Yes, soil does remain in a ball when squeezed..... **B**

No, soil does not remain in a ball when squeezed..... **sand**

SAND Sand (class unknown)
Very coarse texture……COSA Coarse sand
Moderately coarse texture……MESN Medium sand
Moderately fine texture…….. FISN Fine sand

**B.** Add a small amount of water until the soil feels like putty. Squeeze the ball between your thumb and forefinger, attempting to make a ribbon that you push up over your finger. Does soil make a ribbon?

Yes, soil makes a ribbon; though it may be very short.....**C**

No, soil does not make a ribbon.....**loamy sand**
Very gritty with coarse particles…..COLS Coarse, loamy sand
Moderately to slightly gritty with medium to fine particles.....MELS Medium to very fine, loamy sand

**C.** Does ribbon extends more than one inch?

Yes, soil extends > 1 inch.....**D**

No, soil does not extend > 1 inch.....Add excess water

Soil feels gritty……..……..…..**loam or sandy loam**
LOAM Loam (class unknown)
Very gritty with coarse particles…..MCSL Moderately coarse, sandy loam
Moderately gritty with medium to fine particles.....MESA Medium to very fine, sandy loam
Slightly gritty .....MELO Medium loam

Soil feels smooth.....**silt loam**
MESIL medium silt loam

**D.** Does soil extend more than 2 inches?

Yes, ribbon extends more than 2 inches, and does not crack if bent into a ring.....**E**

No, soil breaks when 1–2 inches long; cracks if bent into a ring……...Add excess water

Soil feels gritty…..**sandy clay loam or clay loam**
Very gritty……...MFSA Moderately fine sandy clay loam
Slightly gritty……MFCL Moderately fine clay loam

Soil feels smooth.....**silty clay loam or silt**
Moderately fine texture……...MFSL Moderately fine silty clay loam
Very fine texture…….. MESI Medium silt

**E.** Soil makes a ribbon 2+ inches long; does not crack when bent into a ring.....Add excess water

Soil feels gritty.....**sandy clay or clay**
CLAY Clay (class unknown)
Very gritty…… FISA Fine sandy clay
Slightly gritty…….. FICL Fine clay

Soil feels smooth.....**silty clay**
FISC Fine silty clay

UNKN = UNKNOWN PEAT = PEAT MUCK = MUCK

# Combined rapid assessment and releve field form

**Relevé or Rapid Assessment** (Circle One) (Revised June 17, 2008)

| For Office Use: | Final database #: | Final vegetation type name: | Alliance_____ Association |
|---|---|---|---|

## I. LOCATIONAL/ENVIRONMENTAL DESCRIPTION

| Polygon/Stand #: | Air photo: | Date: | Name(s) of surveyors (circle recorder): |
|---|---|---|---|
| | | | |

**GPS wypt #:** _____ **GPS name:** _____ **Datum:** _____ **or NAD83. Bearing, left axis at SW pt**_____ **(degrees) of Long / Short side**

**UTME** ___ ___ ___ ___ ___ ___ **UTMN** ___ ___ ___ ___ ___ ___ ___ **Zone: 10 / 11** (circle one) **PDOP**_____

**GPS within stand? Yes / No If No, cite from waypoint to stand, distance** _____**(meters) & bearing** _____**(degrees)**

**Elevation**: **ft / m Camera/Photograph #'s**:

**Stand Size (acres): <1, 1-5, >5 | Plot Size ($m^2$): 10 / 100 / 400 / 1000 | Plot Shape** ___ **x**___ **ft / m or Circle Radius**____**ft / m**

**Exposure, Actual °:** _____ **NE NW SE SW Flat Variable /All | Steepness, Actual °:** _____ **0° 1-5° 5-25° > 25°**

**Topography: Macro: top upper mid lower bottom | Micro: convex flat concave undulating**

**Geology code:** _____ **Soil Texture code:** _____ **| Upland** or **Wetland/Riparian** (circle one)

**% Surface cover**

**H20:**____ **BA Stems:**____ **Litter:** ____ **Bedrock:**____ **Boulder:**____ **Stone:**____ **Cobble:** _____ **Gravel:**____ **Fines:**_____ **=100%**
(Incl. outcrops) (>60cm diam) (25-60cm) (7.5-25cm) (2mm-7.5cm) (Incl sand, mud)

**% Current year bioturbation** _____ **Past bioturbation present? Y / N | % Hoof punch** _____

**Site history, stand age, comments:**

**Type/ Level of disturbance codes:** _____/____ _____/____ _____/____ _____/____ _____/____ **"Other"**

## II. HABITAT AND VEGETATION DESCRIPTION

**Tree DBH : T1** (<1" dbh), **T2** (1-6" dbh), **T3** (6-11" dbh), **T4** (11-24" dbh), **T5** (>24" dbh), **T6** multi-layered (T3 or T4 layer under T5, >60% cover)

**Shrub: S1** seedling (<3 yr. old), **S2** young (<1% dead), **S3** mature (1-25% dead), **S4** decadent (>25% dead)

**Herbaceous: H1** (<12" plant ht.), **H2** (>12" ht.) **% Non-Vasc cover:** _____ **Total % Vasc Veg cover:**_____

**% Cover -Overstory Tree Conifer/Hardwood:** _____/_____ **Low-Medium Tree:** _____ **Shrub:** _____ **Herbaceous:** _____

**Height Class - Overstory Conifer/Hardwood:** _____/_____ **Low-Medium Tree:** _____ **Shrub:** _____ **Herbaceous:** _____

*Height classes:* 01=<1/2m 02=1/2-1m 03=1-2m 04=2-5m 05=5-10m 06=10-15m 07=15-20m 08=20-35m 09=35-50m 10=>50m

**Species, Stratum, and % cover. Stratum categories:** T= Overstory tree, U= Understory Tree, S = Shrub, H= Herb, N= Non-vascular.
*% cover intervals for reference*: <1%, 1-5%, >5-15%, >15-25%, >25-50%, >50-75%, 75%.

| Strata | Species | % cover | Strata | Species | % cover |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

**Unusual species:** _____

## III. INTERPRETATION OF STAND

**Field-assessed vegetation alliance name:** _____

**Field-assessed association name** (optional): _____

**Adjacent alliances:** _____

**Confidence in alliance identification: L M H Explain:** _____

**Phenology (E,P,L): Herb**____ **Shrub**____ **Tree**____ **Other identification or mapping information:**

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 156/120323, April 2013

**National Park Service**
**U.S. Department of the Interior**

**Natural Resource Stewardship and Science**

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