



Vegetation Mapping of Lake Mead National Recreation Area

Natural Resource Report NPS/MOJN/NRR—2016/1344





ON THIS PAGE

From the top, clockwise: *Larrea tridentata* – *Ambrosia dumosa* Bajada & Valley Desert Scrub Alliance in the foreground at Roger's Wash, overlooking the Overton Arm of Lake Mead; *Ephedra* spp. - *Leymus salinus* - *Eriogonum corymbosum* Badlands Sparse Vegetation Alliance along the Valley of Fire Highway; *Yucca schidigera* Shrubland Alliance in the Newberry Mountains. Photographs courtesy of Julie M. Evens and Kendra Sikes.

ON THE COVER

Backcountry at Lake Mead National Recreation Area (NPS Photo)
 Photograph by: Lake Mead Imagery

Vegetation Mapping of Lake Mead National Recreation Area

Natural Resource Report NPS/MOJN/NRR—2016/1344

David E. Salas¹, Joe Stevens², Julie Evens³, Dan Cogan⁴, Jaime S. Ratchford³, Daniel Hastings³

¹U.S. Bureau of Reclamation
Technical Service Center
Denver Federal Center
P.O. Box 25007
Bldg 67, 5th Floor
Mail Code D-86620
Denver, CO 80225

²Colorado Natural Heritage Program
1475 Campus Delivery
Colorado State University
Fort Collins, CO 80523

³California Native Plant Society
2707 K Street, Suite 1
Sacramento, CA 95816

⁴Cogan Technology, Inc.
21 Valley Rd.
Galena, IL 61036

December 2016

U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado

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.

The Natural Resource Report Series is used to disseminate comprehensive information and analysis about natural resources and related topics concerning lands managed by the National Park Service. The series supports the advancement of science, informed decision-making, and the achievement of the National Park Service mission. The series also provides a forum for presenting more lengthy results that may not be accepted by publications with page limitations.

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.

Views, statements, findings, conclusions, recommendations, and data in this report do not necessarily reflect views and policies of the National Park Service, U.S. Department of the Interior. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the U.S. Government.

This report is available in digital format from the Mojave Desert Network Inventory and Monitoring website (<http://science.nature.nps.gov/im/units/mojn/index.cfm>) and the Natural Resource Publications Management website (<http://www.nature.nps.gov/publications/nrpm/>). To receive this report in a format optimized for screen readers, please email irma@nps.gov.

Please cite this publication as:

Salas, D. E., J. Stevens, J. Evens, D. Cogan, J. S. Ratchford, and D. Hastings. 2016. Vegetation mapping of Lake Mead National Recreation Area. Natural Resource Report NPS/MOJN/NRR—2016/1344. National Park Service, Fort Collins, Colorado.

Contents

	Page
Figures.....	ix
Tables.....	xiii
Appendices.....	xv
Executive Summary	xvii
Acknowledgments.....	xxi
List of Abbreviations and Acronyms	xxiii
List of Contacts	xxv
Introduction.....	1
NPS Park Vegetation Mapping Program.....	1
Lake Mead National Recreation Area Vegetation Mapping Project.....	2
The National Vegetation Classification (NVC) and Standard (NVCS)	3
General Classification Standards and Procedures	7
General Procedural Steps	7
Planning and Scoping	9
Planning and Coordination.....	9
Scoping Meetings	11
Project ‘Kick-Off’ and Scoping Meeting:	11
Field Preparation Meetings:	12
Map Class Meeting:.....	12
Interim Status Meetings:.....	12
Accuracy Assessment Planning:.....	12
Episodic Planning Meetings:.....	12
Preliminary Data Collection and Review of Existing Information	12
Vegetation Studies.....	12
Digital Data	13
Previous Vegetation Maps.....	13
Other Digital Data	13
Imagery.....	13

Contents (continued)

	Page
Location and Setting	15
Physiographic Setting and Topography.....	16
Climate	16
Geology	16
Soils	17
Park Environment.....	19
Environmental History	19
Regional Setting	19
Classification of Plant Communities	21
Introduction	21
Methods	23
Review/Compilation of Datasets.....	23
Classification Analyses	27
Datasets used in Classification Analyses	28
Vegetation Mapping Classification	32
Results and Discussion of Classification Analyses.....	32
Vegetation Mapping.....	47
Methods	47
Map Classes.....	47
Field Reconnaissance	50
Image Processing / Interpretation.....	51
Image Sources	51
Ancillary Data Sets.....	51
Image Processing.....	52
General Processing Steps	52
Photo Interpretation	53
Map Validation	59
Methods	59

Contents (continued)

	Page
Results	59
Discussion	60
Vegetation Mapping - Results.....	67
Map Classes.....	67
Map class Descriptions.....	68
Woodlands.....	74
Pinyon Pine - (Utah Juniper) Woodland	74
Juniper Woodlands	77
Fan Palm Woodland	79
Palo Verde Woodlands	81
Joshua Tree Woodland	83
Riparian Woodlands	85
Sonoran Live Oak Scrub Woodland.....	88
Shrublands	90
Riparian Wash Scrub Shrublands.....	90
Mid-Elevation Mixed Desert Scrub.....	93
Mojave Yucca Shrub	97
Black Brush Shrubland.....	100
Semi-Desert Scrub Shrublands.....	103
Creosote Bush Shrubland	108
Semi-Desert Wash Woodland/Scrub.....	112
Saltbush Scrub Shrublands	117
Salt Basin Scrub Shrublands	119
Tamarisk Shrubland.....	121
Manzanita - Sonoran Scrub Oak Shrubland	124
Wooded Herbaceous.....	125
Mixed Marsh and Wetland Herbaceous Vegetation.....	125
Herbaceous	127

Contents (continued)

	Page
Grasslands (Native and Ruderal).....	127
Dune Vegetation.....	130
Colorado Plateau Hanging Garden Seep Group.....	133
Big Galleta Herbaceous Vegetation	135
Sparsely Vegetated.....	136
Bare Rock and Sparse Vegetation	136
Beach and Barren Sand Draw-down Area.....	140
Other Miscellaneous.....	143
Agricultural Lands.....	143
Urban or Developed Area.....	143
Transportation / Roads / Trails	143
Open Water.....	143
Mixed Ornamental & Semi-Natural Woodland.....	143
Geodatabase.....	144
Vegetation.....	144
Point Layer:	145
Merging Grand Canyon Vegetation Map to Lake Mead Vegetation Map	145
Accuracy Assessment	147
Methods	148
Sample Design.....	148
Field Data Collection.....	152
Data Management.....	154
Data Analysis.....	155
Results	156
AA Field Data Collection.....	156
AA Data Analysis.....	158
Discussion and Conclusions	161
Vegetation Classification.....	161

Contents (continued)

	Page
Remote Sensing	162
Accuracy Assessment.....	163
Lessons Learned	164
Vegetation Classification.....	165
Development of map classes	165
Mapping.....	166
Accuracy Assessment.....	167
Summary of Park Management Use and Value	167
Ecological Information in Vegetation Datasets.....	167
Application of Vegetation Maps	168
Leveraged use for other Federal agencies	169
Bibliography	171

Figures

	Page
Figure 1. Location map of LAKE.	15
Figure 2. Geologic Strata in LAKE (photos by NPS).	17
Figure 3. General soils map of LAKE.	18
Figure 4. Ecoregions (Bailey 1995) and deserts (Faunt 2006) in the project area.	20
Figure 5. Vegetation mapping park/project boundaries (Death Valley National Park, Lake Mead National Recreation Area, and Mojave National Preserve).	22
Figure 6. Location of field surveys for the vegetation classification of LAKE and Newberry Mountains.	29
Figure 7. Ordination for the full set of classification samples, showing with the NVC Macrogroups and correlated environmental variables ($r > 0.16$).	43
Figure 8. Ordination for a subset of classification samples, showing with the NVC Groups and correlated environmental variables ($r > 0.16$)	44
Figure 9. Distribution of observation and verification points.	50
Figure 10. Mapped distribution of Pinyon Pine - (Utah Juniper) Woodland.	74
Figure 11. Pinyon Pine - (Utah Juniper) Woodlands.	75
Figure 12. Mapped distribution of Juniper Woodlands.	77
Figure 13. Juniper Woodlands	78
Figure 14. Mapped distribution of Fan Palm Woodlands.	79
Figure 15. Fan Palm Woodlands.	80
Figure 16. Mapped distribution of Palo Verde Woodlands.	81
Figure 17. Palo Verde Woodlands.	82
Figure 18. Mapped distribution of Joshua Tree Woodland.	83
Figure 19. Joshua Tree Woodland.	84
Figure 20. Mapped distribution of Riparian Woodlands.	85
Figure 21. Riparian Woodlands	86
Figure 22. Mapped distribution of Sonoran Live Oak Scrub Woodland.	88
Figure 23. Sonoran Live Oak Scrub Woodland.	89
Figure 24. Mapped distribution of Riparian Wash Scrub Shrublands.	91
Figure 25. Riparian Wash Scrub Shrublands.	91
Figure 26. Mapped distribution of Mid-Elevation Mixed Desert Scrub.	94

Figures (continued)

	Page
Figure 27. Mid-Elevation Mixed Desert Scrub.....	94
Figure 28. Mapped distribution of Mojave Yucca Shrub.	97
Figure 29. Mojave Yucca Shrub.	98
Figure 30. Mapped distribution of Black Brush Shrubland.	100
Figure 31. Black Brush Shrubland.	101
Figure 32. Mapped distribution of Semi-Desert Scrub Shrublands.	104
Figure 33. Semi-Desert Scrub Shrublands.	104
Figure 34. Mapped distribution of Creosote Bush Shrubland.....	108
Figure 35. Creosote Bush Shrubland.	109
Figure 36. Mapped distribution of Semi-Desert Wash Woodland.....	113
Figure 37. Semi-Desert Wash Woodland.....	113
Figure 38. Mapped distribution of Saltbush Scrub Shrublands.	117
Figure 39. Saltbush Scrub Shrublands.	118
Figure 40. Mapped distribution of Salt Basin Scrub Shrublands.....	120
Figure 41. Mapped distribution of Tamarisk Shrublands.	121
Figure 42. Tamarisk Shrublands.	122
Figure 43. Mapped distribution of Manzanita – Sonoran Scrub Oak Shrubland.....	124
Figure 44. Mapped distribution of Mixed Marsh and Wetland Herbaceous Vegetation.	125
Figure 45. Mixed Marsh and Wetland Herbaceous Vegetation.	126
Figure 46. Mapped distribution of Grasslands (Native and Ruderal).	128
Figure 47. Mapped distribution of Dune Vegetation.	130
Figure 48. Dune Vegetation.	131
Figure 49. Mapped distribution of Colorado Plateau Hanging Garden Seep Group.	133
Figure 50. Colorado Plateau Hanging Garden Seep Group.	134
Figure 51. Mapped distribution for Big Galleta Herbaceous Vegetation.	135
Figure 52. Mapped distribution for bare rock and Sparse Vegetation.	137
Figure 53. Mapped distribution for Beach and Barren Sand Draw-down Area.....	140
Figure 54. Beach and Barren Sand Draw-down Area.....	141

Figures (continued)

	Page
Figure 55. Overlap area between LAKE administrative area and the GRCA / PARA vegetation map.	146
Figure 56. Area available (cost surface) for accuracy assessment.	150
Figure 57. Locations of the randomly generated Sample A and Sample B target points.	151
Figure 58. Field crew on AA site, filling out AA form.	153
Figure 59. Example page from AA mapbook.	154
Figure 60. Locations of the 548 sampled AA points.	158

Tables

	Page
Table 1. 1997 U.S. National Vegetation Classification physiognomic-floristic hierarchy for terrestrial vegetation with a supplemental Alliance Group level.	5
Table 2. Summary of IVC revised hierarchy levels and criteria for natural vegetation.....	6
Table 3. Summary of LAKE vegetation coverage for SWReGAP vegetation map.....	14
Table 4. List of legacy datasets the MOJN I&M vegetation mapping projects, arranged by date (newer to older).	24
Table 5. List of vegetation alliances, nested within the NVC hierarchy, found at LAKE.	35
Table 6. List of vegetation alliances at LAKE and Newberry Mountains, including the current and former NVC alliance names.....	39
Table 7. LAKE map classes and component alliances.....	48
Table 8. Vegetation plot elevation ranges.	55
Table 9. Vegetation plot slope ranges (%).	56
Table 10. Vegetation plot aspect ranges.....	57
Table 11. Vegetation plot by landform.	58
Table 12. Map validation sampled sites and data review.....	61
Table 13. Map validation summary.....	65
Table 14. Summary of vegetation classification and mapping results.	67
Table 15. Map class names and component alliances.	69
Table 16. Mapped Bio-physical parameters for Pinyon Pine – (Utah Juniper) Woodlands.	76
Table 17. Mapped Bio-physical parameters for Juniper Woodlands.	78
Table 18. Mapped Bio-physical parameters for Fan Palm Woodlands.....	80
Table 19. Mapped Bio-physical parameters for Palo Verde Woodlands.	82
Table 20. Mapped Bio-physical parameters for Joshua Tree Woodland.	84
Table 21. Mapped Bio-physical parameters for Riparian Woodlands.	87
Table 22. Mapped Bio-physical parameters for Sonoran Live Oak Scrub Woodland.	89
Table 23. Mapped Bio-physical parameters for Riparian Wash Scrub Shrublands.	92
Table 24. Mapped Bio-physical parameters for Mid-Elevation Mixed Desert Scrub.....	95
Table 25. Mapped Bio-physical parameters for Mojave Yucca Shrub.	98
Table 26. Mapped Bio-physical parameters for Blackbrush Shrubland.....	101

Tables (continued)

	Page
Table 27. Mapped Bio-physical parameters for Semi-Desert Scrub Shrublands.....	105
Table 28. Mapped Bio-physical parameters for Creosote Bush Shrublands.....	109
Table 29. Mapped Bio-physical parameters for Semi-Desert Wash Woodland / Scrub.	114
Table 30. Mapped Bio-physical parameters for Saltbush Scrub Shrublands.	118
Table 31. Mapped Bio-physical parameters for Salt Basin Scrub Shrubland.	120
Table 32. Mapped Bio-physical parameters for Tamarisk Shrubland.....	122
Table 33. Mapped Bio-physical parameters for Mixed Marsh and Wetland Herbaceous Vegetation.....	126
Table 34. Mapped Bio-physical parameters for Mixed Grassland (disturbed) Herbaceous Vegetation.	128
Table 35. Mapped Bio-physical parameters for Dune Vegetation.....	131
Table 36. Mapped Bio-physical parameters for Bare Rock and Sparse Vegetation.	137
Table 37. Mapped Bio-physical parameters for Beach and Barren Sand Draw-down Area.....	141
Table 38. Map classes and area excluded from accuracy assessment.....	148
Table 39. Standard sample size allocations for NPS Vegetation Inventory thematic accuracy assessment, based on map class area (Lea and Curtis 2010).	149
Table 40. Inference area and count of sample points in each map class at LAKE.	157
Table 41. Error reconciliation summary for LAKE Accuracy Assessment.	159
Table 42. LAKE overall map accuracy.....	159
Table 43. Users' and producers' reconciled accuracies for each map class at LAKE.	160

Appendices

	Page
Appendix A. Field Forms for New Vegetation Data	A-1
Appendix B. Location of Vegetation Field Surveys for the Classification of Riparian/Wash/Wetland and Upland Alliances at Lake Mead National Recreation Area.....	B-1
Appendix C. Field Key to the Vegetation Alliances of Lake Mead National Recreation Area, Nevada and Arizona.....	C-1
Appendix D. Vegetation Alliance Descriptions for Lake Mead National Recreation Area	D-1
Appendix E. List of Plant Taxa.....	E-1
Appendix F: Gradsect Analysis for Lake Mead National Recreation Area.....	F-1
Appendix G: ‘Landform’ Raster	G-1
Appendix H: ‘NED – Digital Elevation Model’	H-1
Appendix I: ‘Vegetation Density’ Raster.....	I-1
Appendix J: ‘Geology’ Raster.....	J-1
Appendix K: ‘Soils’ Layer.....	K-1
Appendix L: Accuracy Assessment Form	L-1
Appendix M: Merging of LAKE Vegetation Map with PARA Portion	M-1
Appendix N: Field Reconnaissance and Validation Trip Reports	N-1

Executive Summary

Lake Mead National Recreation Area (LAKE) encompasses 1,740 square miles in south eastern Nevada and south western Arizona, and lies within the Mojave Desert. Two other national parks share borders with LAKE. These are Grand Canyon National Park and Grand Canyon-Parashant National Monument to the east. The Park is divided into almost equal portions between the states of Arizona and Nevada.

This mapping effort is part of the National Park Services' national inventory and monitoring program and will provide core or 'baseline' information that park managers need to effectively manage and protect park resources. This vegetation inventory was conducted in accordance with specified protocols and quality assurance standards. Data obtained through this inventory are compatible across multiple Park units, allowing for synthesis and analysis at broader levels. The vegetation inventory and mapping described in this report is one of 12 baseline inventories of natural resources to be completed for all 270 national parks within the National Park Service's Inventory and Monitoring (I&M) Program. The National Park Service (NPS) and partners cooperate to produce detailed vegetation classifications and digital databases, including vegetation maps, as part of this nationwide I&M Program. In 2009, the Mojave Desert Inventory & Monitoring Network (MOJN I&M) began its process to develop a vegetation classification and vegetation key for three parks, Lake Mead National Recreation Area (LAKE), Death Valley National Park (DEVA), and Mojave National Preserve (MOJA). Once the classification and vegetation keys were complete, the mapping efforts were started first with LAKE, followed by MOJA and DEVA.

Vegetation inventory and mapping is a process to document the composition, distribution and abundance of vegetation types across the landscape and involves the skills and interactions of several parties; including the NPS, a vegetation classification team, and a mapping team. This required a multi-year approach and consisted of several broadly linked phases: (1) vegetation classification using the National Vegetation Classification (NVC), (2) digital vegetation map production, and (3) map accuracy assessment.

To classify the vegetation, California Native Plant Society (CNPS) sampled 439 representative plots located throughout the 1,111,993-acre (450,008 ha) park during the fall of 2010. Another 199 plots from legacy data were included in the analysis within the vicinity of LAKE. Plot data analysis including ordination and clustering techniques produced 52 distinct vegetation alliances, five of which were newly described and 11 were redefined from previous alliance designations. These alliances include 112 associations, of which 60 are local or regional types not currently defined in the NVC. Using these data, the CNPS has developed the vegetation classification with associated digital vegetation databases, and developed field keys and descriptions to the vegetation types. CNPS also assisted the mapping team at LAKE during reconnaissance visits, follow-up calls for interpreting vegetation patterns being mapped, and map accuracy assessment evaluation.

The source imagery used to produce the digital map included a combination of 2007 Quickbird Imagery, 2012 National Agricultural Imagery Program (NAIP) imagery, Google Earth Imagery, ESRI streaming imagery, visual interpretation, and 4 ground-truthing field trips to interpret the

complex patterns of vegetation at LAKE. The final map includes 31 map classes that crosswalk to corresponding NVC plant alliances and land-use classes. All of the interpreted and remotely sensed data were converted to Geographic Information System (GIS) databases using ArcMap[®] software and are included in a comprehensive geodatabase. Draft maps created from the vegetation classification were field-tested and revised before independent ecologists conducted an assessment of the map's accuracy during 2014. A final hard-copy paper and electronic map for visual purposes are included in the product delivery suite.

The Colorado Natural Heritage Program crews assessed the thematic accuracy of the map, selecting 551 random sample points stratified by map class according to the guidance in Lea and Curtis (2010). Between February 1 and April 2014, three 2-person crews navigated to the randomly selected sample locations and assessed vegetation at the point using the field key to the alliances of Lake Mead NRA. In total, plot data from 548 of those locations were collected and used in the analysis of map accuracy; three points had to be discarded due to inaccessibility.

When the 548 sampled AA points were joined to the vegetation map, 240 evaluated as correct and 308 evaluated as incorrect. Each incorrect AA sample was then evaluated for a variety of potential errors unrelated to map attribution, as described above. Through that process it was determined that 97 of the incorrect samples disagreed due to either an erroneous field call or a change in the vegetation. Those that disagreed because of an erroneous field call or change in the vegetation were reconciled to "correct" for the purpose of the AA.

The sample frame used to define the strata for the AA random point distribution was based on a "preliminary" map different from the "final" map being analyzed. That map is different from the final map being accuracy assessed in that some polygon boundaries have moved and some have been re-classed. These post-stratification changes invalidate the use of the standard error matrix methods provided by Lea and Curtis (2010). To correctly assess the accuracy of the final map required the use of a statistical method presented by Stehman (2014). That method uses the proportion of area in each map class from both the preliminary and final maps to relate the map class proportions of the two maps to arrive at a correct estimate of accuracy for each map class. The analysis was completed in an MS Excel workbook provided with the project products.

For the LAKE vegetation map, analysis of the AA sample points using the Stehman (2014) method described above indicated an overall accuracy of 77% with a 90% C.I of 28% (based on the SE of 0.029).

Products developed for LAKE are described and presented in this report and are stored on the accompanying DVD, these include:

- A Final Report that includes a vegetation key, accuracy assessment information, and a map class visual guide;
- A Spatial Geodatabase containing digital vegetation map, plots, and accuracy assessment;
- Digital Photos of each vegetation type along with representative ground photos and miscellaneous Park views;

- Field key for alliance and map class identification;
- Federal Geographic Data Committee-compliant metadata for all spatial database layers and field data.
- Hardcopy, paper vegetation maps.

The DVD attached to this report contains text and metadata files, keys, lists, field data, spatial data, the vegetation map, graphics, and ground photos. The NPS will post this project on its website: <http://science.nature.nps.gov/im/inventory/veg/index.cfm>.

For more information on the NVCS and NVC associations in the U.S. please go to <http://usnvc.org/>, or you can also visit NatureServe's website: <http://www.natureserve.org>. Colorado Natural Heritage Program and BOR have numerous services and programs and may be visited at <http://www.cnhp.colostate.edu> and <http://www.usbr.gov>.

Acknowledgments

This project was a cooperative effort between the NPS Vegetation Mapping Inventory Program (VMI) national office, with support from Karl Brown, Tammy Cook; the National Park Service, and the Mojave Desert Network. The project funding was provided by the NPS Inventory and Monitoring Division's Vegetation Mapping Inventory Program.

A project of this size, complexity, expanse and onerous logistics necessarily required the enthusiasm and energy of many people over several years. The dedication of all involved helped to produce a product that we, the authors, gratefully acknowledge. The combination of ecologists, geographers, botanists and natural resource professionals in all the cooperating agencies and organizations were instrumental for a project of this size.

We would like to thank Jeanne Taylor and Mindy Trask, the past Vegetation Mapping Coordinators of the MOJN I&M Network, for assisting in providing datasets, coordinating with the field team at UNLV, providing maps, and general oversight on the project. We thank many people for sharing legacy datasets in California, including Todd Keeler-Wolf (California Department of Fish and Wildlife), Julie Evens (CNPS), Jane Cipra and Andrew Kaiser (NPS), Steven Delfavero (NPS), Michele Slaton (formerly NPS, now USFS), Tom Dilts and Peter Weisberg (University of Nevada Reno), and Kathryn Thomas (US Geological Survey), and we thank others for sharing datasets from Arizona and Nevada, including Dianne Bangle (LAKE, now with BOR), Chris Roberts (LAKE), Scott Abella (UNLV), Dave Charlet, Craig Westenburg (USGS), and John Matchett (USGS).

The field data collection for the vegetation classification stage of the project was coordinated by Scott Abella (UNLV) during 2010–2011 with the following field staff participating: Joslyn Curtis, Karin Edwards, Teague Embrey, Julia Gehring, Shannon Henke, Carl Howard, Kathryn Pregelman, and Sarah Schmid.

Field work for the image analysis and photo-interpretation was carried out by a number of scientists, field crew, and volunteers. Field reconnaissance was conducted with help from Kendra Sikes and Sara Taylor from the CNPS. Map verification was conducted with help from volunteers from the Student Conservation Association (SCA) and LAKE seasonal staff.

The accuracy assessment sampling was completed by field staff from the Colorado Natural Heritage Program and included Beth Morrison, Mitchell Shanahan, Katie Rian, Tim Pine, Stephanie Rockwell, Chris Roberts, and Nalleli Carvajal-Acosta. The AA analysis and reporting were also completed at CNHP by Joe Stevens with support from Tom Baldvins.

Special thanks go to Alice Newton of Lake Mead National Recreation Area and Nita Tallent formerly of the Mojave Network for their support and assistance during this project. Data management support and database development were provided by the MOJN I&M Network data management staff and included Bob Truitt and David Gundlach.

The project also benefited from the critical review of the report and digital products by: Karl Brown, Tammy Cook, Alice Newton, and Nita Tallent. The project team is extremely grateful for the help, advice, and assistance provided by all of these people and their respective institutions.

List of Abbreviations and Acronyms

BOR	Bureau of Reclamation (also USBR)
cf.,	an abbreviation for the Latin word confer, meaning "compare" or "consult"
cm	Centimeter(s)
CDFW	California Department of Fish and Wildlife
CNHP	Colorado Natural Heritage Program
CNPS	California Native Plant Society
DEVA	Death Valley National Park
F	Fahrenheit
FGDC	Federal Geographic Data Committee
ft	Foot/Ft
GIS	Geographic Information System
GPS	Global Positioning System
GRCA / PARA	Grand Canyon National Park / Parashant National Monument
LAKE	Lake Mead National Recreation Area
ha	Hectare(s)
in	Inch(es)
IVC	International Vegetation Classification
m	Meter(s)
MMU	Minimum mapping unit
MOJA	Mojave National Preserve
MOJN I&M	Mojave Desert Network Inventory & Monitoring (also MOJN)
NAIP	National Agricultural Imagery Program
NED	National Elevation Dataset
NPS	U.S. National Park Service
NRCS	Natural Resources Conservation Service (formerly the Soil Conservation Service - SCS)
NVC	National Vegetation Classification
NVCS	National Vegetation Classification Standard
PARA	Parashant National Monument
PARK	LAKE
TNC	The Nature Conservancy
UNLV	University of Nevada Reno
USBR	United States Bureau of Reclamation (also BOR)
USDA	U.S. Dept. Of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	United States Geological Survey
VMI	NPS Vegetation Mapping Inventory Program

List of Contacts



U. S. Department of the Interior National Park Service

Karl Brown, Ph.D.

Vegetation Mapping Program Manager, DOI PPS/GPS Coordinator
NPS-WASO Natural Resource Program Center
1201 Oakridge Drive, Suite 200
Fort Collins, CO 80525
Phone: (970) 225-3591
E-mail: karl_brown@nps.gov
Website: <http://science.nature.nps.gov/im/inventory/veg/index.cfm>

Tammy Cook

Vegetation Inventory Program Biologist
1201 Oakridge Drive
Fort Collins, CO 80525
Phone: (970) 267-7201
E-mail: Tammy_Cook@nps.gov

Allen Calvert

Network Program Manager
Mojave Desert I&M Network - NPS
601 Nevada Highway
Boulder City, NV. 89005
Phone: 702-293-8856
E-mail: allen_calvert@nps.gov

Nita Tallent, Ph.D.

Former Network Program Manager
Now: Chief of Natural Resource Management and Science
Cape Cod National Seashore
99 Marconi Site Road
Wellfleet, MA 02667
Phone: (508) 255-3421
E-mail: nita_tallent@nps.gov

Lizette Richardson

Superintendent
Lake Mead NRA
601 Nevada Way
Boulder City, NV 89005
Phone: 719-378-6300

Mark Sappington

Natural Resource Program Manager
Lake Mead National Recreation Area
601 Nevada Way
Boulder City, NV 89005
Phone: (702) 293-8974
E-mail: mark_sappington@nps.gov

Alice C. Newton

Vegetation Management Specialist
National Park Service
Lake Mead National Recreation Area
601 Nevada Way
Boulder City NV 89005
Phone: 702-293-8977
E-mail: alice_corrine_newton@nps.gov

David Gundlach

GIS Specialist
Mojave Desert Network Inventory and Monitoring
National Park Service
601 Nevada Way
Boulder City, NV 89005
Phone: (702) 293-8842
E-mail: david_gundlach@nps.gov



**U. S. Department of the Interior
Bureau of Reclamation**

Kurt Wille

Group Manager
Emergency Management and GIS Group
Mail Code 86-68260
Denver Federal Center, Building 56
Denver, CO 80225
Phone: (303) 445-2267
E-mail: kwille@usbr.gov

David E. Salas

Physical Scientist
Emergency Management and GIS Group
Mail Code 86-68260
Denver Federal Center, Building 56
Denver, CO 80225
Phone: (303) 445-3619
E-mail: desalas@usbr.gov



Colorado Natural Heritage Program

Joe Stevens

Ecology Team Leader
Colorado Natural Heritage Program
1475 Campus Delivery
Fort Collins, CO 80523-1475
Phone: 970-491-7760
E-mail: Joe.Stevens@ColoState.EDU



California Native Plant Society

Julie Evens

Vegetation Program Director
California Native Plant Society
2707 K Street, Suite 1
Sacramento, CA 95816
Phone: (703) 797-4805
E-mail: jevens@cnps.org

Jaime S. Ratchford

California Native Plant Society
2707 K Street, Suite 1
Sacramento, CA 95816
Phone: (703)
E-mail: jratchford@cnps.org

Daniel Hastings

California Native Plant Society
2707 K Street, Suite 1
Sacramento, CA 95816
Phone: (703)
E-mail: dhastings@cnps.org

**Cogan Technology, Inc.****Dan Cogan**

Cogan Tech
21 Valley Road
Galena, Illinois 61036
Phone: (815) 777-1773
E-mail: dancogan@cogantech.com

Introduction

NPS Park Vegetation Mapping Program

In 1994, the U.S. Geological Survey (USGS) and National Park Service (NPS) formed a partnership to map National Parks in the United States using the National Vegetation Classification (NVC). Beginning in around 2012 the role of the USGS was gradually diminished until being eliminated in 2015 and the NPS assumed sole responsibility. The goals of the NPS Vegetation Mapping Inventory Program (VMI) are to provide baseline ecological data for park resource managers, create data in a regional and national context, and provide opportunities for future inventory, monitoring, and research activities (FGDC 1997; Grossman et al. 1998).

Central to fulfilling the goals of this national program is the use of the National Vegetation Classification (NVC) as the standard vegetation classification. This classification:

- is based upon current vegetation;
- uses a systematic approach to classify a continuum;
- emphasizes natural and existing vegetation;
- uses a combined physiognomic-floristic hierarchy;
- identifies vegetation units based on both qualitative and quantitative data;
- is appropriate for mapping at multiple scales.

The use of standard national vegetation classification and mapping protocols facilitate effective resource stewardship by ensuring compatibility and widespread use of the information throughout the NPS as well as by other federal and state agencies. These vegetation maps and associated information support a wide variety of resource assessment, park management, and planning needs, and provide a structure for framing and answering critical scientific questions about vegetation communities and their relationship to environmental processes across the landscape.

The NVC has primarily been developed and implemented by the National Park Service with The Nature Conservancy (TNC) and the network of Natural Heritage Programs over the past twenty years (Grossman et al. 1998). Currently the NVC is maintained and updated by team collaboration with NatureServe. Additional support has come from federal agencies, the Federal Geographic Data Committee (FGDC), and the Ecological Society of America (<http://usnvc.org/>). Refinements to the classification occur in the application process, leading to ongoing proposed revisions that are reviewed both locally and nationally. NatureServe and USNVC.org has made available a 2-volume publication presenting the standardized classification. This document provides a thorough introduction to the classification, its structure, and the list of vegetation types found across the United States as of April 1997 (Grossman et al. 1998). This publication can be found on the Internet at: <http://www.natureserve.org/library/vol1.pdf>.

NatureServe has since superseded Volume II (the classification listing) with an online database server that provides regular updates to ecological communities in the United States and Canada. NatureServe Explorer®, can also be found on the Internet at: <http://www.natureserve.org/explorer>.

Lake Mead National Recreation Area Vegetation Mapping Project

The vegetation at LAKE has been mapped as an integral part of the U.S. Vegetation Mapping Inventory Program. The mapping follows much of the NPS Natural Resources Inventory and Monitoring Guidelines issued in 1992. To assist in these large and cumbersome projects the Network contracted for the development of a vegetation classification and mapping plan for the entire network (Cogan and Von Loh 2008). This plan provided a framework for the network to produce vegetation maps for all their parks. Following these guidelines the network contracted with the California Native Plant Society (CNPS) to collect plot data, process the data, and provide a vegetation classification to the NVC Alliance level. U.S. Bureau of Reclamation (BOR) was contracted to provide the plot locations after development of a gradsect to best estimate the distribution of vegetation across the landscape. In 2010, the Vegetation Mapping Inventory Program Manager, Dr. Karl Brown, in coordination with the Mojave Desert Network, asked the BOR's Geographic Applications & Analysis Group to undertake the mapping portion of this project. At this time Colorado Natural Heritage Program (CNHP) was included with the initial contract to conduct the fieldwork for the accuracy assessment phase.

To sum up the major contributors in this effort, CNPS provided the vegetation classification, BOR provided the vegetation mapping and CNHP was responsible for the accuracy assessment on the final vegetation map. Finally, the MOJN staff provided logistical and technical support, helped coordinate fieldwork, and reviewed and evaluated draft data. The protocols and standards used are those for large parks and are described in the NPS program documents (TNC and ESRI 1994, section 5.1); <http://science.nature.nps.gov/im/inventory/veg/index.cfm>.

Our objectives were to produce final products consistent with the NPS National Vegetation Mapping Program mandated standards as follows:

- National Vegetation Classification Standard (FGDC 1997)
- Spatial Data Transfer Standard (FGDC 1998a)
- Content Standard for Digital Geospatial Metadata (FGDC 1998b)
- United States National Map Accuracy Standards (USGS 1999)
- Integrated Taxonomic Information System
- NPS Program-defined standards for map attribute accuracy and MMU

The products derived from these efforts include:

Spatial Data

- Map classification/descriptions
- Spatial database of vegetation communities
- Over 1150 locations with classification or accuracy assessment data
- Hardcopy maps of vegetation communities
- Metadata for spatial databases

- Complete accuracy assessment of spatial data

Vegetation Information

- Vegetation classification
- Dichotomous field key of vegetation classes
- Formal description for each vegetation class
- Ground photos of vegetation classes
- Field data in database format

The National Vegetation Classification (NVC) and Standard (NVCS)

In 1994, the U.S. Geological Survey - National Park Service (USGS - NPS) Vegetation Mapping Program (VMP) (now the National Park Service Vegetation Mapping Inventory Program) adopted the U.S. National Vegetation Classification (USNVC) (TNC and ESRI 1994a), (Grossman et al. 1998) as a basis for the a priori definition of vegetation units to be inventoried. The Federal Geographic Data Committee (FGDC) adopted a modified version of the upper (physiognomic) levels as a federal standard (FGDC 1997, FGDC 2008). This standard is hereafter termed the National Vegetation Classification Standard (NVCS). This revision was an effort to foster a cohesive view among Federal agencies in their approaches to classifying vegetation, thus reducing duplicative efforts among multiple agencies while promoting consistent classification of vegetation resources across regions. The 2008 Version 2 replaced the original, addressed several issues known with the first version, and included a substantial reorganization of the classification hierarchical structure. The use of a national standard aids effective resource stewardship by augmenting compatibility and widespread use of the information throughout the NPS and other Federal and State agencies.

The NVCS established a federal standard for a complete taxonomic treatment of vegetation in the United States at physiognomic levels. It also established conceptual taxonomic levels for the floristic units of alliance and association, largely following the USNVC, but did not offer a taxonomic treatment for the floristic levels because of the immense scope of establishing robust floristic units for the entire United States. The FGDC standard requires that federally funded vegetation classification efforts collect data in a manner that enables crosswalking the data to the NVCS (i.e., the physiognomic levels) and sharing between agencies, but does not require use of that standard by agencies for internal mission needs

NatureServe maintains a treatment of floristic units (alliances and associations) are used as classification and mapping units by the VMI whenever feasible. This database is available online through the US National Vegetation Classification website (usnvc.org) or at NatureServe Explorer (<http://www.natureserve.org/explorer/>), which provides public access to regularly updated versions of the USNVC plant community listings and descriptions. Groups and macrogroups, also detailed in this website, allow for further grouping at coarser classification levels. NatureServe's documentation of alliances and associations is the most accessible national listing currently available. However, the plant communities within the NVC are not complete, and projects such as the one described in this report constantly add to the documentation and listing of NVC types.

The NVCS classifies existing vegetation within a hierarchical structure. In brief, the classification is separated into two overriding categories: natural vegetation (including ruderal/semi-natural) and cultural (including ornamental/developed) vegetation. From there, each category is further divided into three main sections: (1) Upper (where physiognomy plays a predominant role), (2) Middle (where both floristics and physiognomy play a significant role), and (3) Lower (where floristics plays a predominant role). Within each section, additional levels are subset. Separate hierarchies are developed for cultural and natural vegetation types. Tables 1 and 2 show the hierarchical structures for both natural and cultural vegetation types. Definitions of these various levels are detailed within Section 2 of the NVCS (FGDC 2008); however, because of the emphasis given by the NPS VIP to natural/semi-natural vegetation types of the floristic levels (alliance and association) and the group level of the NVCS, the following brief definitions are provided.

- An association-level type is the finest level of the NVCS and is “defined on the basis of a characteristic range of species composition, diagnostic species occurrence, habitat conditions and physiognomy” (Jennings et al. 2008), as quoted in FGDC (2008). “Associations reflect topo-edaphic climate, substrates, hydrology, and disturbance regimes” (FGDC 2008).
- An alliance-level type is hierarchically one level above the association and is “defined by a characteristic range of species composition, habitat conditions, physiognomy, and diagnostic species, typically at least one of which is found in the uppermost or dominant stratum of the vegetation” (Jennings et al. 2008), as quoted in (FGDC 2008). “Alliances reflect regional to subregional climate, substrates, hydrology, moisture/nutrient factors, and disturbance regimes” (FGDC 2008).
- A group-level type is hierarchically one level above the alliance (two levels above association) yet is also the lowest level of the middle section of the NVCS hierarchy. The group level is defined in Table 2.4 of the NVCS as “combinations of relatively narrow sets of diagnostic plant species (including dominants and co-dominants), broadly similar composition, and diagnostic growth forms that reflect biogeographic differences in composition and sub-continental to regional differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes” (FGDC 2008).

The species nomenclature for all alliances and associations follows that of (Kartesz 1999). Documentation from (NatureServe 2015) describes the naming and syntax for all NVC names:

A hyphen ("-") separates names of species occurring in the same stratum.

A slash ("/") separates names of species occurring in different strata.

Species that occur in the uppermost stratum are listed first, followed successively by those in lower strata.

Order of species names generally reflects decreasing levels of dominance, constancy, or indicator value.

Parentheses around a species name indicates the species is less consistently found either in all associations of an alliance, or in all occurrences of an association.

Association names include the dominant species of the significant strata, followed by the class in which they are classified (e.g., "Forest," "Woodland," or "Herbaceous Vegetation").

Alliance names also include the class in which they are classified (e.g., "Forest," "Woodland," "Herbaceous"), but are followed by the word "Alliance" to distinguish them from associations.

Examples of alliance names from LAKE:

Baccharis sergiloides Shrubland Alliance (Desert baccharis Shrubland Alliance)

Yucca schidigera Shrubland Alliance (Mojave yucca scrub Shrubland Alliance)

Pinus monophylla–(*Juniperus osteosperma*) Woodland Alliance (Two-needle Pinyon - (Juniper species) Woodland Alliance)

The 2008 NVCS revision (FGDC 2008) of the original 1997-1998 (Grossman, et al. 1998) (Anderson, et al. 1998) hierarchy was endorsed by the FGDC in February 2008 (FGDC 2008). The revised NVCS is also hierarchical but has eight levels instead of seven (Tables 1 and 2). The upper three levels, which are a reorganization of the five upper physiognomic levels from Version 1, indicate physiognomic characteristics that reflect geographically widespread (global) topographic and edaphic factors. The middle three levels are new to the NVCS hierarchy and focus on largely biogeographic and habitat factors along very broad, continental-to-regional topographic, edaphic, and disturbance gradients. The lower two levels, the alliance and association, are used in some park mapping and are currently the same in the first and second versions. Substantial future revisions of the Version 2 alliances are expected to improve concordance through the hierarchy, however, for the purposes of this report, they have not been revised. This LAKE report will use the NVCS, version 1 as its standard because version 2, although it provides a new framework for levels of classification, does not yet provide descriptions of vegetation types at all levels.

Table 1. 1997 U.S. National Vegetation Classification physiognomic-floristic hierarchy for terrestrial vegetation (FGDC 1997) (Grossman, et al. 1998) with a supplemental Alliance Group level.

Level	Primary Basis for Classification	Example
Class	Growth form and structure of vegetation	Shrubland
Subclass	Growth form characteristics, e.g., leaf phenology	Deciduous Shrubland
Group	Leaf types, corresponding to climate	Cold-deciduous Shrubland
Formation	Additional physiognomic and environmental factors	Temperate Cold-deciduous Shrubland

Table 1. 1997 U.S. National Vegetation Classification physiognomic-floristic hierarchy for terrestrial vegetation (FGDC 1997) (Grossman et al. 1998) with a supplemental Alliance Group level (continued).

Level	Primary Basis for Classification	Example
Alliance Group	Regional floristically and environmentally related Alliances	Rocky Mountain Montane Deciduous Scrub
Alliance	Dominant/diagnostic species of the uppermost or dominant stratum	Mountain Mahogany (<i>Cercocarpus montanus</i>)
Plant Association	Additional dominant/diagnostic species from any stratum	Mountain Mahogany/New Mexico Muhly Shrubland (<i>Cercocarpus montanus</i> / <i>Muhlenbergia pauciflora</i> Shrubland)

Table 2. Summary of IVC revised hierarchy levels and criteria for natural vegetation.

Hierarchy Level	Criteria
Upper:	Physiognomy plays a predominant role
L1 — Formation Class	Broad combinations of general dominant growth forms that are adapted to basic temperature (energy budget), moisture, and substrate/aquatic conditions.
L2 — Formation Subclass	Combinations of general dominant and diagnostic growth forms that reflect global macroclimatic factors driven primarily by latitude and continental position, or that reflect overriding substrate/aquatic conditions.
L3 — Formation	Combinations of dominant and diagnostic growth forms that reflect global macroclimatic factors as modified by altitude, seasonality of precipitation, substrates, and hydrologic conditions.
Middle:	Floristics and physiognomy play predominant roles
L4 — Division	Combinations of dominant and diagnostic growth forms and a broad set of diagnostic plant species that reflect biogeographic differences in composition and continental differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes.
L5 — Macrogroup	Combinations of moderate sets of diagnostic plant species and diagnostic growth forms, that reflect biogeographic differences in composition and sub-continental to regional differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes.
L6 — Group	Combinations of relatively narrow sets of diagnostic plant species (including dominants and co-dominants), broadly similar composition, and diagnostic growth forms that reflect regional mesoclimate, geology, substrates, hydrology and disturbance regimes.
Lower:	Floristics plays a predominant role
L7 — Alliance	Diagnostic species, including some from the dominant growth form or layer, and moderately similar composition that reflect regional to subregional climate, substrates, hydrology, moisture/nutrient factors, and disturbance regimes.
L8 — Association	Diagnostic species, usually from multiple growth forms or layers, and more narrowly similar composition that reflect topo-edaphic climate, substrates, hydrology, and disturbance regimes.

For more information on the NVC, see (Grossman, et al. 1998). For more information about the NPS Vegetation Mapping Inventory Program, see

<http://science.nature.nps.gov/im/inventory/veg/index.cfm>. Additional information is available at the

FGDC (Federal Geographic Data Committee), National Vegetation Classification Standard websites, <http://usnvc.org/>, <http://www.fgdc.gov/standards/projects/FGDC-standards-projects/vegetation> and the NatureServe Explorer website: <http://explorer.natureserve.org/classeco.htm>.

In addition to the USNVC, NatureServe has created a standardized Terrestrial Ecological Systems Classification for describing sites based on both the vegetation and the ecological processes that drive them. Ecological systems are mid-scale biological communities that occur in similar physical environments and are influenced by similar dynamic ecological processes, such as fire or flooding (Comer, et al. 2003) They are not conceptually a unit within the NVC and do not occupy a place in the NVC hierarchy. However, each Ecological System is directly linked to NVC by a list of core associations that occur within it. Because the structure of the NVC is hierarchical, each association occurs in only one alliance. An association may occur in more than one Ecological System, however, and is limited only by the range of ecological settings in which that association occurs. Ecological Systems are similar in scale to the map classes used for the LAKE map legend; they are a broader scale concept that embodies the concepts of several highly specific associations that might be found in a particular setting. Ecological Systems are also similar in scale to the NVCS Version 2 Group Level.

General Classification Standards and Procedures

The vegetation classification in this project is based upon the U.S. National Vegetation Classification (NVC), in which this classification has been developed by NatureServe in partnership with the State Natural Heritage Programs, including the Department of Fish and Wildlife (CDFW) and California Native Plant Society (CNPS) in California. While the first and second editions of the national classification provide thorough introductions to the classification, its structure, and the list of vegetation units known in the United States (Grossman, et al. 1998, FGDC 2008), many refinements to the classification have occurred during its application. These refinements are found on the web, such as at NatureServe (2014).

Existing vegetation reports were reviewed to obtain current desert vegetation classifications. Literature included recent studies of the Central Mojave Desert Ecosystem Project (Thomas, Franklin, et al. 2004), Anza-Borrego Desert (Keeleer-Wolff, Roye and Lewis 1998) Joshua Tree National Park (J. Evens, K. Sikes, et al. 2014), Northern and Eastern Colorado Desert (Evens and Hartman 2007), *A Manual of California Vegetation* (Sawyer, Keeleer-Wolff and Evens 2009), NatureServe website (NatureServe 2015), Grand Canyon and Great Basin vegetation projects (NatureServe 2010, Schulz and Hall 2011), Death Valley springs data and reports, (Thomas 2006, Dilts and Weisberg 2010, Sada and Cooper 2012), and Desert Renewable Energy Conservation Plan vegetation map report (VegCAMP and AIS 2013).

General Procedural Steps

The NPS I&M program has developed general guidelines for the development and deliverables of vegetation map products. These are detailed in the “12-Step Guidance for NPS Vegetation Inventories” (NPS 2013). This report generally follows all of the items in this following list.

1. Review Existing Data and "Best Practices" to Develop a Brief Proposal (1-5 pages)

2. Planning and Scoping to Gather the Detailed Information Needed to Develop the Study Plan
3. Develop and Submit a Detailed Study Plan for Approval of Funding
4. Field Plot Data Collection (for the Ecological Classification)
5. Develop Vegetation Classification, Vegetation Type Descriptions, and Field Key
6. Develop Mapping Model (Calibration)
7. Acquire and Prepare Imagery
8. Imagery Analysis / Imagery Classification
9. GIS Project Preparation
10. Validation of Thematic Accuracy of Map Products
11. Formal Accuracy Assessment (AA)
12. Deliver Final Reports, GIS Database and Required Products

Planning and Scoping

Planning and Coordination

The methods to produce a vegetation map for parks the size of LAKE are described in detail in –the NPS Vegetation Mapping Inventory Program Document “12-Step Guidance for NPS Vegetation Inventories” (NPS 2013). <http://biology.usgs.gov/npsveg/standards.html> and only summarized here. The general groups of tasks include planning meetings, collecting and analyzing existing data, development of the classification, development of the sampling strategy, field work, data input and analysis, photo interpretation, cartography, map validation and accuracy assessment. These tasks necessarily interact with one another throughout the entire process.

The initial planning and scoping meeting was held at Lake Mead National Recreation Area on November 6, 2012. The LAKE Vegetation Classification and Mapping project team incorporated the combined expertise and oversight of several organizations. The core technical work was split among six groups: The technical mapping portion was contracted to the BOR in Denver, CO. The California Native Plant Society (CNPS) was contracted to collect, analyze, classify, and write-up the requisite plant alliance data. The CNPS effort was started prior to this kick-off meeting and data development was well under way. The Colorado Natural Heritage Program (CNHP) was included to conduct accuracy assessment (AA). The LAKE natural resources staff was to provide ad hoc input as the project progressed. The Mojave Desert Network provided general oversight and project management in addition to coordinating the map validation exercise. Programmatic considerations were managed by the National Vegetation Mapping Inventory Program of the National Park Service.

For the core partners in the project specific technical responsibilities and deliverables included the following:

BOR Responsibilities and Deliverables:

- Participate in scoping and other planning meetings;
- Interpret imagery;
- Transfer interpreted information to a digital spatial database and produce hard copy (paper) vegetation maps;
- Create digital vegetation coverages including relevant attribute information;
- Produce geodatabase with all relevant attributes for map polygons, vegetation plots, and accuracy assessment locations;
- Create a contingency table comparing the mapped classes with the AA classes in order to determine map accuracy;
- Provide any ancillary digital files developed during the mapping process;
- Document and record digital FGDC compliant metadata files (*.html) for all created spatial data;

- Produce hard copy (paper) vegetation maps;
- Produce the final report and CD-ROM describing procedures used in preparing all products.

CNHP Responsibilities and Deliverables:

- Participate in scoping and other planning meetings;
- Collect, and enter data for, 600+ Accuracy Assessment Points;
- Create a Map class Key;
- Provide information for the Final Report;
- Deliver data in digital form from Accuracy Assessment Points;
- Deliver relevant sections in the Final Report.

CNPS Responsibilities and Deliverables:

- Research existing vegetation data from LAKE;
- Collect 600+ Vegetation Plots;
- Work closely with BOR and USGS photo interpreters to assure a common understanding of the classification of vegetation in the Park;
- Enter and analyze data from Vegetation Plots to produce a final classification for mapping;
- Develop a preliminary vegetation classification for the study area;
- Deliver data in digital form from Vegetation Plots;
- Deliver local vegetation descriptions;
 - Review map class field key
- Work closely with BOR to assure a common understanding of the classification of vegetation in the Park;
- Be available for consultation in data management and vegetation classification;
- Collaborate with vegetation mappers in developing mapping classes;
- Support image-interpretation by spending time in field with image-interpreters and being available for consultation and collaboration;
- Review and finalize draft classification, local community descriptions, and field key to community types;
- Provide information and sections for the Final Report;
- Deliver key to the vegetation associations of LAKE;
- Deliver classification of LAKE vegetation;
- Deliver local vegetation descriptions;
 - Reviews CNHP locals, makes standard (QC) and produces final description report.

- Provide information and relevant sections in the Final Report.

Cogan Tech Responsibilities and Deliverables:

- Planning and participating in meetings;
- Creating vegetation classifications;
- Delineating vegetation stands;
- Creating vegetation mapping products;
- Conducting review and analysis of technical documents;
- Identifying project requirements;
- Development of scoping documents and site-specific narrative summaries;
- Tracking and providing feedback on upcoming activities;
- Assuring compliance with project requirements;
- Development and maintenance of project/program data bases;
- Conduct quality assurance/quality control (QA/QC) reviews of analytical results;
- Analysis of program and project data gaps.

Scoping Meetings

The project participants met on several occasions over the course of the project to discuss progress and develop the scope of activities that needed to be completed over the near-term. These usually informally structured meetings were held at least once per year, often more frequently. Perhaps in contrast to other similar projects, the bulk of communication occurred in small group phone calls, e-mails and in face to face meetings that are too numerous and informal to include here. The following is a summary of several of the most pertinent meetings.

Project 'Kick-Off' and Scoping Meeting:

The project kick-off meeting was held at the Mojave Desert Network offices on November 6, 2012. All partners attended with the goals of discussing and planning:

- The background and motivation for the NPS Vegetation Mapping Inventory Program;
- A preliminary vegetation association list;
- A proposed sample design (plot and accuracy assessment) that will attempt to satisfy multiple criteria (vegetation quantification; fuel models and long-term monitoring);
- Options for imagery acquisition and analysis;
- Various approaches to field logistics and the general project timeline.

Field Preparation Meetings:

Prior to beginning field work in 2012 (and 2013) the project team met to discuss issues for the approaching field visits. These issues were generally logistical and required coordination with MOJN and the Park law enforcement.

Map Class Meeting:

An interim project status meeting was held in September 28, 2012 after receiving the preliminary vegetation classification from CNPS. BOR reviewed the alliance level descriptions and produced a rough approximation of potential mapping units. These were discussed at length and a draft final map classification was developed.

Interim Status Meetings:

The purpose of these meetings was for the project participants to summarize their progress on the project and to plan remaining tasks to be completed. Topics covered during the meeting included progress on defining the Map Classes, redefining the mapping limits (i.e. to include/expand drawdown areas), progress of checking the data and entering it into the PLOTS database, and the status of the fuels and photographic data. Other issues included discussions of imagery type being used such as Quickbird and NAIP.

Accuracy Assessment Planning:

Following completion of the vegetation sampling for the LAKE portion of the MOJN vegetation classification in 2012, the project focused on image interpretation and mapping. We began planning for an accuracy assessment (AA) in early 2012. CNHP joined BOR in the spring 2012 field trip to familiarize themselves with the vegetation and Park access. Topics included the methodology for defining the appropriate number and distribution (spatial and thematic) of the AA plots, development of the cost surface to be used in placing the plots on the map, data to be collected at the plot locations, and logistics for completing the required number of plots in a single season.

Episodic Planning Meetings:

As noted most planning and collaboration for the project actually occurred in interactions not listed above. Several planning meetings were held prior to and during field and mapping work. These were intended to provide the forum for discussing various logistical issues and determining the scope and scale of various project aspects. Questions of whether and how to permanently mark the plots, the availability of crew housing, backcountry camping, land access, the content of the preliminary association list, the content of the map class list, image interpretation, data sharing and other questions were discussed at these planning meetings.

Preliminary Data Collection and Review of Existing Information***Vegetation Studies***

Existing studies documenting the vegetation of the LAKE project area were reviewed and incorporated to inform the classification and image analysis portions of the project. These included plots by the Lake Mead National Recreation Area staff, the U.S. Geological Survey, and the Jornada Experimental Range Station with the USDA Agricultural Research Service.

Digital Data

Digital data was acquired from a variety of sources for visualization, background information, and for assisting in the interpretation of vegetation map classes. These data fall into three broad categories: vegetation maps, landscape data, and imagery sources.

Previous Vegetation Maps

No vegetation maps specific to LAKE have been produced. However, there are regional maps that cover the extent of the Park. The Southwest Regional Gap Analysis Project (SWReGAP) has produced a regional land cover map using 2002 and 2003 Landsat Imagery. That data was clipped to the LAKE boundary. Table 3 summarizes the vegetation types reported and the number of acres and hectares. The National Land Cover Data (NLCD) map produced by the USGS also covers the area but does not lend any information to this effort. That effort maps almost the entire Park as “Shrub/Scrub – areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20% of total vegetation. This class includes true shrubs, young trees in an early successional stage or trees stunted from environmental conditions”. Given the general vegetation description this map was not used.

Vegetation maps include regional and local maps over a variety of scales. The coarse scale maps available provide a regional perspective on the landscape and these include various ecoregion maps such as the U.S. EPA Ecoregions, Bailey’s Ecoregions (Bailey 1995), Omernik’s Ecoregions, National Land Cover Data, and SWReGAP. Maps of a more local type are more useful to the interpretive effort.

Other Digital Data

Landscape data includes the digital elevation model (DEM) produced by the USGS. Using the base DEM data we were able to generate aspect, hillshade, and slope rasters that were useful for both the sampling plan and for interpretation. The Park had produced a shape file of aeolian deposits that covered the project area that was particularly helpful in identifying some map classes. A soils (SSURGO - NRCS Soils) database was also available for the project area and was used for reference.

Imagery

A variety of imagery types were made available for this project. The base or primary layer used for interpretation was the 2012 color and CIR National Agricultural Imagery Program (NAIP) 1 m imagery. This image was the primary source for creating the line work used in this project. In addition, we used 2007 Quickbird multiband Image made available by Clark County and were used as reference / ancillary data. In addition, we accessed March 2013 Thematic Mapper (30 m pixel). Streaming data from Arc Map and Google Earth were also used as additional reference sources.

Table 3. Summary of LAKE vegetation coverage for SWReGAP vegetation map.

Description	Acres	Hectares
Barren Lands, Non-specific	1.3	0.5
Colorado Plateau Blackbrush-Mormon-tea Shrubland	170.9	69.2
Colorado Plateau Mixed Bedrock Canyon and Tableland	1,206.1	488.1
Developed, Open Space - Low Intensity	15.1	6.1
Great Basin Pinyon-Juniper Woodland	694.3	281.0
Inter-Mountain Basins Big Sagebrush Shrubland	47.4	19.2
Inter-Mountain Basins Juniper Savanna	61.6	24.9
Inter-Mountain Basins Mixed Salt Desert Scrub	5.1	2.1
Inter-Mountain Basins Semi-Desert Grassland	6.2	2.5
Inter-Mountain Basins Semi-Desert Shrub Steppe	867.7	351.2
Invasive Southwest Riparian Woodland and Shrubland	6,047.6	2,447.4
Mogollon Chaparral	0.7	0.3
Mojave Mid-Elevation Mixed Desert Scrub	10,388.3	4,204.1
North American Arid West Emergent Marsh	1,399.8	566.5
North American Warm Desert Badland	18,253.5	7,387.2
North American Warm Desert Bedrock Cliff and Outcrop	57,474.6	23,260.0
North American Warm Desert Pavement	14,759.8	5,973.3
North American Warm Desert Playa	10.3	4.2
North American Warm Desert Riparian Mesquite Bosque	1,017.3	411.7
North American Warm Desert Riparian Woodland and Shrubland	321.9	130.3
North American Warm Desert Volcanic Rockland	23,953.2	9,693.9
North American Warm Desert Wash	1,866.0	755.2
Sonora-Mojave Creosote Bush-White Bursage Desert Scrub	798,695.6	323,232.1
Sonora-Mojave Mixed Salt Desert Scrub	654.5	264.9
Sonoran Mid-Elevation Desert Scrub	150.6	60.9
Open Water	173,349.3	70,154.5
Sum	1,111,418.5	449,791.1

Location and Setting

The project area lies in Southern Nevada and North West Arizona (Figure 1). The nearest significant city is Las Vegas, approximately 35 miles to the west of the western most boundary. Boulder City lies adjacent to Hoover Dam, and the City of Laughlin lies just to the south of the southernmost boundary adjacent to the Davis Dam. The Grand Canyon National Park and Parashant National Monument (GRCA / PARA) join LAKE on its eastern most extent.

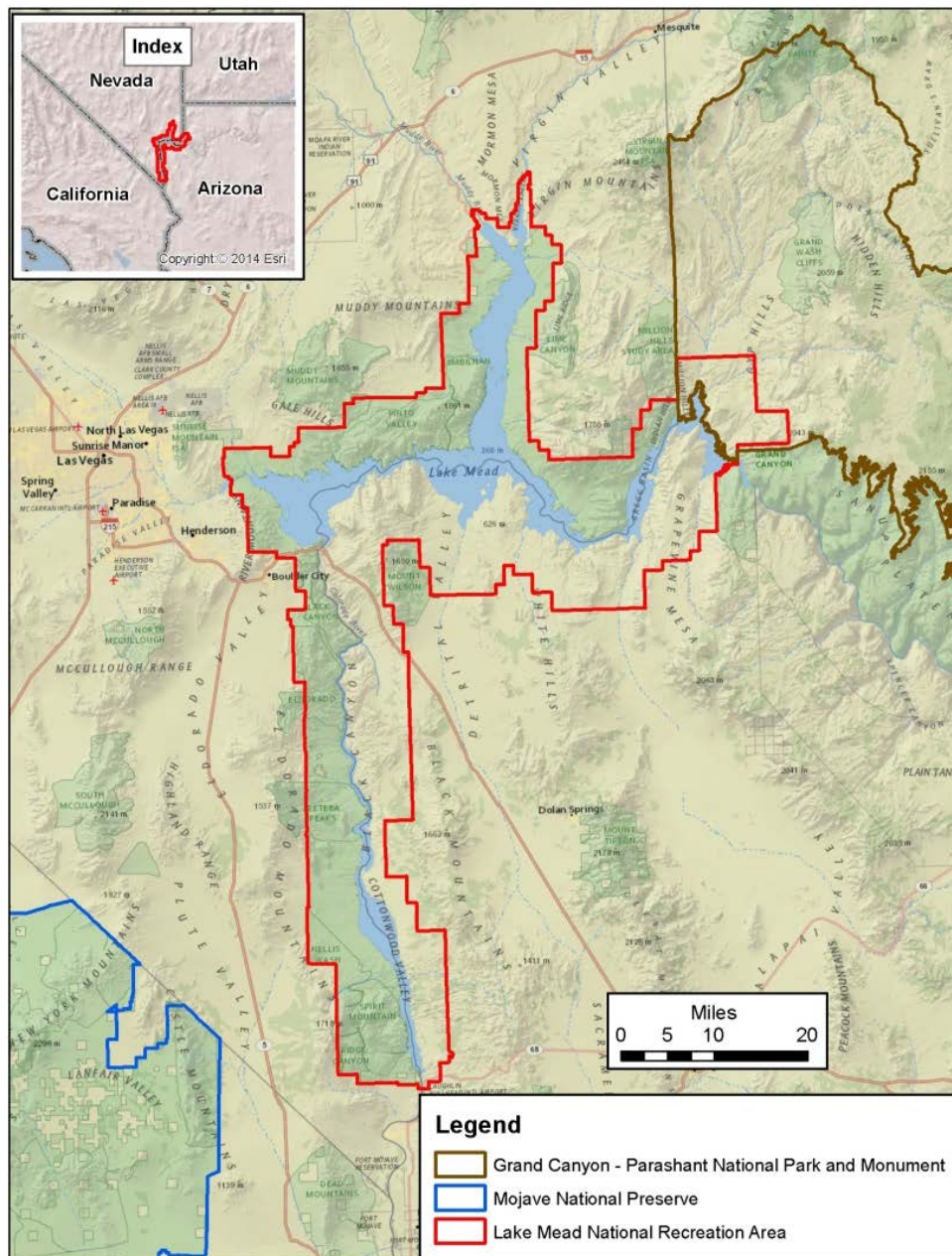


Figure 1. Location map of LAKE.

The project area encompasses 450,008 ha (1,111,993 ac), with about 16% of that area water (72,282 ha, 178,613 ac). The area has an elevational range of approximately 1,559 m (5,115 ft.). The Park extends approximately 100 miles north to south and about 60 miles east to west. To the west are two additional NPS units; Grand Canyon National Park and Grand Canyon – Parashant National monument (GRCA / PARA). The Colorado River runs through the Park and exits at the Davis Dam in the south.

Physiographic Setting and Topography

Lake Mead National Recreation Park is located in southern Nevada and north western Arizona. The Colorado River enters from the Grand Canyon to the east, and exits in the south. The most prominent feature is Lake Mead itself. The Colorado River exits the lake at Hoover Dam and continues south. Other major riverine inflows include the Muddy River and the Virgin River from the north and these course through the Overton Wildlife Management Area. The Las Vegas Wash inflows on the western most portion of the Park. It is generally hilly throughout the Park. The highest mountains are the Newberry Mountains in the southern most portion and the Wilson and Fortification Ridges in the central portion of the Park just east of Hoover Dam. The Black and Eldorado Mountain ranges flank the southern arm of the Park.

Climate

The climate in the Park can be characterized by very hot summers and relatively mild winters. July temperatures can range from 32.0 – 44.0 °C (90 – 111°F) however the occasional heatwave can push that higher. January temperatures can range from -2.0 – 6.0 °C (28.0 – 43.0°F). The lower temperatures are generally only found at higher elevations. Temperatures rise quickly in the spring and can easily get above 38°C (100°F) in May. Precipitation is generally sparse throughout the year. Higher winter precipitation is generally found on the north eastern portion of the Park. Summer precipitation extends south along the Black Mountain Range and the Newberry Mountain area. Dangerous flash flooding can occur when the Park experiences heavy rain events. Appendix F has numerous figures showing the summer and winter temperature and precipitation distribution.

Geology

The Park lies in the central extent of the Basin and Range Province that extends over much of the western United States and can be found as far north as Washington, east to western Utah and extends far into Mexico. The topography in the Basin and Range is typified by north-south trending narrow faulted mountain ranges with flat sedimentary filled arid valleys. The geologic history within the Park rocks covers about two billion years of geologic time (Figure 2). Evidence remains of the giant forces that created this area and includes volcanic events, vast inland seas, uplift and erosion.

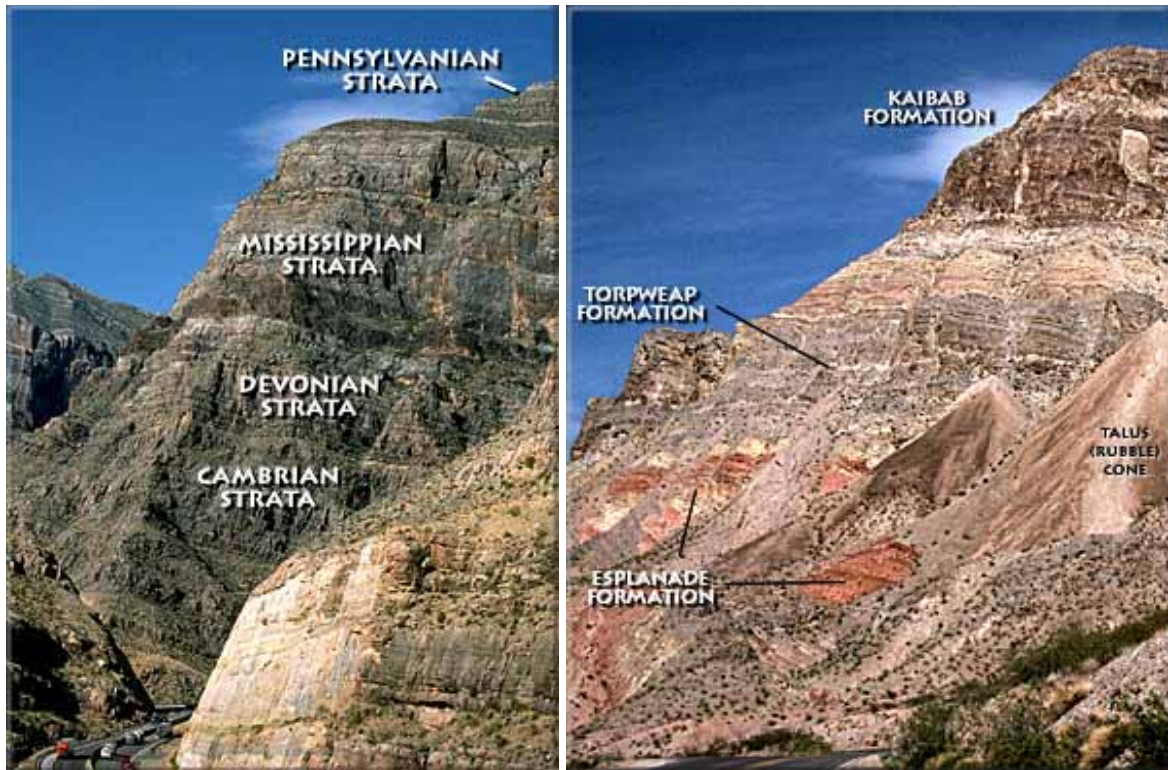


Figure 2. Geologic Strata in LAKE (photos by NPS).

Soils

The soils within the Park are generally of an alluvial or colluvial nature. The soils are either derived from or weathered from a variety of parent material such as sandstones, shales, limestones, igneous or metamorphic rocks or a mix of these. Smaller amounts of lacustrine or aeolian soils exist but these are minor components. The alluvial or colluvial materials are concentrated in the east central portion of LAKE while other types are more generally distributed throughout the Park. Derivatives of limestone and dolomites are less frequent and scattered throughout the Park north of Hoover Dam (Figure 3).

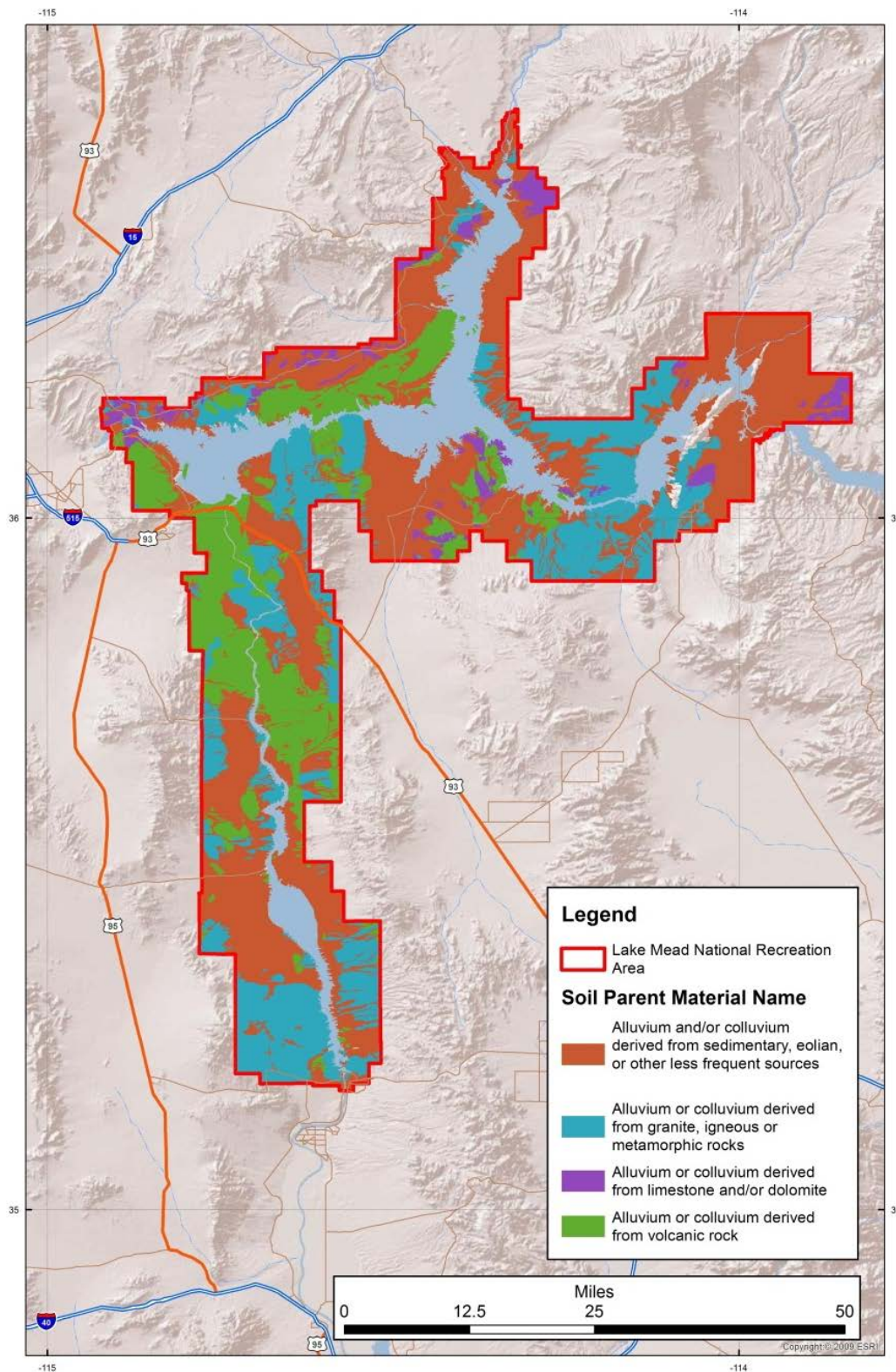


Figure 3. General soils map of LAKE.

Park Environment

Environmental History

“Lake Mead National Recreation Area (NRA) is a startling contrast of desert and water, mountains and canyons, primitive backcountry and human innovation. Two powerful forces created the backdrop for this park. First, natural processes occurring over millions of years along the interface of the Basin and Range geologic province and the Colorado Plateau geologic province built its foundation. This landscape consists of vast desert expanses, dramatic geologic features, and diverse ecological communities. Then, over the past 100 years, humans modified the landscape to better suit it to present day needs. The primary modifications include two massive reservoirs—Mead and Mohave—in one of earth’s hottest, driest regions. These lakes supply high-quality municipal water, power production, and agricultural irrigation water to tens of millions of people across Nevada, Arizona, California, and Mexico. Collectively, Lake Mead NRA encompasses this unique array of natural and modified landscape and waterscape.” (Lake Mead National Recreation Area 2014)

Regional Setting

Regionally this area is part of the western deserts. The Park lies within the Mojave Desert but has some phytogeographical elements of both the Great Basin Desert to the north and the Sonoran Desert to the south. The mountain ranges typically run north-south. Biogeographically, the Park occurs within the Mojave Desert Section of the American Semi-Desert and Desert Province, the Tropical/Subtropical Desert Division and Dry Domain (Bailey 1995, Bailey 1998). The very eastern most portion east of Snap Rock Canyon laps into the Grand Canyon Lands section. Almost the entire Park lies within the Mojave Desert. The southern portion of the Park south of Lake Mohave lies within the Colorado Sonoran Desert (Faunt 2006). Figure 4 shows the ecoregions and deserts.

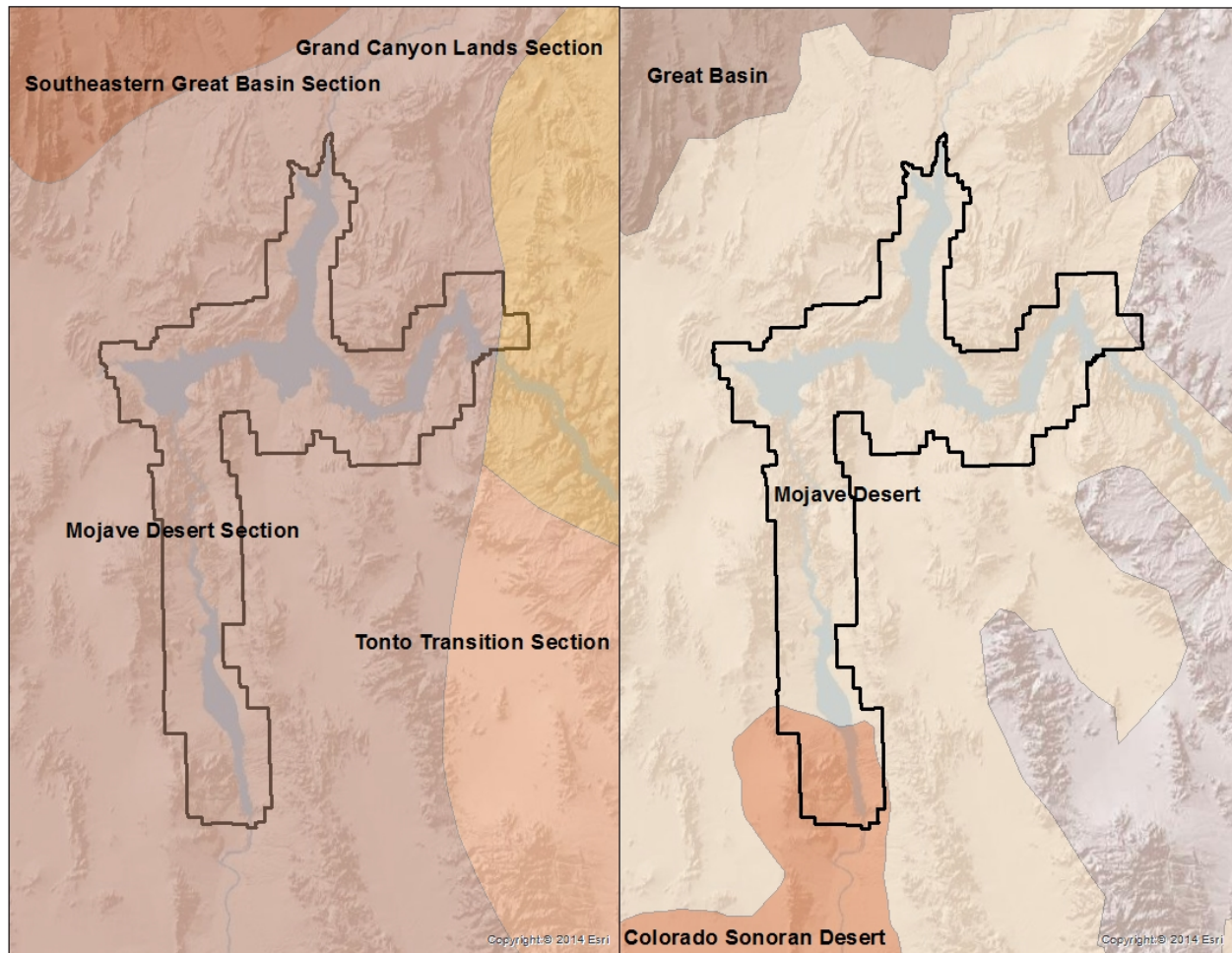


Figure 4. Ecoregions (Bailey 1995) and deserts (Faunt 2006) in the project area.

Classification of Plant Communities

Introduction

In 2009, the Mojave Desert Inventory & Monitoring Network (MOJN I&M) began its process to develop vegetation maps for Lake Mead National Recreation Area (LAKE), Death Valley National Park (DEVA), and Mojave National Preserve (MOJA). This mapping is a multi-step and multi-year process involving skills and interactions of several parties, including NPS staff with a field ecology team, a classification team, and a mapping team. The California Native Plant Society (CNPS), the classification team, was tasked with developing the vegetation classification with associated digital vegetation databases, and developing field keys and descriptions to the vegetation types. This classification is reviewed by partner ecologists at NatureServe and California Department of Fish and Wildlife (CDFW), and ultimately is utilized by mapping teams to develop vegetation maps at each of three parks (see Figure 5) that are more detailed (e.g., alliance-level) than existing maps (e.g., (Lennartz, et al. 2008, Thomas, Franklin, et al. 2004).

Following the guidelines provided by the national Inventory and Monitoring (I&M) Program, the MOJN I&M and CNPS have developed this vegetation classification at the alliance level, and the association level when possible. These are the finest two levels of the National Vegetation Classification (NVC) hierarchy, following the format of the NVC (FGDC 2008) and *A Manual of California Vegetation* (Sawyer, Keeleer-Wolff and Evens 2009). These classification levels are floristically and environmentally defined, and are used to denote plant community types that occur within the major ecological regions of the nation. The NVC supports the development and use of a consistent national vegetation classification to produce uniform statistics about vegetation resources across the nation, based on vegetation data gathered at local, regional or national levels (FGDC 2008). The NVC hierarchy was applied to this classification, and iteratively the hierarchy is being revised based on vegetation inventory efforts such as this project.

A primary project goal is to create a single, consistent vegetation classification for LAKE, DEVA, and MOJA. Vegetation data collected includes floristic composition, vegetation structure, and plant species cover. Pooling collected data from all three parks provides a more robust sample size to define vegetation types common to all three parks as well as those particular to each park. Rather than develop separate classifications for each park, a single classification has been developed to insure uniformity in how vegetation types are defined and mapped across all three parks. Using a multi-step analysis process, vegetation types have been classified and defined and can now be mapped.

Steps taken to achieve this primary project goal include the following:

1. Develop preliminary and interim classifications of vegetation data
2. Train field crews on standard field sampling protocols for collecting new vegetation data
3. Develop a field key representing the interim classification of LAKE
4. Complete classification of all vegetation data, and prepare a key to the vegetation of LAKE, DEVA, and MOJA

5. In collaboration with the mapping team, identify the map classes that will be utilized during vegetation mapping
6. Draft vegetation descriptions for LAKE, DEVA, MOJA, and JOTR
7. Train field crews to conduct map accuracy assessments and implement map accuracy assessment reviews
8. Compile a report describing vegetation classification methods and results that includes vegetation keys and descriptions

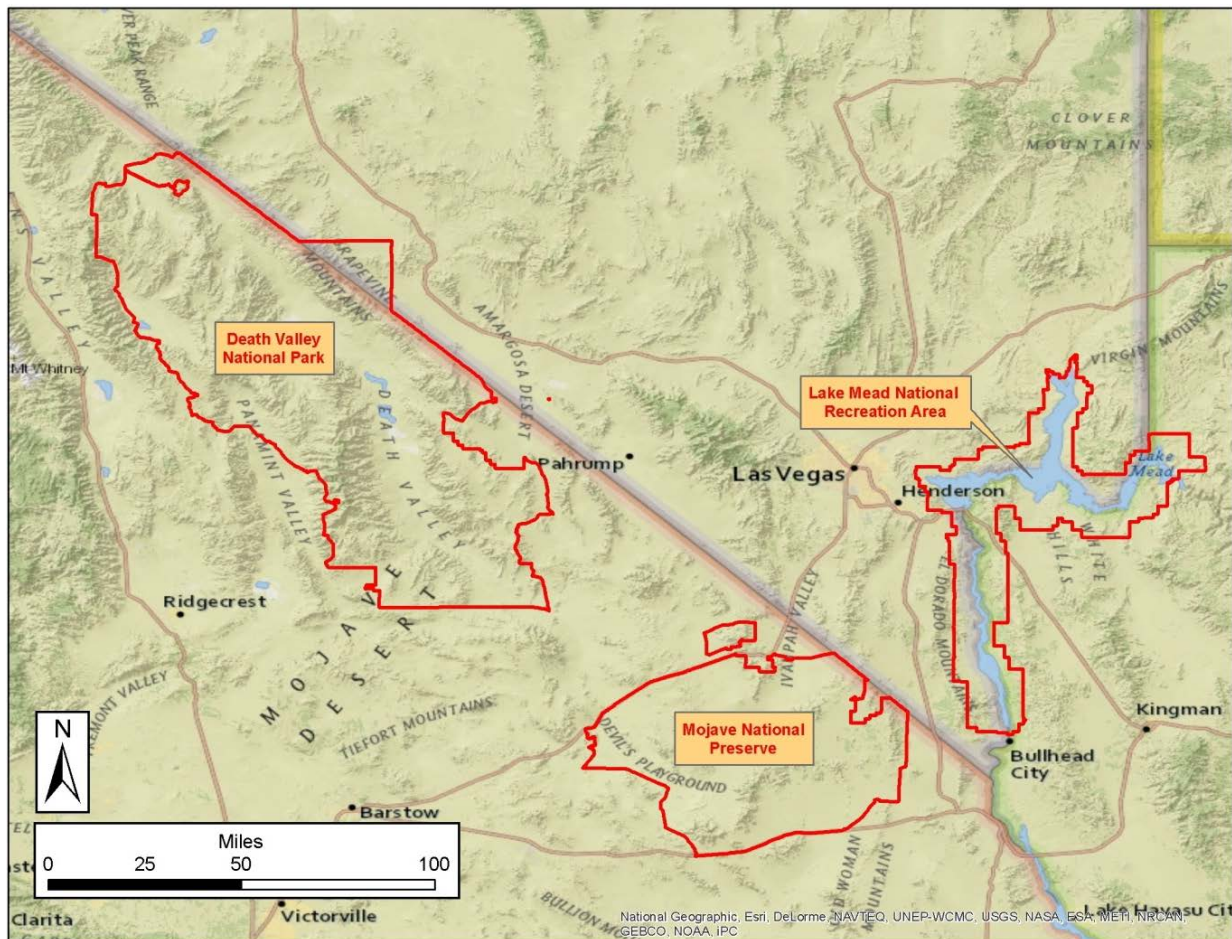


Figure 5. Vegetation mapping park/project boundaries (Death Valley National Park, Lake Mead National Recreation Area, and Mojave National Preserve).

Methods

Review/Compilation of Datasets

CNPS obtained, reviewed, and compiled/standardized a variety of legacy datasets including those provided by Jeanne Taylor, the past MOJN Vegetation Mapping Coordinator (VMC), during 2009–2012, and from botanists at DEVA, during 2010–2013. These data were from a variety of vegetation resource assessment and monitoring projects undertaken within and near LAKE, DEVA, and MOJA. Additionally, new classification/mapping data collected specifically for this NPS project were provided by Kathryn Prengaman (Prengaman, et al. 2011), following the standard NPS protocols (see Appendix A). CNPS also obtained and compiled/standardized legacy datasets from Kathryn Thomas, Todd Keeler-Wolf, and Julie Evens that were used in the Central Mojave Vegetation Database mapping project, Joshua Tree National Park (JOTR), the Northern and Eastern Colorado Desert mapping project, and watercourse vegetation in California’s eastern Mojave Desert. CNPS reformatted other recent datasets and new field data from NPS and USFS staff including from Steven Delfavero, Michele Slaton, Jane Cipra, and Andrew Kaiser. See Table 4 for a list of these legacy datasets.

After receiving the data, CNPS resolved various data type/transcription issues. For example, the plant data from different legacy datasets contained many different types of species codes and scientific names, which needed to be resolved in order to merge the datasets. A downloaded list of USDA Plants Database codes and names from July 2014, for Arizona, California, and Nevada (USDA-NRCS 2010 - 2014), have been used to assign current taxonomic names to the legacy data. The plant data from the different projects also included different vegetation cover/abundance types such as cover classes, actual percent covers, relative percent covers, or numbers of hits. This was resolved by storing cover values as specific number values (with midpoint values for cover classes and specific values for percent cover or hits). Associated plot and environmental data from each dataset were also varied in nature, from only a few fields of information to many. More than half the datasets contained geographic UTM coordinate values while others lacked these values, and some datasets contained elevation in feet while others were in meters. Elevation was standardized to meters; if elevation was missing but UTM coordinates were present, then elevation (in meters) was derived using a digital elevation model. CNPS also derived other environmental variables (e.g., precipitation, temperature, soil characteristics) from existing GIS layers for those plots with UTM coordinates.

Throughout 2010–2013, CNPS compiled the legacy and new data into a large merged database that contains three primary data tables of plant, plot, and site impact data (when available) along with related lookup tables. The merged dataset tables are compiled within the Microsoft (MS) Access database format of CNPS/CDFW, which typically contains a combination of plot-based (relevé) data and stand-based (observation level, rapid assessment or accuracy assessment) data. Different legacy data were merged together by placing similar appropriate values of information into a standard set of table fields/columns. When certain quantitative or categorical plot data values were unique to datasets, those values were placed in PlotOther fields with a description of what the data appeared to be. CNPS received the standard NPS Metadata Tools and Editor to create a metadata file explaining the data types and fields in the merged legacy database. Also, CNPS continued to quality control the legacy data values.

Table 4. List of legacy datasets the MOJN I&M vegetation mapping projects, arranged by date (newer to older).

Document/Study Title	Authors	Year	Spatial Data	# Samples	Classification	Mapping	Synopsis
Exotic Species Survey Methods, DEVA	Delfavero, Steven	2008–2010	Yes	115	X	X	Rapid assessments with complete or partial plant data. The focus was for exotic species inventory, which included data on plant communities/habitats in which exotics both do and do not occur.
Death Valley Springs Monitoring dataset, DEVA	Dilts, T. and Weisberg, P.	2010	Yes	42 (800+)	X	X	Detailed field mapping at 42 representative springs including quadrats (1m ²), transects, photo lines, and vegetation patches with over 800 polygons (minimum size 10 m ²) of the dominant vegetation.
Final vegetation mapping classification data, JOTR	JOTR staff; Keeler-Wolf, Todd	2009	Yes	110	X	X	Rapid assessments in plots of 10 m x 100 m in area or 50 m radius.
Final vegetation mapping accuracy assessment data, JOTR	JOTR staff; Lea, Chris	2009	Yes	1,313	--	X	Accuracy assessments in plot sizes of 25 m radius or 50 m radius.
Rare plant monitoring data for rare plant species in Las Vegas Valley, LAKE, and environs	Bangle, Dianne	2008, 2009	Yes	21 macro-plots (529 quadrats)	X	X	Long-term monitoring design set up for <i>Arctomecon californica</i> ; found on gypsum soils in Las Vegas Valley and near springs associated with the Colorado River. Additional rare plant data for <i>Anulocaulis leiosolenus</i> , <i>Astragalus geyeri</i> var. <i>triquetrus</i> , and <i>Eriogonum viscidulum</i> .
High resolution imagery project, LAKE	Jornada Experimental Range Station and LAKE staff	2009	Yes	23 macro-plots (138 transects) + 32 transects	X	X	One data set with 50 m x 50 m macro-plots with 6 line transects per plot at various sites/communities; 23 macro-plots (and 138 transects total) at LAKE. Another data set with varying numbers of transects at springs (32 transects total) in LAKE. Point-intercept data at 0.5-meter intervals along each transect.
High resolution imagery project, MOJA	Jornada Experimental Range Station and LAKE staff	2009	Yes	4 macro-plots (24 transects)	X	X	50 m x 50 m plots with 6 line transects per plot. Total of 4 macro-plots sampled within MOJA in Joshua Tree/Blackbrush community. Point intercept data collected at 1-meter intervals along transects.

Table 4. List of legacy datasets the MOJN I&M vegetation mapping projects, arranged by date (newer to older) (continued).

Document/Study Title	Authors	Year	Spatial Data	# Samples	Classification	Mapping	Synopsis
Vegetation Plot database, DEVA	Slaton, Michele	2009	Yes	250	X	X	Circular plots of 0.2 acre for woody vegetation, rectangular plots 10 x 10 m for herbaceous vegetation.
A floristic and vegetation analysis of the Newberry mountains, Clark County, Nevada	Abella, S. (UNLV); Roberts, C. and Holland, J. S. (LAKE)	2008, 1982	Yes	107	X	X	Study originally conducted in 1982; plots re-read in 2008. Project goal: identify the major vegetation units of the Newberry Mountains. Four major vegetation communities defined: Encelia, Larrea-Ambrosia, Mixed Shrub, and Mixed Shrub-Woodland.
Vegetation classification of data from the Northern and Eastern Colorado Desert Management Planning project	Evens, J. M.	2007 (1997)	Yes	729	X	X	Relevé data from this project provides reference information for the MOJN I&M classification, since majority of data is not within NPS lands.
Riparian vegetation following tamarisk removal (Sacatone Wash, Burro Spring, Meadow Springs), LAKE	Matchett, John R.	2007	Yes	16	X	X	30-meter line transects with a 5-meter brush belt, using the point-intercept method. In areas with tamarisk plots installed, tamarisk was cut and burned. All areas have native vegetation reestablishment.
DEVA Travertine Springs complex vegetation	Thomas, K.	2006	Yes	--	--	X	Polygon and point data of the spring's complex.
Central Mojave Vegetation Database	Thomas, Keeler-Wolf, Franklin, and Stine	2004	Yes	1,199	X	X	Relevé plots of 1,000 m ² , including 1,199 plots with plant data and 45 others without plant data. Technical report has more information about dataset and related data used in project.
Preliminary vegetation mapping data, JOTR	AIS	2000–2001	Yes	300	X	X	Rapid assessments in plots of 1,000 m ² (20 x 50 m in area or 17.85 m radius in area).
Watercourse vegetation in the eastern Mojave Desert, MOJA	Evens, J. M.	2000	Yes	262	X	X	Relevé plots of 1,000 m ² . Watercourse plots for master's thesis and desert riparian/wash classification.
Preliminary vegetation mapping data (JOTR)	Long, et.al.	1997	No	74	X	--	Relevés averaging 2,100 m ² (or 2 x 100 m ²) in representative stands.

Table 4. List of legacy datasets the MOJN I&M vegetation mapping projects, arranged by date (newer to older) (continued).

Document/Study Title	Authors	Year	Spatial Data	# Samples	Classification	Mapping	Synopsis
Preliminary data from vegetation mapping of Malapai Hill quad, JOTR	Watts	1996	Yes	108	X	X	100 m2 plots with average size of all shrubs estimated for cover.
Ft. Irwin	Novak	1996	Yes	300	X	X	5-10 parallel 100-ft line intercepts per plot.
Preliminary data from vegetation mapping of Ft. Irwin (N of Barstow)	Watts	1996	Yes	125	X	--	Abundance and cover data (cover used in analysis) in 100 m2 plots with average size of all shrubs estimated for cover.
East Mojave Scenic Area	Johnson, Hyrum	1978	No	751	X	--	100-pace toe-point within representative pre-delineated polygons.
Ground truthing NASA-NPS Landsat Mapping (DEVA)	Root	1978	Yes	152	X	X	100 ft. x 100 ft. orthogonal transects from a central point.
Master's thesis within Black Mountains, DEVA	Schramm, D.	1977	No	88 (92)	--	--	Master's thesis data of Belt transects 100 x 6 yd., line intercept 2-33 m lines.

Classification Analyses

Since plant community datasets are inherently complex, and multiple environmental variables may determine the heterogeneity in the patterns, Cluster Analysis with a hierarchical agglomerative technique was employed, typically using Sørensen distance and flexible beta group linkage method at -0.25 in PC-ORD (McCune and Mefford 2006). The agglomerative clustering technique was used instead of TWINSpan's divisive technique, which is usually employed when a dataset has one main underlying environmental determinant (McCune and Grace 2002). The cluster analysis technique was based on species abundance (cover) values converted to 7 different classes using the following modified (Braun-Blanquet 1932/1951) cover categories: 1=<1%, 2=1-5%, 3=>5-15%, 4=>15-25%, 5=>25-50%, 6=>50-75%, 7=>75%. The majority of the species values fell within the first four cover classes. If the data were not based on percent cover, and instead as point intercept (proportion) data, then an arc sine square root transformation was used on the data within PC-ORD before cluster analysis was performed.

Prior to the cluster analysis runs, outlier analysis was performed on the dataset using PC-ORD. Plots with Sørensen distances of more than three standard deviations away from the mean were deleted. To additionally reduce heterogeneity within each dataset, rare species occurring in fewer than 2 or up to fewer than 6 plots were removed from datasets. The cluster analysis groupings were displayed in dendrogram outputs, and dendrograms were interpreted at 2 to 30 or more cluster group levels.

After the cluster analysis generated groups, Indicator Species Analysis (ISA) was employed to objectively decide at what number of "groups" or cut levels to explicitly interpret the cluster dendrograms (McCune and Grace 2002). The intent was to display and interpret the groups generated by the cluster analyses first at generic levels (to classify higher level macrogroups and alliances) and subsequently finer levels (to classify associations). Further, ISA was used to determine which species were characteristic indicators for the different groups. ISA produced indicator values for each species according to their group membership for all levels of groups within the dendrogram, and the statistical significance of the indicator species was evaluated using a Monte Carlo test with 1000 randomizations (Dufrêne and Legendre 1997). ISA was repeated for datasets divided into 2 groups through 30 or more groups. All analyses were evaluated to determine the total number of significant indicator species ($p\text{-value} \leq 0.5$) and the mean p -value for all species within each group level. The group levels with highest numbers of significant indicators and low overall mean p -values were selected for the final evaluations of the community classification (McCune and Grace 2002). At the most significant group level per ISA, plant community names within floristic levels (i.e., alliance and association names) were applied to each field survey. Alliance and association names were defined by species composition, degree of constancy, indicator species, and species cover values. Further, each plot was reviewed within the context of the cluster to which it had been assigned to determine association names, and an ordination (e.g., Bray Curtis with Sørensen distance) was employed to review the main groupings of plots.

Upon revisiting each sample, some samples were misclassified in earlier versions of the cluster analysis, usually because of their rarity in the dataset, and these samples were classified based on their similarity to existing associations or defined as new provisional associations. Thus, pre-existing

classifications and floras were consulted to locate analogous/similar classifications or descriptions of vegetation.

A summary of the above analysis process is provided in the following steps:

- Run cover category Cluster Analysis to display a specific arrangement of plots based on species presence and abundance.
- Run Indicator Species Analysis (ISA) at each of the successive group levels for each of the Cluster Analysis dendrograms from 2 groups up to the maximum number of groups (all groups with at least 2 samples).
- Settle on the final representative grouping level of each Cluster Analysis to use in the preliminary labeling.
- Preliminarily label alliance and association for each of the samples, noting indicator species from the ISA.
- Review existing classifications to determine relatedness of current dataset to existing alliances and associations, and assign each association and alliance based on review of species constancy and cover on a sample-by-sample basis.
- Review ordination of the same plots to identify main groupings of plots.
- Re-label final alliance names for each sample and arrange in a database table.

Datasets used in Classification Analyses

In late 2011 and early 2012, CNPS coordinated with the MOJN VMC about the new 2010–2011 data that were collected by UNLV field crews for use in vegetation classification analysis, and we subsequently received/downloaded new data in two batches for the analysis process. CNPS staff had initially analyzed data in two previous (preliminary and intermediate) classification analyses, when data from within LAKE and surrounding areas were available. Once all new data from DEVA and MOJA as well as LAKE had been collected, CNPS staff completed the compilation of existing legacy and new data from the Mojave Desert region, and we utilized data from LAKE, DEVA, MOJA and immediate environs for a final stage of classification analysis in 2013–2014. Data for this analysis included approximately 4,000 surveys, as follows, and see Figure 6 for a representation of field surveys in LAKE:

- DEVA new vegetation plot and observation surveys from NPS/UNLV (n=620)
- DEVA plot data from Slaton (n=233) and Delfavero (n=114)
- DEVA plot data, plus plots within a 4 km buffer of DEVA from the Thomas et al. (2004) Central Mojave Vegetation Database (n=411)
- DEVA plot data from Root (n=102)
- LAKE new vegetation plot and observation surveys from NPS/UNLV (n=439)
- LAKE fire monitoring handbook riparian/tamarisk removal transects from USGS (n=16)

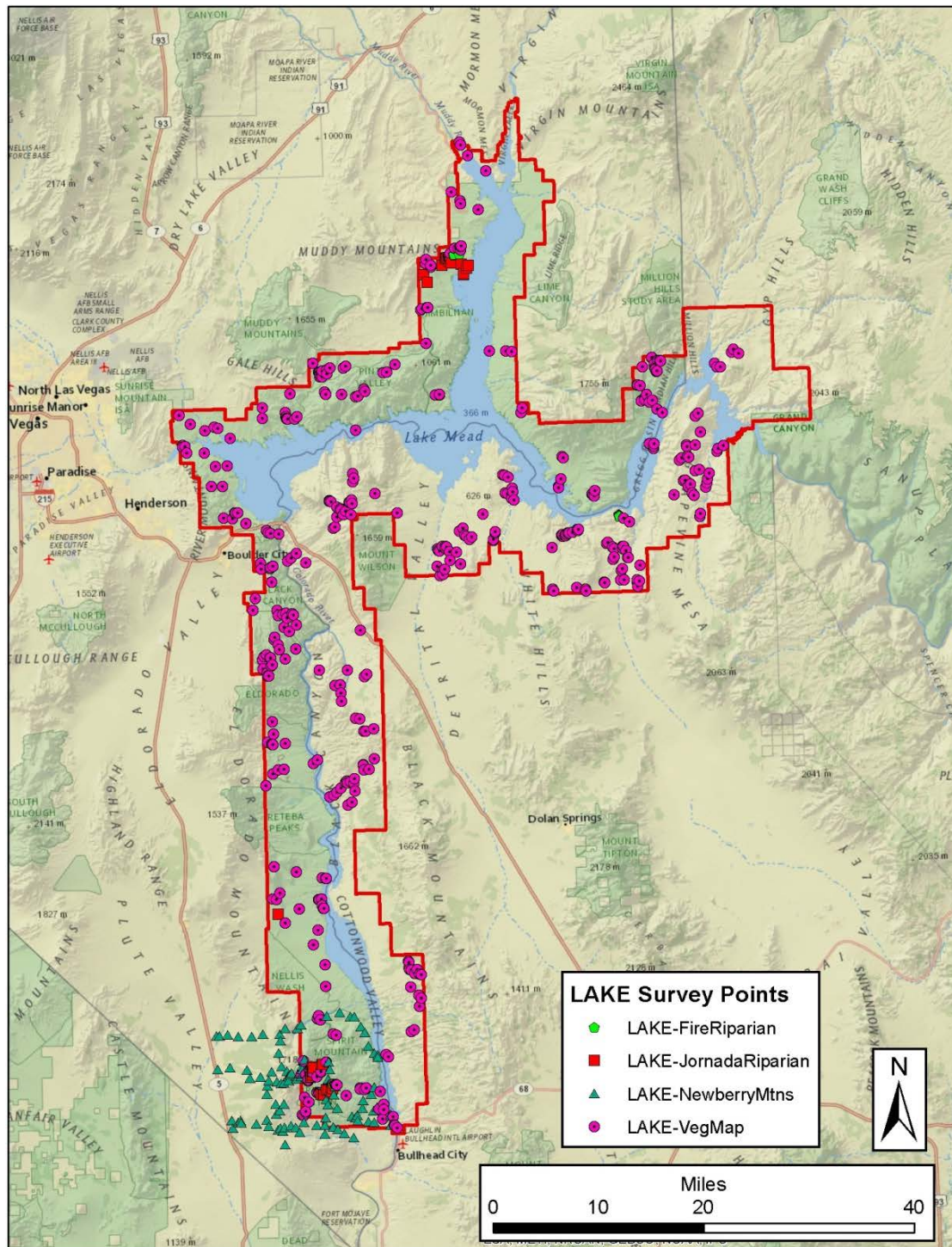


Figure 6. Location of field surveys for the vegetation classification of LAKE and Newberry Mountains.

- LAKE macroplots and transects from Jornada Experimental Range Station (n=55)
- LAKE/Newberry Mountains vegetation data from Roberts (n=107)
- East Mojave Scenic Area transect data subset from Johnson (n=750)
- MOJA new vegetation plot and observation surveys from NPS/UNLV (n=600)
- MOJA plot data, plus plots within a 4 km buffer of MOJA from the Thomas et al. (2004) Central Mojave Vegetation Database (n=244)
- MOJA plot data in watercourses/washes from Evens (2000, n=264)

Before analysis, CNPS performed a thorough quality control of the plant composition data. We provided questions to MOJN VMC about uncertain taxa from the new LAKE, DEVA, and MOJA surveys, and received plant data corrections to update our database. We also decided how to resolve similar plant taxa that had different identifications. For example, some taxa had been determined to the genus level and other times to the species and/or subspecies level (e.g., *Achnatherum* vs. *A. hymenoides* vs. *A. speciosum*, etc.). The following decisions were made to generate a plants analysis file:

- For taxa with 2 or 3 species and the genus level determined, where the taxa generally appear as ecological equivalents (occurring in a small range of habitats), we merged all into the genus level (e.g., *Antheropeas*, *Allium*) and retained them in the analysis.
- For taxa with very few records (≤ 10) determined at both the species level and the genus level, where the species are ecologically dissimilar (ranging across many different habitats), and where a higher number of records were at genus level compared to species level, the genus records were removed for analysis (e.g., *Arabis*).
- For taxa where we have many records (> 10 records) at the species level as well as at the genus level (e.g., *Camissonia*), these records were both retained and removed from the cluster analysis runs to see if there were different results.
- In comparing these two runs, groupings appeared similar and not weighted by the genus level being retained, so we did not remove the genus determinations from the analysis.

Datasets were combined and analyzed using agglomerative cluster analysis, indicator species analysis, and other summary statistics using the PC-ORD suite of multivariate software tools. Because the newly compiled dataset for analysis was large and complex in nature, CNPS also split up the dataset into smaller subsets to perform successive cluster and indicator species analyses. The first cluster analysis run provided a separation of the data into nine different groups, based on where a peak in the number of significant indicator species occurred. These nine groups included the following significant indicator species:

- *Artemisia tridentata*, *Pinus monophylla*, *Ephedra viridis*, *Elymus elymoides*, *Chrysothamnus viscidiflorus*, *Artemisia tridentata* spp. *vaseyana* (193 plots)

- *Atriplex confertifolia*, *Tetradymia axillaris*, *Krascheninnikovia lanata*, *Lycium andersonii*, *Picrothamnus desertorum*, *Grayia spinosa* (293 plots)
- *Yucca schidigera*, *Porophyllum gracile* and other herbs, Cryptogamic crust (721 plots)
- *Suaeda moquinii*, *Salsola*, *Pluchea sericea*, *Distichlis spicata*, *Atriplex polycarpa* (474 plots)
- *Ambrosia eriocentra*, *Chilopsis linearis*, *Acacia greggii*, *Adenophyllum cooperi*, *Hymenoclea salsola* (297 plots)
- *Plantago ovata*, *Encelia farinosa*, *Atriplex hymenelytra*, *Chorizanthe rigida* and other herbs (590 plots)
- *Gutierrezia sarothrae*, *Prunus fasciculata*, *Artemisia ludoviciana*, *Rhus trilobata*, *Yucca baccata*, *Sphaeralcea ambigua*, *Baccharis sergiloides* (535 plots)
- *Ambrosia dumosa*, *Larrea tridentata*, *Krameria erecta*, *Cylindropuntia ramosissima*, *Senna armata*, *Encelia frutescens*, *Cylindropuntia echinocarpa* (424 plots)*
- *Ericameria cooperi*, *Ephedra nevadensis*, *Pleuraphis rigida*, *Coleogyne ramosissima*, *Gutierrezia microcephala* (326 plots)*

The nine groups were analyzed separately using cluster analysis and indicator species analysis. The latter two groups (*) were from the Johnson dataset of toe-point transects, a sampling technique that is non-standard relative to the plot- or stand-based techniques by which all other data were collected. Out of the 750 records included from Johnson, 736 records grouped together into these latter two groups, and 14 other records were included in other groups above. Because most of the Johnson data grouped apart from the rest of the data, all of the Johnson samples were separated to perform analyses on them individually.

After these successive analyses were run, the data were pooled together in an MS Access database to review and standardize classification names across the 4,000 surveys. The resulting analyses in addition to existing classifications and keys were used as guides to assign classification names of alliances and associations. The classification names were standardized with existing NVC and other desert classifications, and MS Access and Excel summary tables of the classification are being produced for review by our partners at NatureServe and CDFW. This classification has been placed within the newly revised version of the NVC hierarchy, by nesting alliances within groups and macrogroups. At the same time, CNPS staff has been providing expert review of the new hierarchy and placed new alliances within this hierarchy; therefore, dialog with NatureServe and CDFW has been necessary to complete the hierarchical assignments.

To further examine and display patterns of plant community composition among groups and macrogroups, we used nonmetric multidimensional scaling ordination (NMS) in PC-ORD (McCune and Mefford 2006). The ordination used Sørensen (Bray-Curtis) similarities. Species found in fewer than three sample units were removed from analysis. Sample units determined to be outliers based on having distance measurements more than two standard deviations from the mean were also removed. We compared 50 iterations with real data and 50 iterations with randomized data to select a

dimensionality. Then we performed 200 iterations with the chosen dimensionality to find a stable solution with minimal stress (McCune and Grace 2002). To assess the variance represented by each axis, we calculated the coefficient of determination between distances in the ordination space and distances in the original space (i.e., Sørensen [Bray-Curtis] similarities). Environmental variables were combined in a secondary matrix to determine correlations between environmental variables and the NMS axes. Correlations with r-values greater than 0.16 were displayed as vectors overlain on NMS ordination graphs indicating the direction and strength of correlations.

Upon classifying the vegetation, CNPS staff conferred with NPS staff on the type, content and format of descriptions to be written. With input from Nita Tallent, Tammy Cook, and Tom Philippi, a decision was made for CNPS to write alliance-level descriptions for the local park areas. We also received input from MOJN I&M staff, Jean Pan, and NatureServe staff, Kristin Snow and Marion Reid, on the format and content for the descriptions. CNPS staff drafted sets of alliance-level vegetation descriptions, including woodland, shrub, and herbaceous vegetation types, which have been merged subsequently into a complete set of descriptions organized by the NVC hierarchy. Data compilation was supplemented by information from literature searches.

Vegetation Mapping Classification

Alliance and higher level group and macrogroup mapping of vegetation at LAKE begun in 2015, while the mapping of vegetation of MOJA and DEVA will occur in subsequent years.

Results and Discussion of Classification Analyses

From the data received by MOJN I&M and various partners from 2009–2013, CNPS compiled approximately 9,000 existing vegetation data records into a legacy database in MS Access. CNPS created a metadata file to explain the data types and fields contained in the tables of the merged legacy database using the standard NPS metadata tool.

Of the surveys available, approximately 4,000 had adequate vegetation and/or landform information (i.e., species composition and abundance data) to inform the classification of LAKE and environs. The final draft classification resulted in the identification of approximately 110 alliances and landform types, and 240 associations. Of these types, 52 alliances and 108 associations from LAKE were nested within the upper levels of the newly revised NVC hierarchy (see Table 5). A map that geographically displays the location of vegetation field surveys for this LAKE classification is provided in Appendix B. This classification was subsequently reviewed and vetted by partners at MOJN (Jeanne Taylor), NatureServe (Mark Hall and Keith Schulz) and CDFW (Todd Keeler-Wolf) in early 2012, so that the mapping classification for LAKE could be established.

Based on the analysis of legacy and new samples at LAKE, CNPS staff worked with BOR mapping staff to translate and simplify the classification of alliances (e.g., *Quercus turbinella* Shrubland Alliance) and landform types (e.g., playa and cultural/ornamental developed mapping units) into a coarser mapping classification. CNPS also assisted BOR with crosswalking the vegetation map classes from the border area with Grand Canyon-Parashant National Monument (GRCA-PARA) to edge-match the maps of LAKE and GRCA-PARA. Based on this map crosswalk, six additional types were identified in this region, and were added to the classification tables and keys. These types are

further described in the report for GRCA-PARA (NatureServe 2010). Local descriptions for LAKE were not written since classification plots were not taken of these types; however, three of these were also sampled and classified for DEVA and MOJA so brief notations were made in the vegetation alliance descriptions (i.e., Colorado Plateau Hanging Garden Seep Group). Additionally, three other alliances were discovered during map accuracy assessment field sampling (i.e., *Allenrolfea occidentalis* Shrubland, *Distichlis spicata* Alkaline Wet Meadow, and *Muhlenbergia asperifolia* - *Spartina gracilis* - *Sporobolus airoides* Alkaline Herbaceous alliances), so these were added to the classification tables, and brief notations were made in their descriptions.

Upon evaluating the revised NVC hierarchy and previously described alliances, CDFW, CNPS and NatureServe ecologists also proposed updates to this hierarchy, including changes in upper-level hierarchy placements for some alliances and in new lower-level alliances. For example, temperate wetland shrubland and herbaceous groups, which had been designated in a Formation (e.g., 2.B.6. Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland Formation), have been changed recently to nest within a separate Subclass level (i.e., 2.C. Shrub & Herb Wetland Subclass instead of under 2.B. Temperate & Boreal Grassland & Shrubland Subclass. These recent changes are reflected in the classification for LAKE nested within the NVC hierarchy (see Table 5). However, since the hierarchy is still undergoing peer-review, changes like this are expected to occur after this project is completed, and future updates will be needed.

The lower-level Alliance changes are further reflected in Table 6. A variety of recommendations and/or updates in the NVC classification have been made, which include broadened and/or redefined alliance level concepts. For example, *Ephedra* spp. - *Leymus salinus* - *Eriogonum corymbosum* Badlands Cold Desert Sparse Vegetation Alliance has been recently redefined by NatureServe, instead of the former *Ephedra torreyana* Sparsely Vegetated Alliance. Another recent recommendation made by CNPS that was accepted is a mixed *Prunus fasciculata* – *Salazaria mexicana* Shrubland Alliance, instead of separate alliances for these taxa previously described in Sawyer et al. (2009) and Evens et al. (2012). Other alliance concepts still need further peer-review, such as the *Encelia farinosa* Desert Scrub and *Fouquieria splendens* Desert Scrub alliances being separated versus merged within *Larrea tridentata* - *Encelia farinosa* Upper Bajada & Rock outcrop Desert Scrub Alliance. While the NVC has recently merged these three former alliances into one, we have kept them separated because the latter type was mapped in a different mapping class at LAKE.

CNPS staff additionally inspected the classification with ordination analysis using NMS. For example, we ordinated the entire set of approximately 4,000 field samples to review the NVC Macrogroup and Group determinations. An ordination diagram of the full dataset (see Figure 7) includes the following patterns: montane and mid-elevation vegetation types on the right-hand side; riparian forest, shrubland and other wetland types on the lower left-hand side; and lower elevation creosote bush, bursage, and related scrub and warm semi-desert cliff, rock and pavement vegetation on the upper left-hand side. We also ordinated specific subsets of NVC groups to examine alliance determinations (e.g., wash groups and mid to higher elevation shrub and herb groups). An ordination diagram of selected shrub and herb groups (see Figure 8) includes the following patterns: lower elevation creosote bush, bursage and related scrub (in G295) and warm semi-desert dune vegetation

(in G675) are on the upper left-hand side of the graph, correlated with higher temperatures and lower rainfall, while the mid-elevation mixed desert scrub (G296) is on the lower right-hand side of the graph (correlated with lower temperatures and higher rainfall). While these three NVC Groups had been placed in the same Macrogroup (M088), this data analysis showed that G296 should be separate (at least at the Macrogroup level) because of its distinctly different correlations with climatic variables. Upon bringing this issue to the attention of the NVC peer review committee, its Macrogroup has been changed. Additionally, this ordination assisted us in evaluating the placement of specific alliances in the NVC hierarchy. For example, *Pleuraphis rigida* Herbaceous Alliance was previously placed in the mid-elevation group (G296) and has now been moved into the dune & sand flat group (G675, as indicated by the oval drawn around the center of the alliance's plot distribution in Figure 8).

Table 5. List of vegetation alliances, nested within the NVC hierarchy, found at LAKE.

Class
Subclass Formation Division Macrogroup Group Alliance
1. Forest & Woodland
1.B. Temperate & Boreal Forest & Woodland
1.B.2. Cool Temperate Forest & Woodland
1.B.2.Nc. Western North American Cool Temperate Woodland & Scrub
M026. Intermountain Singleleaf Pinyon - Utah Juniper - Western Juniper Woodland
G247. Great Basin Pinyon - Juniper Woodland
<i>Pinus monophylla</i> - <i>Juniperus osteosperma</i> / Shrub Understory Woodland
1.B.3. Temperate Flooded & Swamp Forest
1.B.3.Nd. Interior Lowland West Flooded & Swamp Forest
M036. Interior Warm & Cool Desert Riparian Forest
G797. Western Interior Riparian Forest & Woodland
<i>Populus fremontii</i> - <i>Fraxinus velutina</i> - <i>Salix gooddingii</i> Flooded Forest & Woodland Alliance
<i>Salix gooddingii</i> - <i>Salix laevigata</i> - <i>Salix lucida</i> Riparian Forest
M298. Interior West Ruderal Flooded & Swamp Forest
G510. Interior West Ruderal Riparian Forest & Scrub
<i>Phoenix dactylifera</i> - <i>Washingtonia filifera</i> Ruderal Woodland
<i>Tamarix</i> spp. Ruderal Temporarily Flooded Shrubland
2. Shrub & Herb Vegetation
2.B. Temperate & Boreal Grassland & Shrubland
2.B.1. Mediterranean Scrub & Grassland
2.B.1.Nb. California Grassland & Meadow
M045. California Annual & Perennial Grassland
G766. California Annual Grassland & Forb Meadow
<i>Amsinckia menziesii</i> - <i>Amsinckia tessellata</i> - <i>Phacelia</i> spp. Herbaceous
2.B.2. Temperate Grassland & Shrubland
2.B.2.Nd. Western North American Interior Sclerophyllous Chaparral Shrubland
M091. Warm Interior Chaparral
G281. Western Madrean Chaparral
<i>Quercus turbinella</i> Shrubland
<i>Arctostaphylos</i> - <i>Quercus</i> Shrubland**
2.C. Shrub & Herb Wetland
2.C.4. Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland
2.C.4.Nb. Western North American Freshwater Shrubland, Wet Meadow & Marsh
M301. Western North American Ruderal Wet Shrubland, Meadow & Marsh
G524. Western North American Ruderal Wet Shrubland, Meadow & Marsh
<i>Phragmites australis</i> - <i>Arundo donax</i> - <i>Alopecurus pratensis</i> Native & Semi-native Flooded Herbaceous

Table 5. List of vegetation alliances, nested within the NVC hierarchy, found at LAKE (continued).

Class
Subclass Formation Division Macrogroup Group Alliance
M888. Arid West Interior Freshwater Emergent Marsh
G531. Arid West Interior Freshwater Emergent Marsh
<i>Cladium californicum</i> Alkaline Seep
<i>Typha domingensis</i> – <i>Typha latifolia</i> – <i>Typha angustifolia</i>
Western Herbaceous Emergent*
2.C.4.Nc. Southwestern North American Warm Desert Freshwater Bosque & Marsh
M076. Warm Desert Lowland Freshwater Shrubland, Meadow & Marsh
G533. North American Warm Desert Riparian Low Bosque & Shrubland
<i>Baccharis emoryi</i> - <i>Baccharis sergiloides</i> Dry Wash Shrubland
<i>Prosopis glandulosa</i> - <i>Prosopis velutina</i> - <i>Prosopis pubescens</i> Riparian Forest, Woodland & Shrubland
<i>Salix exigua</i> Warm Desert Riparian*
<i>Vitis arizonica</i> - <i>Vitis girdiana</i> Shrubland
G545. Colorado Plateau Hanging Garden Seep**
<i>Calamagrostis scopulorum</i> - <i>Andropogon glomeratus</i>
Saturated Hanging Garden Herbaceous*
2.C.5. Salt Marsh
2.C.5.Nd. North American Western Interior Brackish Marsh
M082. Warm & Cool Desert Alkali-Saline Wetland
G537. North American Desert Alkaline-Saline Shrub Wetland
<i>Allenrolfea occidentalis</i> Shrubland**
<i>Atriplex lentiformis</i> Shrubland
<i>Pluchea sericea</i> Shrubland
<i>Suaeda moquinii</i> - <i>Salicornia rubra</i> Alkaline Scrub
G538. North American Desert Alkaline-Saline Herbaceous Wetland & Playa
<i>Distichlis spicata</i> Alkaline Wet Meadow**
<i>Muhlenbergia asperifolia</i> - <i>Spartina gracilis</i> - <i>Sporobolus airoides</i> Alkaline Herbaceous**
3. Desert & Semi-Desert
3.A. Warm Desert & Semi-Desert Woodland, Scrub & Grassland
3.A.2. Warm Desert & Semi-Desert Scrub & Grassland
3.A.2.Na. North American Warm Desert Scrub & Grassland
M088. Mojave-Sonoran Semi-Desert Scrub
G293. Sonoran Paloverde - Mixed Cacti Desert Scrub
<i>Carnegiea gigantea</i> - <i>Parkinsonia microphylla</i> - <i>Prosopis velutina</i> Desert Scrub
<i>Simmondsia chinensis</i> - <i>Canotia holacantha</i> - <i>Eriogonum fasciculatum</i> Desert Scrub**
G295. Mojave-Sonoran Bajada & Valley Desert Scrub
<i>Ambrosia dumosa</i> Desert Dwarf Scrub
<i>Encelia farinosa</i> Desert Scrub
<i>Fouquieria splendens</i> Desert Scrub
<i>Larrea tridentata</i> - <i>Ambrosia dumosa</i> Bajada & Valley Desert Scrub

Table 5. List of vegetation alliances, nested within the NVC hierarchy, found at LAKE (continued).

Class	Subclass	Formation	Division	Macrogroup	Group	Alliance
						<i>Larrea tridentata</i> - <i>Encelia farinosa</i> Upper Bajada & Rock Outcrop Desert Scrub
						<i>Larrea tridentata</i> Desert Scrub
						<i>Opuntia bigelovii</i> Shrubland
					G675.	North American Warm Semi-Desert Dunes & Sand Flats
						<i>Dicoria canescens</i> - <i>Abronia villosa</i> - <i>Panicum urvilleanum</i> Dune
						<i>Pleuraphis rigida</i> Herbaceous
					M092.	North American Warm-Desert Xeric-Riparian Scrub
					G541.	Warm Semi-Desert Shrub & Herb Dry Wash & Colluvial Slope
						<i>Acacia greggii</i> - <i>Hyptis emoryi</i> - <i>Justicia californica</i> Desert Wash
						<i>Chilopsis linearis</i> - <i>Psoralea argophylla</i> Desert Wash
						Desert Wash and River Bottom Sparsely Vegetated*
						<i>Ericameria paniculata</i> Mojave Desert Wash
						<i>Fallugia paradoxa</i> Wash**
						<i>Hymenoclea salsola</i> - <i>Bebbia juncea</i> Mojave-Sonoran Desert Wash
						<i>Prunus fasciculata</i> - <i>Salazaria mexicana</i> Northern Mojave Desert Wash
						<i>Psoralea argophylla</i> - <i>Psoralea polydenia</i> Wash
					M117.	North American Warm Semi-Desert Cliff, Scree & Rock Vegetation
					G569.	North American Warm Semi-Desert Cliff, Scree & Pavement Sparse Vegetation
						<i>Aloysia wrightii</i> - <i>Pericoma caudata</i> - <i>Ephedra nevadensis</i> Sparsely Vegetated Bedrock Cliff & Lava Field
						<i>Atriplex hymenelytra</i> Shrubland
						<i>Chorizanthe rigida</i> - <i>Geraea canescens</i> Desert Pavement
						<i>Peucephyllum schottii</i> Shrubland
					M512.	North American Warm Desert Ruderal Scrub & Grassland
					G677.	North American Warm Desert Ruderal Scrub & Grassland
						<i>Brassica tournefortii</i> and Other Mustards Ruderal Herbaceous
						<i>Bromus rubens</i> - <i>Schismus arabicus</i> - <i>Schismus barbatus</i> Ruderal Herbaceous
3.B.	Cool Semi-Desert Scrub & Grassland					
	3.B.1.	Cool Semi-Desert Scrub & Grassland				
		3.B.1.Ne.	Western North American Cool Semi-Desert Scrub & Grassland			
		M093.	Great Basin Saltbush Scrub			
		G300.	Intermountain Shadscale - Saltbush Scrub			
			<i>Atriplex canescens</i> Shrubland			
			<i>Atriplex confertifolia</i> Shrubland			
			<i>Atriplex polycarpa</i> Shrubland			

Table 5. List of vegetation alliances, nested within the NVC hierarchy, found at LAKE (continued).

Class
Subclass Formation Division Macrogroup Group Alliance
M118. Intermountain Basins Cliff, Scree & Badland Sparse Vegetation
G570. Intermountain Basins Cliff, Scree & Badland Sparse Vegetation
<i>Ephedra</i> spp. - <i>Leymus salinus</i> - <i>Eriogonum corymbosum</i> Badlands Cold Desert Sparse Vegetation
M171. Great Basin & Intermountain Dry Shrubland & Grassland
G296. Mojave Mid-Elevation Mixed Desert Scrub
<i>Coleogyne ramosissima</i> Mojave Desert Shrubland
**
<i>Eriogonum wrightii</i> - <i>Eriogonum heermannii</i> - <i>Buddleja utahensis</i> Shrubland
<i>Eriogonum fasciculatum</i> - <i>Viguiera parishii</i> Shrubland
<i>Juniperus californica</i> Wooded Shrubland
<i>Lycium andersonii</i> - <i>Lycium cooperi</i> Shrubland
<i>Mortonia utahensis</i> Shrubland
<i>Opuntia acanthocarpa</i> Shrubland
<i>Yucca brevifolia</i> Wooded Shrubland
<i>Yucca schidigera</i> Shrubland
G310. Intermountain Semi-Desert Shrubland & Steppe
<i>Gutierrezia sarothrae</i> - <i>Gutierrezia microcephala</i> Dwarf-shrubland**
<i>Krascheninnikovia lanata</i> Dwarf-shrubland & Dwarf-shrub Herbaceous
G311. Intermountain Semi-Desert Grassland
<i>Achnatherum hymenoides</i> - <i>Pseudoroegneria spicata</i> - <i>Muhlenbergia pungens</i> Herbaceous*
<i>Sphaeralcea ambigua</i> Herbaceous*
G312. Colorado Plateau Blackbrush - Mormon-tea Shrubland
<i>Ephedra viridis</i> Colorado Plateau Shrubland
7. Agricultural & Developed Vegetation
7.C Herbaceous & Woody Developed Vegetation
7.C.2 Other Developed Vegetation
7.C.2.1 Other Developed Vegetation
CGR039 and CGR040. Shrub & Herb Developed Vegetation and Tree Developed Vegetation
CSG045 and CSG047. Temperate Shrub & Herb Developed Vegetation and Temperate Tree Developed Vegetation**
<i>Tamarix aphylla</i> Planted**
12.B.x. Unconsolidated Natural Bare Areas Landform
12.B.x.x. Unconsolidated Natural Bare Areas Landform
U002. Unconsolidated Natural Bare Areas Landform
U002. Unconsolidated Natural Bare Areas Landform
Playa Mapping Unit**

*Types not sampled during the classification stage at LAKE but expected in study area are denoted with *.

**Types either found during the map accuracy assessment field sampling or found in the map product, including at the border with GRCA-PARA, are denoted with **.

Table 6. List of vegetation alliances at LAKE and Newberry Mountains, including the current and former NVC alliance names. The table is organized by life form and sorted by current NVC alliance scientific name, and includes the alliance code (e.g., A####, or “Park Special” code) and vegetation sample size (N).

Current Name (NVC or other)	Alliance Code	N	Former Alliance Name	Former Code
Forest, Woodland, and Wooded Shrubland				
<i>Chilopsis linearis</i> - <i>Psoralea argophylla</i> Desert Wash	A1044	5	<i>Chilopsis linearis</i> Woodland	A.1044
		1	<i>Psoralea argophylla</i> Woodland	PS.015
<i>Juniperus californica</i> Wooded Shrubland	A0502	7	<i>Juniperus californica</i> Wooded Shrubland	A.502
<i>Phoenix dactylifera</i> - <i>Washingtonia filifera</i> Ruderal Woodland	A4161	2	<i>Washingtonia filifera</i> Woodland	A.485
<i>Pinus monophylla</i> - <i>Juniperus osteosperma</i> / Shrub Understory Woodland	A2108	3	<i>Pinus monophylla</i> -(<i>Juniperus osteosperma</i>) Woodland	A.543
<i>Populus fremontii</i> - <i>Fraxinus velutina</i> - <i>Salix gooddingii</i> Flooded Forest & Woodland	A3803	3	<i>Populus fremontii</i> Forest	A.313
<i>Prosopis glandulosa</i> - <i>Prosopis velutina</i> - <i>Prosopis pubescens</i> Riparian Forest, Woodland & Shrubland	A3877	21	<i>Prosopis glandulosa</i> Woodland	A.1031
		15	<i>Prosopis pubescens</i> Woodland	A.1042
<i>Salix gooddingii</i> - <i>Salix laevigata</i> - <i>Salix lucida</i> Riparian Forest	A3752	2	<i>Salix gooddingii</i> Woodland	A.640
		-	<i>Salix laevigata</i> Woodland*	A.646
<i>Tamarix</i> spp. Planted Woodland**	cf. A0842	-	<i>Tamarix</i> spp. Planted Woodland**	A.842
<i>Yucca brevifolia</i> Wooded Shrubland	A3148	4	<i>Yucca brevifolia</i> Wooded Shrubland	A.884
Shrubland				
<i>Acacia greggii</i> - <i>Hyptis emoryi</i> - <i>Justicia californica</i> Desert Wash	A4187	18	<i>Acacia greggii</i> Shrubland	A.1036
		1	<i>Hyptis emoryi</i> Shrubland	A.2537
<i>Allenrolfea occidentalis</i> - <i>Isocoma acradenia</i> Shrubland**	A0866	-	<i>Allenrolfea occidentalis</i> Shrubland**	A.866
<i>Ambrosia dumosa</i> Desert Dwarf Scrub	A3279	19	<i>Ambrosia dumosa</i> Shrubland	PS.012
<i>Atriplex canescens</i> Shrubland	A0869	2	<i>Atriplex canescens</i> Shrubland	A.869
<i>Atriplex confertifolia</i> Shrubland	A0870	3	<i>Atriplex confertifolia</i> Shrubland	A.870
<i>Atriplex lentiformis</i> Shrubland	A3173	2	<i>Atriplex lentiformis</i> Shrubland	PS.006
<i>Atriplex polycarpa</i> Shrubland	A3174	1	<i>Atriplex polycarpa</i> Shrubland	A.873
<i>Baccharis emoryi</i> - <i>Baccharis sergiloides</i> Dry Wash Shrubland	A3874	9	<i>Baccharis sergiloides</i> Shrubland	A.2531

Table 6. List of vegetation alliances at LAKE and Newberry Mountains, including the current and former NVC alliance names. The table is organized by life form and sorted by current NVC alliance scientific name, and includes the alliance code (e.g., A####, or “Park Special” code) and vegetation sample size (N) (continued).

Current Name (NVC or other)	Alliance Code	N	Former Alliance Name	Former Code
<i>Carnegiea gigantea</i> - <i>Parkinsonia microphylla</i> - <i>Prosopis velutina</i> Desert Scrub	A3282	8	<i>Parkinsonia microphylla</i> Shrubland	A.883
<i>Coleogyne ramosissima</i> Mojave Desert Shrubland	A3144	11	<i>Coleogyne ramosissima</i> Shrubland	A.874
<i>Encelia farinosa</i> Desert Scrub	cf. A3278	30	<i>Encelia farinosa</i> Shrubland	PS.013
<i>Ephedra fasciculata</i> Shrubland**	A3139	-	<i>Ephedra (fasciculata, nevadensis)**</i>	A.857
<i>Ephedra viridis</i> Colorado Plateau Shrubland	A3201	2	<i>Ephedra viridis</i> Shrubland	A.858
<i>Ericameria paniculata</i> Mojave Desert Wash	A2509	6	<i>Ericameria paniculata</i> Shrubland	A.2509
<i>Eriogonum fasciculatum</i> - <i>Viguiera parishii</i> Shrubland	A3150	40	<i>Eriogonum fasciculatum</i> – <i>Viguiera parishii</i> Shrubland	PS.011
<i>Eriogonum wrightii</i> - <i>Eriogonum heermannii</i> - <i>Buddleja utahensis</i> Shrubland	A4167	1	<i>Eriogonum heermannii</i> Shrubland	PS.008
<i>Fallugia paradoxa</i> Wash**	A3259	-	<i>Fallugia paradoxa**</i>	A.934
<i>Fouquieria splendens</i> Desert Scrub	cf. A3278	5	<i>Fouquieria splendens</i> Shrubland	A.863
<i>Gutierrezia sarothrae</i> - <i>Gutierrezia microcephala</i> Dwarf-shrubland**	A3203	-	<i>Gutierrezia (microcephala, sarothrae)**</i>	A.2528
<i>Hymenoclea salsola</i> - <i>Bebbia juncea</i> Mojave-Sonoran Desert Wash	A4188	35	<i>Hymenoclea salsola</i> Shrubland	A.2512
<i>Krascheninnikovia lanata</i> Dwarf-Shrubland & Dwarf-shrub Herbaceous	A3202	1	<i>Krascheninnikovia lanata</i> Shrubland	A.1104
<i>Larrea tridentata</i> - <i>Ambrosia dumosa</i> Bajada & Valley Desert Scrub	A3277	10	<i>Larrea tridentata</i> – <i>Ambrosia dumosa</i> Dune	PS.030
		141	<i>Larrea tridentata</i> – <i>Ambrosia dumosa</i> Shrubland	A.2532
<i>Larrea tridentata</i> - <i>Encelia farinosa</i> Upper Bajada & Rock outcrop Desert Scrub	cf. A3278	47	<i>Larrea tridentata</i> – <i>Encelia farinosa</i> Shrubland	A.2533
<i>Larrea tridentata</i> Desert Scrub	cf. A3278	25	<i>Larrea tridentata</i> Shrubland	A.851
<i>Lycium andersonii</i> - <i>Lycium cooperi</i> Shrubland	A3142	1	<i>Lycium (andersonii, cooperi)</i> Shrubland	na
<i>Mortonia utahensis</i> Shrubland	A4158	5	<i>Mortonia utahensis</i> Shrubland	PS.009
<i>Opuntia acanthocarpa</i> Shrubland	A4156	2	<i>Cylindropuntia acanthocarpa</i> Shrubland	na
<i>Opuntia bigelovii</i> Shrubland	A3146	8	<i>Cylindropuntia bigelovii</i> Shrubland	A.877
<i>Pluchea sericea</i> Shrubland	A0798	16	<i>Pluchea sericea</i> Shrubland	A.798
<i>Prunus fasciculata</i> - <i>Salazaria mexicana</i> Northern Mojave Desert Wash	A4185	3	<i>Prunus fasciculata</i> – <i>Salazaria mexicana</i> Shrubland	A.2519

Table 6. List of vegetation alliances at LAKE and Newberry Mountains, including the current and former NVC alliance names. The table is organized by life form and sorted by current NVC alliance scientific name, and includes the alliance code (e.g., A####, or “Park Special” code) and vegetation sample size (N) (continued).

Current Name (NVC or other)	Alliance Code	N	Former Alliance Name	Former Code
<i>Psorothamnus fremontii</i> - <i>Psorothamnus polydenius</i> Wash	A4186	11	<i>Psorothamnus</i> (<i>arborescens</i> , <i>fremontii</i> , <i>polydenius</i>) Shrubland	PS.014
<i>Quercus turbinella</i> Shrubland	A0793	11	<i>Quercus turbinella</i> Shrubland	A.793
<i>Salix exigua</i> Warm Desert Riparian Shrubland*	A0947	-	<i>Salix exigua</i> Shrubland*	A.649
<i>Simmondsia chinensis</i> - <i>Canotia holacantha</i> - <i>Eriogonum fasciculatum</i> Desert Scrub**	A3283	-	<i>Canotia holacantha</i> Association**	CEGL 005296
<i>Suaeda moquinii</i> - <i>Salicornia rubra</i> Alkaline Scrub	A3880	1	<i>Suaeda moquinii</i> Shrubland	A.941
<i>Tamarix</i> spp. Ruderal Temporarily Flooded Shrubland	cf. A0842	15	<i>Tamarix</i> spp. Semi-natural Shrubland	A.842
<i>Vitis arizonica</i> - <i>Vitis girdiana</i> Shrubland	A4162	12	<i>Vitis</i> (<i>arizonica</i> , <i>girdiana</i>) Shrubland	PS.001
<i>Yucca schidigera</i> Shrubland	A3147	7	<i>Yucca schidigera</i> Shrubland	A.881
Herbaceous				
<i>Achnatherum hymenoides</i> - <i>Pseudoroegneria spicata</i> - <i>Muhlenbergia pungens</i> Herbaceous*	A1262	-	<i>Achnatherum hymenoides</i> Herbaceous*	A.1262
<i>Amsinckia menziesii</i> - <i>Amsinckia tessellata</i> - <i>Phacelia</i> spp. Herbaceous	A4182	1	<i>Amsinckia</i> (<i>menziesii</i> , <i>tessellata</i>) Herbaceous	PS.002
<i>Brassica tournefortii</i> and other Ruderal Herbaceous	cf. A4166	1	<i>Brassica tournefortii</i> and other mustards Semi-natural Herbaceous	PS.003
<i>Bromus rubens</i> - <i>Schismus arabicus</i> - <i>Schismus barbatus</i> Ruderal Herbaceous	A4121	3	<i>Bromus rubens</i> – <i>Schismus</i> (<i>arabicus</i> , <i>barbatus</i>) Semi-natural Herbaceous	PS.004
<i>Calamagrostis scopulorum</i> - <i>Andropogon glomeratus</i> Saturated Hanging Garden Herbaceous*	A2655	-	<i>Andropogon glomeratus</i> - <i>Schoenus nigricans</i> *	A.1338
<i>Cladium californicum</i> Alkaline Seep	A4164	1	<i>Cladium californicum</i> (provisional) Herbaceous	PS.005
<i>Distichlis spicata</i> Alkaline Wet Meadow**	A1332	-	<i>Distichlis spicata</i> Herbaceous**	A.1332
<i>Muhlenbergia asperifolia</i> - <i>Spartina gracilis</i> - <i>Sporobolus airoides</i> Alkaline Herbaceous**	A1334	-	<i>Sporobolus airoides</i> Herbaceous**	A.1267
<i>Phragmites australis</i> - <i>Arundo donax</i> - <i>Alopecurus pratensis</i> Native & Semi-native Flooded Herbaceous	A3847	2	<i>Phragmites australis</i> Herbaceous	A.1431
<i>Pleuraphis rigida</i> Herbaceous	A3170	1	<i>Pleuraphis rigida</i> Herbaceous	A.1246

Table 6. List of vegetation alliances at LAKE and Newberry Mountains, including the current and former NVC alliance names. The table is organized by life form and sorted by current NVC alliance scientific name, and includes the alliance code (e.g., A####, or “Park Special” code) and vegetation sample size (N) (continued).

Current Name (NVC or other)	Alliance Code	N	Former Alliance Name	Former Code
Sparsely Vegetated & Non-vegetated				
Aloysia wrightii - Pericome caudata - Ephedra nevadensis Sparsely Vegetated Bedrock Cliff & Lava Field	A4025	2	Sparsely Vegetated rock outcrop	PS.019
		1	Sparsely vegetated carbonate rock open scrub	na
Atriplex hymenelytra Shrubland	A0872	13	Atriplex hymenelytra Sparsely Vegetated	A.872
Chorizanthe rigida - Geraea canescens Desert Pavement	A4024	1	Chorizanthe rigida–Geraea canescens Desert Pavement Sparsely Vegetated	PS.017
Desert Wash and River Bottom Sparsely Vegetated**	na	-	Alluvial Wash Sparsely Vegetated**	PS.021
Dicoria canescens - Abronia villosa - Panicum urvilleanum Dune	A4026	1	Dicoria canescens–Abronia villosa Sparsely Vegetated	PS.016
Ephedra spp. - Leymus salinus - Eriogonum corymbosum Badlands Cold Desert Sparse Vegetation	A4052	15	Ephedra torreyana Sparsely Vegetated	A.2571
		9	Psoralea spp. Sparsely Vegetated	PS.018
Lake Margin**	na	-	Lake Margin**	PS.025
Montane Ravine Sparsely Vegetated**	na	-	Montane Ravine Sparsely Vegetated**	PS.020
Peucephyllum schottii Shrubland	A3143	15	Peucephyllum schottii Sparsely Vegetated	A.2516
Playa**	na	-	Playa Map Class**	PS.023

*Types not sampled during the classification stage at LAKE but expected in the study area are denoted with *.

**Types either found during the map accuracy assessment field sampling or contained in the map product, including at the border with GRCA-PARA, are denoted with **



Figure 7. Ordination for the full set of classification samples, showing with the NVC Macrogroups and correlated environmental variables ($r>0.16$)

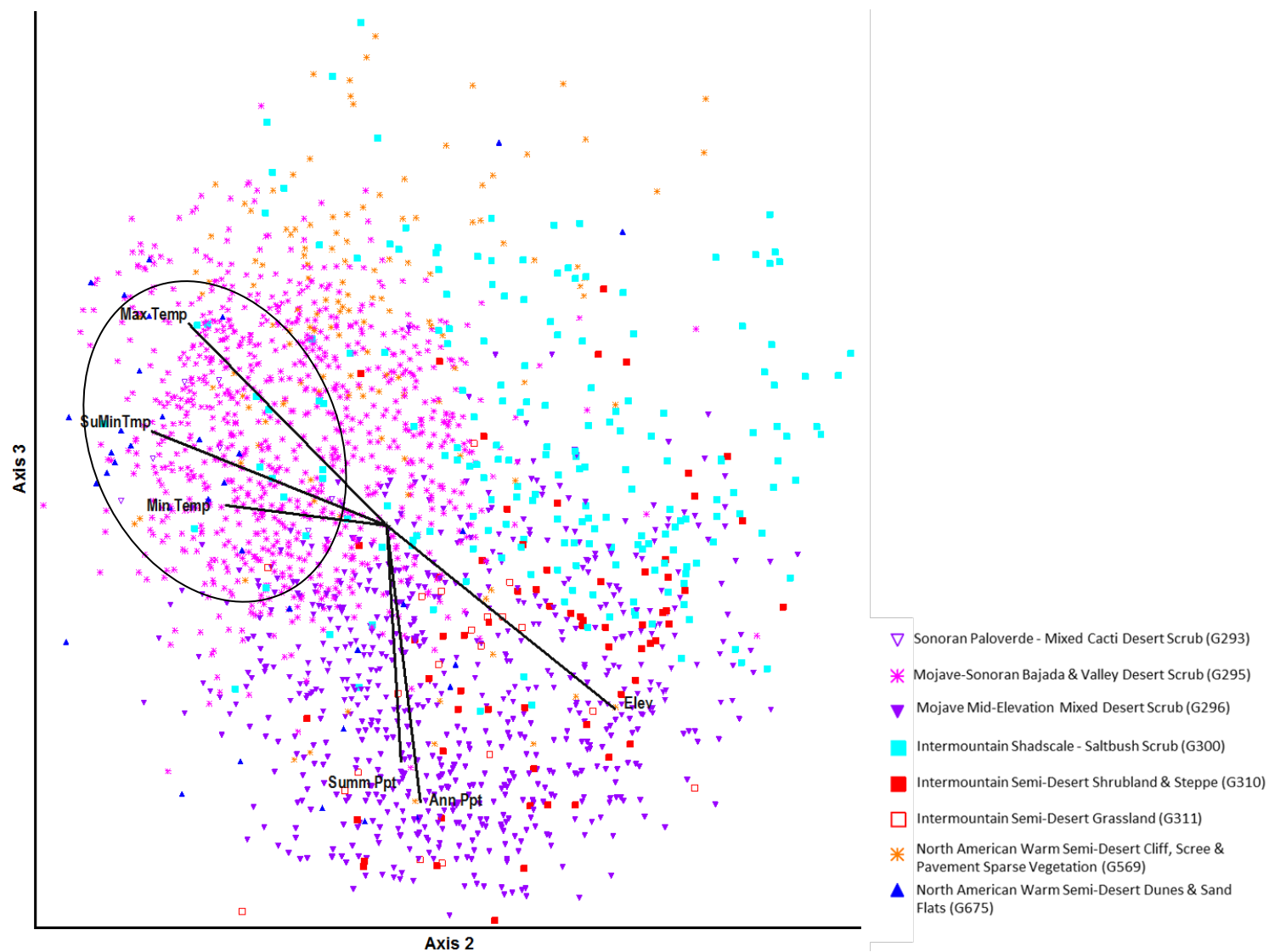


Figure 8. Ordination for a subset of classification samples, showing with the NVC Groups and correlated environmental variables ($r > 0.16$)

Based on the classification results, CNPS staff wrote a set of field keys and descriptions for both LAKE and for all three parks (DEVA, LAKE and MOJA): See Appendix C for the key written specifically for LAKE, which was field tested by NPS staff) and Colorado Natural Heritage Program Staff. This appendix also provides a cross-walk between the floristic alliance-level classification and the resulting mapping classification, as well as a primary list of species found at LAKE and used in the key. Appendix D provides the set of local alliance-level descriptions, arranged within the NVC hierarchy, for alliances sampled and found at LAKE (though including the combined data with DEVA and MOJA). The taxa found within the key and descriptions are based on USDA-NRCS (2010–2014). A species list is derived from the legacy data samples and 2010 vegetation classification samples that were analyzed for LAKE and environs (Appendix E).

From the data in this vegetation inventory project, we have classified a variety of alliances and associations that are new to the NVC (and the *Manual of California Vegetation* state classification). These include the *Cylindropuntia acanthocarpa*, *Eriogonum wrightii* - *Eriogonum heermannii* - *Buddleja utahensis*, and *Vitis arizonica* - *Vitis girdiana* shrubland alliances, and the *Chorizanthe rigida* - *Geraea canescens* desert pavement alliance. We also recommended the broadening and/or redefining of mixed species alliances, including *Eriogonum fasciculatum* - *Viguiera parishii*, *Hymenoclea salsola* - *Bebbia juncea*, *Lycium andersonii* - *Lycium cooperi*, *Prunus fasciculata* - *Salazaria mexicana*, *Psorothamnus fremontii* - *Psorothamnus polydenius* shrubland alliances, and the *Eleocharis palustris* - *Eleocharis rostellata* alkaline-saline herbaceous alliance.

CNPS and partners also have provided input on the vegetation mapping efforts at LAKE by BOR and partners. Staff at CNPS, Julie Evens, and CDFW, Todd Keeler-Wolf, reviewed the LAKE mapping classification with other partners, including Joe Stevens of the Colorado Natural Heritage Program (CNHP), in September 2012. CNPS staff participated with BOR on two map reconnaissance trips (in January and April, 2013), and we have provided general input on the ecological and floristic components of the vegetation classification. Additionally, CNPS and CNHP staff participated in training of field crews on accuracy assessment (AA) sampling at LAKE (in February 2014), which included field testing of the key, plant identification, and general overview of AA sampling. All partners also participated in the AA analysis meeting at LAKE (in August 2015) to discuss types that appeared to be misclassified or that did not meet desired accuracy.

Vegetation Mapping

Methods

After an initial draft classification of existing alliances are established the team then determines appropriate initial map classes to use to start the interpretation. Field reconnaissance typically follows this and is repeated as necessary during the mapping process. An initial vegetation map is produced and subjected to a map validation to identify any areas that may need additional attention or corrections. The final draft map is then used to select points for an accuracy assessment.

Map Classes

An initial grouping of alliances was first undertaken as a group exercise between BOR, CNPS, CNHP, LAKE, and MOJN. This discussion relied on past experience mapping desert environments, the limits of the available imagery, and the realities of sparse or rare species being reliably and consistently discernable. The creation of map classes is typically an exercise where vegetation associations or alliances are grouped together for a variety of reasons. The preferred map class designation is a one to one relationship between vegetation description (e.g. alliance, association) and map class; however this is rarely the case. Often, vegetation classification uses annual, scarce, or species in the sub-canopy (Kearsley, et al. 2015) that preclude their use as a map class. Although sub-canopy problems were not noted at LAKE, the often ephemeral and scarce occurrence of many species required their vegetation classification to be grouped. In addition, many diagnostic annual or perennial species are quite small and not discernable using 1 M resolution imagery.

Using the preliminary list of alliances within the Park a draft list of map classes was compiled. Other map classes were added as the mapping progressed. These additional map classes were typically non-vegetated cultural types such as urban or developed areas, roads, or mixed ornamentals found in campsites or boat launch areas. Additional alliances were also discovered throughout the project, either by field reconnaissance or data collected during the accuracy assessment. These new alliances were added to the initial map class to alliance table. Table 7 shows the links between LAKE final map classes and their component alliances or other groupings. These map classes are only vegetated map classes.

Table 7. LAKE map classes and component alliances.

LAKE Map Class Name	Alliance Name (NVC or other)	Alliance Common Name (NVC or other)
Fan Palm Woodland	Phoenix dactylifera - Washingtonia filifera Ruderal Woodland	Ruderal Date Palm - California Fan Palm Stands
Disturbed Grassland	Achnatherum hymenoides - Pseudoroegneria spicata - Muhlenbergia pungens Herbaceous	Indian Ricegrass - Bluebunch Wheatgrass - Sandhill Muhly Grassland
	Amsinckia menziesii - Amsinckia tessellata - Phacelia spp. Herbaceous	Fiddleneck Fields
	Brassica tournefortii and other mustards Semi-natural Herbaceous	Asian Mustard and other mustards Semi-natural Herbaceous
	Bromus rubens - Schismus arabicus - Schismus barbatus Ruderal Herbaceous	Red Brome - Arabian Schismus - Common Mediterranean Grass Ruderal Grassland
Hanging Garden	Calamagrostis scopulorum - Andropogon glomeratus Saturated Hanging Garden Herbaceous*	Arid West Saturated Hanging Garden
Joshua Tree Woodland	Yucca brevifolia Wooded Shrubland	Joshua Tree Wooded Shrubland
Juniper Woodlands	Juniperus californica Wooded Shrubland	California Juniper Wooded Shrubland
Mixed Marsh and Wetland Herbaceous Vegetation	Cladium californicum Alkaline Seep	California Sawgrass Alkaline Seep
	Phragmites australis - Arundo donax - Alopecurus pratensis Native & Semi-native Flooded Herbaceous	Western Common Reed Marsh
	Typha domingensis - Typha latifolia - Typha angustifolia Western Herbaceous Emergent	Western Emergent Cattail Marsh
Mid-Elevation Mixed Desert Scrub	Ephedra fasciculata Shrubland*	Arizona Joint-fir Shrubland
	Ephedra viridis Colorado Plateau Shrubland	Mormon Tea Scrub
	Eriogonum wrightii - Eriogonum heermannii - Buddleja utahensis Shrubland	Wright's Buckwheat - Heermann's Buckwheat - Utah Butterfly-bush Scrub
	Gutierrezia sarothrae - Gutierrezia microcephala Dwarf-shrubland*	Snakeweed Scrub
	Lycium andersonii - Lycium cooperi Shrubland	Desert-Thorn Scrub
	Mortonia utahensis Shrubland	Utah Mortonia Scrub

Table 7. LAKE map classes and component alliances (continued).

LAKE Map Class Name	Alliance Name (NVC or other)	Alliance Common Name (NVC or other)
Sonoran Live Oak Scrub Woodland	Quercus turbinella Shrubland	Sonoran Scrub Oak Chaparral
Sonoran Live Oak / Pointleaf Manzanita Scrub Woodland	Arctostaphylos pungens - Arctostaphylos pringlei - Ceanothus greggii Shrubland Alliance*	Manzanita - Ceanothus Shrubland
Palo Verde Woodland	Carnegiea gigantea - Parkinsonia microphylla - Prosopis velutina Desert Scrub	Saguaro - Yellow Paloverde - Velvet Mesquite Desert Scrub
Pinyon Pine - (Utah Juniper) Woodland	Pinus monophylla - Juniperus osteosperma / Shrub Understory Woodland	Singleleaf Pinyon – Utah Juniper Woodland
Riparian Wash Scrub Shrubland	Baccharis emoryi - Baccharis sergiloides Dry Wash Shrubland	Baccharis Dry Wash Shrubland
	Prosopis glandulosa - Prosopis velutina - Prosopis pubescens Riparian Forest, Woodland & Shrubland	Mesquite Riparian Forest, Woodland & Shrubland Alliance
	Salix exigua Warm Desert Riparian Shrubland	Narrowleaf Willow Warm Desert Riparian Shrubland
	Vitis arizonica - Vitis girdiana Shrubland	Wild Grape Desert Shrubland
Riparian Woodland	Populus fremontii Riparian Forest	Fremont cottonwood Riparian Forest
	Salix gooddingii - Salix laevigata -Salix lucida Riparian Forest	Goodding's Willow - Red Willow - Shining Willow Riparian Forest
Salt Basin Scrub Shrubland	Muhlenbergia asperifolia - Spartina gracilis - Sporobolus airoides Alkaline Herbaceous	Scratchgrass - Alkali Cordgrass - Alkali Sacaton Alkaline Grassland
	Distichlis spicata Alkaline Wet Meadow	Saltgrass Alkaline Wet Meadow
	Allenrolfea occidentalis Shrubland	Iodinebush Shrubland
	Atriplex lentiformis Shrubland	Big Saltbush Scrub
	Suaeda moquinii - Salicornia rubra Alkaline Scrub	Mojave Seablite - Red Swampfire Alkaline Scrub
Saltbush Scrub Shrubland	Atriplex canescens Shrubland	Fourwing Saltbush Scrub

Field Reconnaissance

To familiarize the mappers with the terrain and vegetation two trips were conducted in November 2012 and a subsequent trip in April of 2013. The first trip focused on the southern arm of the Park south of Hoover Dam and the north western portion of the Park along Northshore Rd and up into the Pinto Valley and Overton Arm. Technical problems with the GPS did not allow for the collection of data points in that area. The second trip included portions of the southern arm on the west side of the river, the entire southern portion of the main body of the Park in addition to a trip into the Gold Butte area. The November trip included the collection of observation points in addition to verification points and notes added to field maps. Observation points are a less intensive data point similar to what is collected for accuracy assessment points. Verification points are very quick looks at the landscape which received a visual determination of map class. Figure 9 shows the distribution of all three field data collected during both these trips. The field reports are included in Appendix N.

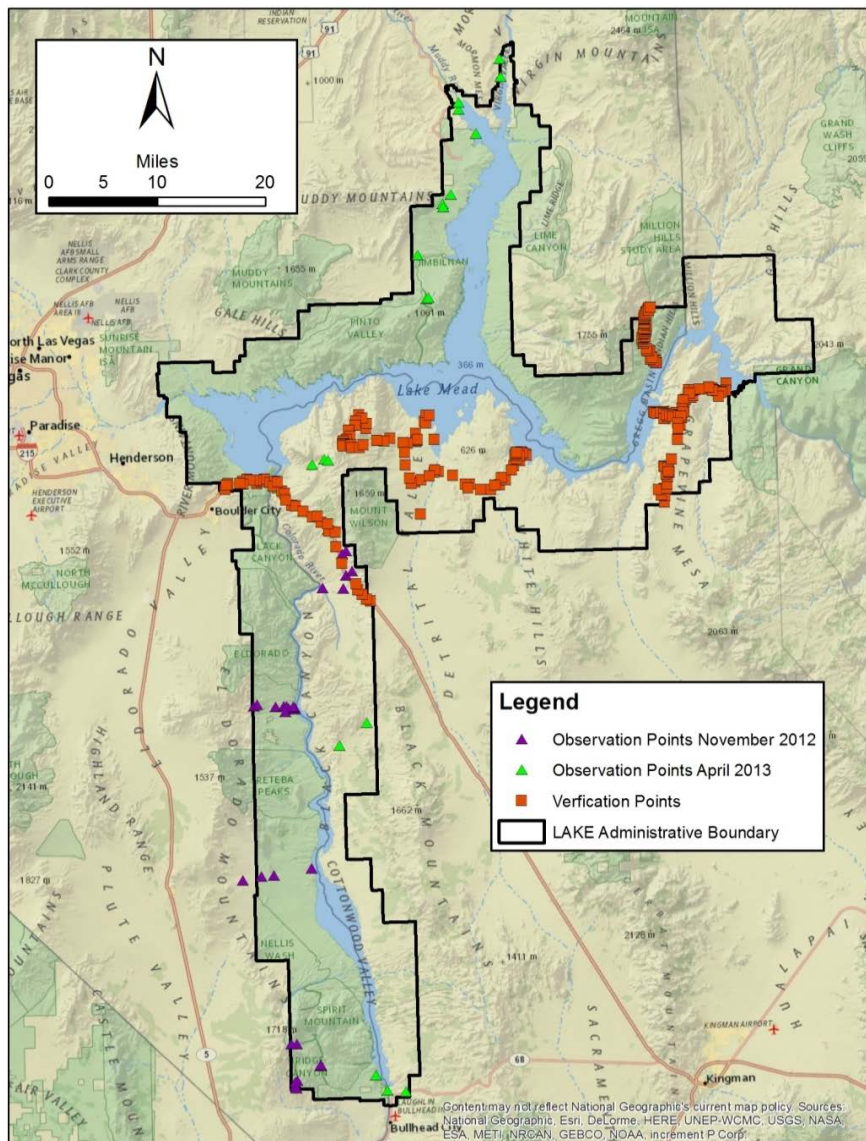


Figure 9. Distribution of observation and verification points.

Image Processing / Interpretation

The vegetation mapping followed two different methods for producing a quality product. The project initially used an object-oriented machine logic approach similar to what had been done in other parks (Kearsley, et al. 2015). This guided automation process proved unsuccessful as initial products were very unsatisfactory, primarily due to the exceedingly sparse nature of the vegetation throughout the Park and the inability to adequately resolve transition areas. Similar difficulties with image processing of sparsely vegetated areas were also acknowledged during the mapping of the adjacent Grand Canyon Vegetation mapping project (Green and Tukman 2010). The interpretation then went to a more traditional visual interpretation of the imagery which produced a much more satisfactory product, albeit with considerable additional effort. We briefly describe the initial object oriented approach below and concentrate more on the visual interpretation.

Image Sources

The base imagery for the image processing and visual interpretation was the 2013 NAIP imagery for Arizona and Nevada. Other images used as support for interpretation include 2006 QuickBird imagery for Clark County, 2011 TM imagery, ESRI streaming imagery and Google Earth.

Ancillary Data Sets

Landform: An existing landform set derived for the Southwest GAP Regional Land Cover mapping project (Lowry, et al. 2005) was used to further define and assist in the delineation of map classes. The landform model is a predictive dataset that is defined by ranges of slope angles and aspect, landform position, hydrologic relationships, and microclimatic parameters (Manis, Lowry and Ramsey 2002). The model is further refined by adjustments to a developed Topographic Relative Moisture Index (TRMI) (Parker 1982) which uses relative slope position, slope angle, slope shape, and slope aspect. Additional refinements include a landform position model and life zone stratification. The elevation dataset used for this model is 1 arc-second (approx. 30 m). Appendix G includes further description and examples.

NED: Topography is always a key dataset for analysis of vegetation patterns. In addition to the topography within the Landform dataset described above, we used National Elevation Dataset (NED) 1/3 arc-second (approx. 10 m). Using this dataset we developed elevation, slope, and aspect rasters to assist in identifying potential vegetation ranges. Appendix H shows a number of examples of this dataset.

Vegetation Density: Vegetation density was added as an additional field in the vegetation dataset. To derive the values for this attribute we used a 2011 March 23 Thematic Mapper (TM) image and a Modified Soil Adjusted Vegetation Index (MSAVI2). The MSAVI image was classified into 5 groups using 'Natural Breaks' to define the ranges. Examples of this dataset are shown and described in Appendix I.

Geology: A geology layer was included for analysis and descriptive purposes. Although geology maps are available for the entire PARK, they are in a variety of scales and have no comprehensive legend. One 1:100,000 scale digital map does exist for the Park with a southerly extent about 8 miles south of Willow Beach. Appendix J shows the extent and details of this layer.

Soils: The soils layer was derived from the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) soils database. The dataset has an extensive library of attributes. For the purposes of mapping, classification, and description, we extracted soil parent material as one of many potential attributes to assist in the mapping effort. Appendix K shows examples of this data set.

Image Processing

The initial interpretation of vegetation used a multi-spectral analysis using an object oriented paradigm using eCognition as the processing software. The advantages of an object oriented approach over traditional pixel oriented analysis are many. These include the addition to spectral analysis of spatial, morphological, contextual, and time series parameters. The object oriented approach also includes supervised classification, fuzzy logic, and rule-based classification, the inclusion of ancillary datasets and feature extraction at different resolutions (Navulur 2007).

General Processing Steps

Preprocessing

National Agriculture Image Program (NAIP) 2012 DMC 4 band, 8 bit Digital Ortho Quarter Quads (DOQQs) collected in June and July 2012 were used as the basis for image analysis. Ancillary 2006 Quickbird Multispectral pan-sharpened images for Clark County were used as reference. To facilitate the image analysis, the NAIP imagery were clipped to USGS 1:24,000 scale topographic quadrangle boundaries. The mapping boundary intersects with 104 USGS quadrangles. Landform, geology, elevation, and soil ancillary data were clipped to equivalent boundaries. Image and ancillary data were combined into working data blocks for subsequent steps

Multiresolution Segmentation

The image segmentation used is bottom-up region-merging technique and creates a multitude of individual objects that are later merged into other like objects. The four criteria used for segmentation are scale, color, smoothness, and compactness. Segmentation parameters varied from image block to image block and were modified considerably depending on existing vegetation and soil background influences. In addition to the four image bands we included landform, soils, elevation, and geology as layers.

Create General Classes

Using the list of land cover types (Table 7) we created general classes specific to each image block. To simplify the classification process, land cover types not expected to be in the image block were not included.

Classification

A number of different classification rules were tested and ultimately settled on nearest-neighbor classification. Training samples were identified using the vegetation plot database produced for this project. Additional spectrally homogenous areas were chosen as training samples for each land cover type in sites visually similar to the plot locations and were manually selected.

Photo Interpretation

On screen visual interpretation of vegetation patterns provided the bulk of the interpretation for the final product. In this effort we used existing vegetation plot data (Figure 6), three field trips where we collected observation points in addition to verification points (Figure 9 and Appendix N). The observation points are “quick plot” data collection efforts designed to rapidly collect just enough data to key a point to a map class while verification points are strictly a visual determination of map class. The rather extensive road and trail network throughout the Park allowed for excellent access to just about every area.

The photo interpretation process is a methodical approach where the interpreter determines the most common or easily discerned vegetation and then works towards the less clear or more difficult to interpret. No classic stereoscopic interpretation was available for this project which greatly helps for those more cryptic vegetation types. Typical photo interpretive methods were used and include the analysis of size (dimension), shape, pattern, tone and hue, texture, shadows, and associations or locations. Associations were determined using various ancillary data, such as geology, soils, landform, and terrain visualizations in addition to vegetation descriptions. The interpreted areas were decided upon using a convergence of multiple lines of evidence.

Areas with preliminary interpretation were visited and compared to field observations to further refine the visual interpretation of the images. The field teams used paper maps with preliminary interpretation, existing plot locations and descriptions, a preliminary map class key, and the imagery on laptop computers. Observations in the field provided for a better understanding of image signatures and additional map classes that had not been considered prior to the trip. Inclusions or exclusions were noted and drawn on the paper map for later updating in the office. Polygon boundaries were visited to determine their validity. Photographs taken at each vegetation plot location were also referenced during the photo-interpretive process.

Given the challenging visual interpretation of sparse vegetation, we also extracted from the vegetation plot data several biophysical metrics to assist in the interpretation. Using the NED we extracted the elevation (Table 8), slope (Table 9), and aspect (Table 10) ranges for each vegetation plot location and corresponding map class. From the landform dataset we extracted landform classes for each vegetation plot (Table 11). This information is used cautiously for those vegetation map classes with few plots to describe their biophysical ranges. Biophysical data were particularly helpful in drawing the boundaries to the ‘Mid-Elevation Mixed Desert Scrub’ map class. The boundaries between ‘Mid-Elevation Mixed Desert Scrub’ and the typically adjacent, but lower in elevation map class, ‘Semi-Desert Scrub Shrubland’, are indistinct. A model was created using strictly plot location elevation data for the ‘Mid-Elevation Mixed Desert Scrub’ map class to delineate its extent. Slope and aspect were not considered given the paucity of data. All model data can be estimated with greater precision post project using AA data to flesh out biophysical parameters.

Draft versions of the vegetation layer were reviewed and modified during the entire process as vegetation patterns, field visits, and comments were incorporated into the final product.

A combination of digital elevation models and NAIP imagery enabled the image interpretation. Although not flown as a stereo product, the NAIP imagery draped over the elevation model in a GIS allowed improved viewing and interpretation of the vegetation types. Additional 3-D high resolution views were available from Google Earth's web browser and were particularly helpful in the mountainous regions of the Park.

Table 8. Vegetation plot elevation ranges.

Map class Equivalent	LT 1000 (ft.)	1000 – 2000 (ft.)	2000 – 3000 (ft.)	3000 – 4000 (ft.)	GT 5000 (ft.)	Total
Black Brush Shrubland			2	5		7
Creosote Bush Shrubland	21	105	64	8		198
Dune Vegetation		2				2
Fan Palm Woodlands		2				2
Grasslands (Native and Ruderal)		1	2			3
Joshua Tree Woodland			5			5
Juniper Woodlands				2		2
Mixed Marsh and Wetland Herbaceous Vegetation		3				3
Mid-Elevation Mixed Desert Scrub			1	6	2	9
Palo Verde Woodlands	3	4				7
Pinyon Pine - (Utah Juniper) Woodlands					2	2
Riparian Wash Scrub Shrublands		5	11	7		23
Riparian Woodlands		1	3	1		5
Salt Basin Scrub Shrubland	2	1				3
Saltbush Scrub Shrublands		4				4
Semi-Desert Scrub Shrublands	7	59	23	1		90
Semi-Desert Wash Woodland/Scrub	5	43	20	8		76
Sonoran Live Oak Scrub Woodland				3	3	6
Bare Rock and Sparse Vegetation	1	34	11	1		47
Tamarisk Shrubland	3	1				4
Mojave Yucca Shrubland		6	14	16		36
Total	42	271	156	58	7	534

Table 9. Vegetation plot slope ranges (%).

Map class Equivalent	0 - 10	10 - 25	25 - 50	50 - 100	Total
Black Brush Shrubland	1	2	4		7
Creosote Bush Shrubland	95	52	36	15	198
Dune Vegetation	1	1			2
Fan Palm Woodlands	1	1			2
Grasslands (Native and Ruderal)	3				3
Joshua Tree Woodland	5				5
Juniper Woodlands		2			2
Mixed Marsh and Wetland Herbaceous Vegetation	2	1			3
Mid-Elevation Mixed Desert Scrub	1	1	4	3	9
Palo Verde Woodlands	1	3	1	2	7
Pinyon Pine - (Utah Juniper) Woodlands			1	1	2
Riparian Wash Scrub Shrublands	14	6	2	1	23
Riparian Woodlands	2	2	1		5
Salt Basin Scrub Shrubland	3				3
Saltbush Scrub Shrublands	3	1			4
Semi-Desert Scrub Shrublands	40	24	17	9	90
Semi-Desert Wash Woodland/Scrub	36	22	11	7	76
Sonoran Live Oak Scrub Woodland	2			4	6
Bare Rock and Sparse Vegetation	23	12	8	4	47
Tamarisk Shrubland	1	1	2		4
Mojave Yucca Shrubland	4	14	10	8	36
Total	238	145	97	54	534

Table 10. Vegetation plot aspect ranges.

Map class Equivalent	East	North	North east	North west	South	South east	South west	West	Total
Black Brush Shrubland	1	2	1	1		1		1	7
Creosote Bush Shrubland	33	24	18	23	22	18	31	29	198
Dune Vegetation							2		2
Fan Palm Woodlands						1		1	2
Grasslands (Native and Ruderal)	1		1			1			3
Joshua Tree Woodland	1					3		1	5
Juniper Woodlands	1					1			2
Mixed Marsh and Wetland Herbaceous Vegetation	1					1	1		3
Mid-Elevation Mixed Desert Scrub	1			3		1	1	3	9
Palo Verde Woodlands		1		1	2	1		2	7
Pinyon Pine - (Utah Juniper) Woodlands	2								2
Riparian Wash Scrub Shrublands	5	1	5		5	7			23
Riparian Woodlands			1		3	1			5
Salt Basin Scrub Shrubland	1	1						1	3
Saltbush Scrub Shrublands	2					1	1		4
Semi-Desert Scrub Shrublands	11	7	13	5	14	21	13	6	90
Semi-Desert Wash Woodland/Scrub	19	4	15	7	5	19	5	2	76
Sonoran Live Oak Scrub Woodland		2	1		1			2	6
Bare Rock and Sparse Vegetation	10		9	5	4	8	4	7	47
Tamarisk Shrubland	1			1		1		1	4
Mojave Yucca Shrubland	10	5	3	2	3	6	2	5	36
Total	100	47	67	48	59	92	60	61	534

Table 11. Vegetation plot by landform.

Map class Equivalent	Cool aspect cliffs, scarps, cirques, canyons	Flat, nearly level to gently sloping	Hot aspect cliffs, scarps, cirques, canyons	Moderately dry slopes	Moderately moist steep slopes	Very dry steep slopes	Very moist steep slopes	Total
Black Brush Shrubland		3			2		2	7
Creosote Bush Shrubland	1	130	1	28	24	5	9	198
Dune Vegetation		2						2
Fan Palm Woodlands		1			1			2
Grasslands (Native and Ruderal)		3						3
Joshua Tree Woodland		5						5
Juniper Woodlands		2						2
Mixed Marsh and Wetland Herbaceous Vegetation		3						3
Mid-Elevation Mixed Desert Scrub	2	1	2	2	2			9
Palo Verde Woodlands		3	1	1	2			7
Pinyon Pine - (Utah Juniper) Woodlands					2			2
Riparian Wash Scrub Shrublands	1	20		2				23
Riparian Woodlands		4				1		5
Salt Basin Scrub Shrubland		3						3
Saltbush Scrub Shrublands		4						4
Semi-Desert Scrub Shrublands		53	1	22	8		6	90
Semi-Desert Wash Woodland/Scrub	2	50	2	5	11		6	76
Sonoran Live Oak Scrub Woodland	2	2	1	1				6
Bare Rock and Sparse Vegetation	2	31	1	6	4		3	47
Tamarisk Shrubland		2			1		1	4
Mojave Yucca Shrubland		11		7	12	2	4	36
Total	10	333	9	74	69	8	31	534

Map Validation

The validation effort on the draft Lake Mead National Recreation Area (LAKE) vegetation map began in the fall of 2013. The validation task is a recommended step in the National Park Service (NPS) 12-Step Guidance for NPS Vegetation Inventories (National Park Service 2013). Precise protocols have not been developed or needed, and the process is similar to the accuracy assessment protocols but not as rigorous. A simple 50+ point random check can validate the map product. Although this process is called a map validation effort it also serves to test the vegetation key developed for the accuracy assessment step that follows.

Methods

The draft map was sampled using random samples within a 1.5 km buffer of roads and trails. The buffer was chosen to maintain relatively easy access to sample points. The more common vegetation types received a greater number of sample points whilst the more rare types received less to better approximate the NPS AA sampling protocol.

A total of 134 validation sample points were produced. Given the compressed time and budget constraints of the NPS Mojave Inventory and Monitoring Network (MOJN), it was decided to concentrate the validation efforts on the vegetation types that were less frequent and more prone to error than the matrix map classes (e.g. creosote) that make up most of LAKE. The vegetation map classes receiving less attention were the Creosote Bush and Semi-Desert Scrub types.

Prior to the field efforts, the Bureau of Reclamation (BOR) vegetation mapping team provided a validation protocol, sample validation field forms, training for the field crews, sample point selection and map books showing the location of the selected sampling points. The MOJN field crews were given an overview of the NPS Vegetation Inventory Program and an extensive description of the datasheets and procedures for filling out each section during a morning training session held at MOJN offices. The following afternoon meeting included field visits to three training sites with different vegetation types to test the entire validation process. Validation testing of the field crews included navigation to each point, site overview, data sheet recording, and a general discussions and questions about the entire process.

Results

Validation fieldwork was continued by the MOJN field crews after the completion of the training and testing. During an approximate 6-week period, a total of 75 validation sites were visited and vegetation data was recorded. As datasheets were reviewed and compiled by MOJN staff, they were periodically sent to the BOR mapping team for addition into a validation spatial point file (i.e. shapefile). An initial comparison of the field validation designation to the draft vegetation map showed an overall accuracy of 49%. As part of the process, all of the initial results were examined to check for data recording errors, misclassifications due to various reasons including cover values, misidentification of plant species, wrong topographic position, or problems with the key. Each validation point initially classified as an error was reviewed on the map and on the datasheet. Errors were found and results recalculated to produce a final validation accuracy of 72%. These results

include only 3 points within the Semi-Desert Scrub map class and none within the Creosote Bush map class.

Discussion

Typical errors found within the datasheets were related to problems with the key, misidentification of map class using the key or other field errors. Most of the valid errors were seen in the confusion of riparian map classes. These areas were revisited on the map and adjustments were made. One problematic map class was the Riparian Wash Scrub which is being confused with all other riparian types. Polygons mapped as this type were manually revisited and adjusted as necessary. Table 12 below shows each of the points visited, initial field call, secondary field call, office call (corrected form), and comments that describe why the field calls were revised. Table 13 summarizes the validation accuracy.

The results of the validations effort were very instructive and provided perspective and caution for the interpretation of confusing map classes. Discrepancies in the riparian vegetation map classes were disappointing. The riparian map class is not frequent on the landscape but does represent an important component to the Park therefore this map class received greater attention for the duration of the mapping effort. Black Brush was only sampled twice with complete error. Only a few areas in the Park have Black Brush in any abundance. These sites were visited during the last field trip and adjustments were made to the map. Sonoran Live Oak also shows a low accuracy however, this is a very small patch community and confusion with adjacent vegetation types are to be expected. Mid-Elevation Mixed Desert Scrub also shows a low accuracy but with only two sample points it was difficult to draw conclusions.

Table 12. Map validation sampled sites and data review.

Site No.	Class Name	Field Call 1	Secondary Field Call	Office Call	Comments	Final Call
11	Juniper Woodlands	Yucca Shrub				Yucca Shrub
12	Juniper Woodlands	Creosote Bush		Semi-Desert Wash Woodland/Scrub	Trace of Yucca - could possibly go to Yucca Shrub	Yucca Shrub
13	Juniper Woodlands	Yucca Shrub				Yucca Shrub
15	Marsh	Marsh				Marsh
17	Mid-Elevation Mixed Desert Scrub	Black brush scrub				Black brush scrub
20	Mid-Elevation Mixed Desert Scrub	Creosote Bush		Mid-Elevation Mixed Desert Scrub	LATR below 2%, presence of Ephedra, Acacia, and Sphaeralcea puts this into Mid-Elevation type	Mid-Elevation Mixed Desert Scrub
21	Semi-Desert Scrub	Creosote Bush		Semi-Desert Scrub	LATR below 2%, presence of AMDU, ENFA puts this to Semi-Desert Scrub	Semi-Desert Scrub
22	Semi-Desert Wash Woodland/Scrub	Semi-Desert Wash Woodland/Scrub			Fixed after points selected and prior to field work - OK	Semi-Desert Wash Woodland/Scrub
23	Semi-Desert Wash Woodland/Scrub	Semi-Desert Wash Woodland/Scrub			Fixed after points selected and prior to field work - OK	Semi-Desert Wash Woodland/Scrub
24	Semi-Desert Wash Woodland/Scrub	Semi-Desert Wash Woodland/Scrub			Fixed after points selected and prior to field work - OK	Semi-Desert Wash Woodland/Scrub
25	Semi-Desert Wash Woodland/Scrub	Semi-Desert Wash Woodland/Scrub			Fixed after points selected and prior to field work - OK	Semi-Desert Wash Woodland/Scrub
26	Riparian Wash Scrub	Tamarisk				Tamarisk
27	Riparian Wash Scrub	Riparian Woodlands				Riparian Woodlands
28	Riparian Wash Scrub	Tamarisk				Tamarisk
32	Semi-Desert Scrub	Semi-Desert Scrub				Semi-Desert Scrub
34	Semi-Desert Wash Woodland/Scrub	Creosote Bush		Semi-Desert Wash Woodland/Scrub		Semi-Desert Wash Woodland/Scrub
35	Semi-Desert Wash Woodland/Scrub	Creosote Bush		Semi-Desert Wash Woodland/Scrub	Plot in wash - bad call	Semi-Desert Wash Woodland/Scrub

Table 12. Map validation sampled sites and data review (continued).

Site No.	Class Name	Field Call 1	Secondary Field Call	Office Call	Comments	Final Call
37	Semi-Desert Wash Woodland/Scrub	Semi-Desert Wash Woodland/Scrub			Erroneous name on field sheet. Semi-Desert Wash Woodland/Scrub	Semi-Desert Wash Woodland/Scrub
38	Semi-Desert Wash Woodland/Scrub	Creosote Bush	Yucca Shrub	Semi-Desert Wash Woodland/Scrub	In a wash - Semi-Desert Wash Woodland/Scrub	Semi-Desert Wash Woodland/Scrub
39	Sparse Vegetation	Creosote Bush		Sparse Vegetation	LATR less than 2% - bad call - map OK	Sparse Vegetation
40	Sparse Vegetation	Creosote Bush			LATR under 1% could go to Sparse - image looks like LATR	Sparse Vegetation
41	Sparse Vegetation	Sparse Vegetation				Sparse Vegetation
42	Sparse Vegetation	Sparse Vegetation				Sparse Vegetation
43	Tamarisk	Tamarisk				Tamarisk
44	Tamarisk	Tamarisk				Tamarisk
45	Tamarisk	Tamarisk				Tamarisk
46	Tamarisk	Tamarisk				Tamarisk
52	Black brush scrub	Yucca Shrub				Yucca Shrub
55	Black brush scrub	Semi-Desert Scrub			Could possibly be Yucca Shrub - density YUSC = LA*	Semi-Desert Scrub
56	Oak Woodlands	Yucca Shrub		Semi-Desert Wash Woodland/Scrub	YUSC GT AMDU - should be YUSC plot?	Yucca schidigera
66	Fan Palm Woodlands	Fan Palm Woodlands				Fan Palm Woodlands
67	Fan Palm Woodlands	Fan Palm Woodlands				Fan Palm Woodlands
68	Fan Palm Woodlands	Fan Palm Woodlands				Fan Palm Woodlands
69	Fan Palm Woodlands	Fan Palm Woodlands				Fan Palm Woodlands
70	Fan Palm Woodlands	Fan Palm Woodlands				Fan Palm Woodlands
72	Saltbush Scrub	Sparse Vegetation		Saltbush Scrub	Trace ATCO not keying to Saltbush Scrub	Saltbush Scrub

Table 12. Map validation sampled sites and data review (continued).

Site No.	Class Name	Field Call 1	Secondary Field Call	Office Call	Comments	Final Call
73	Saltbush Scrub	Sparse Vegetation		Saltbush Scrub	Trace ATCO not keying to Saltbush Scrub	Saltbush Scrub
74	Saltbush Scrub	Tamarisk				Tamarisk
75	Saltbush Scrub	Semi-Desert Wash Woodland/Scrub		Semi-Desert Wash Woodland/Scrub	Not a half hectare - keep map designation	Saltbush Scrub
76	Marsh	Marsh				Marsh
78	Riparian Wash Scrub	Riparian Woodlands				Riparian Woodlands
87	Juniper Woodlands	Juniper Woodlands				Juniper Woodlands
88	Juniper Woodlands	Juniper Woodlands				Juniper Woodlands
95	Riparian Wash Scrub	Semi-Desert Wash Woodland/Scrub				Semi-Desert Wash Woodland/Scrub
96	Riparian Wash Scrub	Creosote Bush				Creosote Bush
97	Riparian Wash Scrub	Tamarisk				Tamarisk
98	Riparian Wash Scrub	Tamarisk				Tamarisk
99	Riparian Wash Scrub	Semi-Desert Wash Woodland/Scrub				Semi-Desert Wash Woodland/Scrub
103	Semi-Desert Scrub	Semi-Desert Scrub				Semi-Desert Scrub
105	Semi-Desert Wash Woodland/Scrub	Semi-Desert Wash Woodland/Scrub				Semi-Desert Wash Woodland/Scrub
106	Semi-Desert Wash Woodland/Scrub	Creosote Bush		Semi-Desert Wash Wood-land/ Scrub	point lands in a wash	Semi-Desert Wash Woodland/Scrub
108	Semi-Desert Wash Woodland/Scrub	Semi-Desert Scrub		Semi-Desert Wash Wood-land/ Scrub	point falls within a wash	Semi-Desert Wash Woodland/Scrub
110	Sonoran Live Oak Scrub	Sonoran Live Oak Scrub				Sonoran Live Oak Scrub
111	Sonoran Live Oak Scrub	Sonoran Live Oak Scrub				Sonoran Live Oak Scrub

Table 12. Map validation sampled sites and data review (continued).

Site No.	Class Name	Field Call 1	Secondary Field Call	Office Call	Comments	Final Call
112	Sonoran Live Oak Scrub	Semi-Desert Wash Woodland/Scrub				Semi-Desert Wash Woodland/Scrub
113	Sonoran Live Oak Scrub	Semi-Desert Wash Woodland/Scrub				Semi-Desert Wash Woodland/Scrub
114	Sonoran Live Oak Scrub	Semi-Desert Wash Woodland/Scrub				Semi-Desert Wash Woodland/Scrub
117	Sparse Vegetation	Sparse Vegetation				Sparse Vegetation
118	Sparse Vegetation	Semi-Desert Scrub			very sparse vegetation noted on field form - could go to sparse vegetation?	Sparse Vegetation
119	Tamarisk	Tamarisk				Tamarisk
120	Tamarisk	Tamarisk				Tamarisk
121	Tamarisk	Tamarisk				Tamarisk
122	Tamarisk	Tamarisk				Tamarisk
123	Yucca Shrub	Juniper Woodlands		Yucca Shrub	Yucca Shrub some noted in data sheet	Yucca Shrub
124	Yucca Shrub	Semi-Desert Scrub		Yucca Shrub	Could be YUSC - 'present' amounts as are most spe	Yucca Shrub
125	Yucca Shrub	Creosote Bush				Creosote Bush
126	Yucca Shrub	Yucca Shrub				Yucca Shrub
127	Yucca Shrub	Yucca Shrub				Yucca Shrub
128	Riparian Woodlands	Tamarisk		Riparian Woodlands	Riparian woodlands - plenty present here	Riparian Woodlands
129	Riparian Woodlands	Tamarisk		Riparian Woodlands	Cottonwood / Salix obvious in imagery. Site impossible to get to but surrounded by Tamarisk	Riparian Woodlands
130	Palo Verde	Palo Verde				Palo Verde
131	Palo Verde	Palo Verde				Palo Verde

Table 12. Map validation sampled sites and data review (continued).

Site No.	Class Name	Field Call 1	Secondary Field Call	Office Call	Comments	Final Call
132	Palo Verde	Palo Verde				Palo Verde
133	Palo Verde	Palo Verde				Palo Verde
134	Palo Verde	Palo Verde				Palo Verde

Table 13. Map validation summary.

Map class Name	Number of points	Accuracy %
Black brush scrub	2	0
Fan Palm Woodlands	5	100
Juniper Woodlands	5	40
Marsh	2	100
Mid-Elevation Mixed Desert Scrub	2	50
Palo Verde	5	100
Riparian Wash Scrub	9	0
Riparian Woodlands	2	100
Saltbush Scrub	4	75
Semi-Desert Scrub	3	100
Semi-Desert Wash Woodland/Scrub	11	100
Sonoran Live Oak Scrub	6	33
Sparse Vegetation	6	100
Tamarisk	8	100
Yucca Shrub	5	80

Vegetation Mapping - Results

Map Classes

A summary of the map classes is detailed in Table 14 below. The table shows the map class name, the polygon frequency, and area in both acres and hectares. Formation level descriptions, where appropriate, are also included as group headings. More detailed descriptions of each type are included following this section. Detailed information about the component alliances for each map class may be found in Appendix D.

Table 14. Summary of vegetation classification and mapping results.

Map class	Frequency	Acres	Hectares
Woodland			
Pinyon Pine - (Utah Juniper) Woodlands	10	200	81
Juniper Woodlands	22	888	359
Fan Palm Woodland	10	9	4
Palo Verde Woodlands	57	1,139	461
Joshua Tree Woodland	301	8,882	3,595
Riparian Woodlands	108	307	124
Sonoran Live Oak Scrub Woodland	69	419	169
Mixed Ornamental and Semi-natural Woodland	30	78	32
Shrubland			
Riparian Wash Scrub Shrublands	598	1,142	462
Mid-Elevation Mixed Desert Scrub	464	35,699	14,447
Mojave Yucca Shrubland	530	15,300	6,192
Blackbrush Shrubland	153	3,217	1,302
Semi-Desert Scrub Shrublands	5,339	208,282	84,289
Creosote Bush Shrubland	8,343	512,966	207,590
Semi-Desert Wash Woodland / Scrub	2,637	90,584	36,658
Saltbush Scrub Shrublands	44	1,401	567
Salt Basin Scrub Shrubland	4	10	4
Map class	Frequency	Acres	Hectares
Tamarisk Shrubland	1,064	29,058	11,759
Manzanita - Sonoran scrub oak Shrubland Alliance	31	43	21
Wooded Herbaceous			
Mixed Marsh and Wetland Herbaceous Vegetation	13	51	31

Table 14. Summary of vegetation classification and mapping results (continued).

Map class	Frequency	Acres	Hectares
Herbaceous			
Grasslands (Native and Ruderal)	144	850	344
Dune Vegetation	125	4,993	2,021
Colorado Plateau Hanging Garden Seep Group	3	4	2
Big Galleta Herbaceous Vegetation	3	7	3
Sparsely Vegetated			
Bare Rock and Sparse Vegetation	1,635	39,437	15,959
Beach and Barren Sand Draw-down Area	975	32,150	13,011
Cropland			
Agricultural Land	41	499	202
Urban			
Transportation / Roads / Trails	105	4,794	1,940
Urban or Developed Areas	212	759	307
Water			
Open Water	43	118,790	48,073
Total	23,114	1,111,992	450,007

Map class Descriptions

Each map class description provides an overall perspective of the vegetation within. Included are photographs, distribution map, and summaries of a number of biophysical properties for the mapped polygons. Table 15 summarizes the mapping results by map class and includes map class names, polygon frequency, and area in acres and hectares. The alliances that make up the map classes are listed in Table 15. Complete descriptions of the component alliances are in Appendix D and in a relate table in the geodatabase that includes links to full NatureServe descriptions. Map classes are given descriptive names and these are either the name of the alliance if only one alliance occurs per map class, or, if multiple alliances exist for a map class, then a more general name is used. Mapped occurrences of each map class are highlighted in red for each distribution figure. Locations of sparse and small map classes are overrepresented in the figures solely for illustrative purposes and do not represent their actual areal extent. Those alliances found only within the GRCA / PARA portion of the map are noted with an *. No plot data were collected for the asterisked types during this effort. Details of these types may be found in the GRCA / PARA vegetation mapping report (Kearsley, et al. 2015).

The following map class descriptions are compiled from a number of sources. These include this document, (Ecological Society of America 2015), (Sawyer, Keeler-Wolf and Evens 2009), and (Evens and Sikes 2015).

Table 15. Map class names and component alliances.

LAKE Map Class Name	Alliance Name (NVC or other)	CEGL Code(s)	Macro group Code(s)	Alliance Code(s)
Woodland				
Pinyon Pine - (Utah Juniper) Woodlands	<i>Pinus monophylla</i> - <i>Juniperus osteosperma</i> / Shrub Understory Woodland	CEGL002941	MG026.	A2108
Juniper Woodlands	<i>Juniperus californica</i> Wooded Shrubland	na	MG088.	A4161
Fan Palm Woodland	<i>Phoenix dactylifera</i> - <i>Washingtonia filifera</i> Ruderal Woodland	na	MG036	A4161
Palo Verde Woodlands	<i>Carnegiea gigantea</i> - <i>Parkinsonia microphylla</i> - <i>Prosopis velutina</i> Desert Scrub	na	na	A4161
Joshua Tree Woodland	<i>Yucca brevifolia</i> Wooded Shrubland	CEGL003116, CEGL005294	MG088.	A3148
Riparian Woodlands	<i>Populus fremontii</i> - <i>Fraxinus velutina</i> - <i>Salix gooddingii</i> Flooded Forest & Woodland Alliance	na	MG036.	A3803
	<i>Salix gooddingii</i> - <i>Salix laevigata</i> - <i>Salix lucida</i> Riparian Forest	CEGL002743	MG036.	A3752, A3803
Sonoran Live Oak Scrub Woodland	<i>Quercus turbinella</i> Shrubland	na	MG051	A0793
Shrubland				
Riparian Wash Scrub Shrublands	<i>Baccharis emoryi</i> - <i>Baccharis sergiloides</i> Dry Wash Shrubland	CEGL002953	MG036.	A3874
	<i>Prosopis glandulosa</i> - <i>Prosopis velutina</i> - <i>Prosopis pubescens</i> Riparian Forest, Woodland & Shrubland	cf. CEGL002193, CEGL001382, CEGL001385, CEGL001381, cf. CEGL004934	MG092.	A3877, A3153
	<i>Salix exigua</i> Warm Desert Riparian Shrubland	CEGL001203, CEGL001197	MG036.	A0947, A3800
	<i>Vitis arizonica</i> - <i>Vitis girdiana</i> Shrubland	CEPS009693	MG036.	A4162

Table 15. Map class names and component alliances (continued).

LAKE Map Class Name	Alliance Name (NVC or other)	CEGL Code(s)	Macro group Code(s)	Alliance Code(s)
Mid-Elevation Mixed Desert Scrub	<i>Ephedra fasciculata</i> Shrubland*	na	na	A3139
	<i>Ephedra viridis</i> Colorado Plateau Shrubland	na	MG088.	A3201
	<i>Eriogonum wrightii</i> - <i>Eriogonum heermannii</i> - <i>Buddleja utahensis</i> Shrubland	na	MG088.	A4167
	<i>Gutierrezia sarothrae</i> - <i>Gutierrezia microcephala</i> Dwarf-shrubland*	na	na	A3203
	<i>Lycium andersonii</i> - <i>Lycium cooperi</i> Shrubland	CEGL005150	na	A3142
	<i>Mortonia utahensis</i> Shrubland	CEGL005153	MG088.	A4158
Mojave Yucca Shrubland	<i>Eriogonum fasciculatum</i> - <i>Viguiera parishii</i> Shrubland	CEGL002721, CEGL001260	MG088.	A3150
	<i>Yucca schidigera</i> Shrubland	CEGL005295	MG088.	A3147
Blackbrush Shrubland	<i>Coleogyne ramosissima</i> Mojave Desert Shrubland	CEGL001332, CEGL005297, CEGL001333, CEGL002717	MG088.	A3144, A3220
Semi-Desert Scrub Shrublands	<i>Ambrosia dumosa</i> Desert Dwarf Scrub	CEGL005074	MG088.	A3279
	<i>Atriplex polycarpa</i> Shrubland	CEGL001318	MG088.	A3174
	<i>Simmondsia chinensis</i> - <i>Canotia holacantha</i> - <i>Eriogonum fasciculatum</i> Desert Scrub*	na	na	A3283
	<i>Opuntia acanthocarpa</i> Shrubland	na	na	A4156
	<i>Opuntia bigelovii</i> Shrubland	CEGL003065	na	A3146
	<i>Encelia farinosa</i> Desert Scrub	CEGL001251, CEGL002955	MG088.	cf. A3278
	<i>Fouquieria splendens</i> Desert Scrub	CEGL001168, CEGL005118	MG088.	cf. A3278
	<i>Krascheninnikovia lanata</i> Dwarf-shrubland & Dwarf-shrub Herbaceous	CEGL001320	MG098.	A3202
	<i>Psoralea fremontii</i> - <i>Psoralea polydenius</i> Wash	CEGL005154, CEGL001353	MG088.	A4186

Table 15. Map class names and component alliances (continued).

LAKE Map Class Name	Alliance Name (NVC or other)	CEGL Code(s)	Macro group Code(s)	Alliance Code(s)
Creosote Bush Shrubland	<i>Larrea tridentata</i> Desert Scrub	CEGL005145	na	A3277
	<i>Larrea tridentata</i> - <i>Ambrosia dumosa</i> Bajada & Valley Desert Scrub	CEGL002954, CEGL005136, CEGL005137	MG088.	A3277
	<i>Larrea tridentata</i> - <i>Encelia farinosa</i> Upper Bajada & Rock Outcrop Desert Scrub	CEGL002955	na	cf. A3278
Semi-Desert Wash Woodland / Scrub	<i>Acacia greggii</i> - <i>Hyptis emoryi</i> - <i>Justicia californica</i> Desert Wash	cf. CEPS009522, CEGL005390, CEGL002960	MG092.	A4187
	<i>Chilopsis linearis</i> - <i>Psoralea argophylla</i> Desert Wash	CEGL001164	MG092.	A1044
	<i>Ericameria paniculata</i> Mojave Desert Wash	CEGL002706	MG092.	A2509
	<i>Hymenoclea salsola</i> - <i>Bebbia juncea</i> Mojave-Sonoran Desert Wash	CEGL005391, CEGL005398	MG088.	A4188
	<i>Fallugia paradoxa</i> Wash	CEGL003875	MG036.	A3259
	<i>Pluchea sericea</i> Shrubland	CEGL003080	MG092.	A0798
	<i>Prunus fasciculata</i> - <i>Salazaria mexicana</i> Northern Mojave Desert Wash	CEGL002704, CEGL005293, CEGL002965	na	A4185, A1129
	<i>Chilopsis linearis</i> - <i>Psoralea argophylla</i> Desert Wash	CEGL001164	MG092.	A1044
Saltbush Scrub Shrublands	<i>Atriplex canescens</i> Shrubland	CEGL001281	MG093.	A0869, A3266
	<i>Atriplex confertifolia</i> Shrubland	CEGL001294, CEGL001303, CEGL001308, CEGL001295	MG093.	A0870
Salt Basin Scrub Shrubland	<i>Distichlis spicata</i> Alkaline Wet Meadow	CEGL001770	MG081.	A1332
	<i>Muhlenbergia asperifolia</i> - <i>Spartina gracilis</i> - <i>Sporobolus airoides</i> Alkaline Herbaceous	CEGL001688	na	A1334
	<i>Allenrolfea occidentalis</i> - <i>Isocoma acradenia</i> Shrubland	CEGL000988	MG083.	A0866

Table 15. Map class names and component alliances (continued).

LAKE Map Class Name	Alliance Name (NVC or other)	CEGL Code(s)	Macro group Code(s)	Alliance Code(s)
Salt Basin Scrub Shrubland	<i>Atriplex lentiformis</i> Shrubland	na	MG083.	A3173
	<i>Suaeda moquinii</i> - <i>Salicornia rubra</i> Alkaline Scrub	CEGL001991	MG083.	A3880
Manzanita - Sonoran scrub oak Shrubland Alliance	<i>Arctostaphylos</i> - <i>Quercus turbinella</i> Shrubland Alliance	na	na	cf. A.766
Tamarisk Shrubland	<i>Tamarix</i> spp. Semi-natural Shrubland	CEGL003114	MG298.	cf. A0842
Wooded Herbaceous				
Mixed Marsh and Wetland Herbaceous Vegetation	<i>Cladium californicum</i> Alkaline Seep	CEGL009683	MG073.	A4164
	<i>Phragmites australis</i> - <i>Arundo donax</i> - <i>Alopecurus pratensis</i> Native & Semi-native Flooded Herbaceous	CEGL004115, cf. CEGL001475	MG073.	A3847
	<i>Typha domingensis</i> - <i>Typha latifolia</i> - <i>Typha angustifolia</i> Western Herbaceous Emergent	CEGL001845, CEGL002010	na	A3896
Herbaceous				
Grasslands (Native and Ruderal)	<i>Achnatherum hymenoides</i> - <i>Pseudoroegneria spicata</i> - <i>Muhlenbergia pungens</i> Herbaceous	cf. CEGL002343	MG098.	A1262, A4011
	<i>Amsinckia menziesii</i> - <i>Amsinckia tessellata</i> - <i>Phacelia</i> spp. Herbaceous	na	MG045.	A4182
	<i>Brassica tournefortii</i> and other mustards Semi-natural Herbaceous	na	na	cf. A4166
	<i>Bromus rubens</i> - <i>Schismus arabicus</i> - <i>Schismus barbatus</i> Ruderal Herbaceous	cf. CEPS009691	na	A4121
Dune Vegetation	<i>Dicoria canescens</i> - <i>Abronia villosa</i> - <i>Panicum urvilleanum</i> Dune	na	MG117.	A4026
	<i>Larrea tridentata</i> - <i>Ambrosia dumosa</i> Bajada & Valley Desert Scrub	CEGL002954, CEGL005136, CEGL005137	na	A3277
	<i>Pleuraphis rigida</i> Herbaceous	cf. CEGL000955, cf. CEGL003051	na	A3170, (A3281)
Colorado Plateau Hanging Garden Seep Group	<i>Calamagrostis scopulorum</i> - <i>Andropogon glomeratus</i> Saturated Hanging Garden Herbaceous	na	MG112	A2655
	<i>Cladium californicum</i> Seep [GRCA Park Special CEPS009683]	na	MG112	na

Table 15. Map class names and component alliances (continued).

LAKE Map Class Name	Alliance Name (NVC or other)	CEGL Code(s)	Macro group Code(s)	Alliance Code(s)
Colorado Plateau Hanging Garden Seep Group	<i>Celtis laevigata</i> / <i>Cladium</i> sp. Saturated Seep Shrubland [GRCA Park Special CEPS009681]	na	MG112	na
	<i>Cercis orbiculata</i> Seep Shrubland [GRCA Park Special CEPS009682]	na	MG112	na
	<i>Betula occidentalis</i> Desert Spring Shrubland [GRCA Park Special CEPS009680]	na	MG112	na
Big Galleta Herbaceous Vegetation	<i>Pleuraphis rigida</i> Herbaceous Vegetation	cf. CEGL000955, cf. CEGL003051	na	A3170, (A3281)
Sparsely Vegetated				
Bare Rock and Sparse Vegetation	Desert Wash and River Bottom Sparsely Vegetated	na	na	na
	<i>Atriplex hymenelytra</i> Shrubland	CEGL001317, cf. CEGL001264	MG117.	A0872
	<i>Chorizanthe rigida</i> - <i>Geraea canescens</i> Desert Pavement	cf. CEPS009686	MG117.	A4024
	<i>Ephedra</i> spp. - <i>Leymus salinus</i> - <i>Eriogonum corymbosum</i> Badlands Cold Desert Sparse Vegetation	CEGL002349	MG117.	A4052, cf. A2572
	Montane Ravine Sparsely Vegetated	na	na	na
	<i>Peucephyllum schottii</i> Shrubland	CEGL002722	MG117.	A3143
	Playa Mapping Unit	na	na	na
	<i>Aloysia wrightii</i> - <i>Pericome caudata</i> - <i>Ephedra nevadensis</i> Sparsely Vegetated Bedrock Cliff & Lava Field Alliance		na	A4025
	<i>Sphaeralcea ambigua</i> Herbaceous	cf. CEPS009532	MG117.	na
Beach and Barren Sand Draw-down Area	Lake Margin	na	na	na
Other Miscellaneous				
Agricultural Lands	Cropland	na	na	na
Urban or Developed Areas	Urban	na	na	na
Transportation / Roads / Trails	Transportation / Roads / Trails	na	na	na
Open Water	Water	na	na	na

Woodlands

Pinyon Pine - (Utah Juniper) Woodland

Alliances:

Pinus monophylla - *Juniperus osteosperma* Understory Woodland

CEGL Code C EGL002941

Macrogroup Code MG026.

Alliance Code na

Description: This woodland map class occurs on a number of different landforms in the Park including cool aspect scarps, cliffs, and canyons, gently sloping ridges and hills, and slopes that range from dry to moist and steep (Figure 10). Soils are variable, but generally coarse-textured and well-drained. The parent materials are typically colluvium and residuum weathered from granite. Vegetation densities are typically low to medium. Table 16 shows the areas of the mapped bio-physical properties in addition to the elevation range.

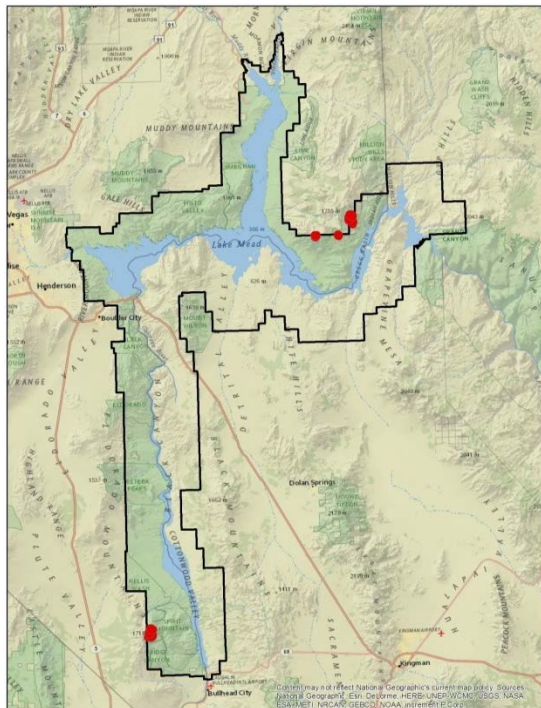


Figure 10. Mapped distribution of Pinyon Pine - (Utah Juniper) Woodland.

Vegetation included in this alliance is characterized by an open tree canopy dominated by *Pinus monophylla*, quite often in association with *Juniperus osteosperma* (Figure 11). *Pinus monophylla* may be the sole tree in some cases, or *Juniperus osteosperma* may be codominant. The shrub layer is present to moderately dense. Shrub associates may include *Artemisia tridentata*, *A. nova*, *A. arbuscula*, *Ephedra viridis*, *Ericameria nauseosa*, *Grayia spinosa* and *Purshia tridentata*, *P. mexicana*. Other shrubs may include *Eriogonum fasciculatum*, *Yucca schidigera*, and *Coleogyne*

ramosissima. The typically sparse herbaceous layer is usually composed of caespitose perennial grasses, including *Pseudoroegneria spicata*, *Festuca idahoensis*, *Elymus elymoides*, and *Stipa* spp. Diagnostic of this woodland alliance is the tree canopy dominated by *Pinus monophylla* often with *Juniperus osteosperma* as a codominant.

This type is only found in the Park above elevations of 750 m (2,460 ft.). This map class is sparse within the park, found only in the southern portion of the Park in the Spirit Mountain area and northerly locations near Bonelli Peak and west of Hell's Kitchen.



Figure 11. Pinyon Pine - (Utah Juniper) Woodlands.

Table 16. Mapped Bio-physical parameters for Pinyon Pine – (Utah Juniper) Woodlands. Elevation range is 2464 – 5247 ft (751 – 1599 m).

Pinyon Pine - (Utah Juniper) Woodlands	Acres	Hectares
Landform		
cool aspect scarps, cliffs, canyons	17	7
gently sloping ridges and hills	7	3
moderately dry slopes	93	38
moderately moist steep slopes	84	34
Vegetation Density		
Low	20	8
Medium	181	73
Geology		
Mafic-ultramafic rock	64	26
No Data	87	35
Silicic-intermediate rock	49	20
Soil Parent Material		
colluvium and/or residuum weathered from granite	102	41
residuum weathered from granite	98	40

Juniper Woodlands

Alliances:

Juniperus californica Wooded Shrubland

CEGL Code na

Macrogroup Code MG088.

Alliance Code A4161

Description: This map class consists of only one alliance, the California Juniper Woodland Alliance. It forms a sparse to open tree canopy with an open shrub understory and an open tree canopy dominated by *Juniperus californica*, typically with low cover (Figures 12 and 13; Table 17). It is found from bottoms to summits and at all aspects. Soil parent materials are typically mixed alluviums or colluvium or residuum derived granites. Elevations range from approximately 900 to 1,500 meters (3,100 – 4,900 ft.). The dominant tree is *Juniperus californica*. Commonly associated shrubs include *Cylindropuntia acanthocarpa*, *Echinocereus engelmannii*, *Ephedra nevadensis*, *Eriogonum fasciculatum*, *Yucca schidigera*, *Coleogyne ramosissima*, *Ferocactus cylindraceus*, and *Krameria erecta*. This map class is sparsely represented in the Park, only found in the Newberry Range in the south and the Indian Hills to the north.

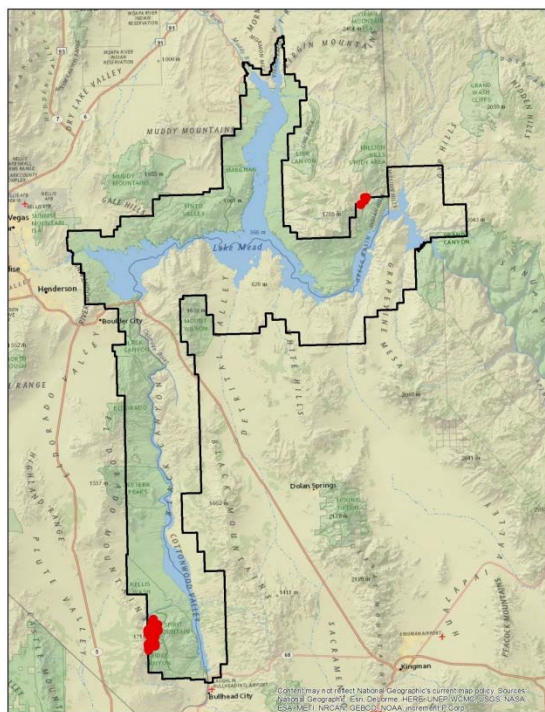


Figure 12. Mapped distribution of Juniper Woodlands.



Figure 13. Juniper Woodlands

Table 17. Mapped Bio-physical parameters for Juniper Woodlands. Elevation range is 3136 – 4922 ft (956 – 1500 m).

Juniper Woodlands	Acres	Hectares
Landform		
gently sloping ridges and hills	47	19
hot aspect scarps, cliffs, canyons	5	2
moderately dry slopes	371	150
moderately moist steep slopes	68	28
nearly level plateaus or terrace	60	24
very dry steep slopes	208	84
very moist steep slopes	128	52
Vegetation Density		
Low	137	55
Medium	751	304
Geology		
Mafic-ultramafic rock	10	4
No Data	865	350
Silicic-intermediate rock	12	5
Soil Parent Material		
colluvium and/or residuum weathered from granite	769	311
mixed alluvium	97	39
residuum weathered from granite	22	9

Fan Palm Woodland

Alliances:

Phoenix dactylifera - *Washingtonia filifera* Ruderal Woodland

CEGL Code na

Macrogroup Code MG036

Alliance Code A4161

Description: This Ruderal Date Palm – California Palm Stands woodland alliance of the Mojave Desert is found in desert springs on intermittently flooded sites below 500 m (1,600 ft.) in elevation within the Park (Figures 14 and 15; Table 18). This type requires some sort of permanent water such as stream bottoms or permanent springs. There is often considerable floristic diversity and other species may include *Populus fremontii*, *Salix gooddingii*, *Salix exigua*, and *Prosopis glandulosa*. Other shrub species that may intermingle include *Atriplex* sp., *Baccharis emoryi*, *Encelia farinosa*, and *Pluchea sericea*, *Suaeda moquinii* and *Tamarix* spp. There are mapped areas on the southern edge of the Park and these are mapping errors. These erroneous polygons are other introduced non-native palm varieties.

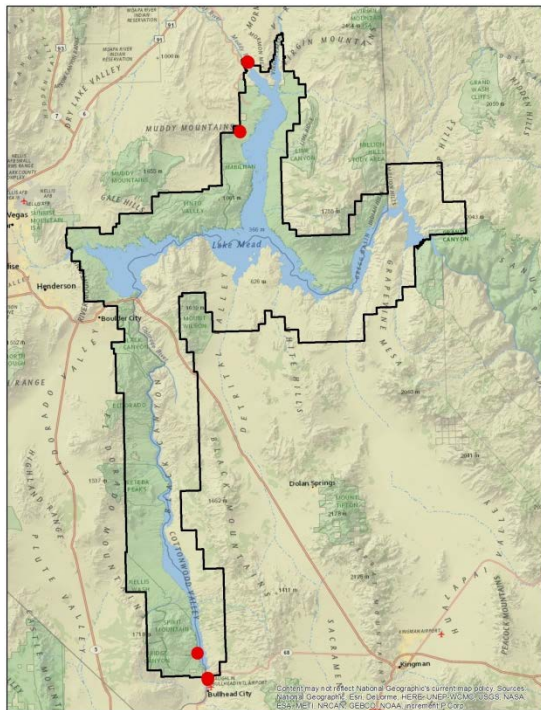


Figure 14. Mapped distribution of Fan Palm Woodlands.



Figure 15. Fan Palm Woodlands.

Table 18. Mapped Bio-physical parameters for Fan Palm Woodlands. Elevation range is 504 – 1625 ft (154 – 495 m).

Fan Palm Woodland	Acres	Hectares
Landform		
gently sloping ridges and hills	6	2
nearly level plateaus or terrace	1	<1
toe slopes, bottoms, and swales	2	1
Vegetation Density		
Low	5	2
Medium	4	2
Geology		
Alluvium	1	<1
No Data	5	2
Sedimentary rock	3	1
Soil Parent Material		
alluvium derived from basalt and gypsum	1	<1
alluvium derived from mixed	5	2
alluvium derived from mixed sources	2	1
calcareous alluvium derived from sedimentary rock	1	1

Palo Verde Woodlands

Alliances:

Carnegiea gigantea - *Parkinsonia microphylla* - *Prosopis velutina* Desert Scrub

CEGL Code na

Macrogroup Code na

Alliance Code A4161

Description: This map class consists of only one alliance, the Saguaro - Yellow Paloverde - Velvet Mesquite Desert Scrub Alliance (Figures 16 and 17; Table 19). It forms a sparse to intermittent shrub canopy and a sparse to intermittent herbaceous understory. It is found primarily on channel beds and walls and low slopes to summits at all aspects. Soils are a variety of alluviums derived from igneous, metamorphic, or volcanic rock. Elevations range from approximately 200 to 600 m (860 – 2,200 ft.). This type often intermingles with Semi-Desert Scrub Shrublands, Creosote Bush Shrubland, and Semi-Desert Wash Woodland / Scrub. The dominant tall shrub is *Parkinsonia microphylla*. Commonly associated sub canopy shrubs include *Encelia farinosa*, *Larrea tridentata*, *Acacia greggii*, and *Ambrosia dumosa*. This alliance is characterized by a sparse to open tree canopy of *Parkinsonia microphylla*, which ranges from 1 to 7 percent cover. The distribution is highly localized, found only east of the Colorado River, south of Fire Mountain.

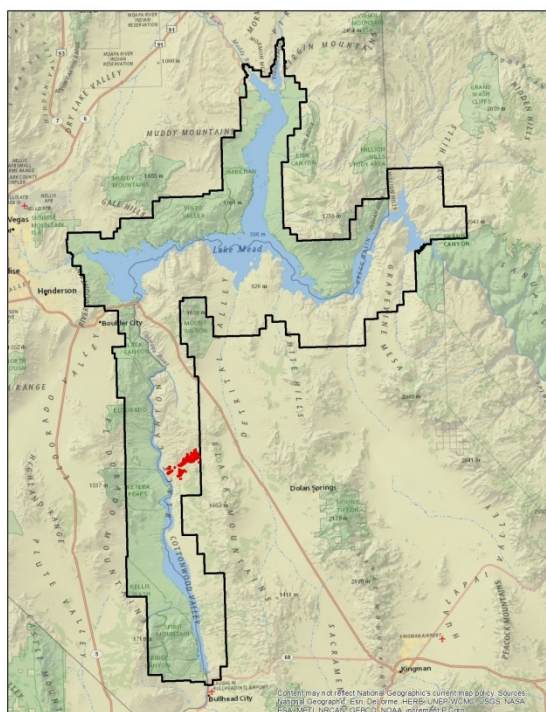


Figure 16. Mapped distribution of Palo Verde Woodlands.



Figure 17. Palo Verde Woodlands.

Table 19. Mapped Bio-physical parameters for Palo Verde Woodlands. Elevation range is 858 – 2243 ft (261-684 m).

Palo Verde Woodlands	Acres	Hectares
Landform		
gently sloping ridges and hills	769	311
moderately moist steep slopes	123	50
nearly level plateaus or terrace	173	70
toe slopes, bottoms, and swales	16	7
valley flats (or water bodies)	6	2
very moist steep slopes	52	21
Vegetation Density		
Low	48	19
Very Low	1091	442
Geology		
No Data	1139	461
Soil Parent Material		
alluvium derived from igneous and metamorphic rock	5	2
alluvium derived from mixed	314	127
colluvium derived from volcanic rock	819	331

Joshua Tree Woodland

Alliances:

Yucca brevifolia Wooded Shrubland

CEGL Codes CEG003116, CEG005294

Macrogroup Code MG088.

Alliance Code A3148

Description: This map class consists of only one alliance, the Joshua Tree Woodland Shrubland Alliance. It forms a sparse to open tree canopy with an open to intermittent shrub understory (Figures 18 and 19; Table 20). It is found on channel beds and bottoms to summits at variable aspects. Soils are derived from a variety of substrates and textures are variable. Elevations range from approximately 700 to 1,300 m (2,300 – 4,100 ft.). The dominant tree is *Yucca brevifolia*. Commonly associated shrubs include *Ephedra nevadensis*, *Cylindropuntia acanthocarpa*, *Menodora spinescens*, and *Lycium andersonii*. Commonly associated herbs include *Bromus rubens*, *Erodium cicutarium*, *Achnatherum speciosum*, and *Sphaeralcea ambigua*. The overall tree cover ranges from low to medium densities.

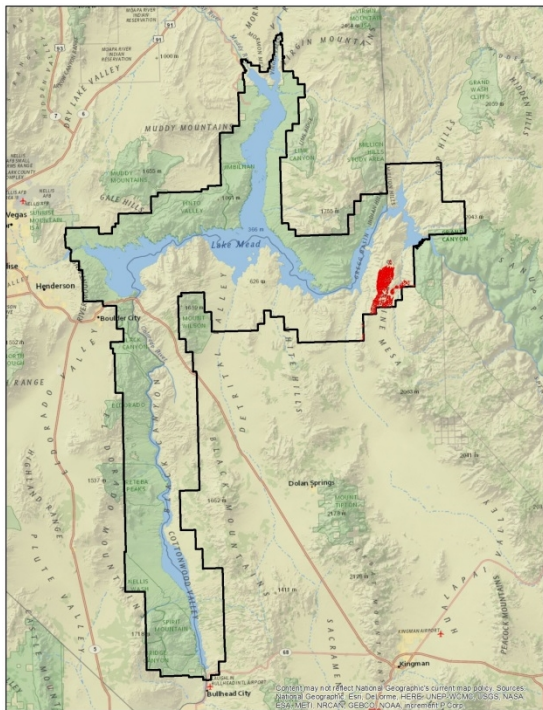


Figure 18. Mapped distribution of Joshua Tree Woodland.



Figure 19. Joshua Tree Woodland.

Table 20. Mapped Bio-physical parameters for Joshua Tree Woodland. Elevation range is 2319 – 4149 ft (707 – 1264 m).

Joshua Tree Woodland	Acres	Hectares
Landform		
gently sloping ridges and hills	3265	1321
moderately dry slopes	36	15
moderately moist steep slopes	114	46
nearly level plateaus or terrace	5168	2091
toe slopes, bottoms, and swales	129	52
valley flats (or water bodies)	15	6
very moist steep slopes	156	63
Vegetation Density		
Low	4558	1845
Medium	4324	1750
Geology		
Alluvium	1024	415
Mafic-ultramafic rock	145	59
Older alluvium	1715	694
Sedimentary rock	5999	2428
Soil Parent Material		
alluvium and colluvium derived from granite	145	59
alluvium and colluvium derived from limestone	795	322
alluvium derived from granite	5587	2261
alluvium derived from limestone and granite	1220	494
alluvium derived from mixed	1135	459

Riparian Woodlands

Alliances:

Populus fremontii - *Fraxinus velutina* - *Salix gooddingii* Flooded Forest & Woodland Alliance

Salix gooddingii - *Salix laevigata* - *Salix lucida* Riparian Forest

CEGL Codes CEGLO02743

Macrogroup Codes MG036,

Alliance Codes A3803, A3752, A3803

Description: This forest and tall shrub map class occurs in riparian areas throughout the Park (Figures 20 and 21; Table 21). Stands have been described from floodplains along the streams, seeps, springs, and adjacent to Lake Mead, the Colorado River, and Lake Mojave. The landforms for this map class vary and can occur in a variety of settings, however they predominate on plateaus and terraces, toe slopes, bottoms and swales, valley flats and even gently sloping ridges and hills. Water tables are generally high throughout the year, with surface flooding during the spring months. Vegetation densities range from low to high. Soils types vary but typically include alluvial or colluvial derived from a variety of sources, and deposited in stratified layers of clays, sands, silts and gravels. The elevation range is extensive being found as low as 200 – 1,000 m (500 - 3,260 ft.).

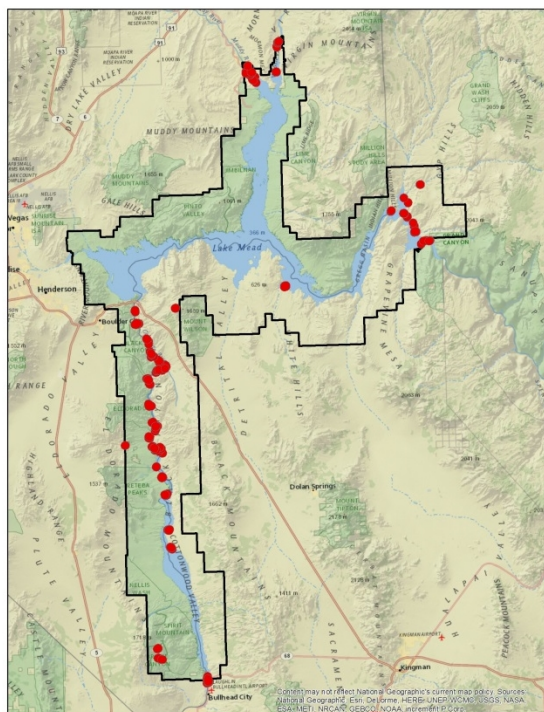


Figure 20. Mapped distribution of Riparian Woodlands.

Woodlands included in this map class are characterized in mature stands by a dense overstory canopy 20-25 m tall of *Populus fremontii*. Canopy cover is variable, depending upon the age of the stand, but averages well over 60%. If in the *Populus fremontii* Alliance, the subcanopy, *Salix gooddingii*, a

small tree (to 15 m tall), is usually present with low cover. Other species that might share co-dominance with *Populus* include *Acer negundo*, *Fraxinus latifolia*, *Juglans hindsii* and hybrids. *Prosopis* spp. May also be present. *Salix gooddingii* may also occur in stands by itself when occurring as a separate alliance. Scattered shrubs are found in the understory, but total cover of this layer is typically less than 10% in *Populus* stands but may be continuous in *Salix gooddingii* stands. Shrub species may include *Amorpha fruticosa*, *Baccharis salicifolia*, and *Salix exigua*.



Figure 21. Riparian Woodlands

Table 21. Mapped Bio-physical parameters for Riparian Woodlands. Elevation range is 515 – 3257 ft (157 – 993 m).

Riparian Woodlands	Acres	Hectares
Landform		
cool aspect scarps, cliffs, canyons	2	1
gently sloping ridges and hills	67	27
moderately dry slopes	13	5
moderately moist steep slopes	37	15
nearly level plateaus or terrace	95	39
toe slopes, bottoms, and swales	30	12
valley flats (or water bodies)	18	7
very dry steep slopes	2	1
very moist steep slopes	42	17
Vegetation Density		
High	67	27
Low	100	40
Medium	133	54
Very Low	7	3
Geology		
Alluvium	33	13
Mafic-ultramafic rock	29	12
No Data	130	53
Sedimentary rock	1	<1
Silicic-intermediate rock	48	19
Water	66	27
Soil Parent Material		
alluvium	19	8
alluvium and colluvium derived from granite	2	1
alluvium derived from mixed	49	20
alluvium derived from mixed sources	13	5
alluvium derived from sandstone and shale	2	1
calcareous alluvium derived from sedimentary rock	5	2
calcareous loess influenced alluvium derived from igneous and metamorphic rock	15	6
colluvium and/or residuum weathered from granite	32	13
colluvium and/or residuum weathered from volcanic rock	43	17
colluvium derived from volcanic rock	18	7
aeolian deposits derived from mixed sources	15	6
gravelly alluvium	9	4
mixed alluvium	22	9
residuum and colluvium derived from granite	7	3
residuum weathered from granite	2	1
Water	56	23

Sonoran Live Oak Scrub Woodland

Alliances:

Quercus turbinella Shrubland

CEGL Code na

Macrogroup Code MG051

Alliance Code A0793

Description: This map class has one alliance described for the LAKE project, the Sonoran Live Oak Scrub Alliance and forms an open to intermittent shrub layer (Figures 22 and 23; Table 22). The emergent tree layer is typically sparse to open, and the herbaceous layer is sparse to open. This small patch map class is found primarily tucked in amongst large boulders and rock outcrops. Soils are derived from alkali-granite (alaskite) and granodiorite, and textures include medium to coarse sand. Elevations range from approximately 816 to 1,264 m (2,600 – 5,200 ft.). Dominant and characteristic shrubs include *Gutierrezia sarothrae* and *Quercus turbinella*. Those often present include *Eriogonum wrightii*, *Ericameria linearifolia*, *Lotus rigidus*, and *Eriogonum fasciculatum*. The tree layer is emergent and often includes *Juniperus californica*, *Pinus edulis*, or *Pinus monophylla*. The herbaceous layer includes *Achnatherum speciosum*, *Artemisia ludoviciana*, and *Sphaeralcea ambigua*. This map class is highly localized found only in the Newberry Range intermixed with Juniper and Yucca Woodlands.

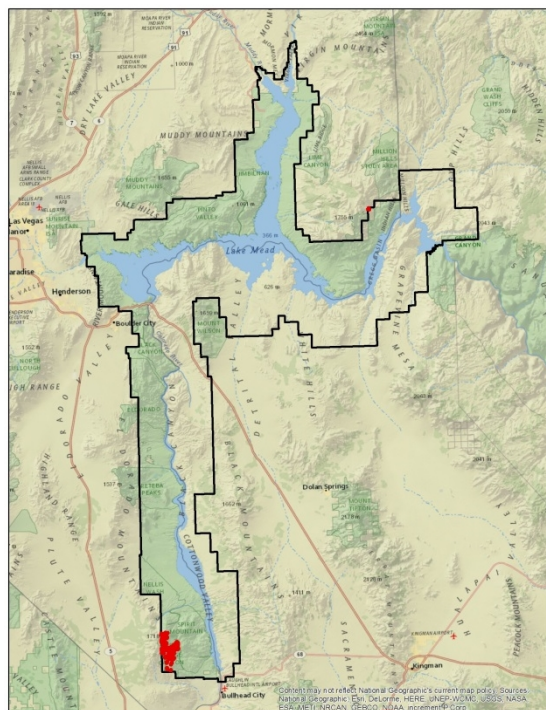


Figure 22. Mapped distribution of Sonoran Live Oak Scrub Woodland.



Figure 23. Sonoran Live Oak Scrub Woodland.

Table 22. Mapped Bio-physical parameters for Sonoran Live Oak Scrub Woodland. Elevation range is 2577 – 5260 ft (816 – 1264 m).

Sonoran Live Oak Scrub Woodland	Acres	Hectares
Landform		
cool aspect scarps, cliffs, canyons	33	13
gently sloping ridges and hills	18	7
hot aspect scarps, cliffs, canyons	3	1
moderately dry slopes	77	31
moderately moist steep slopes	101	41
nearly level plateaus or terrace	26	11
toe slopes, bottoms, and swales	1	0
very dry steep slopes	63	26
very moist steep slopes	149	60
Vegetation Density		
Low	33	13
Medium	436	177
Very Low	2	1
Geology		
Carbonate rock	43	17
No Data	416	168
Sedimentary rock	10	4
Silicic-intermediate rock	2	1
Soil Parent Material		
alluvium derived from granite	1	0
colluvium and/or residuum weathered from granite	386	156
colluvium and/or residuum weathered from gypsum	51	21
colluvium and/or residuum weathered from metamorphic rock	2	1
mixed alluvium	1	0
residuum weathered from granite	29	12

Shrublands

Riparian Wash Scrub Shrublands

Alliances:

Baccharis emoryi - *Baccharis sergiloides* Dry Wash Shrubland

Prosopis glandulosa - *Prosopis velutina* - *Prosopis pubescens* Riparian Forest, Woodland & Shrubland

Salix exigua Warm Desert Riparian Shrubland

Vitis arizonica - *Vitis girdiana* Shrubland

CEGL Codes CEGL002953, cf. CEGL002193, CEGL001382, CEGL001385, CEGL001381, cf. CEGL004934, CEGL001203, CEGL001197, CEPS009693

Macrogroup Codes MG036., MG092.

Alliance Codes A3874, A3877, A3153, A0947, A3800, A4162

Description: This riparian shrubland map class is composed of several alliances and are typically found along rivers and streams, on recently flooded riparian areas, or other areas that may have recent disturbance (Figures 24 and 25; Table 23). They generally have an open to continuous shrub layer. *Salix exigua* is the dominant canopy species. Stands are generally closed. The herbaceous cover is sparse to moderate, but rarely exceeds 30%. Soil parent materials are alluviums from a variety of sources. The elevation ranges from 150 – 1,000 m (500 – 3,600 ft.). The composition of this community, especially the herbaceous layer, varies from year to year with succession or renewed disturbance but may include *Bromus rubens*, *Erodium cicutarium*, and *Achnatherum speciosum*. The shrub species often found in association with this map class are varied and include *Acacia greggii*, *Baccharis sergiloides* and *Eriogonum fasciculatum*.

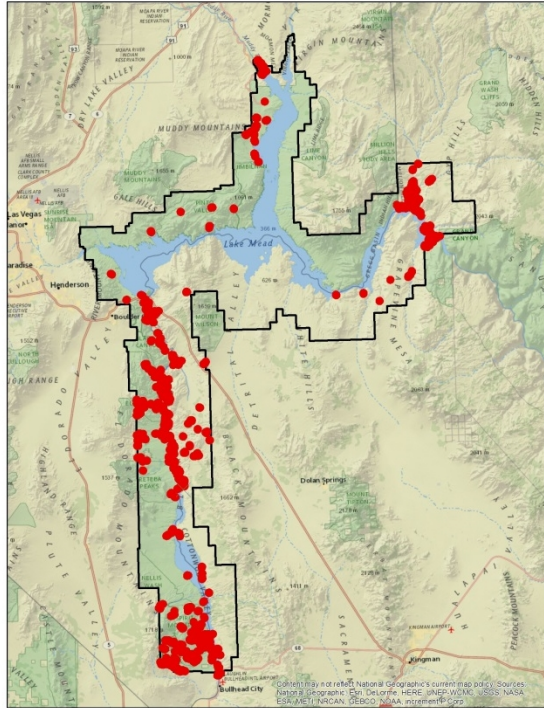


Figure 24. Mapped distribution of Riparian Wash Scrub Shrublands.



Figure 25. Riparian Wash Scrub Shrublands.

Table 23. Mapped Bio-physical parameters for Riparian Wash Scrub Shrublands. Elevation is 517 – 3568 ft (157 – 1087 m).

Riparian Wash Scrub Shrublands	Acres	Hectares
Landform		
cool aspect scarps, cliffs, canyons	1	1
gently sloping ridges and hills	328	133
moderately dry slopes	94	38
moderately moist steep slopes	174	70
nearly level plateaus or terrace	265	107
toe slopes, bottoms, and swales	37	15
valley flats (or water bodies)	12	5
very dry steep slopes	16	7
very moist steep slopes	205	83
No Data	9	4
Vegetation Density		
High	24	10
Low	475	192
Medium	480	194
None or Water	3	1
Very Low	160	65
Geology		
Alluvium	234	95
Carbonate rock	0	0
Mafic-ultramafic rock	32	13
No Data	502	203
Older alluvium	17	7
Sedimentary rock	96	39
Silicic-intermediate rock	149	60
Spring Deposits	9	4
Water	99	40
Weakly lithified sedimentary rock	3	1
Soil Parent Material		
alluvium derived from mixed	6	2
gravelly alluvium	2	1
mixed alluvium	3	1

Mid-Elevation Mixed Desert Scrub

Alliances:

Ephedra fasciculata Shrubland

Ephedra viridis Colorado Plateau Shrubland

Eriogonum wrightii - *Eriogonum heermannii* - *Buddleja utahensis* Shrubland

Gutierrezia sarothrae - *Gutierrezia microcephala* Dwarf-shrubland

Lycium andersonii - *Lycium cooperi* Shrubland

Mortonia utahensis Shrubland

CEGL Codes CEGL005150, CEGL005153

Macrogroup Codes MG088.,

Alliance Codes A3139, A3201, A4167, A3203, A3142, A4158

Description: Both *Mortonia utahensis* and *Eriogonum heermannii* Alliances are not well described but are included here as they are in the Mojave Mid-Elevation Mixed Desert Scrub Group with the *Ephedra viridis* Alliance (Figures 26 and 27; Table 24). Stands of these alliances occur on canyon slopes and ridges. Sites occur on slopes on a variety of aspects. Elevation ranges from 250 – 1,400 m (814 – 4,600 ft.). The soil parent materials are generally residuums, alluviums, and colluviums from volcanic rock, granites, igneous, metamorphic or limestones. Stands are dominated by a sparse to moderately dense cover of xeromorphic evergreen and broad-leaved shrubs ranging from 0.3-1.0 m in height with perennial grasses usually less than 0.3 m tall. Total vegetation cover is generally low to medium. The diagnostic species shrub species are the shrubs *Ephedra viridis*, *Mortonia utahensis*, *Eriogonum heermannii*, *Artemesia tridentata*, *Chrysothamnus viscidiflorus*, *Ericameria nauseosa*, *Gutierrezia microcephala*, *Opuntia erinacea*, *Purshia glandulosa*, and *P. mexicana*. *Juniperus californica*, *J. osteosperma*, and *Pinus monophylla* may be present. The herbaceous layer is typically sparse with perennial bunchgrass *Pleuraphis rigida* (= *Hilaria rigida*) and others.

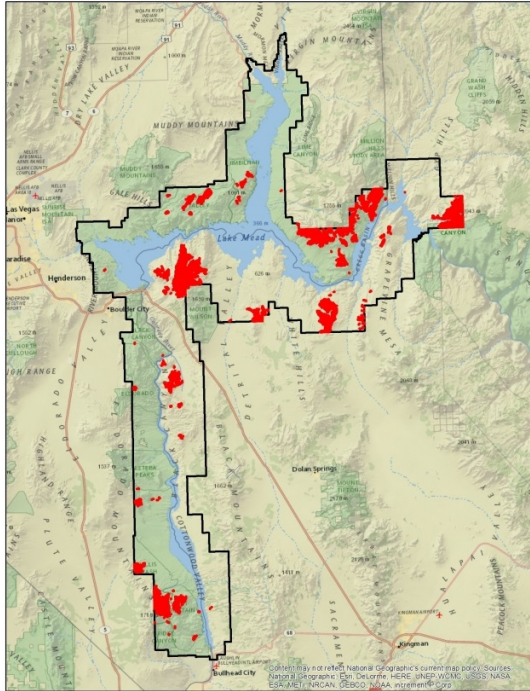


Figure 26. Mapped distribution of Mid-Elevation Mixed Desert Scrub.



Figure 27. Mid-Elevation Mixed Desert Scrub.

Table 24. Mapped Bio-physical parameters for Mid-Elevation Mixed Desert Scrub. Elevation is 814 – 4596 ft (248 – 1401 m).

Mid-Elevation Mixed Desert Scrub	Acres	Hectares
Landform		
cool aspect scarps, cliffs, canyons	36	14
gently sloping ridges and hills	269	109
moderately dry slopes	10401	4209
moderately moist steep slopes	15279	6183
nearly level plateaus or terrace	1284	520
toe slopes, bottoms, and swales	3	1
very dry steep slopes	426	172
very moist steep slopes	3778	1529
Vegetation Density		
Low	16082	6508
Medium	7939	3213
None or Water	3	1
Very Low	7451	3015
Geology		
Alluvium	33	13
Carbonate rock	3413	1381
Mafic-ultramafic rock	11473	4643
No Data	5684	2300
Older alluvium	7	3
Sedimentary rock	794	321
Silicic-intermediate rock	9635	3899
Weakly lithified sedimentary rock	438	177
Soil Parent Material		
No Data	290	117
alluvium and colluvium derived from granite	8019	3245
alluvium derived from basalt	1203	487
alluvium derived from granite	26	10
alluvium derived from igneous and metamorphic rock	922	373
alluvium derived from mixed	280	113
colluvium and/or residuum weathered from granite	4033	1632
colluvium and/or residuum weathered from limestone	3956	1601
colluvium and/or residuum weathered from volcanic rock	548	222
colluvium derived from volcanic rock	1823	738
colluvium residuum weathered from limestone	145	58
aeolian deposits derived from mixed sources	64	26

Table 24. Mapped Bio-physical parameters for Mid-Elevation Mixed Desert Scrub. Elevation is 814 – 4596 ft (248 – 1401 m) (continued).

Mid-Elevation Mixed Desert Scrub	Acres	Hectares
Soil Parent Material (continued)		
mixed gravelly alluvium	3	1
residuum and colluvium derived from granite	1972	798
residuum weathered from granite	8193	3316
alluvium derived from granite	0	0
alluvium derived from mixed	6	2

Mojave Yucca Shrub

Alliances:

Yucca schidigera Shrubland Alliance

Eriogonum fasciculatum–*Viguiera parishii* Shrubland

CEGL Codes CEGLO02721, CEGLO01260, CEGLO05295

Macrogroup Code MG088.

Alliance Code A3147, A3150

Description: This map class forms an open to intermittent shrub layer. The herbaceous layer is sparse to continuous. The map class is found on a variety of upland landforms including hills and upper bajadas at various aspects, drainage channels to mid-elevation slopes to ridges at various aspects. Soils are derived from a variety of parent materials and include alluvium and colluviums derived from granite, limestone, volcanic, and metamorphic rocks (Figures 28 and 29; Table 25). Elevations range from approximately 240 to 1550 m (785 – 5,100 ft.). *Yucca schidigera* may be co-dominant in the shrub layer, and include *Viguiera parishii*. Other characteristic species include *Cylindropuntia acanthocarpa*, *Echinocereus engelmannii*, *Ephedra nevadensis* and *Eriogonum fasciculatum*. Shrubs that are often present include *Acacia greggii*, *Ferocactus cylindraceus*, *Krameria erecta*, *Larrea tridentata*, *Thamnosma montana*, *Stephanomeria pauciflora* and *Viguiera parishii*.

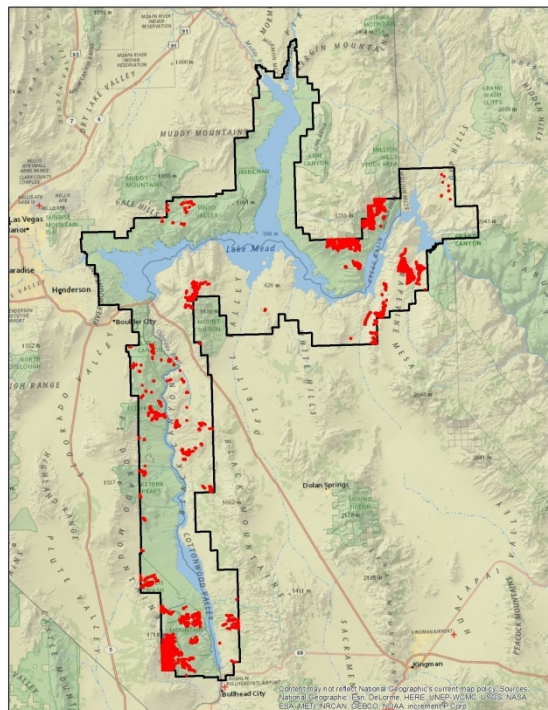


Figure 28. Mapped distribution of Mojave Yucca Shrub.



Figure 29. Mojave Yucca Shrub.

Table 25. Mapped Bio-physical parameters for Mojave Yucca Shrub. Elevation is 785 – 5094 ft (239 – 1553 m).

Mojave Yucca Shrubland	Acres	Hectares
Landform		
cool aspect scarps, cliffs, canyons	16	7
gently sloping ridges and hills	1098	444
moderately dry slopes	1564	633
moderately moist steep slopes	3413	1381
nearly level plateaus or terrace	6295	2548
toe slopes, bottoms, and swales	12	5
very dry steep slopes	82	33
very moist steep slopes	2819	1141
Vegetation Density		
Low	5464	2211
Medium	8298	3358
Very Low	1538	622
Geology		
Alluvium	580	235
Carbonate rock	62	25
Mafic-ultramafic rock	2122	859
No Data	6598	2670

Table 25. Mapped Bio-physical parameters for Mojave Yucca Shrub. Elevation is 785 – 5094 ft (239 – 1553 m) (continued).

Mojave Yucca Shrubland	Acres	Hectares
Geology (continued)		
Older alluvium	5	2
Sedimentary rock	2256	913
Silicic-intermediate rock	3624	1467
Weakly lithified sedimentary rock	54	22
Soil Parent Material		
No Data	88	35
alluvium	7	3
alluvium and colluvium derived from granite	884	358
alluvium and colluvium derived from limestone	2463	997
alluvium and colluvium derived from volcanic rock	15	6
alluvium derived from granite	7	3
alluvium derived from igneous and metamorphic rock	300	121
alluvium derived from mixed	112	45
colluvium and/or residuum weathered from granite	3589	1452
colluvium and/or residuum weathered from limestone	132	54
colluvium and/or residuum weathered from metamorphic rock	30	12
colluvium and/or residuum weathered from noncalcareous conglomerate	7	3
colluvium and/or residuum weathered from sandstone and siltstone	9	4
colluvium and/or residuum weathered from volcanic rock	423	171
colluvium derived from limestone and dolomite over residuum weathered from limestone and dolomite	19	8
colluvium derived from volcanic rock	571	231
gravelly alluvium	10	4
gravelly pedisediment derived from limestone	32	13
mixed alluvium	917	371
mixed gravelly alluvium	31	12
residuum and colluvium derived from granite	245	99
residuum weathered from granite	5398	2184
residuum weathered from sandstone and siltstone	12	5

Black Brush Shrubland

Alliances:

Coleogyne ramosissima Mojave Desert Shrubland

CEGL Codes CEGL001332, CEGL005297, CEGL001333, CEGL002717

Macrogroup Code MG088.

Alliance Code A3144, A3220

Description: This map class consists of only one alliance, the Black Brush Scrub Alliance and forms an open to intermittent shrub layer (Figures 30 and 31; Table 26). The emergent tree layer is typically sparse, and the herbaceous layer is sparse to intermittent. The alliance is found from toe slopes to summits at all aspects. Soil parent materials are various and include alluvium, colluvium and residuums derived from granite, limestone, and gypsum. Elevations range from approximately 620 to 1,450 m. (2,030 – 4,750 ft.). *Coleogyne ramosissima* is dominant or co-dominant in stands. Shrubs that are often present include *Ephedra nevadensis*, *Eriogonum fasciculatum*, *Lycium andersonii*, and *Thamnosma montana*. *Bromus rubens* is a characteristic herb and those often present are *Achnatherum speciosum* and *Sphaeralcea ambigua*.

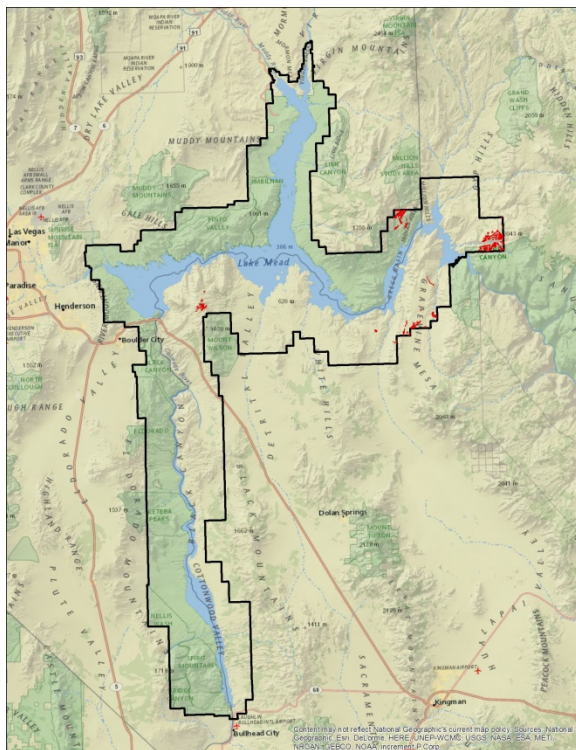


Figure 30. Mapped distribution of Black Brush Shrubland.



Figure 31. Black Brush Shrubland.

Table 26. Mapped Bio-physical parameters for Blackbrush Shrubland. Elevation is 2034 – 4751 ft (620 – 1448 m).

Blackbrush Shrubland	Acres	Hectares
Landform		
cool aspect scarps, cliffs, canyons	9	4
gently sloping ridges and hills	202	82
moderately dry slopes	384	155
moderately moist steep slopes	1084	438
nearly level plateaus or terrace	671	272
toe slopes, bottoms, and swales	8	3
valley flats (or water bodies)	4	2
very dry steep slopes	69	28
very moist steep slopes	791	320
Vegetation Density		
Low	918	372
Medium	2236	905
Very Low	68	28

Table 26. Mapped Bio-physical parameters for Blackbrush Shrubland. Elevation is 2034 – 4751 ft (620 – 1448 m) (continued).

Blackbrush Shrubland	Acres	Hectares
Geology		
Alluvium	137	55
Carbonate rock	902	365
Mafic-ultramafic rock	751	304
Older alluvium	69	28
Sedimentary rock	982	397
Silicic-intermediate rock	382	155
Soil Parent Material		
alluvium and colluvium derived from granite	485	196
alluvium and colluvium derived from limestone	33	13
alluvium derived from granite	193	78
alluvium derived from mixed	871	353
colluvium and/or residuum weathered from gypsum	882	357
colluvium and/or residuum weathered from limestone	20	8
residuum and colluvium derived from granite	14	6
residuum weathered from granite	723	293

Semi-Desert Scrub Shrublands

Alliances:

Ambrosia dumosa Desert Dwarf Scrub

Atriplex polycarpa Shrubland

Simmondsia chinensis - *Canotia holacantha* - *Eriogonum fasciculatum* Desert Scrub

Opuntia acanthocarpa Shrubland

Opuntia bigelovii Shrubland

Encelia farinosa Desert Scrub

Fouquieria splendens Desert Scrub

Krascheninnikovia lanata Dwarf-shrubland & Dwarf-shrub Herbaceous

Psoralea argemone - *Psoralea polydenia* Wash

CEGL Codes CEG005074, CEG001318, CEG003065, CEG001251, CEG002955

CEGL001168, CEG005118 CEG001320 CEG005154, CEG001353

Macrogroup Code MG088.

Alliance Codes A3279, A3174, A3283, A4156, A3146, cf. A3278, cf. A3278, A3202, A4186

Description: The Semi-Desert Scrub mapping unit consists of six alliances within the Mojave-Sonoran Bajada & Valley Desert Scrub Group and is one of the largest map classes within LAKE (Figures 32 and 33; Table 27). This map class can vary but will form an open to intermittent shrub layer. The emergent tree layer is typically not present, but if present is usually sparse to open as is the herbaceous layer. The map class is found primarily on rocky slopes and alluvial fans at all aspects. Given the vast distribution of this map class soil parent materials are varied are derived from a variety of substrates including sandstone, rhyolite, basalt, and alluvium, and textures are variable.

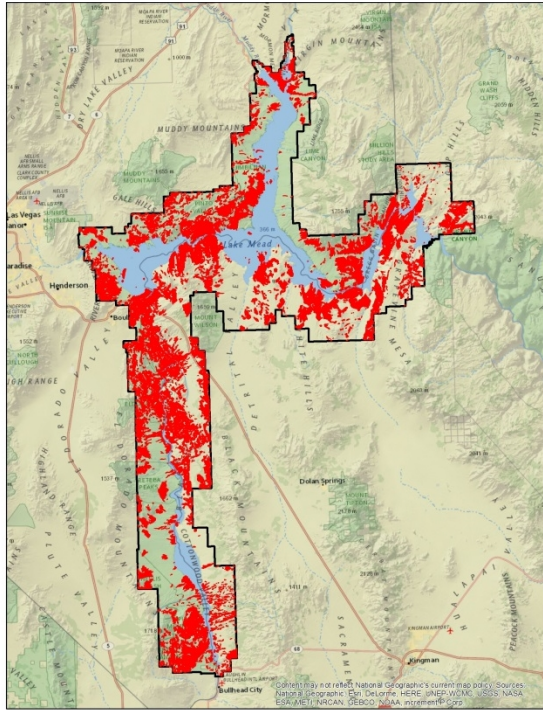


Figure 32. Mapped distribution of Semi-Desert Scrub Shrublands.

Elevations range from approximately 170 to 1,400 m. (570 – 6,400 ft.). *Ambrosia dumosa* and *Encelia farinosa* are the most common but many other species may dominate the shrub layer. The overall shrub cover ranges from 2 to 34 percent and only occasionally reaching higher densities.



Figure 33. Semi-Desert Scrub Shrublands.

Table 27. Mapped Bio-physical parameters for Semi-Desert Scrub Shrublands. Elevation is 571 – 6407 ft (174 – 1404 m).

Semi-Desert Scrub Shrublands	Acres	Hectares
Landform		
cool aspect scarps, cliffs, canyons	1334	540
gently sloping ridges and hills	20651	8357
hot aspect scarps, cliffs, canyons	51	21
moderately dry slopes	41050	16612
moderately moist steep slopes	74739	30246
nearly level plateaus or terrace	28842	11672
toe slopes, bottoms, and swales	585	237
valley flats (or water bodies)	87	35
very dry steep slopes	5445	2204
very moist steep slopes	39712	16071
Vegetation Density		
High	26	11
Low	88435	35788
Medium	28132	11385
None or Water	15	6
Very Low	95887	38804
Geology		
Aeolian sand	5	2
Alluvium	3507	1419
Carbonate rock	14761	5973
Mafic-ultramafic rock	38188	15454
No Data	46284	18730
Older alluvium	6116	2475
Sedimentary rock	35919	14536
Silicic-intermediate rock	65994	26707
Spring Deposits	20	8
Water	282	114
Weakly lithified sedimentary rock	1419	574
Soil Parent Material		
No Data	9221	3732
alluvium	199	81
alluvium and colluvium derived from granite	9168	3710
alluvium and colluvium derived from limestone	6719	2719
alluvium and colluvium derived from tuff	180	73
alluvium and colluvium derived from volcanic rock	360	146
alluvium derived from basalt	1462	592

Table 27. Mapped Bio-physical parameters for Semi-Desert Scrub Shrublands. Elevation is 571 – 6407 ft (174 – 1404 m) (continued).

Semi-Desert Scrub Shrublands	Acres	Hectares
Soil Parent Material (continued)		
alluvium derived from basalt and gypsum	140	57
alluvium derived from fanglomerate	667	270
alluvium derived from granite	2591	1049
alluvium derived from gypsum	299	121
alluvium derived from gypsum over residuum weathered from gypsum	3517	1423
alluvium derived from igneous and metamorphic rock	1718	695
alluvium derived from igneous, metamorphic and sedimentary rock	62	25
alluvium derived from limestone	4398	1780
alluvium derived from limestone and sandstone	306	124
alluvium derived from mixed	7162	2898
alluvium derived from mixed sources	34	14
alluvium derived from sandstone	275	111
alluvium derived from sandstone and shale	5	2
alluvium derived from shale	750	304
calcareous alluvium derived from sedimentary rock	90	36
calcareous loess influenced alluvium derived from igneous and metamorphic rock	1123	454
colluvium and/or residuum	546	221
colluvium and/or residuum weathered from andesite	3484	1410
colluvium and/or residuum weathered from calcareous conglomerate	364	147
colluvium and/or residuum weathered from granite	21176	8570
colluvium and/or residuum weathered from gypsum	5617	2273
colluvium and/or residuum weathered from limestone	3475	1406
colluvium and/or residuum weathered from metamorphic rock	65	26
colluvium and/or residuum weathered from noncalcareous conglomerate	89	36
colluvium and/or residuum weathered from sandstone and siltstone	229	93
colluvium and/or residuum weathered from volcanic rock	43129	17454
colluvium derived from limestone and dolomite over residuum weathered from limestone and dolomite	285	115
colluvium derived from sedimentary rock over residuum weathered from sedimentary rock	2034	823
colluvium derived from volcanic rock	29789	12055
colluvium residuum weathered from limestone	1030	417
eolian deposits	3	1
eolian deposits derived from mixed sources	891	361
eolian sands	8	3
eolian sands derived from mixed	5	2
eolian sands over alluvium derived from sandstone	127	52

Table 27. Mapped Bio-physical parameters for Semi-Desert Scrub Shrublands. Elevation is 571 – 6407 ft (174 – 1404 m) (continued).

Semi-Desert Scrub Shrublands	Acres	Hectares
Soil Parent Material (continued)		
gravelly alluvium	1008	408
gravelly pedisediment derived from limestone	463	187
loess over residuum weathered from basalt	982	397
mixed alluvium	1055	427
mixed alluvium derived from metamorphic rock	84	34
mixed gravelly alluvium	4283	1733
residuum and colluvium derived from granite	19539	7907
residuum weathered from granite	18423	7456
residuum weathered from gypsum	1958	792
residuum weathered from sandstone and siltstone	641	259
Water	1264	511
Elevation Range	Feet	Meters
	571 - 6407	174 - 1404

Creosote Bush Shrubland

Alliances:

Larrea tridentata Desert Scrub

Larrea tridentata - *Ambrosia dumosa* Bajada & Valley Desert Scrub

Larrea tridentata - *Encelia farinosa* Upper Bajada & Rock Outcrop Desert Scrub

CEGL Codes CEG005145, CEG002954, CEG005136, CEG005137, CEG002955

Macrogroup Code MG088.

Alliance Codes A3277, A3277, cf. A3278

Description: The Creosote Bush map class is comprised of three Creosote alliances and makes up the largest map class within the Park (Figures 34 and 35; Table 28). It forms a sparse to intermittent shrub layer. The emergent tree layer is sparse, when present, and the herbaceous layer is sparse to open. The alliance is found primarily on alluvial fans and bajadas at all aspects. Soil parent material is quite broad and includes alluviums and colluviums from igneous, metamorphic and sedimentary rock. Elevations range from approximately 170 – 1,300 m (550 – 4,300 ft.), though stands are typically found at lower to mid-elevations. *Larrea tridentata* is the dominant and characteristic shrub of this map class. *Ambrosia dumosa* and *Encelia farinosa* are sometimes present similar or significantly lower cover. *Krameria erecta* and *Opuntia basilaris* are sometimes present. *Plantago ovata*, *Chorizanthe rigida*, *Eriogonum inflatum*, *Cryptantha* spp., *Amsinkia* spp., *Bromus rubens*, and *Schismus* spp. are all sometimes present in this map class. Cryptogamic crust is also sometimes present.

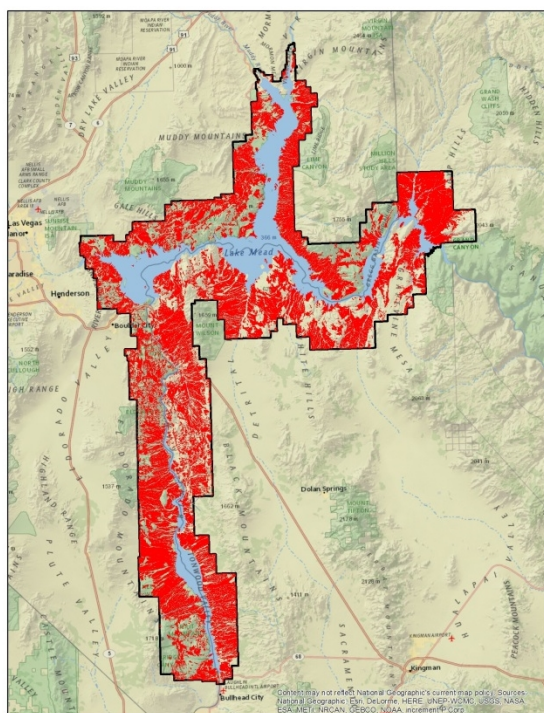


Figure 34. Mapped distribution of Creosote Bush Shrubland.



Figure 35. Creosote Bush Shrubland.

Table 28. Mapped Bio-physical parameters for Creosote Bush Shrublands. Elevation is 554 – 4328 ft (169 – 1319 m).

Creosote Bush Shrubland	Acres	Hectares
Landform		
cool aspect scarps, cliffs, canyons	104	42
gently sloping ridges and hills	182929	74029
hot aspect scarps, cliffs, canyons	11	4
moderately dry slopes	11615	4700
moderately moist steep slopes	46750	18919
nearly level plateaus or terrace	149573	60530
toe slopes, bottoms, and swales	2384	965
valley flats (or water bodies)	301	122
very dry steep slopes	630	255
very moist steep slopes	118669	48024
Vegetation Density		
High	9	4
Low	254664	103059
Medium	58435	23648
None or Water	1	1
Very Low	199858	80880

Table 28. Mapped Bio-physical parameters for Creosote Bush Shrublands. Elevation is 554 – 4328 ft (169 – 1319 m) (continued).

Creosote Bush Shrubland	Acres	Hectares
Geology		
Alluvium	49968	20221
Carbonate rock	3676	1488
Mafic-ultramafic rock	34664	14028
No Data	149089	60334
Older alluvium	64933	26277
Sedimentary rock	147962	59878
Silicic-intermediate rock	58576	23705
Spring Deposits	445	180
Water	267	108
Weakly lithified sedimentary rock	3386	1370
Soil Parent Material		
No Data	2232	903
alluvium	1772	717
alluvium and colluvium derived from granite	15410	6236
alluvium and colluvium derived from limestone	6491	2627
alluvium and colluvium derived from tuff	34	14
alluvium and colluvium derived from volcanic rock	438	177
alluvium derived from basalt	4383	1774
alluvium derived from basalt and gypsum	751	304
alluvium derived from fanglomerate	11118	4499
alluvium derived from granite	8959	3626
alluvium derived from gypsum	1696	686
alluvium derived from gypsum over residuum weathered from gypsum	1885	763
alluvium derived from igneous and metamorphic rock	20926	8468
alluvium derived from igneous, metamorphic and sedimentary rock	2348	950
alluvium derived from limestone	16867	6826
alluvium derived from limestone and granite	29	12
alluvium derived from limestone and sandstone	405	164
alluvium derived from mixed	107646	43563
alluvium derived from mixed sources	106	43
alluvium derived from sandstone	1923	778
alluvium derived from sandstone and shale	37	15
alluvium derived from shale	3203	1296
calcareous alluvium derived from sedimentary rock	229	93
calcareous loess influenced alluvium derived from igneous and metamorphic rock	9956	4029
colluvium and/or residuum	2492	1009
colluvium and/or residuum weathered from andesite	1489	603

Table 28. Mapped Bio-physical parameters for Creosote Bush Shrublands. Elevation is 554 – 4328 ft (169 – 1319 m) (continued).

Creosote Bush Shrubland	Acres	Hectares
Soil Parent Material (continued)		
colluvium and/or residuum weathered from calcareous conglomerate	3415	1382
colluvium and/or residuum weathered from granite	15352	6213
colluvium and/or residuum weathered from gypsum	97	39
colluvium and/or residuum weathered from limestone	5978	2419
colluvium and/or residuum weathered from metamorphic rock	20	8
colluvium and/or residuum weathered from noncalcareous conglomerate	32715	13239
colluvium and/or residuum weathered from sandstone and siltstone	323	131
colluvium and/or residuum weathered from volcanic rock	41152	16654
colluvium derived from limestone and dolomite over residuum weathered from limestone and dolomite	338	137
colluvium derived from sedimentary rock over residuum weathered from sedimentary rock	444	180
colluvium derived from volcanic rock	26084	10556
colluvium residuum weathered from limestone	244	99
eolian deposits derived from mixed sources	346	140
eolian sands	143	58
eolian sands derived from mixed	8	3
eolian sands over alluvium derived from sandstone	1433	580
gravelly alluvium	36577	14802
gravelly pedisediment derived from limestone	3928	1590
loess over residuum weathered from basalt	2589	1048
mixed alluvium	38367	15527
mixed alluvium derived from metamorphic rock	723	292
mixed gravelly alluvium	45989	18611
residuum and colluvium derived from granite	17939	7259
residuum weathered from calcareous shale	2	1
residuum weathered from granite	14707	5952
residuum weathered from gypsum	162	66
residuum weathered from sandstone and siltstone	559	226
tertiary lacustrine deposits	49	20
Water	458	185

Semi-Desert Wash Woodland/Scrub

Alliances:

Acacia greggii - *Hyptis emoryi* - *Justicia californica* Desert Wash

Chilopsis linearis - *Psoralea argophylla* Desert Wash

Ericameria paniculata Mojave Desert Wash

Hymenoclea salsola - *Bebbia juncea* Mojave-Sonoran Desert Wash

Fallugia paradoxa Wash*

Pluchea sericea Shrubland

Prunus fasciculata - *Salazaria mexicana* Northern Mojave Desert Wash

Chilopsis linearis - *Psoralea argophylla* Desert Wash

CEGL Codes cf. CEPS009522, CEG005390, CEG002960, CEG001164, CEG002706
CEGL005391, CEG005398, CEG005390, CEG003875, CEG003080
CEGL002704, CEG005293, CEG002965, CEG001164

Macrogroup Codes MG088., MG092., MG036.

Alliance Codes A4187, A1044, A2509, A4188, A4187, A3259, A0798, A4185, A1129
A1044

Description: The Semi-Desert Wash Woodland/Scrub map class forms an open to continuous tree canopy with a sparse to continuous shrub understory (Figures 36 and 37; Table 29). It is found primarily on channel beds and bottoms where flooding is infrequent but subterranean water is available but will also occur around the perimeter of the lake. It is found at all aspects. Soils are derived from a variety of substrates and textures that are highly variable. Elevations range from approximately 160 – 4,300 m (500 – 4850 ft.). The dominant or co-dominant trees are *Chilopsis linearis*, *Prosopis glandulosa*, *Prosopis pubescens*. Commonly associated shrubs include *Prunus fasciculata* or *Prunus eremophila*, *Ericameria paniculata*, *Pluchea sericea*, *Acacia greggii*, *Salix* spp., *Tamarix* spp., *Hymenoclea salsola*, *Pluchea sericea*, *Larrea tridentata*, *Phoradendron californicum*, *Suaeda moquinii*, *Allenrolfea occidentalis*, *Vitis arizonica*, *Cylindropuntia acanthocarpa*, *Ephedra nevadensis*, *Eriogonum fasciculatum*, *Larrea tridentata*, *Salazaria mexicana*, and *Stephanomeria pauciflora*. *Hyptis emoryi* may be found but was only sampled once. The map class is defined primarily by the geomorphic hydrology rather than the component alliances as numerous other alliances such as Creosote Bush Shrublands are often found within many arroyos.

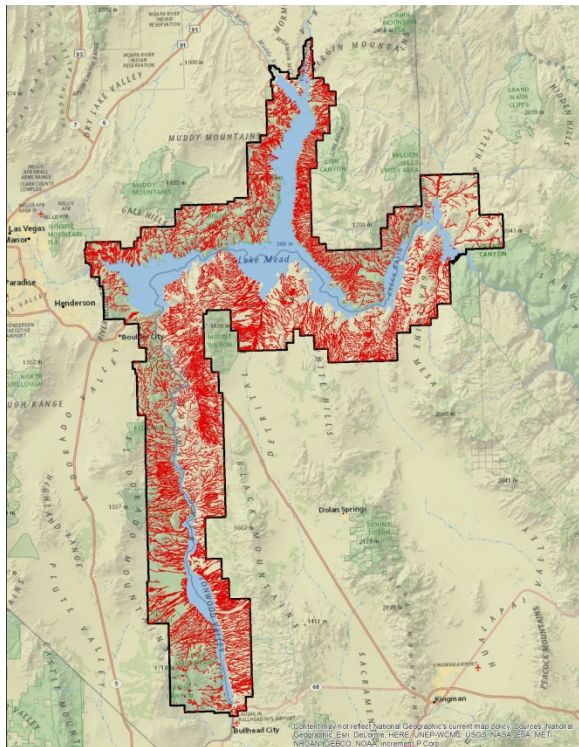


Figure 36. Mapped distribution of Semi-Desert Wash Woodland.



Figure 37. Semi-Desert Wash Woodland.

Table 29. Mapped Bio-physical parameters for Semi-Desert Wash Woodland / Scrub. Elevation is 531 – 4829 ft (162 – 4272 m).

Semi-Desert Wash Woodland / Scrub	Acres	Hectares
Landform		
cool aspect scarps, cliffs, canyons	17	7
gently sloping ridges and hills	60253	24383
hot aspect scarps, cliffs, canyons	5	2
moderately dry slopes	525	212
moderately moist steep slopes	2704	1094
nearly level plateaus or terrace	20840	8434
toe slopes, bottoms, and swales	1567	634
valley flats (or water bodies)	54	22
very dry steep slopes	36	15
very moist steep slopes	4584	1855
Vegetation Density		
High	10	4
Low	47624	19273
Medium	8436	3414
Very Low	34515	13968
Geology		
Aeolian sand	5	2
Alluvium	35207	14248
Carbonate rock	673	272
Mafic-ultramafic rock	2639	1068
No Data	30868	12492
Older alluvium	4672	1891
Sedimentary rock	9204	3725
Silicic-intermediate rock	6192	2506
Spring Deposits	260	105
Water	712	288
Weakly lithified sedimentary rock	153	62
Soil Parent Material		
No Data	105	42
alluvium	648	262
alluvium and colluvium derived from granite	2152	871
alluvium and colluvium derived from limestone	392	159
alluvium and colluvium derived from tuff	2	1
alluvium derived from basalt	3	1
alluvium derived from basalt and gypsum	306	124
alluvium derived from fanglomerate	1214	491
alluvium derived from granite	2268	918

Table 29. Mapped Bio-physical parameters for Semi-Desert Wash Woodland / Scrub. Elevation is 531 – 4829 ft (162 – 4272 m) (continued).

Semi-Desert Wash Woodland / Scrub	Acres	Hectares
Soil Parent Material (continued)		
alluvium derived from gypsum	523	211
alluvium derived from gypsum over residuum weathered from gypsum	688	279
alluvium derived from igneous and metamorphic rock	798	323
alluvium derived from igneous, metamorphic and sedimentary rock	345	140
alluvium derived from limestone	1363	551
alluvium derived from limestone and sandstone	27	11
alluvium derived from mixed	36793	14890
alluvium derived from mixed sources	37	15
alluvium derived from sandstone	180	73
alluvium derived from shale	182	74
calcareous alluvium derived from sedimentary rock	59	24
calcareous loess influenced alluvium derived from igneous and metamorphic rock	1835	743
colluvium and/or residuum	46	19
colluvium and/or residuum weathered from andesite	151	61
colluvium and/or residuum weathered from calcareous conglomerate	162	66
colluvium and/or residuum weathered from granite	1803	730
colluvium and/or residuum weathered from gypsum	116	47
colluvium and/or residuum weathered from limestone	159	64
colluvium and/or residuum weathered from noncalcareous conglomerate	310	126
colluvium and/or residuum weathered from volcanic rock	3524	1426
colluvium derived from limestone and dolomite over residuum weathered from limestone and dolomite	8	3
colluvium derived from sedimentary rock over residuum weathered from sedimentary rock	67	27
colluvium derived from volcanic rock	2378	962
colluvium residuum weathered from limestone	51	21
eolian deposits derived from mixed sources	76	31
eolian sands	36	15
eolian sands derived from mixed	3	1
eolian sands over alluvium derived from sandstone	38	15
gravelly alluvium	3544	1434
gravelly pedisegment derived from limestone	283	115
loess over residuum weathered from basalt	125	51
mixed alluvium	18868	7636
mixed alluvium derived from metamorphic rock	5	2
mixed gravelly alluvium	4767	1929
residuum and colluvium derived from granite	1256	508

Table 29. Mapped Bio-physical parameters for Semi-Desert Wash Woodland / Scrub. Elevation is 531 – 4829 ft (162 – 4272 m) (continued).

Semi-Desert Wash Woodland / Scrub	Acres	Hectares
Soil Parent Material (continued)		
residuum weathered from granite	2078	841
residuum weathered from gypsum	18	7
residuum weathered from sandstone and siltstone	86	35
Water	708	286

Saltbush Scrub Shrublands

Alliances:

Atriplex canescens Shrubland

Atriplex confertifolia Shrubland

CEGL Codes CEG001281, CEG001294, CEG001303, CEG001308, CEG001295

Macrogroup Code MG093.

Alliance Codes A0869, A3266, A0870

Description: The Saltbush Scrub mapping unit forms an open to intermittent shrub layer (Figures 38 and 39; Table 30). The emergent tree layer, when present, is typically sparse, when present, and the herbaceous layer is sparse to open. The alliance is found primarily on valley floors and dry washes at various aspects. Soils are derived exclusively from alluviums derived from basalts and gypsums. Elevations range from approximately 350 to 500 m (1,200 – 1,500 ft.). *Atriplex canescens* or *Atriplex confertifolia* are dominant or co-dominant in the shrub canopy, and *Kraschennikovia lanata* and *Lycium andersonii* are often present. *Eriogonum inflatum*, *Bromus rubens*, *Xylorhiza tortifolia*, *Mentzelia albicaulis* and *Salsola* spp. are often present in the herbaceous layer. The overall shrub cover ranges from 0 to 60 percent. This map class is highly localized being found only east of Blue Point Spring and south of NPS road 103.

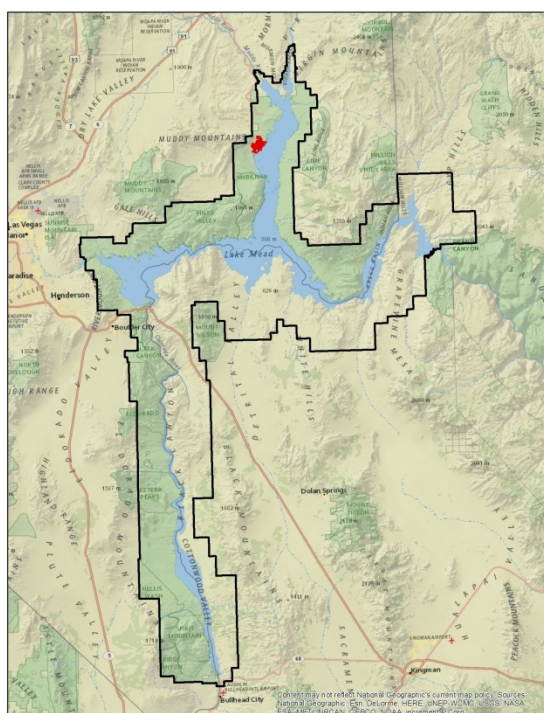


Figure 38. Mapped distribution of Saltbush Scrub Shrublands.



Figure 39. Saltbush Scrub Shrublands.

Table 30. Mapped Bio-physical parameters for Saltbush Scrub Shrublands. Elevation range is 1237 – 1537 ft (377 – 468 m).

Saltbush Scrub Shrublands	Acres	Hectares
Landform		
gently sloping ridges and hills	732	296
nearly level plateaus or terrace	668	271
Vegetation Density		
Low	1294	524
Medium	106	43
Geology		
Alluvium	826	334
Sedimentary rock	54	22
Spring Deposits	521	211
Soil Parent Material		
alluvium derived from basalt and gypsum	20	8
alluvium derived from gypsum	1379	558
Elevation Range	Feet	Meters
	1237 - 1537	377 - 468

Salt Basin Scrub Shrublands

Alliances:

Distichlis spicata Alkaline Wet Meadow

Muhlenbergia asperifolia - *Spartina gracilis* - *Sporobolus airoides* Alkaline Herbaceous

Allenrolfea occidentalis - *Isocoma acradenia* Shrubland

Atriplex lentiformis Shrubland

Suaeda moquinii - *Salicornia rubra* Alkaline Scrub

CEGL Codes CEGL001770, CEGL001688, CEGL000988, CEGL001991

Macrogroup Codes MG081., MG083.

Alliance Codes A1332, A1334, A0866, A3173, A3880

Description: This map class forms an open to intermittent shrub layer (Figure 40; Table 31). The emergent tree layer is typically sparse, and the herbaceous layer is sparse to open. The alliance is found primarily on disturbed bottomlands and channel beds at flat and south aspects, playas and sand dunes. Soil parent material is generally mixed alluviums. Elevations range from approximately 160 to 575 m (500 – 1,900 ft.). *Atriplex lentiformis* or *Suaeda moquinii* are usually dominant and characteristic in the shrub layer. *Encelia farinosa* and *Atriplex canescens* are often present. *Prosopis glandulosa* is commonly an emergent tree at sparse cover. Dominant and characteristic herbs include *Cryptantha* spp., and *Schismus* spp., and those often present are *Amsinckia* spp., *Bassia scoparia*, *Bromus rubens*, *Bromus tectorum*, *Camissonia brevipes*, *Chaenactis fremontii*, *Chorizanthe brevicornu*, *Cryptantha pterocarya*, *Eriogonum deflexum*, *Malacothrix glabrata*, *Phacelia crenulata*, *Plantago ovata*, and *Salsola* spp. The overall shrub cover ranges from 0 to 55 percent. This map class is a very minor component of the Park possibly due to the scarcity and also to the difficulty in discerning this type from surrounding Semi-Desert Scrub Shrublands.

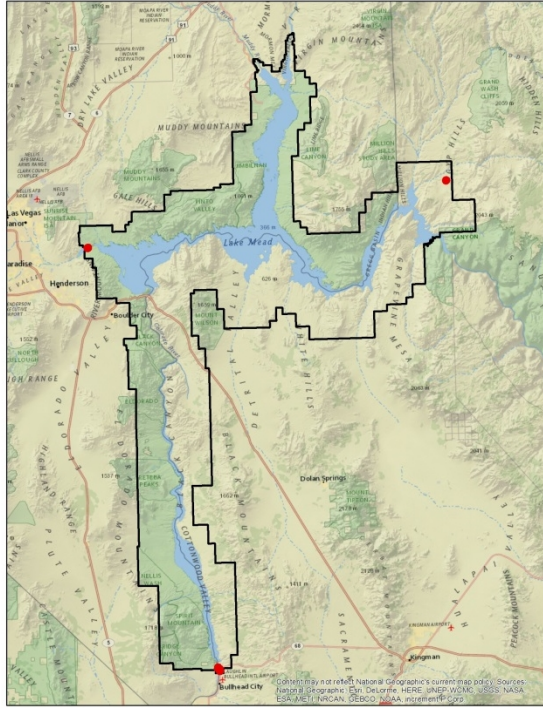


Figure 40. Mapped distribution of Salt Basin Scrub Shrublands.

Table 31. Mapped Bio-physical parameters for Salt Basin Scrub Shrubland. Elevation range is 523 – 1888 ft (159 – 575 m).

Salt Basin Scrub Shrubland	Acres	Hectares
Landform		
gently sloping ridges and hills	3	1
nearly level plateaus or terrace	8	3
Vegetation Density		
Low	4	2
Medium	6	2
Geology		
Alluvium	3	1
No Data	8	3
Soil Parent Material		
alluvium derived from mixed	6	2
gravelly alluvium	2	1
mixed alluvium	3	1

Tamarisk Shrubland

Alliances:

Tamarix spp. Semi-natural Shrubland

CEGL Code CEG L003114

Macrogroup Code MG298.

Alliance Code cf. A0842

Description: The Tamarisk map class forms an open to continuous shrub layer (Figures 41 and 42; Table 32). The emergent tree layer is typically sparse to open, and the herbaceous layer is sparse to intermittent. The alliance is found primarily along lake margins and drainage channel beds at variable aspects. Soil parent materials include alluviums derived from igneous, metamorphic and sedimentary rock in addition to occasional eolian deposits. Elevations range from approximately 150 to 700 m (500 – 2,300 ft.). This alliance is defined by a non-native, naturalizing *Tamarix* species as the strong dominant in the shrub layer. Characteristic herbs include *Schismus* spp. and those often present are *Bromus rubens* and *Eriogonum deflexum*. The overall shrub cover ranges from 5 to 100 percent. The densest stands are often impenetrable.

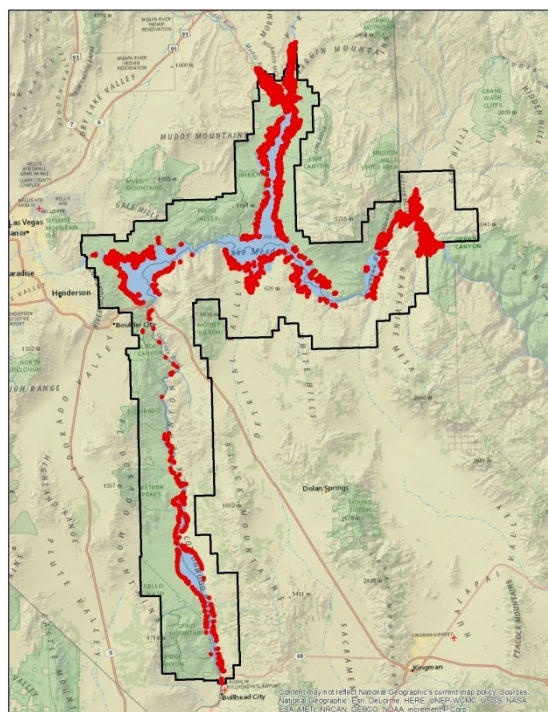


Figure 41. Mapped distribution of Tamarisk Shrublands.



Figure 42. Tamarisk Shrublands.

Table 32. Mapped Bio-physical parameters for Tamarisk Shrubland. Elevation is 508 – 2313 ft (155 – 705 m).

Tamarisk Shrubland	Acres	Hectares
Landform		
gently sloping ridges and hills	15912	6439
moderately dry slopes	65	26
moderately moist steep slopes	94	38
nearly level plateaus or terrace	4615	1868
toe slopes, bottoms, and swales	5453	2207
valley flats (or water bodies)	2805	1135
very dry steep slopes	5	2
very moist steep slopes	109	44
Vegetation Density		
High	4353	1762
Low	10010	4051
Medium	14020	5674
None or Water	23	9
Very Low	651	264
Geology		
Aeolian sand	3	1
Alluvium	2971	1202
Mafic-ultramafic rock	21	8
No Data	1045	423
Older alluvium	290	117
Sedimentary rock	315	128

Table 32. Mapped Bio-physical parameters for Tamarisk Shrubland. Elevation is 508 – 2313 ft (155 – 705 m) (continued).

Tamarisk Shrubland	Acres	Hectares
Geology (continued)		
Silicic-intermediate rock	72	29
Spring Deposits	16	6
Water	24325	9844
Soil Parent Material		
No Data	27	11
alluvium	2852	1154
alluvium and colluvium derived from tuff	53	21
alluvium derived from gypsum	11	4
alluvium derived from gypsum over residuum weathered from gypsum	67	27
alluvium derived from igneous, metamorphic and sedimentary rock	3	1
alluvium derived from limestone and sandstone	9	4
alluvium derived from mixed	1516	614
alluvium derived from mixed sources	507	205
alluvium derived from sandstone and shale	149	60
alluvium derived from shale	269	109
calcareous alluvium derived from sedimentary rock	1419	574
calcareous loess influenced alluvium derived from igneous and metamorphic rock	102	41
colluvium and/or residuum	11	4
colluvium and/or residuum weathered from andesite	2	1
colluvium and/or residuum weathered from granite	32	13
colluvium and/or residuum weathered from volcanic rock	16	7
colluvium derived from sedimentary rock over residuum weathered from sedimentary rock	47	19
colluvium derived from volcanic rock	15	6
eolian deposits derived from mixed sources	89	36
eolian sands derived from mixed	29	12
gravelly alluvium	47	19
mixed alluvium	182	74
mixed gravelly alluvium	55	22
residuum and colluvium derived from granite	80	32
Water	21470	8688

Manzanita - Sonoran Scrub Oak Shrubland

Alliances:

Arctostaphylos - *Quercus turbinella* Shrubland Alliance *

CEGL Code	na
Macrogroup Code	na
Alliance Code	cf. A.766

Description: The Manzanita - Sonoran Scrub Oak Shrubland is described from the GRCA / PARA portion and was not sampled during the LAKE project. This GRCA / PARA map class is included here solely with reference to the GRCA / PARA Vegetation mapping project (Kearsley, et al. 2015; Figure 43). A description of this type from (VegBank No date) is as follows: “This alliance includes evergreen shrublands where *Quercus turbinella* forms thickets with other desert shrubs. Important shrub associates can include *Arctostaphylos* spp., *Cercocarpus montanus*, *Coleogyne ramosissima*, *Ephedra viridis*, *Juniperus osteosperma*, *Rhus virens*, *Rhus trilobata*, *Rhus microphylla*, *Fraxinus greggii*, *Ceanothus greggii*, *Quercus mohriana*, *Quercus pungens*, and *Garrya wrightii*. Ground cover is typically sparse with scattered grasses, forbs, and ferns. Some typical herbaceous components include *Bouteloua curtipendula*, *Bouteloua eriopoda*, *Aristida* spp., *Astrolepis sinuata* (= *Notholaena sinuata*), and *Notholaena standleyi*. Shrublands in this alliance are small in extent and occur in a matrix of succulent desert scrub and semi-desert grassland. *Quercus turbinella* shrublands are typically found on steep, rocky slopes, often sheltered slopes in limestone canyons, in the mountains of Nevada, Arizona, New Mexico, and western Texas.” The species in this description may or may not be present in these mapped locals.

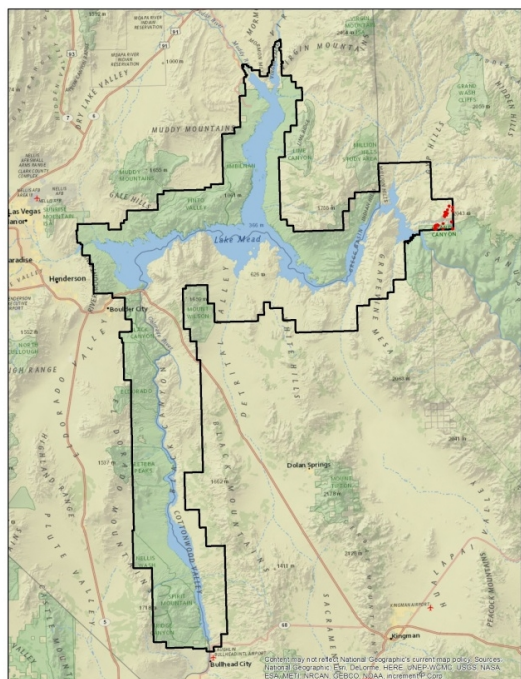


Figure 43. Mapped distribution of Manzanita – Sonoran Scrub Oak Shrubland.

Wooded Herbaceous

Mixed Marsh and Wetland Herbaceous Vegetation

Alliances:

Cladium californicum Alkaline Seep

Phragmites australis - *Arundo donax* - *Alopecurus pratensis* Native & Semi-native Flooded Herbaceous

Typha domingensis - *Typha latifolia* - *Typha angustifolia* Western Herbaceous Emergent

CEGL Codes CEGLO09683, CEGLO04115, cf. CEGLO01475, CEGLO01845, CEGLO02010

Macrogroup Code MG073.

Alliance Codes A4164, A3847, A3896

Description: This map forms an intermittent to continuous herbaceous layer (Figures 44 and 45; Table 33). The shrub layer is open and the tree layer, when present, is sparse. Soil parent materials are generally alluvium derived from gypsum or mixed sources, and, in some instances, eolian deposits. Stands occur in alkali springs along slopes and alkali washes with carbonate rock water discharges at low elevation, washes and wetlands. Elevation ranges from approximately 350 – 450 m (1,200 – 4,100 ft.). The dominant herbs may include *Phragmites australis*, *Distichlis spicata*, *Cladium californicum*, and other herbs include *Anemopsis californica*, *Cirsium neomexicanum*, *Distichlis spicata*, *Eleocharis rostellata*, *Juncus arcticus*, *Samolus valerandi* ssp. *parviflorus*, *Schoenoplectus americanus*, and *Solidago spectabilis*. Associated emergent shrubs at sparse to open cover include *Suaeda moquinii*, *Pluchea sericea*, *Allenrolfea occidentalis*, and *Vitis arizonica*. The overall herbaceous cover ranges from 85 to 97 percent cover.

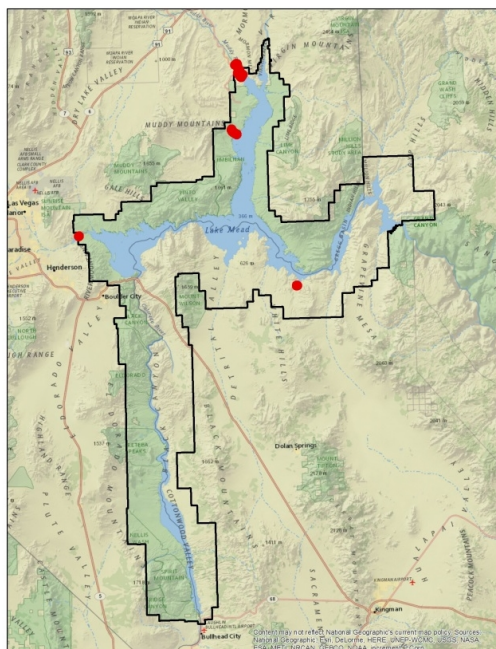


Figure 44. Mapped distribution of Mixed Marsh and Wetland Herbaceous Vegetation.



Figure 45. Mixed Marsh and Wetland Herbaceous Vegetation.

Table 33. Mapped Bio-physical parameters for Mixed Marsh and Wetland Herbaceous Vegetation. Elevation is 1203 – 4075 ft (367 – 450 m).

Mixed Marsh and Wetland Herbaceous Vegetation	Acres	Hectares
Landform		
gently sloping ridges and hills	39	16
moderately moist steep slopes	3	1
nearly level plateaus or terrace	11	4
toe slopes, bottoms, and swales	19	8
valley flats (or water bodies)	5	2
Vegetation Density		
High	7	3
Low	11	4
Medium	58	24
Geology		
Alluvium	23	9
Mafic-ultramafic rock	3	1
Spring Deposits	32	13
Water	19	8
Soil Parent Material		
alluvium derived from gypsum	32	13
alluvium derived from mixed sources	20	8
eolian deposits derived from mixed sources	21	9
mixed alluvium	1	1
residuum and colluvium derived from granite	3	1

Herbaceous

Grasslands (Native and Ruderal)

Alliances:

Achnatherum hymenoides - *Pseudoroegneria spicata* - *Muhlenbergia pungens* Herbaceous

Amsinckia menziesii - *Amsinckia tessellata* - *Phacelia* spp. Herbaceous

Brassica tournefortii and other mustards Semi-natural Herbaceous

Bromus rubens - *Schismus arabicus* - *Schismus barbatus* Ruderal Herbaceous

CEGL Codes cf. CEG002343, cf. CEPS009691

Macrogroup Codes MG098., MG045.

Alliance Codes A1262, A4011, A4182, cf. A4166, A4121

Description: This map class has an herbaceous layer that can range from open to continuous (Figure 46; Table 34). The map class may occur on low slopes to mid slopes with east to southwest or flat aspects and a variety of soil types. The *Bromus rubens* alliance will be found typically on disturbed or reclaimed sites. Elevations for this map class are typically lower within the Park around 150 – 1,000 (500 – 3,200 ft.). The herbaceous layer may contain a variety of species as follows; *Amsinckia* species, including *Amsinckia tessellata*, *Asclepias subulata*, *Chamaesyce polycarpa*, *Chorizanthe brevicornu*, *Erodium cicutarium*, *Eschscholzia minutiflora*, *Leptosiphon aureus*, *Lupinus sparsiflorus*, *Mirabilis laevis*, *Pectocarya recurvata*, *Phacelia distans*, *Physalis hederifolia*, *Plagiobothrys* spp., *Porophyllum gracile*, *Schismus* spp., *Schismus arabicus*, *Schismus barbatus*, *Eriogonum deflexum*, *Brassica tournefortii*, *Malcolmia Africana*, *Cryptantha* spp, *Gilia* spp., *Ipomopsis polycladon*, *Plantago ovata* and *Stillingia linearifolia*. Associated emergent shrubs at open percent cover include *Hymenoclea salsola*, *Acamptopappus sphaerocephalus*, *Ambrosia dumosa*, *Encelia farinosa*, *Eriogonum plumatella*, *Larrea tridentata*, *Salazaria mexicana*, *Stephanomeria pauciflora*, *Tetradymia stenolepis*, *Viguiera parishii*, *Gutierrezia sarothrae*, and *Yucca schidigera*.

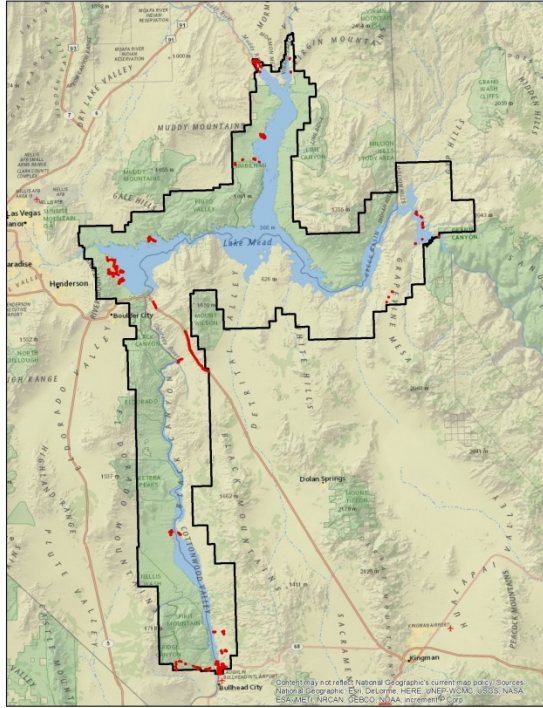


Figure 46. Mapped distribution of Grasslands (Native and Ruderal).

Table 34. Mapped Bio-physical parameters for Mixed Grassland (disturbed) Herbaceous Vegetation. Elevation is 517 – 3174 ft (158 – 968 m).

Mixed Grassland (disturbed) Herbaceous Vegetation	Acres	Hectares
Landform		
gently sloping ridges and hills	402	163
moderately dry slopes	2	1
moderately moist steep slopes	18	7
nearly level plateaus or terrace	187	76
toe slopes, bottoms, and swales	100	41
valley flats (or water bodies)	95	39
very moist steep slopes	53	22
Vegetation Density		
High	10	4
Low	353	143
Medium	91	37
Very Low	403	163
Geology		
Alluvium	212	86
Mafic-ultramafic rock	45	18
No Data	177	72
Older alluvium	21	8

Table 34. Mapped Bio-physical parameters for Mixed Grassland (disturbed) Herbaceous Vegetation. Elevation is 517 – 3174 ft (158 – 968 m) (continued).

Mixed Grassland (disturbed) Herbaceous Vegetation	Acres	Hectares
Geology (continued)		
Sedimentary rock	179	72
Silicic-intermediate rock	8	3
Water	216	87
Soil Parent Material		
alluvium	1	1
alluvium and colluvium derived from granite	36	14
alluvium derived from fanglomerate	5	2
alluvium derived from granite	10	4
alluvium derived from igneous and metamorphic rock	3	1
alluvium derived from mixed	205	83
alluvium derived from mixed sources	52	21
alluvium derived from sandstone and shale	7	3
calcareous alluvium derived from sedimentary rock	13	5
colluvium and/or residuum weathered from andesite	2	1
colluvium and/or residuum weathered from granite	5	2
colluvium and/or residuum weathered from volcanic rock	8	3
eolian deposits derived from mixed sources	8	3
eolian sands	1	1
gravelly alluvium	3	1
mixed alluvium	149	60
mixed gravelly alluvium	67	27
residuum and colluvium derived from granite	11	4
residuum weathered from granite	20	8
Water	252	102

Alliances:

Larrea tridentata - Ambrosia dumosa Bajada & Valley Desert Scrub

Pleuraphis rigida Herbaceous

Macrogroup Code na

Alliance Codes A3277, A3170, A3281

Dicoria canescens is often present but not necessarily dominant. Shrubs that are sometimes present include *Petalonyx thurberi* and *Larrea tridentata*. However, the presence of stabilized sand sheets and sand dunes more reliably characterize this alliance than does any set of species.

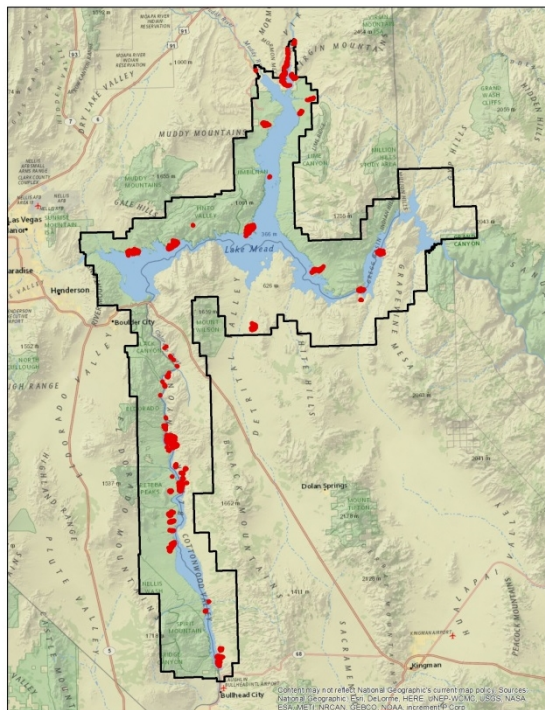


Figure 47. Mapped distribution of Dune Vegetation.



Figure 48. Dune Vegetation.

Table 35. Mapped Bio-physical parameters for Dune Vegetation. Elevation is 655 – 2246 ft (200 – 685 m).

Dune Vegetation	Acres	Hectares
Landform		
gently sloping ridges and hills	2289	926
moderately dry slopes	16	6
moderately moist steep slopes	135	55
nearly level plateaus or terrace	2387	966
very moist steep slopes	166	67
Vegetation Density		
Low	3468	1403
Medium	1218	493
Very Low	307	124
Geology		
Aeolian sand	1174	475
Alluvium	778	315
Mafic-ultramafic rock	97	39
No Data	1636	662
Older alluvium	1049	424
Sedimentary rock	175	71
Silicic-intermediate rock	79	32

Table 35. Mapped Bio-physical parameters for Dune Vegetation. Elevation is 655 – 2246 ft (200 – 685 m) (continued).

Dune Vegetation	Acres	Hectares
Geology (continued)		
Weakly lithified sedimentary rock	5	2
Soil Parent Material		
alluvium derived from limestone	71	29
alluvium derived from limestone and sandstone	108	44
alluvium derived from mixed	354	143
alluvium derived from mixed sources	12	5
calcareous loess influenced alluvium derived from igneous and metamorphic rock	293	119
colluvium and/or residuum weathered from granite	86	35
colluvium and/or residuum weathered from volcanic rock	38	16
colluvium derived from sedimentary rock over residuum weathered from sedimentary rock	87	35
colluvium derived from volcanic rock	142	58
eolian deposits	62	25
eolian deposits derived from mixed sources	340	137
eolian sands	2183	883
eolian sands derived from mixed	788	319
eolian sands over alluvium derived from sandstone	195	79
gravelly alluvium	36	15
mixed alluvium	11	4
mixed gravelly alluvium	114	46
residuum and colluvium derived from granite	55	22
Water	18	7

Colorado Plateau Hanging Garden Seep Group

Alliances:

Calamagrostis scopulorum - *Andropogon glomeratus* Saturated Hanging Garden Herbaceous

Cladium californicum Seep [GRCA Park Special CEPS009683]

Celtis laevigata / *Cladium* sp. Saturated Seep Shrubland [GRCA Park Special CEPS009681]

Cercis orbiculata Seep Shrubland [GRCA Park Special CEPS009682]

Betula occidentalis Desert Spring Shrubland [GRCA Park Special CEPS009680]

CEGL Code na

Macrogroup Code MG112.

Alliance Code A2655

Description: This wetland type is currently described from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona (Figures 49 and 50). This type was not described in the LAKE vegetation mapping project and is included here as the GRCA / PARA portion of the LAKE administrative boundary. No complete description is provided other than the component associations. However, some broad generalities exist. Vegetation in hanging gardens varies from canyon to canyon as well as separate alcoves within a canyon. There are generally some common species that are found at most of the hanging gardens (Colorado Natural Heritage Program 2015).

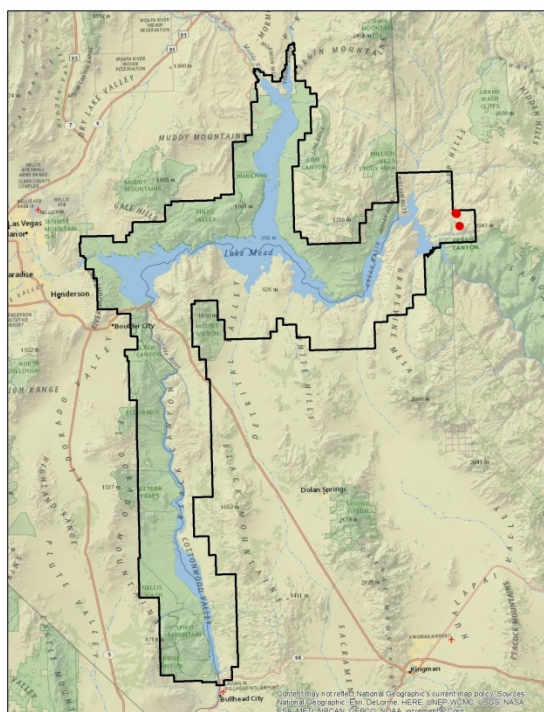


Figure 49. Mapped distribution of Colorado Plateau Hanging Garden Seep Group.



Figure 50. Colorado Plateau Hanging Garden Seep Group. Photo credit: <http://www.nps.gov/grca/learn/nature/seepspringstudy.htm>

Big Galleta Herbaceous Vegetation

Alliances:

Pleuraphis rigida Herbaceous Vegetation

CEGL Codes cf. CEGLO00955, cf. CEGLO03051

Macrogroup Code na

Alliance Codes A3170, A3281

Description: This grassland association is currently described from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona (Figure 51). This type was not described in the LAKE vegetation mapping project and is included here as the GRCA / PARA portion of the LAKE administrative boundary. “It predominantly occurs on side slopes, but also sometimes occurs in drainage channels and on valley bottoms, mesas, and plateaus from approximately 1050 to 1600 m (3420-5250 feet) elevation, but has been found as low as 470 m (1540 feet). It is typically found on flat to gently sloping gradients (0-5 degrees), but also occurs on moderately steep slopes (15-30 degrees) as well. Soils are well-to rapidly-drained sandy clays or loams that occasionally contain silt. The underlying geology is usually limestone. Tree and tall shrubs are essentially absent from this graminoid-dominated community type. A relatively sparse short-shrub layer occurs, in which *Coleogyne ramosissima* and *Ephedra fasciculata* occur most frequently. *Opuntia polyacantha* and *Gutierrezia* spp. are commonly seen in a sparse dwarf-shrub stratum. A well-developed graminoid layer dominated by *Pleuraphis rigida* characterizes this association. The invasive grass *Bromus rubens* also occurs on a regular basis, while the native perennials *Bouteloua eriopoda* and *Aristida purpurea* occur sporadically. Species such as *Sphaeralcea grossulariifolia* and *Erodium cicutarium* are common in the forb understory.” (Kearsley, et al. 2015). No photographs are available for this description.

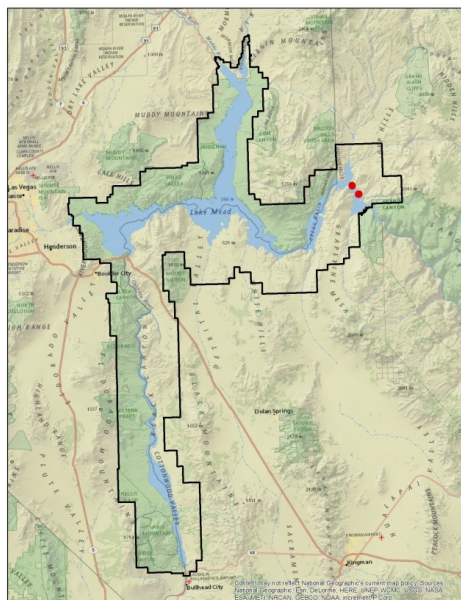


Figure 51. Mapped distribution for Big Galleta Herbaceous Vegetation.

Sparsely Vegetated

Bare Rock and Sparse Vegetation

Alliances:

Desert Wash and River Bottom Sparsely Vegetated

Atriplex hymenelytra Shrubland

Chorizanthe rigida - *Geraea canescens* Desert Pavement

Ephedra spp. - *Leymus salinus* - *Eriogonum corymbosum* Badlands Cold Desert Sparse Vegetation

Montane Ravine Sparsely Vegetated

Peucephyllum schottii Shrubland

Playa Mapping Unit

Aloysia wrightii - *Pericome caudata* - *Ephedra nevadensis* Sparsely Vegetated Bedrock Cliff & Lava Field Alliance

Sphaeralcea ambigua Herbaceous

CEGL Codes CEG001317, cf. CEG001264, cf. CEP009686, CEG002349, CEG002722, cf. CEP009532

Macrogroup Code MG117.

Alliance Codes A0872, A4024, A4052, cf. A2572, A3143, A4025

Description: The Sparse Vegetation map class forms a sparse to open shrub layer (Figure 52 and Table 36). The emergent tree layer, when present, is typically sparse and the herbaceous layer is sparse to open. The map class is found on a variety of landforms and aspects, including alkaline basins and mud hills, low-slope position desert pavement and washes, limestone slopes and volcanic deposition. Soils are derived from a variety of substrates including alluvium, rhyolite, sandstone, and limestone, basalt, limestone, sandstone, and calcareous gravel gypsum rock outcrops, and the soil texture is highly variable. Elevations range from approximately 200 to 640 m. *Atriplex hymenelytra* may be dominant or co-dominant in the shrub layer, and those shrubs often present include *Ambrosia dumosa*, *Ephedra torreyana*, *Peucephyllum schottii*, *Eriogonum fasciculatum*, *Eucnide urens*, *Pleurocoronis pluriseta*, *Psoralea fremontii*, *Larrea tridentata*, *Lepidium fremontii*, *Stephanomeria pauciflora* and *Atriplex confertifolia*. On rare gypsum outcrops one might also find uncommon and rare plants such as *Arctostaphylos californica* and *Enceliopsis argophylla*. A sparse cover of *Larrea tridentata* may also be present. The herbaceous layer is variable, but *Eriogonum inflatum*, *Chorizanthe rigida*, *Cryptantha* spp., *Geraea canescens*, *Bromus rubens*, *Sphaeralcea ambigua*, *Nicotiana obtusifolia* and *Plantago ovata* are sometimes present. Cryptogamic crust may be present.

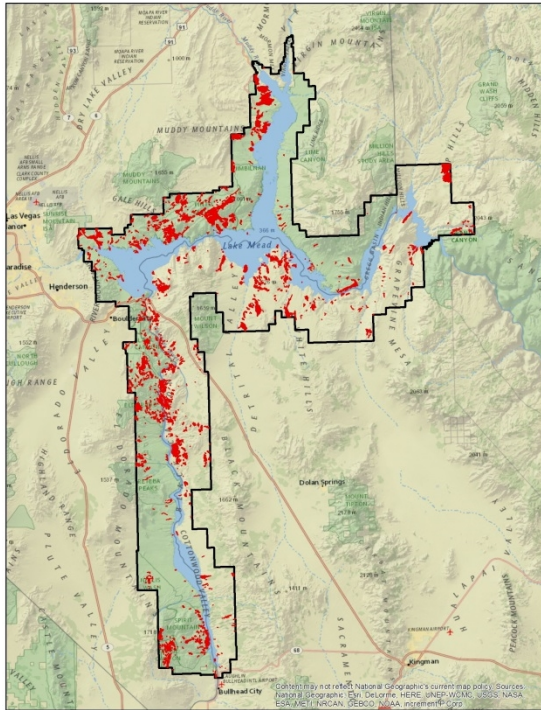


Figure 52. Mapped distribution for bare rock and Sparse Vegetation.

Table 36. Mapped Bio-physical parameters for Bare Rock and Sparse Vegetation. Elevation is 632 – 4286 ft (193 – 1471 m).

Bare Rock and Sparse Vegetation	Acres	Hectares
Landform		
cool aspect scarps, cliffs, canyons	409	166
gently sloping ridges and hills	7050	2853
hot aspect scarps, cliffs, canyons	24	10
moderately dry slopes	5444	2203
moderately moist steep slopes	8611	3485
nearly level plateaus or terrace	9927	4017
toe slopes, bottoms, and swales	151	61
valley flats (or water bodies)	21	9
very dry steep slopes	2559	1035
very moist steep slopes	5240	2121
Vegetation Density		
Low	20931	8470
Medium	674	273
None or Water	34	14
Very Low	17798	7202
Geology		
Aeolian sand	6	2
Alluvium	1591	644
Carbonate rock	1403	568

Table 36. Mapped Bio-physical parameters for Bare Rock and Sparse Vegetation. Elevation is 632 – 4286 ft (193 – 1471 m) (continued).

Bare Rock and Sparse Vegetation	Acres	Hectares
Geology (continued)		
Mafic-ultramafic rock	2162	875
No Data	6962	2817
Older alluvium	179	72
Sedimentary rock	12992	5258
Silicic-intermediate rock	12141	4913
Spring Deposits	216	87
Water	159	64
Weakly lithified sedimentary rock	1626	658
Soil Parent Material		
No Data	459	186
alluvium and colluvium derived from granite	187	76
alluvium and colluvium derived from limestone	284	115
alluvium and colluvium derived from tuff	440	178
alluvium and colluvium derived from volcanic rock	71	29
alluvium and/or colluvium derived from limestone and sandstone over colluvium	23	9
alluvium derived from basalt	120	49
alluvium derived from basalt and gypsum	136	55
alluvium derived from fanglomerate	8	3
alluvium derived from granite	12	5
alluvium derived from gypsum	1013	410
alluvium derived from gypsum over residuum weathered from gypsum	1493	604
alluvium derived from igneous and metamorphic rock	158	64
alluvium derived from igneous, metamorphic and sedimentary rock	975	395
alluvium derived from limestone	1503	608
alluvium derived from mixed	2008	813
alluvium derived from sandstone	90	36
alluvium derived from shale	1458	590
calcareous loess influenced alluvium derived from igneous and metamorphic	67	27
colluvium and/or residuum weathered from andesite	989	400
colluvium and/or residuum weathered from granite	3163	1280
colluvium and/or residuum weathered from gypsum	255	103
colluvium and/or residuum weathered from limestone	659	267
colluvium and/or residuum weathered from sandstone and siltstone	74	30
colluvium and/or residuum weathered from volcanic rock	8146	3297
colluvium derived from limestone and dolomite over residuum weathered from	17	7
colluvium derived from sedimentary rock over residuum weathered from	13	5
colluvium derived from volcanic rock	5394	2183
colluvium residuum weathered from limestone	494	200
eolian deposits derived from mixed sources	121	49
eolian sands	33	13

Table 36. Mapped Bio-physical parameters for Bare Rock and Sparse Vegetation. Elevation is 632 – 4286 ft (193 – 1471 m) (continued).

Bare Rock and Sparse Vegetation	Acres	Hectares
Soil Parent Material (continued)		
eolian sands derived from mixed	10	4
gravelly alluvium	389	157
gravelly pedisediment derived from limestone	535	217
loess over residuum weathered from basalt	30	12
mixed alluvium	263	106
mixed alluvium derived from metamorphic rock	12	5
mixed gravelly alluvium	2030	821
residuum and colluvium derived from granite	775	313
residuum weathered from granite	1262	511
residuum weathered from gypsum	822	333
residuum weathered from sandstone and siltstone	3228	1306
Water	220	89
Elevation Range	Feet	Meters
	632 - 4286	193 - 1471

Beach and Barren Sand Draw-down Area

Alliances:

Not sampled

Description: No plot data were collected within the drawdown area (Figures 53 and 54; Table 37) as these areas are ephemeral given the changing hydrological variability. These areas are generally bare but annual grasses may appear in those locations where sediment may accumulate and persist when areas are not reflooded. *Tamarix* spp. encroaches in many areas but is generally small in stature and sparse. *Tamarix* spp. stands in the drawdown area are often found adjacent to and below drainages. The upper margins of the drawdown area tend to see greater amounts of vegetation as these areas have not been flooded in some time. *Tamarix* spp. is also found along the river edge below Hoover Dam however these occurrences are often found mixed with other riparian map classes.

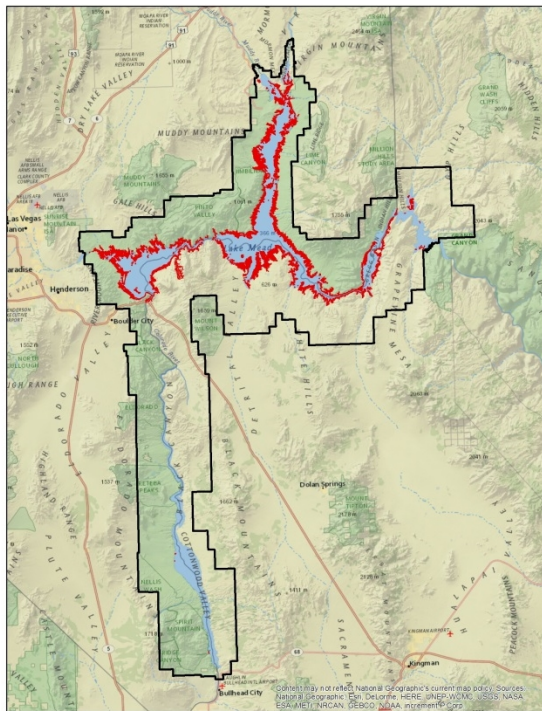


Figure 53. Mapped distribution for Beach and Barren Sand Draw-down Area.



Figure 54. Beach and Barren Sand Draw-down Area.

Table 37. Mapped Bio-physical parameters for Beach and Barren Sand Draw-down Area. Elevation is 653 – 2086 ft (199 – 636 m).

Beach and Barren Sand Draw-down Area	Acres	Hectares
Landform		
cool aspect scarps, cliffs, canyons	5	2
gently sloping ridges and hills	11778	4766
moderately dry slopes	51	21
moderately moist steep slopes	267	108
nearly level plateaus or terrace	8240	3335
toe slopes, bottoms, and swales	7359	2978
valley flats (or water bodies)	3131	1267
very dry steep slopes	14	6
very moist steep slopes	1304	528
Vegetation Density		
High	332	134
Low	15216	6158
Medium	5795	2345
None or Water	18	7
Very Low	10790	4367
Geology		
Aeolian sand	14	6
Alluvium	634	256
Carbonate rock	41	17
Mafic-ultramafic rock	19	8
No Data	13	5
Older alluvium	183	74

Table 37. Mapped Bio-physical parameters for Beach and Barren Sand Draw-down Area. Elevation is 653 – 2086 ft (199 – 636 m) (continued).

Beach and Barren Sand Draw-down Area	Acres	Hectares
Geology (continued)		
Sedimentary rock	2027	820
Silicic-intermediate rock	651	263
Spring Deposits	31	12
Water	28538	11549
Soil Parent Material		
No Data	31	12
alluvium	22	9
alluvium and colluvium derived from tuff	9	4
alluvium derived from fanglomerate	20	8
alluvium derived from gypsum over residuum weathered from gypsum	1712	693
alluvium derived from igneous, metamorphic and sedimentary rock	8	3
alluvium derived from limestone	36	15
alluvium derived from limestone and sandstone	4	2
alluvium derived from mixed	464	188
alluvium derived from shale	143	58
colluvium and/or residuum weathered from andesite	10	4
colluvium and/or residuum weathered from granite	2	1
colluvium and/or residuum weathered from volcanic rock	73	29
colluvium derived from sedimentary rock over residuum weathered from sedimentary rock	5	2
colluvium derived from volcanic rock	53	22
eolian deposits derived from mixed sources	25	10
eolian sands derived from mixed	9	4
gravelly alluvium	6	2
mixed alluvium	36	14
mixed gravelly alluvium	100	40
residuum and colluvium derived from granite	302	122
residuum weathered from granite	2	1
residuum weathered from gypsum	38	15
residuum weathered from shale and siltstone	2	1
Water	29040	11752

Other Miscellaneous

Agricultural Lands

This class consists of lands in the Overton area along the Muddy River planted for wildlife conservation

Urban or Developed Area

Many areas within the Park have facilities either associated with the Park or Dam operations and have been identified within this map class.

Transportation / Roads / Trails

All transportation facilities, roads, and trails are combined into this one map class.

Open Water

The primary delineation for this map class is Lake Mead and the Colorado River; however, there are numerous other small bodies that have been identified.

Mixed Ornamental & Semi-Natural Woodland

Many of the campgrounds and boat launches have exotic vegetation planted as ornamentals and for shade. These are lumped into this one map class.

Geodatabase

The geodatabase has a number of data layers related to the vegetation map. These include the vegetation polygon layer and associated attributes, point layer feature class depicting vegetation plot and accuracy assessment sites with associated attributes, ancillary vector and raster data used to assist in the vegetation interpretation, several related tables for additional information, stand alone tables, and metadata for all layers contained in the final geodatabase.

Vegetation

The vegetation layer has a number of fields. These include; vegetation description, landform type, vegetation density, geology, soil parent material, elevation, data source, and Park specials in addition to various fields containing polygon geometry information. The first five in this list also have an associated numeric or text ID.

The vegetation information is recorded under the Land Cover field. This field has a number of classes that are not strictly vegetation, such as water, urban areas, roads, etc. and therefore, ‘Land Cover’ is a better description of this item. The vegetation alliances associated with each type are listed in Table 15 and the relate table described below. A text code is also included for each map class.

‘Landform’ is extracted from a dataset produced by the RS/GIS Laboratory, College of Natural Resources, Utah State University (Manis, Lowry and Ramsey 2001). Details of this dataset are described in Appendix G. This attribute also has an associated numerical ID, ‘Landform_ID’.

‘Vegetation Density’ is a categorical variable derived from the creation of a vegetation index (MSAVI2) using 30 meter Thematic Mapper images (March 23, 2011 imagery). This variable also has an associated numeric ID (VegDensity_ID). Details of this dataset are described in Appendix I.

The ‘Geology’ field is extracted from a USGS digital map (Beard, et al. 2007). This dataset only extends south to about 9 miles below Willow Beach. Polygon values for areas south of the geologic dataset have “Null” values. A description of this dataset can be seen in Appendix J.

‘Soil Parent Material’ is a subset of the USDA SSURGO (NRCS No date) dataset and is included to add additional perspective to the vegetation distribution within the Park. Additional information about this data can be seen in Appendix K.

Elevation data has been extracted from USGS 10 meter National Elevation Dataset (NED) and is provided in both feet and meters.

‘Data Source’ is an additional field added to clarify the source of the vegetation information. The eastern most portion of the LAKE administrative boundary was mapped separately as part of the Grand Canyon National Park-Grand Canyon / Parashant National Monument vegetation classification and mapping project (Kearsley, et al. 2015) and that portion was included with the LAKE product. Boundary polygons that were modified to create a seamless dataset are noted.

Geometry fields include ESRI generated fields such as shape_length, shape_area, perimeter and area are included in addition to two calculated fields for ‘Acres’ and Hectares’.

Point Layer:

This data layer contains all the vegetation data points collected during the mapping process. They are identified by the data collection name (Plot_Code) and the type collected e.g. AA point, plot, or verification point (Pnts_Type). Also included are the x and y coordinates for each point.

Ancillary Vector

Additional reference shape files are included. These are ‘Highwater’, LAKE Administrative Boundary, and the original mapping boundary (does not include GRCA / PARA portion).

Ancillary Raster

Numerous raster datasets were used for reference and for generating additional information related to the vegetation map classes. These include landform, elevation, MSAVI, geology, and soil parent material described above. The landform, elevation, and MSAVI raster were resampled from either 30 meter or 10 meter data to 5 meter data to allow for more precise polygon characterization. In addition, the original TM scenes used for the MSAVI dataset is included as a mosaicked and clipped dataset. All of these rasters are further described in the appendices.

Tables

A number of tables are included to store plot and vegetation data. These include PLOTS data with both the vegetation plot and AA information. Relationship classes are included to link the spatial data (plots, observation points, accuracy assessment points and vegetation polygons) to the data tables.

Metadata

FGDC compliant metadata is included for all digital data whether it was generated by this project or included as ancillary data derived from other sources.

Merging Grand Canyon Vegetation Map to Lake Mead Vegetation Map

The eastern most portion of LAKE was mapped by the GRCA - PARA vegetation mapping project. In order for LAKE to have a vegetation map that included its entire administrative boundary, that portion of the PARA project was added to the LAKE map. The intersect area covers 24,486 hectares (Figure 55). Details of the merging process are described in Appendix M, and the objective was a seamless blend with the GRCA/PARA product.

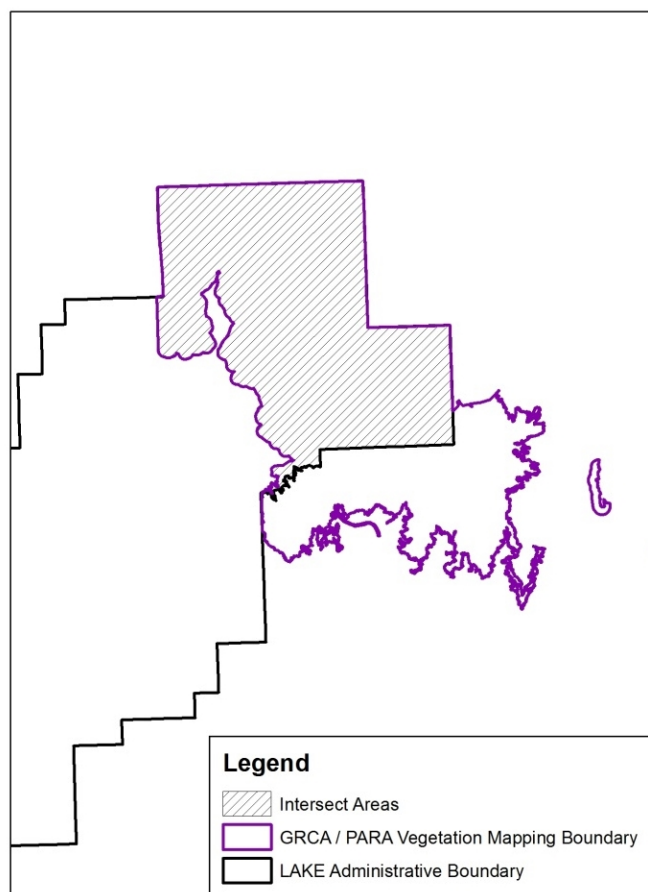


Figure 55. Overlap area between LAKE administrative area and the GRCA / PARA vegetation map.

Accuracy Assessment

Accuracy Assessment (AA) of vegetation inventory data is a statistical analysis of the thematic accuracy of the vegetation map. It does not evaluate the spatial accuracy of map polygon boundaries. The AA measures the degree of confusion, or error, between map classes presented on the map and the vegetation as sampled on the ground. The AA tests the ability of the map to accurately identify the patterns of the vegetation classes on the landscape, and provides map users with information on the strengths and limitations of the map and its suitability for particular applications. It also informs map producers of potential sources of error and how to improve the mapping procedure (Lea & Curtis, 2010). The results of the AA provide measures of overall accuracy and a class by class estimate of the “users’” and “producers’” accuracy. Users’ accuracy is the probability that map polygons correctly classify the vegetation communities as they occur on the ground. Producers’ accuracy is the probability that a vegetation community is correctly identified on the map.

In order to produce a quantitative estimate of accuracy, AA involves field assessment of sample points randomly distributed by strata throughout the LAKE project area. Vegetation at each of these survey points is classified in the field and assigned a USNVC recognized vegetation type or other local type (i.e., Park Special) by a field technician using the dichotomous key to plant associations of LAKE. The field classifications are then related to the associated map class assigned to each location on the map. Using these data, different analyses can estimate overall accuracy of the map and the users’ and producers’ accuracy of each map class.

The patterns of mismatches and low accuracy can then be explored by map producers. Classes with low accuracy and the classes they are confused with can be aggregated to improve the per class accuracy. This process of aggregating low accuracy classes was completed for the LAKE map and is described below.

The sample design and field methods were conducted in accordance with NPS Vegetation Inventory Program, Thematic Accuracy Assessment Procedures (Lea and Curtis 2010). The methods of data analysis were based on an alternative method presented by (Stehman 2014) to account for differences between the strata used to select sample points and the map classes on the final map. Typically, a complete and field verified map is used to create the sample frame and strata within which the random sample points are distributed. In the case of the LAKE project, a preliminary map developed using automated mapping methods is what was available at the time needed for the field survey work to begin. This preliminary map was subsequently refined to correct line-work and mis-allocation of map classes and serves as the final map. Because sample point allocations were based on the preliminary map strata and not the final map being accuracy assessed the AA analysis methods employed by the (Lea and Curtis 2010) are not applicable. To resolve this problem, the method presented by (Stehman 2014) was used. That method computes the areas of the map polygons from both maps and uses them to appropriately weight the results for each map class. Additional details of how the (Stehman 2014) method was applied to the case of the LAKE vegetation inventory are provided in the data analysis section below.

Methods

Sample Design

A stratified random sampling approach was used to determine AA sampling locations. The area of inference was developed by applying several constraints to the classes and polygon boundaries of the map layer. The classes excluded from the inference area, the buffers applied to polygon edges, and other plot allocation adjustments are described below.

In defining the sample frame, several map classes for non-vegetated and land use types were excluded from the inference area. These included water, urban and other developed areas, and transportation infrastructure. Urban or cultural areas not sampled were the campgrounds, lakeside developments that are often planted with exotic species and represent a very minimal amount of area within the Park. Highly disturbed areas such as the drawdown were also not sampled for two reasons. The initial determination at the mapping kick-off meeting was not to map these areas due to their highly disturbed and variable nature and therefore, these areas were not sampled for vegetation classification. At a later date these areas were included in the mapping effort, as areas of management concern. Because these drawdown areas were added after the mapping process was underway their delineation was not ready when the initial vegetation layer was used for the selection of accuracy assessment points. The GRCA/PARA portion also was not sampled as it had been tested in the previous mapping effort.

Those areas and map classes not sampled are detailed in Table 38. Buffers were applied to the point distribution to ensure independence among observations within the same polygon, to minimize edge effects and promote homogeneity within samples, and to avoid the effects of land use classes and other disturbance. The polygon boundary buffer was 10 meters and applied to all map classes except linear and small patch types which did not use a buffer. Additionally, a cost surface was developed to exclude areas of steep or otherwise unsafe terrain and areas requiring excessive travel times from the random point generation. The cost surface used a threshold of ≥ 40 degrees (89 percent) slope developed using a 10 m DEM data. Areas greater than 0.6 miles (1.0 km) miles distant from any access point were also excluded from the point allocation. These areas are, however, within the inference area. Figure 56 shows the areas included for AA sample site selection.

Table 38. Map classes and area excluded from accuracy assessment.

Map Class	Acres	Hectares	% of Mapped Area
Mixed Ornamental and Semi-natural Woodland	78	32	0.007
Agricultural Land	499	202	0.045
Urban or Developed Areas	759	307	0.068
Transportation / Roads / Trails	4,788	1,938	0.431
Beach and Barren Sand Draw-down Area	32,148	13,010	2.891
Open Water	118,791	48,073	10.683
Total	157,064	63,562	14.125

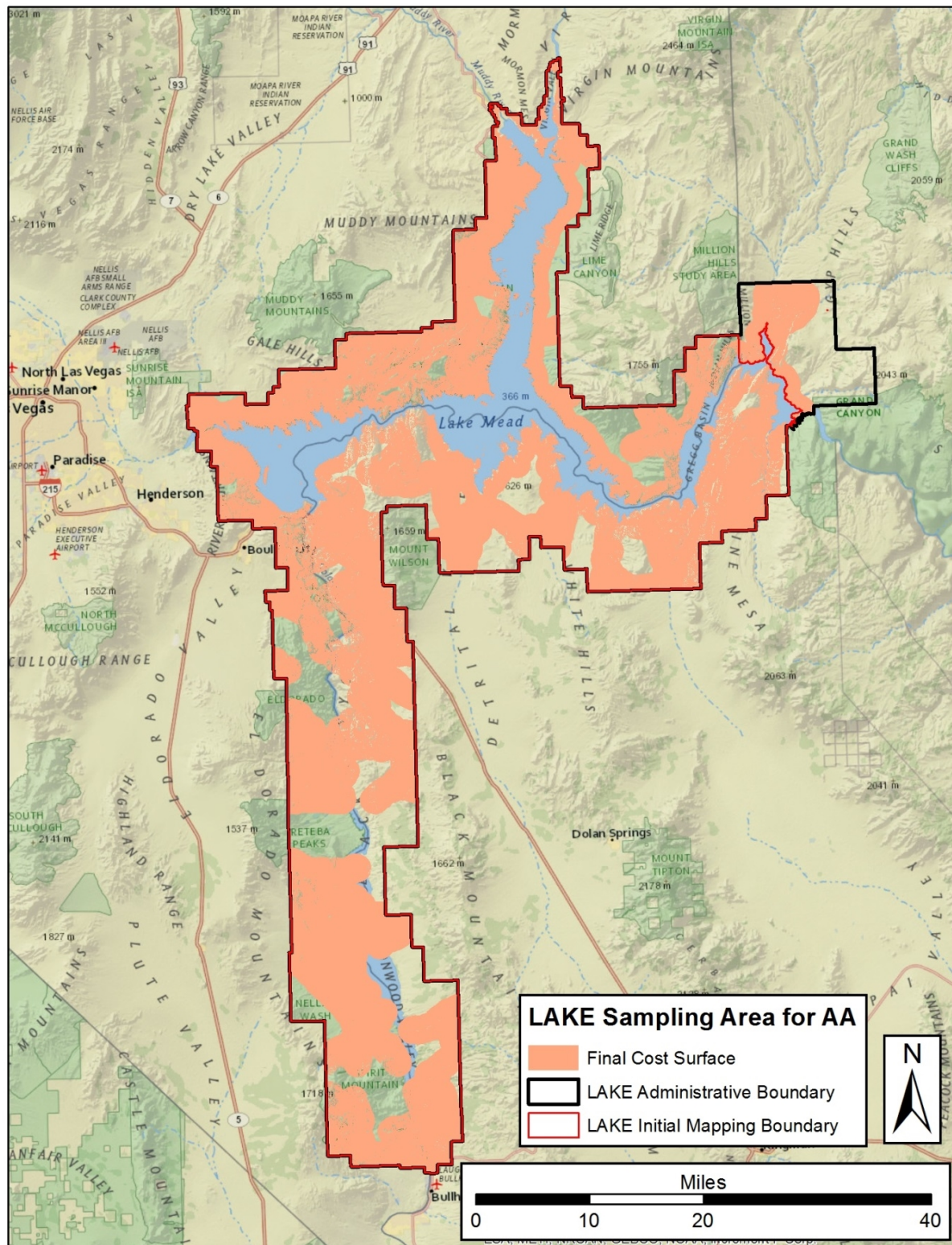
Sample sizes for each evaluated map class were selected using guidance from (Lea and Curtis 2010) (Table 39). A total of 551 sample sites, henceforth referred to as “Sample A,” were generated using a stratified random sampling design based on map class total area. An alternate set of 508 sample sites was also generated using the same design, henceforth referred to as “Sample B”. In the event that a site from the Sample A set was not accessible, a replacement site of the same map class would be randomly selected from the Sample B set. Sample points were randomly allocated to the inference area of the cost surface layer using the random point generation tool in the ESRI, Inc. ArcGIS software. Figure 57 shows the distribution of the Sample A and Sample B target points. The proportion of samples placed in any given map class was determined following (Lea and Curtis 2010) guidelines.

Table 39. Standard sample size allocations for NPS Vegetation Inventory thematic accuracy assessment, based on map class area (Lea and Curtis 2010).

Map Class Abundance	Map Class Total Area*	Number of Observations per Map Class**
Abundant	> 50 hectares	30
Relatively Abundant	8.33 to 50 hectares	0.6 per hectare
Relatively Rare	< 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.



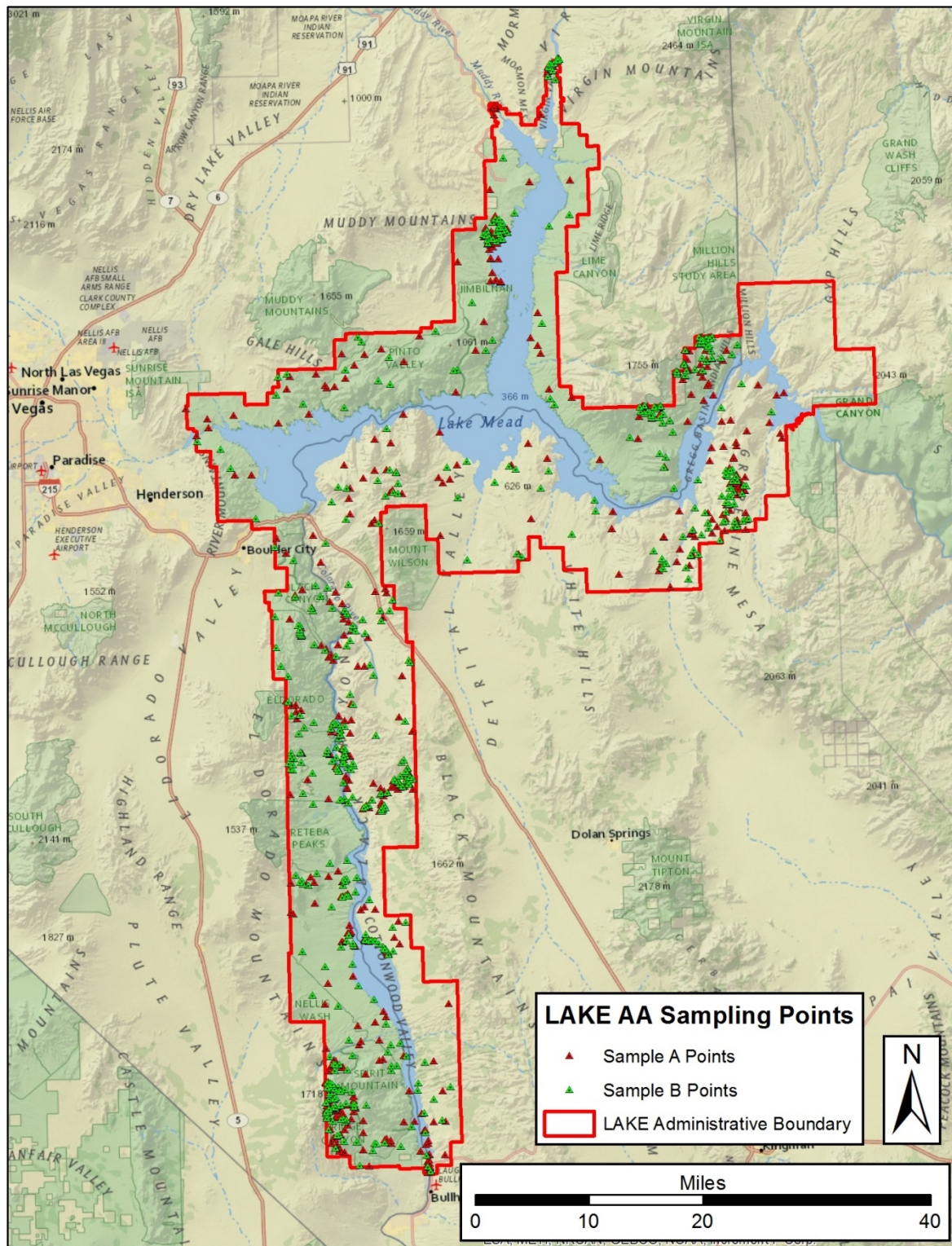


Figure 57. Locations of the randomly generated Sample A and Sample B target points.

Field Data Collection

The Colorado Natural Heritage Program field crew was comprised of a single crew lead and six crew members, all of whom were trained in AA data collection and field work during a training session at the beginning of the season. Other topics covered during the training session included: plant species of the area, how to use the Field Key to Alliances, the purpose and scope of the vegetation mapping project, and the rules and safety regulations of working with MOJN and the Park.

The six crew members would typically be split into three crews of two. Each work day, a cluster of target points would be assigned to each crew. Crew members were responsible for using GPS units (Garmin Oregon 650) and paper maps to navigate to the target AA plot locations. Upon arriving at a sample site the crew would assess the area to discern whether the plot was an adequate representation of the vegetation community (Figure 58). The standard AA plot size (corresponding with MMU) is a 0.5 hectare circle. At LAKE, the *Washingtonia filifera* Seasonally Flooded Woodland Alliance was the only exception to this rule, as the MMU for this map class was 0.25 hectares. If necessary, the crews would reshape or move the plot according to the steps outlined in the “Decision Tree”. All information on the reshaping or moving the plot was recorded on the field form. The center of the plot would be recorded in the GPS unit as a waypoint.

Once the crew had deemed the plot acceptable for sampling, they were responsible for completing an Accuracy Assessment Field Form (Appendix L). Information on surveyors, date, AA plot number, waypoint UTM coordinates, physical characteristics of the plot, percent cover of species and strata present in the plot, relevant notes, and the alliance assigned to the plot were all components of the field form. Crews would conduct an ocular (40m) survey of the vegetation community within the plot and use the Field Key to Alliances to guide them to a “Primary Alliance.” They would then read the corresponding alliance description to determine if the primary alliance selected was a good fit for the community. If there was any uncertainty during the keying process, or the alliance description did not sound like an ideal fit, the crew could record a “Secondary Alliance.” In those scenarios, detailed note-taking was encouraged.

The crews were also required to take four photos at each plot. These photos were taken from the plot center in each of the cardinal directions, in the order: North, East, South, and West. These photos were intended to represent the vegetation present at the each plot at the time of sampling and are to be used during data analysis and for historical record. Photos were taken using the camera function of the Garmin Oregon 650 units set on the highest picture quality (8 megapixels). Because the Garmin Oregon 650 units record the UTM coordinates of the photo locations into the file header, additional efforts to document the photo files was unnecessary.



Figure 58. Field crew on AA site, filling out AA form.

Map Books

To assist the field crews trying to locate their sample points, map books were generated. Each map sheet had a background image supplied for visual context, a UTM coordinate grid, polygons of the vegetation layer without attribute information, the road network, and the location of the point to be sampled. An example of this is shown below in Figure 59.

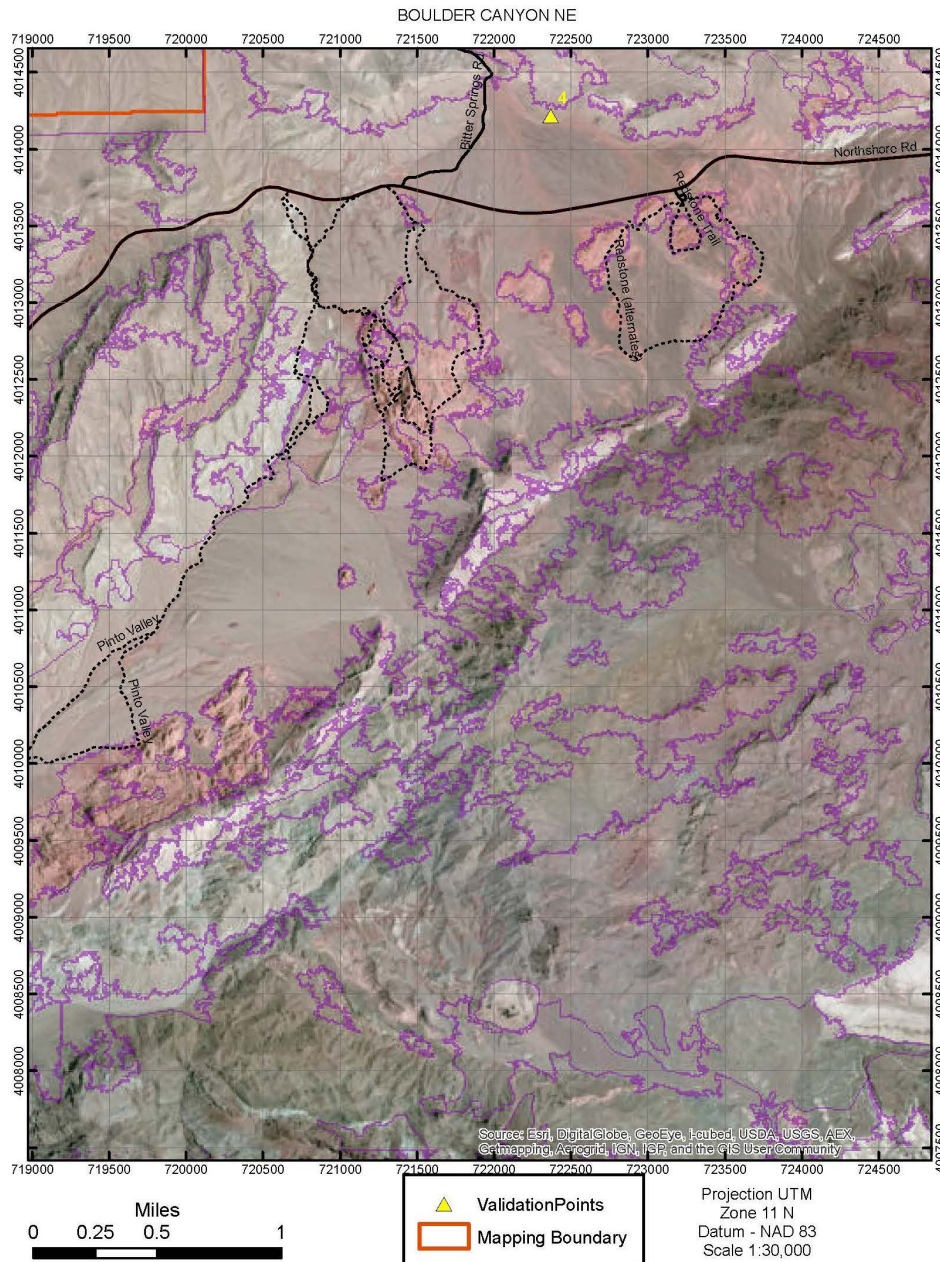


Figure 59. Example page from AA mapbook.

Data Management

At the end of each work day or multi-night trip, waypoints from each GPS unit were downloaded, organized by date and specific GPS unit, and stored as a text file (.txt) using the DNR GIS Software (DNR 2015) Photos were also downloaded and archived by plot number, GPS unit and date.

The data sheets were then reviewed for errors and omissions before the data from all completed fields on the AA field form were entered into the PLOTS database (version 3.3). The populated database was thoroughly Quality Checked (QC) to identify and eliminate any data entry errors. These checks included searching for null values, checking for values out of range, nonsensical, or otherwise

erroneous values. After making necessary corrections the data were imported into ArcGIS as a layer file and a data QC check was completed to ensure that the geocoding was correct for all points.

The AA point photos were renamed in accordance with LAKE photo-naming protocols. That protocol required the name to include a project id, PARK, purpose, plot code, aspect of photo, and photo date. As an example of a single file name, the file for plot number 164 looking south (180 degrees) taken on Feb.17, 2014 is: vmap_LAKE_AA_164_180_20140217.jpg.

Data Analysis

Analysis of the AA field data and map accuracy requires several separate steps. Initially, sample data must be spatially compared to the map class data to identify the sample points that agree and those that disagree with the mapped class. Those in disagreement then need to be evaluated to ensure the field call is valid and that the source of the disagreement is only due to an incorrect map class and not some confounding factor. This process of “reconciling” the erroneous sample points eliminates sample points that appear to be in disagreement with the mapped class, but in reality result from some other factor than an incorrectly mapped polygon. Examples of possible confounding factors include land cover changes that occurred between when the imagery used to create the map was acquired and when the field sampling occurred (usually a period of two to three years), data transcription errors, and field crew errors related to ocular estimating of the MMU or species cover.

The spatial join of sample point data and final map class was done in ArcGIS. The point data were first reviewed to identify and correct for common errors resulting from GPS error, intentional plot offset, or other spatial differences. Each point still in disagreement with the mapped class was then individually evaluated by reviewing all the available data for the sample point and the map polygon. The reconciled sample points remain unbiased by correcting only errors that can objectively be attributed to an erroneous field call or a change in land use or land cover.

Three potential sources of disagreement were identified prior to verifying the sources of error. These included errors where the disagreement was due to an erroneous map call (MC), an erroneous field call (FC), or due to changes in the land use or land cover (RC) occurring after the imagery date.

Errors due to an erroneous field call were further classified as due to a species or association ID error (FC1), a cover or density estimate error (FC2), a minimum map class (MMU) estimate error (FC3), or a simple recording error (FC4). Any error that could not objectively be attributed to other than a map call were classified MC. All errors classified MC were retained as errors. All map class errors classified as FC1 – FC3 or RC1 were considered to be correct.

The review of all errors included reviewing the field data sheets, the sample point photos, the map polygons, and imagery of the area. Prior to starting the review, additional columns were added to the evaluation spreadsheet for “Error Classification”, “Comments/Justification”, and “Reconciled Field Call”. Error Classification is one of five codes listed above (FC1–FC3, MC1, RC1), Comments/Justification provides a short description of what the specific issue was, and Reconciled Field Call is the post reconciliation value assigned to the point (may remain same or change).

To build the data set necessary for the analysis required the ArcGIS shapefiles for the preliminary and final maps and the reconciled point data from the PLOTS database to be joined using a spatial join in ESRI ArcGIS. An MS Excel table was exported from the PLOTS DB that contained the Plot ID, Primary Association, Secondary Association, Primary Map Class, Secondary Map Class, Plot XY Coordinates, and Field XY Coordinates. These data were imported to ESRI ArcGIS and converted to a shapefile. The shapefiles for the preliminary and final maps were joined and the areas of the combined polygons were calculated. This combined polygon layer was then joined to the shapefile of the plot data. A table of these three spatially-joined datasets was then exported to excel for analysis.

As indicated above, the sample frame used to define the strata for the AA point random distribution was based on a “preliminary” map different from the “final” map being analyzed. To correctly assess the accuracy of the final map required the use of a statistical method presented by Stehman (2014). That method uses the proportion of area in each map class from both the preliminary and final maps to relate the map class proportions of the two maps to arrive at a correct estimate of accuracy for each map class. The analysis was completed in an MS Excel workbook provided with the project products.

The set of stratified random sample points was based on strata from the preliminary map developed using automated methods. That map is different from the final map being accuracy assessed in that some polygon boundaries have moved and some areas have been re-classed. These post-stratification changes invalidate the use of the standard error matrix methods provided by (Lea and Curtis 2010). To correctly assess the accuracy of the final map, the method presented by Stehman (2014) was applied. Because the strata used for the sampling design do not correspond exactly to the map classes of the final map (the rows of the error matrix), the conventional estimators for accuracy and area used in (Lea and Curtis 2010) are biased. The Stehman (2014) method uses essentially the same estimators as the (Lea and Curtis 2010) method, but estimates the accuracy and area proportions using simple indicator functions. The indicator functions provide a binary indicator (0 or 1) for parameters to identify proportions for stratum, map class, and reference class in the calculations. The calculations include overall accuracy, as well as users’ and producers’ accuracies for each map class. For complete descriptions of the method used, please refer to the original paper (Stehman 2014).

Results

AA Field Data Collection

Accuracy Assessment data was collected from February 1, 2014 through April 3, 2014. Of the 551 Sample A points visited, the field crew rejected 14 and collected data from 537 of the Sample A points. Eleven of the rejected Sample A points were replaced with alternates from the Sample B set. Two of the rejected Sample A points were not replaced with alternates. Overall, 548 AA plots were sampled (537 Sample A and 11 Sample B). Figure 60 shows the location of the 548 sampled AA points. Reasons for rejecting a plot were largely due to inaccessibility and include: unsafe approach to plot, usually due to cliffs and steep unstable rocks, plots falling within a restricted security zone such as the Davis Dam restricted area, or plots located in extremely difficult to access areas with no feasible land or boat approach.

The total inference area (mapped sample) within the 595,041 hectare (1,470,328 acres) LAKE NRA is 362,130.65 ha (894,842. ac), or 7.7%. Not included in the inference area are the open water reservoir areas and land use areas (agriculture, roads, urban, etc.). The inference area in each map class and the count of sample points collected across them is shown in Table 40.” Inference area and count of sample points in each map class at LAKE.”

Table 40. Inference area and count of sample points in each map class at LAKE.

Map Class Code	Map Class Inference Area (ha)	Number of AA Sample Points
BB	667.69	15
CB	190,960.45	96
DV	2,020.53	29
FOR	31.62	2
FP	3.55	2
GL	340.72	7
JT	3,594.52	25
JW	359.26	28
MARSH	31.08	13
MID_MDS	12,738.06	24
OAK	169.47	9
PV	460.84	30
PW	81.07	13
RIP	340.67	20
RIPW	110.05	16
SB	566.83	20
SBS	4.07	0
SD_WASH	35,582.10	57
SDS	81,853.33	48
SV	15,175.64	20
TAM	10,856.73	23
YS	6,182.29	43
Grand Total	362130.57	548

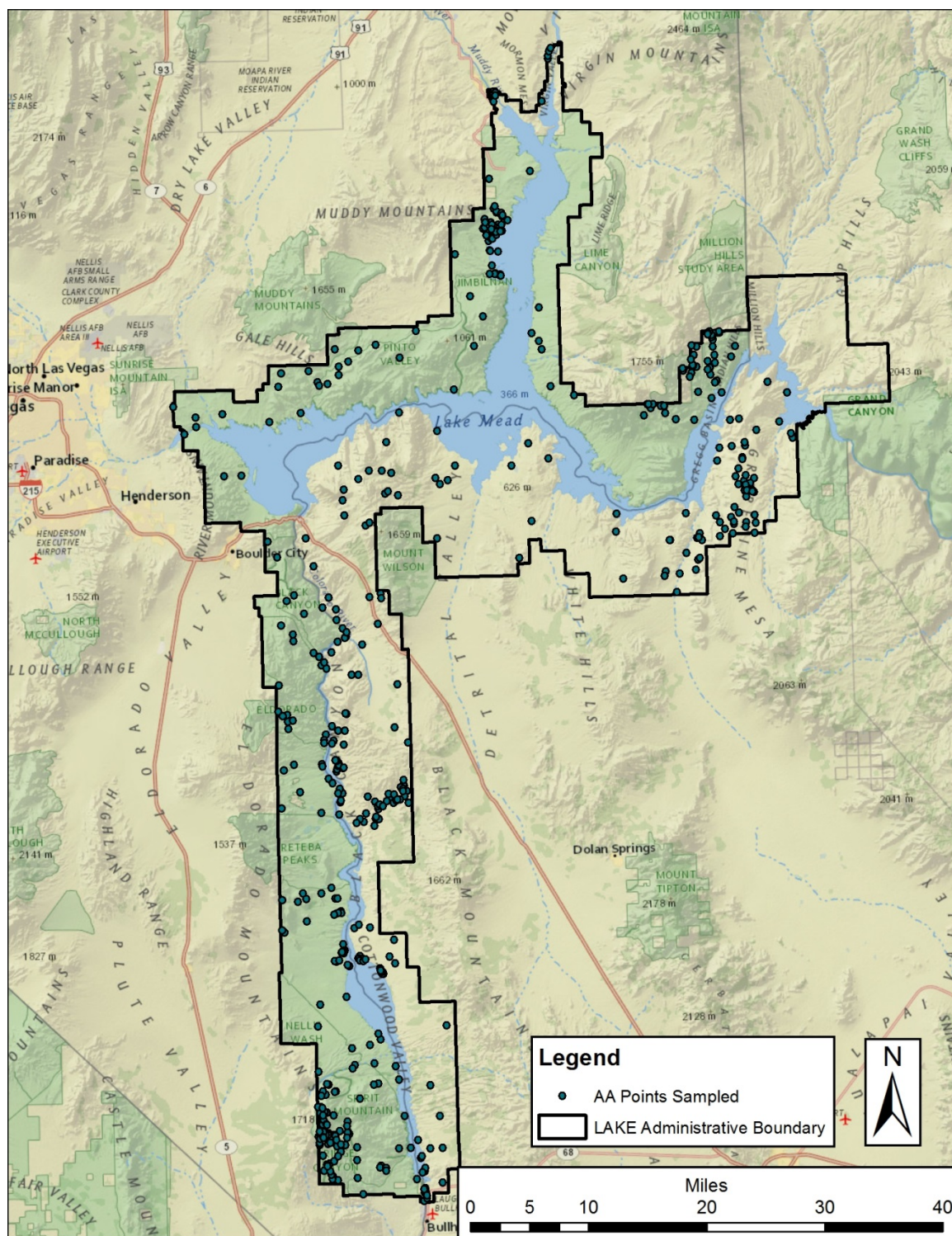


Figure 60. Locations of the 548 sampled AA points.

AA Data Analysis

When the 548 sampled AA points were joined to the vegetation map, 240 evaluated as correct and 308 evaluated as incorrect. Each incorrect AA sample was then evaluated for a variety of potential

errors unrelated to map attribution, as described above. Through that process it was determined that 97 of the incorrect samples disagreed due to either an erroneous field call or a change in the vegetation, and 211 disagreed due to a true map classification error. Those that disagreed because of an erroneous field call or change in the vegetation were reconciled for the purpose of the AA. In a few cases it was obvious that both the map call and the field call were erroneous and the sample point was retained as an error. The 211 plots in disagreement following the reconciliation were attributed to map classification error and retained (Table 41).

Table 41. Error reconciliation summary for LAKE Accuracy Assessment.

Accuracy Assessment	Count	Percent
Initial (raw) Accuracy*		
Map Class Agreement	240	43.8%
Map Class Disagreement	308	56.2%
Concise (reconciled) Accuracy*		
Map Class Agreement	337	61.5%
Map Class Disagreement	211	38.5%

Notes: * Based on simple plot count proportion, not spatially weighted

For the LAKE vegetation map, analysis of the AA sample points using the Stehman (2014) method described above indicated an overall accuracy of 77% with a 90% C.I of 28% (based on the SE of 0.029). Table 42 presents the overall accuracy of the LAKE vegetation map based on the reconciled field sample points.

Table 42. LAKE overall map accuracy.

Reconciled Field Samples	Percent
Overall Accuracy:	77%
Lower Limit, 90% Confidence Interval	49%
Upper Limit, 90% Confidence Interval	100%

Individual class accuracies are considered a more valuable measure of the map accuracy than the overall accuracy. Individual class accuracies are presented as either the “users’ accuracy” or the “producers’ accuracy”. Users’ accuracy is based on the mapped classes and is defined as the probability that a location mapped as class x is in fact class x on the ground. Users’ accuracy is more important to map users because they are most interested in knowing how well the map represents the types on the ground (Lea and Curtis 2010).

Producers’ accuracy is based on the true vegetation class in the field and is defined as the probability that a location of vegetation class x in the field is correctly mapped as class x . Producers’ accuracy provides the map producer with an indication of how accurately a class may be detected wherever it occurs within the mapped area (inference area) (Lea and Curtis 2010). The users’ and producers’

accuracies for each map class in the reconciled dataset are presented in Table 43. Project data and the MS Excel workbook used to conduct the analysis are included with the final project products.

Table 43. Users' and producers' reconciled accuracies for each map class at LAKE.

Map Class Code	Users' Accuracy	SE	Users' 90% C.I.	Producers' Accuracy	SE	Producers' 90% C.I.
BB	40%	0.173	70%	5%	0.044	36%
CB	95%	0.021	25%	83%	0.037	33%
DV	79%	0.077	47%	96%	0.041	35%
FP	50%	0.395	113%	33%	0.304	101%
GL	0%	0.000	8%	0%	0.000	8%
JT	19%	0.149	65%	79%	0.084	49%
JW	89%	0.074	46%	25%	0.172	70%
MARSH	100%	0.000	2%	100%	0.000	2%
MID_MDS	35%	0.127	60%	46%	0.236	82%
OAK	76%	0.151	66%	59%	0.150	65%
PV	87%	0.063	43%	100%	0.000	2%
PW	34%	0.150	65%	100%	0.000	2%
RIP	14%	0.085	50%	100%	0.000	2%
RIPW	41%	0.155	66%	16%	0.138	63%
SB	52%	0.121	59%	16%	0.127	60%
SD_WASH	76%	0.096	53%	96%	0.027	29%
SDS	53%	0.099	53%	68%	0.090	51%
SV	42%	0.144	64%	69%	0.168	69%
TAM	75%	0.138	63%	89%	0.067	44%
YS	61%	0.100	54%	83%	0.068	45%

Discussion and Conclusions

This report summarizes a multi-year effort to produce a vegetation classification and map for Lake Mead National Recreation Area; vegetation plot work was conducted in 2010-2011, mapping in 2012-2013, accuracy assessment in 2014 and project completion in 2016. The efforts included initial meetings and clarifications of duties and deliverables, sampling approaches, vegetation classification, land cover / vegetation mapping, an accuracy assessment, and the production of final deliverables. Although this process is often described linearly, that is, each step follows the next, it is common for the classification, mapping, and accuracy assessment to produce a feedback loop, and adjustments to all steps are made throughout the project. Constant communication between the Park, network, the NPS VMI Program, classification, mapping, and accuracy assessment team made this a relatively smooth process.

We anticipate that vegetation classification and map may be used by LAKE and MOJN in conjunction with the map, or alone, to address any number of management issues. Vegetation plot or accuracy assessment samples sites may be queried for rare or endangered species and then coupled with the map to identify other potential sites. Habitat or range for Park mammals can now be more accurately defined using the vegetation map and associated products such as landform, topography, geology, etc. For example, the spring, summer, and winter ranges of the desert bighorn sheep (*Ovis canadensis nelsoni*) can be mapped using basic queries of the map. Similarly, habitats for the desert tortoise (*Gopherus agassizii*) and the relict leopard frog (*Rana onca*) can be mapped, and impacts to their habitat evaluated using ancillary datasets such as roads, urban corridors, water, etc. and may be quantified for more precise management action. Similarly, the map can be combined with animal counts to determine which areas might be under or over utilized to adaptively manage the Park lands to maintain functioning habitats for the animals.

Vegetation Classification

The vegetation classification used data collected for this effort and compiled existing data and included about 9,000 data records from the environs to produce the current classification. The classification produced 110 alliance types and 240 associations. This classification will be part of the overall vegetation classification for Death Valley National Park (DEVA), Mojave National Preserve (MOJA), and Lake Mead National Recreation Area (LAKE) to be produced as one document once the DEVA and MOJA vegetation mapping projects are completed.

The classification drove the development of a coarser map classification suitable for the vegetation mapping. Initial map classes were developed based upon existing information, the likely ability to consistently discern features in the imagery, and sampling team experience. The map classes were revised as the mapping proceeded, and additional information came to light. Additional map classes, alliances, and associations were incorporated towards the end of the project as the border area with Grand Canyon-Parashant National Monument (GRCA-PARA) were incorporated into the LAKE administrative boundary. GRCA-PARA alliances and associations are included in the final classification. In addition, the accuracy assessment revealed three previously un-sampled alliances, which are also included.

On a broader view, the classification provided extensive new insight into the existing and newly revised NVC hierarchy and has allowed for adjustments to the vegetation hierarchy. These changes include upper level (e.g., group, macrogroup, division) and alliance level modifications, which broaden several concepts and add to the knowledge of these types. This is an ongoing process and changes and modifications are to be expected as future information becomes available.

Remote Sensing

Several existing image products were used for the vegetation polygon delineation. The base imagery used was 2012 NAIP four-band imagery. Ancillary datasets included TM imagery, Google Earth imagery, and 2007 Quick Bird imagery. The interpretation initially used machine interpretation (Trimble software eCognition (<http://www.ecognition.com/>)) to classify the imagery. This approach was difficult and the results were poor. The use of automated machine processing for this project was complicated by factors particular to mapping in desert environments with sparse vegetation and with the imagery used for this project. These included the radiance domination of background soil, the NAIP imagery itself, and spectral similarity between some map classes.

Soil background complications using image processing techniques are exacerbated in areas of sparse vegetation leading to very unsatisfactory map output. Not only is the soil background a challenge to separate from vegetation, but the project area has an abundance of soil types with different colors all sustaining the same vegetation types. Thus, mapping to soil properties and assuming coincident vegetation will yield considerable error. Other researchers have found similar soil background issues. Using hyperspectral Airborne Visible / Infrared Imaging Spectrometer (AVIRIS) data, field spectra and sophisticated multiple endmember spectral mixture analysis (MESMA) (Okin, et al. 2001) also reported unreliable mapping at vegetation densities less than 30%. These low cover densities are typical for the LAKE and GRCA-PARA mapping areas.

Much of the land cover within LAKE is dominated by shrubs, with Creosote Bush Shrubland, Semi-Desert Scrub Shrublands, and Semi-Desert Wash Woodland Scrub dominating the coverage. Detection and differentiation between shrub types was difficult. Large shrubs, such as creosote bush were readily detected however separation of these larger shrubs from others, such as blackbrush and other higher elevation shrub types, was not possible using machine classification. Smaller shrubs, forbs, and grasses, were similarly impossible to separate using 1 m resolution imagery within a sparse vegetation environment. This situation was also noted by McGlynn & Okin (2006) “While features such as shrubs are easily identified and classified, several limitations are inherent with the use of high spatial-resolution color imagery. Without the availability of high spectral resolution data, it is not possible to accurately distinguish amongst shrub types through a comparison of spectral reflectance. Additionally, centimeter or decimeter-scale vegetation such as grasses cannot be directly detected from meter-scale imagery “. McGlynn & Okin (2006) also noted the difficulty inherent in classifying shrubs with low leaf area index (LAI) as is typical throughout the Park. The separation of shrub types was most effectively done by visual interpretation using ancillary data such as plot and observation locations, and some modeling of expected vegetation occurrences.

Many of the more abundant map classes often had broad ecotones between types with varying densities of creosote bush (*Larrea tridentata*), often leading the confusion. For example, Riparian

Wash Shrub Scrublands often times could not be delineated by machine processing as it often shares identical vegetation signatures with adjacent map classes, or the riparian shrub or tree types were so sparse as to make their delineation impossible. The broad overlap between Semi-Desert Scrub and Mid-elevation Mixed Desert Scrub was also difficult to delineate. The difficult delineation of broad transition zones from shrub to grasslands or small shrubs is common in sparsely vegetated desert environments (McGlynn and Okin 2006) (Gibbens, et al. 2005) (Laliberte, et al. 2004). A model was developed from existing plots describing Mid-Elevation Desert Scrub to attempt to define these areas. The generally low number of classification/observation plots did not produce a great model as accuracy assessment results showed the Mid-Elevation Desert Scrub to have a higher elevation than that mapped. Comparisons to the adjacent GRCA-PARA project are useful. Although the GRCA-PARA project successfully used eCognition with Classification and Regression Tree (CART) models in many areas within the Park, other areas, such as the PARA portion merged into the LAKE project, were sparsely vegetated and suffered similarly poor results. These are typical challenges when using machine mapping in a semi-arid desert environment that varies in geologic/soil and topographic features.

In addition to soil background challenges, we used 2012 NAIP imagery as our base imagery. The use of NAIP imagery for machine processing has a number of problems. The most pervasive problem is inconsistent radiometry. The imagery is 4-band aerial photography that is mosaicked together. Because the timing of the acquisition may be spread out over several days and at varying times during the day, the radiance measured will vary considerably. In addition, the mosaicking process also alters pixel radiance values. Banding between flight lines is notable in some areas, effectively nullifying any similarity between like targets.

A visual interpretation and on-screen digitizing have produced much more satisfactory results. Map classes with low density trees or shrubs, which would have been missed by machine interpretation, were properly delineated. Small patch map classes, sometimes obscured by rock formations or shadows, such as shrub live oak (*Quercus turbinella*) were also identified. The line work was also much more aesthetically pleasing than that produced by object oriented machine processing, such as eCognition. The amount of time spent manually delineating was actually less than that spent calibrating and recalibrating a number of times for different areas using eCognition.

Although the eCognition classification did produce some accurate results, the precision was not good enough for this map product. The NAIP imagery is an excellent product with broad utility, but for some automated vegetation mapping projects in desert environments, one might need additional resources. The great benefit, however, is the low cost; essentially the cost of storage media. Given that NAIP imagery is now streamed free over the internet, even the cost of storage is nil.

Accuracy Assessment

The decision to use a draft map based upon eCognition machine processing to define the sampling strata and select the stratified random sample points prior to completing the final map significantly complicated the accuracy assessment (AA). The alternative analysis method used (Stehman 2014) does not result in the standard contingency table of results and instead provides accuracy estimates in an MS Excel workbook containing several worksheets that calculate the various formulas. That

workbook is provided with the final products and includes a worksheet of notes that describe the purpose of each worksheet and the formula and variables they contain. This deviation from the standard AA procedures used for other NPS vegetation inventory projects (Lee and Curtis 2010) was unfortunate but necessary. For further information on the Stehman (2014) method, please refer to the document referenced in the literature cited section of this report.

The overall accuracy of the final map was calculated at 77%, with several individual classes having user's accuracies as high as 100% (Marsh) and as low as 0% (Grassland). Twelve of the vegetated map classes have user's accuracies of 50% or more, while four have user's accuracies of 80% or more. Of the eight classes with user's accuracies below 50%, three of those have user's accuracies below 20%.

The creosote bush map class is the dominant type by area within the LAKE project area occupying 54% (193,523 ha) of the vegetated inference area. Other than the marsh class which has a user's accuracy of 100% and an area of only 60 hectares, the creosote bush class has the highest user's accuracy of all map classes (95%). Many of the map classes that changed when the draft map was refined to create the final map were changed to the more common creosote bush class.

Confusion between the mappers and the AA field team led to poor sampling of the naturally occurring grassland type. This type is very poorly represented at LAKE and occurs as a small number of small areas dominated by native grasses. Many areas of developed vegetation, such as road right-of-ways and parking area margins have been planted with these same grass species. Because these areas are composed of native grass vegetation, the map classification labeled them as grasslands. However, because these areas are part of the developed landscape the field crews keyed them to the developed map class. The mapping did accurately identify these as grass dominated areas, however, because of their location on developed sites they were assessed as developed.

The LAKE map classification originally listed the dune vegetation map class as containing only one vegetation type while the AA sampling identified several other vegetation types that also occur on dunes at LAKE. This resulted in a low accuracy for the dune type. To resolve this, the concept for the dune vegetation map class was modified to include other vegetation types that are obviously present on areas of sand dunes. Using this broader, geomorphological definition, the dune vegetation map class ended with a 79% user's accuracy. The map class descriptions and the field key to the vegetation alliances were updated to reflect this change.

Lessons Learned

Given the number of steps necessary to produce a vegetation map for over 1 million acres of land, there are ample opportunities to take lessons from existing experience, program standards, and current mapping techniques to improve future projects. These lessons may be applied to the two additional Parks within MOJN, i.e., Mojave National Preserve and Death Valley National Park, that are currently starting the vegetation mapping process. There are a number of areas where improvements or modifications to existing methods may occur, or where mappers may be made cognizant of processes that may not proceed smoothly. These areas include the vegetation

classification, development map classes, other general mapping issues, and accuracy assessment methods and analysis.

Vegetation Classification

This project benefited from performing classification analysis across an ecoregion, the Mojave Desert, and incorporated knowledge across the Colorado, Sonoran, and Great Basin Deserts within California, Arizona, and Nevada. Instead of analyzing data compiled just from LAKE, we had assembled a larger dataset that included nearby areas, such as Red Rock Canyon National Conservation Area, to help inform the classification. We also had included knowledge from a recently revised classification of Joshua Tree National Park, which has vegetation characteristic of the Mojave Desert, Sonoran Desert, and Southern California Mountains & Valleys ecoregions. Thus, we were able to better resolve a number of questions that typically come up in the analysis process, and often due to low sample sizes of classification surveys in one Park. Additive data from other parks allowed us to more confidently classify the data to the alliance level as well as evaluate the higher and lower levels of the vegetation classification hierarchy. This enabled a more synthetic approach to analyze and classify vegetation data, which was of benefit to the 3 Parks being mapped within the MOJN.

During the classification process, the NVC hierarchy was changing and evolving with revised or new classification names at every level of the hierarchy. This project allowed us to provide feedback into the national process; however, it also complicated our work because scientific and colloquial names were changing at every level. We did not anticipate the scope of these changes, so CNPS staff provided in-kind time to help contribute to this overall process.

Development of map classes

This project had the good fortune of having in hand a well-developed draft vegetation classification prior to the mapping process. The classification assisted greatly in creating reasonable mapping classes. The original map classes were modified during the mapping process as the team became more familiar with the terrain. For example, originally we did not include desert washes as a separate map class as the vegetation within these ephemeral areas is often very similar to the adjacent land cover, typically creosote bush. As the mapping proceeded we realized these areas, although floristically similar, were geomorphically important and were later included. This process of adding map classes during the mapping process is not ideal but allows for newly discovered land cover nuances to be included in the final product. This necessitates having to go back over previously mapped areas to update and correct for changing map classes but the final result makes this effort well worthwhile. Addition or changes to the map classes should be considered a normal part of the mapping process as mappers often find or discern new or different features as they conduct their field reconnaissance with their different perspective of land cover.

Other changes that occurred during the mapping process were updates to the draft vegetation classification for the Park. These changes were discussed between team members and did not negatively affect the map classes or mapping effort. These changes were typically name changes with some species memberships moved around. The map classes were sufficiently broad to absorb these changes.

Mapping

Interpretation: The mapping technique initially chosen for delineation of map classes was machine processing using NAIP imagery and eCognition software. Some successes were noted using this approach in the adjacent Grand Canyon National Park and Parashant National Monument (GRCA/PARA) (Kearsley et al. 2015). These machine processing successes were not duplicated with this project for a number of reasons. The vegetation at LAKE is, overall, considerably sparser than at GRCA/PARA which created numerous problems for machine interpretation. These have been discussed earlier however, problems include spectrally indeterminate vegetation types, varied background soil colors often overwhelm the digital signature of many vegetation types, not using CART¹ modeling as in GRCA, and the limits of NAIP imagery for consistent image analysis. A significant amount of time was spent trying to establish working models within eCognition. These models, when successful, were only moderately so and did not transfer well to other adjacent areas necessitating the development of new models with new parameters. This process is unwieldy and time consuming. We switched to visual interpretation supported by a number of ancillary datasets such as TM imagery, MSAVI2 models, topographic models, vegetation plot locations, vegetation plot location models, soil and geology layers, and various image sources. This process tended to be much quicker and allowed the interpreter to rapidly assess various ancillary datasets on adjacent computer screens while determining the location of polygon lines and associated map class. The final product was not only easier to produce but hand digitized polygons are much more esthetically pleasing to the eye over jagged lines produced by object oriented softwares such as eCognition.

Landform Mapping: Topography plays an important role in the location and distribution of desert plant communities. Even a small shift in aspect, slope, elevation, or distance to groundwater can dramatically alter the species composition. To help capture these subtle differences, vegetation mappers tend to look at landform breaks as logical places to delineate between map classes. One of the more obvious features at LAKE was the intricate network of drainages, washes, and arroyos. These channels vary in size and width and can start in the higher elevations and continue on for miles. They are prone to flash floods, erosion, and the rapid deposition of rocks and soil. All of these events, coupled with higher moisture levels, create a very dynamic environment for the establishment of vegetation communities. Users of the LAKE classification, vegetation map, classification key, and map class key need to fully understand the variable nature of the desert washes and the high probability that a single wash may have multiple dominant or diagnostic plants present (e.g. rabbitbrush, seep willow, desert willow, etc...) or contain the same species as present on the surrounding uplands (e.g. creosote bush). In some instances, the floristic difference may be nil and the classification may depend entirely upon topographic position. When keying a plant community at LAKE, we recommend that a Park user or reviewer should first fully appreciate their location on the landscape prior to identifying the plant species and abundance. This lack of topographic location awareness led to numerous field call errors during the accuracy assessment process.

¹ Classification and Regression Tree (CART)

Draw-down Zone (6/18/2010): Mapping vegetation in a reservoir draw-down zone is challenging due to the dynamic response of early succession vegetation. As water is depleted, new shoreline areas are exposed creating new niches for weedy annual herbaceous vegetation and aggressive shrubs and trees (e.g. salt cedar). Since the aerial photography used for mapping only represents one moment in time, it is hard to fully capture the seasonal, temporal, and annual impacts that various water levels have on the shoreline vegetation. Possible solutions include mapping the reservoir at different water levels using multiple sets of imagery acquired at different times or years, mapping only the vegetation that occurs above the highest known water level (i.e. full pool), or mapping the draw-down zone as a single unit using a specific map unit that documents all of the possible plant combinations that can occur there. At LAKE we initially agreed to map the draw-down zone as a single unit given the ephemeral nature of this land cover. Further into the mapping process this approach was changed and we mapped vegetation discernable from the June 18th, 2010 4-band NAIP imagery. Given the unlikely chance that Lake Mead will ever reach full pool elevation one might expect that the once ephemeral vegetation in the upper elevations below full pool may begin to re-establish more permanent vegetation types. This process may be an interesting future management monitoring and mapping exercise.

Sparse Vegetation: Desert plants are usually widely dispersed and are heavily dependent on soil formation and moisture levels. The tendency of observers in these arid environments is to weigh more heavily the amount of vegetation cover present at any one location. This can lead to miss-key issues when trying to correctly classify vegetation associations or when using the field key. For example, common species that occur together on a rocky, hot, south facing slope may have less than 5% total cover. However, these same dominant species when present on cooler, deeper, and more developed soils may exhibit greater than 20-30% cover. It is important to recognize the differences between these two communities and how they are addressed in the classification and field key. For example, at LAKE we found that species overlap between the Sparse Desert Scrub vs. Creosote bush led to considerable confusion, not only during the mapping but also in the accuracy assessment process. The field key adjustment learned here was to emphasize the cover values in the key and train field crews to more accurately recognize cover values.

Accuracy Assessment

Accuracy assessment in very sparse community types requires a fine level of resolution in cover class values and in distinctions between species composition for mixed types. Additional discussion between the mappers and the ecologists prior to completing the field key can ensure that parameters for cover classes and species composition are well defined and consistent. When these are well defined and consistent, errors in very sparse types can be reduced.

Summary of Park Management Use and Value

Ecological Information in Vegetation Datasets

Ecological information in geodatabases contain not only ecological data derived from highly precise and descriptive vegetation plots, but also ecosystem data such as soils, topography, geology, hydrology, landform, and derived climatic data (inferred by locations and elevation zones). The information available from vegetation datasets residing within modern GIS systems can be quite

powerful. As in the data provided for this project, one will find not only a map showing distribution and quantity of vegetation communities but also structure, composition and the corresponding relationships to the landscape. Using the database one might generate additional special purpose maps directly from this product. The coupling of the ecological information with accuracy assessment results allow a researcher to not only analyze ecosystem variables but also to assign reliability of the results and how those results might vary depending upon the vegetation being studied. These data provide a robust foundation to any phytocenological studies that might be advanced (Kuchler 1988).

As seen in this project, we have been able to utilize data across multiple ecological regions (e.g., Mojave, Great Basin, and Sonoran deserts) to inform a robust vegetation classification. In addition, the data have been compiled into one database system that can be shared and used by others in future analyses to answer any number of questions – for example, the compiled dataset of 9,000+ surveys can be used as baseline data to analyze change over time, or they can be co-analyzed with other datasets in additional phytocenological studies across the Western U.S. and beyond. The compiled data can also be queried for specific ecological and habitat features, for specific species (e.g., non-native plants, rare plants, etc.), and they can serve as a basis for co-locating plots for wildlife, climate change, or other studies.

Application of Vegetation Maps

The use of vegetation datasets are so varied that their limits are often predicated by the imagination of the researcher or manager coupled with the technical GIS sophistication necessary for advanced use. Applications that would benefit greatly from the use of the LAKE vegetation dataset include broad applications in research, land management, general park planning, and natural resource management (Gillock et al. 2009).

Research applications and resource management may include monitoring and mapping of various invasive species. For example, Tamarisk is a widely invasive species not only within the Park but throughout the southwest. Effective control measures include the use of saltcedar leaf beetle (*Diorhabda elongata*). Using the mapped distribution of Tamarisk, researchers may better plan and monitor the effectiveness of the control measures. The presence and location of other invasive species may be determined by mining the PLOTS database for their occurrence. Ecosystem relationships of the invasive species may then be determined using many of the ecosystem parameters included with the vegetation dataset. This mining and geospatial analysis of exotic species may also be applied to rare or endangered species. Similar studies may use other mapped distributions of avian, mammalian, amphibian or insect species to establish correlations with the broader ecosystem. The increasing habitat being made available by the continual drawdown of Lake Mead may lend itself to studies of recolonizations of previously flooded lands. Water quality studies often rely upon nutrient contributions from adjacent watersheds. The vegetation on these watersheds is a critical component to all nutrient flow models. Reservoir sedimentation estimates rely heavily on the contributing basins vegetation. The ancillary soils, geology, and topographic data lend themselves to these analyses. Species diversity studies would use the PLOTS database. Climate change studies would also use the vegetation information within the PLOTS database. Using all or some of the plot

locations, repeat sampling and photography may be used to establish any changing habitat or suite of plant species.

Land management is a critical component to any Park manager's job. Information about landcover lends itself to such topics as fire management, grazing, planning of park facilities, evaluation of existing or planned trail systems, sensitive habitat considerations etc. Relationships and interactions with adjacent neighbors, be they public or private, are facilitated by a solid knowledge of Park resources. By combining land cover information with other related databases, a solid decision support system may be created or improved upon.

Leveraged use for other Federal agencies

The vegetation layer may also be of considerable use to other agencies that may be mapping in the area. Other landcover maps such as the Southwest Regional Gap Analysis Project (<http://swregap.nmsu.edu>), National Land Cover Database (<http://www.mrlc.gov>), LandFire (<http://www.landfire.gov>), and others mapping at a coarser scale will find the information very useful for populating or calibrating their own maps. Other researchers will also find the vegetation classification and accuracy assessment plots to be very useful for fine scale descriptions of the flora within the Park.

Bibliography

- Anderson, M. P., et al. 1998. International classification of ecological communities: Terrestrial vegetation of the United States. Volume II. The National Vegetation Classification System: list of types. The Nature Conservancy, Arlington, VA.
- Bailey, R. G. 1995. Description of the ecoregions of the United States. 2d ed. Rev. and expanded (1st ed. 1980). Miscellaneous Publication No. 1391 (rev.). U.S. Department of the Agriculture, U.S. Forest Service, Washington, D.C.
- Bailey, R. G. 1995. Description of the Ecoregions of the United States. U.S. Forest Service Miscellaneous Publication 1391 (Revised). U.S. Department of the Agriculture, U.S. Forest Service, Washington, D.C.
- Bailey, R. G. 1998. Ecoregion map of North America: Explanatory note. Miscellaneous Publication No. 1548. U.S. Department of the Agriculture, U.S. Forest Service, Washington, D.C.
- Beard, L. S., et al. 2007. Preliminary geologic map of the Lake Mead 30' X 60' quadrangle, Clark County, Nevada, and Mohave County, Arizona. Open-File Report 2007-1010 version 1.0, U.S. Geological Survey.
- Braun-Blanquet, J. 1932/1951. Plant sociology: the study of plant communities. McGraw Hill, New York, NY
- Buja, K., and C. Menza. 2013. NCCOS Science Serving Coastal Communities. Available online: <http://coastalscience.noaa.gov> (accessed 2012).
- Cogan, D., and J. Von Loh. 2008. Mojave Network Vegetation Classification and Mapping Work Plan. Internal Document.
- Colorado Natural Heritage Program. 2015. Colorado Plateau Hanging Garden. Available online: http://www.cnhp.colostate.edu/download/projects/eco_systems/pdf/CP_Hanging_Garden.pdf (accessed 2015).
- Comer, P., et al. 2003. Ecological systems of the United States, a working classification Of U.S. terrestrial systems. NatureServe, Arlington, VA.
- Dilts, T., and P. Weisberg. 2010. Death Valley springs monitoring dataset. Unpublished data. University of Nevada, Reno, NV.
- DNR, MN. 2015. Open source software used to transfer and convert data between Garmin and other handled GPS receivers and various GIS software packages. Minnesota Department of Natural Resources. Available online: <http://www.dnr.state.mn.us/mis/gis/index.html> (accessed 22 December 2015).

- Dufrêne, M., and P. Legendre. 1997. Species assemblages and indicator species: the need for a flexible asymmetrical approach. *Ecological Monographs* 1997:67:345-366.
- Ecological Society of America. 2015. Vegbank. Available online: <http://vegbank.org/vegbank/index.jsp> (accessed 2015).
- Evens, J. M., D. Roach-McIntosh, and D. Stout. 2012. Vegetation descriptions for Joshua Tree National Park. Unpublished report. Submitted to USDI. National Park Service, Mojave Desert Inventory and Monitoring Program. California Native Plant Society, Sacramento, CA.
- Evens, J., and S. Hartman. 2007. Vegetation survey and classification for the Northern and Eastern Colorado Desert Coordinated Management Plan (NECO). Unpublished Report. California Native Plant Society, Sacramento, CA.
- Evens, J., K. Sikes, J. Stevens, and B. Morrison. 2014. Vegetation descriptions for Joshua Tree National Park. Unpublished Report. Submitted to USDI, National Park Service, Mojave Desert Inventory and Monitoring Network. California Native Plant Society, Sacramento, CA.
- Evens, J. M., and K. Sikes. 2015. Field Key to the Vegetation Alliances of Lake Mead National Recreation Area. California Native Plant Society, Sacramento, CA.
- Faunt, C. C. 2006. Deserts of the southwestern United States, for the Death Valley regional groundwater flow system study, Nevada and California. U.S. Geological Survey, Denver, CO.
- FGDC. 2008. National Vegetation Classification Standard (Version 2). Available online: http://www.fgdc.gov/standards/projects/FGDC-standards-projects/vegetation/NVCS_V2_FINAL_2008-02.pdf/view (accessed December 2015).
- FGDC. 2008. FGDC endorses National Vegetation Classification Standard (Version 2), FGDC-STD-005-2008. Federal Geographic Data Committee, Reston, VA.
- FGDC. 1997. Vegetation Classification Standard. Vegetation Subcommittee, Federal Geographic Data Committee, Reston, VA.
- Gibbens, R. P., R. P. McNeely, K. M. Havstad, R. F. Beck, and B. Nolen. 2005. Vegetation changes in the Jornada Basin from 1858 to 1998. *Journal of Arid Environments* 2005: 61: 651-668.
- Gillock, B., P. Valentine-Darby, and A. Cully. 2009. Vegetation mapping in the American Southwest - Vegetation map applications, *in* Series: Vegetation Mapping in the American Southwest. Available online: <https://www.nps.gov/articles/sw-vegetation-mapping-applications.htm> (accessed August 2016).
- Green, K., and M. Tukman. 2010. Grand Canyon vegetation mapping, phase 1 final report. Natural Resource Program Center, National Park Service, U.S. Department of the Interior, Fort Collins, CO.

- Grossman, D. H., et al. 1998. International classification of ecological communities: terrestrial vegetation of the United States. Volume I. The National Vegetation Classification System: development, status, and applications. The Nature Conservancy, Arlington, VA.
- Jennings, M. D., et al. 2008. Description, documentation, and evaluation of associations and alliances within the U.S. National Vegetation Classification, Version 4.5. Ecological Society of America, Vegetation Classification Panel. Washington, D.C. *In* National Vegetation Classification Standard, Version 2, by FGDC. Federal Geographic Data Committee, Reston, VA.
- Kartesz, J. T. 1999. A synonymized checklist and atlas with biological attributes for the vascular flora of the United States, Canada, and Greenland. First edition. *In* J. T. Kartesz, and C. A. Meacham. Synthesis of the North American flora [computer program]. Version 1.0. North Carolina Botanical Garden, Chapel Hill, NC.
- Kearsley, M. J., et al. 2015. Grand Canyon National Park-Grand Canyon / Parashant National Monument vegetation classification and mapping project. Natural Resource Report. NPS/GRCA/NRR—2015/913. National Park Service. Fort Collins, CO.
- Keeleer-Wolff, T., C. Roye, and K. Lewis. 1998. Vegetation classification and mapping of Anza-Borrego Desert State Park. Unpublished Report. California Department of Fish and Game, Sacramento, CA.
- Keeler-Wolf, T., and K. A. Thomas. 2000. Draft list of vegetation alliances and associations for the Mojave ecosystem mapping project. Unpublished Report. California Department of Fish and Game, Sacramento, CA.
- Keeler-Wolff, T., S. San, and D. Hickson. 2005. Vegetation classification of Joshua Tree National Park, Riverside and San Bernardino counties, California. Unpublished Report. National Park Service and California Department of Fish and Game, Sacramento, CA.
- Kuchler, A. W. 1988. Ecological vegetation maps and their interpretation. Pages 469-479 *in* A. W. Kuchler, and I. S. Zonneveld (eds.). Vegetation mapping, handbook of vegetation science, Volume 10. Kluwer Academic Publishers, Dordrecht / Boston / London.
- Lake Mead National Recreation Area. 2014. Resource Stewardship Strategy. National Park Service, Boulder City, NV.
- Laliberte, A. S., A. Rango, K. M. Havstad, J. F. Paris, R. F. Beck, and R. P. McNeely. 2004. Object-oriented image analysis for mapping shrub encroachment from 1937 to 2003 in southern New Mexico. *Remote Sensing of Environment* 93:198-210.
- Lea, C., and A. Curtis. 2010. Thematic accuracy assessment procedures. National Park Service.
- Lennartz, S., T. Bax, J. Aycrigg, A. Davidson, M. Reid, and R. Congalton. 2008. Final report on land cover mapping methods for California map zones 3, 4, 5, 6, 12, and 13. Sanborn Solutions for the USGS Gap Analysis Program (GAP) Headquarters, Portland, OR and Moscow, ID.

- Lowry, J. H., Jr., et al. 2005. Southwest Regional Gap Analysis Project: Final report on land cover mapping methods. RS/GIS Laboratory, Utah State University, Logan, UT.
- Manis, G., J. Lowry, and R. Ramsey. 2002. Pre-classification: An eEcologically predictive landform model. Logan: Remote Sensing/GIS Laboratory, College of Natural Resources, Utah State University, Logan, UT.
- Manis, G., J. Lowry, and R. D. Ramsey. 2001. Preclassification: An ecologically predictive landform model. Gap Analysis Program Bulletin No. 10, December 2001. USGS GAP Analysis Program, Moscow, ID.
- McCune, B., and J. B. Grace. 2002. Analysis of ecological communities. MjM Software, Gleneden Beach, OR.
- McCune, B., and M. J. Mefford. 2006. PC-Ord. Multivariate analysis of ecological data, Version 5.33. MjM Software, Gleneden Beach, OR.
- McGlynn, I. O, and G. S. Okin. Characterization of shrub distribution using high spatial resolution remote sensing: EcoSystem implications for a former Chihuahuan Desert grassland. Remote Sensing of Environment 2006:101:554-566.
- National Park Service (NPS). 2013. 12-Step Guidance for NPS Vegetation Inventories. National Park Service Inventory & Monitoring Program. Available online: http://science.nature.nps.gov/im/inventory/veg/docs/Veg_Inv_12step_Guidance_v1.1.pdf (accessed 2014).
- National Park Service (NPS). No date. Vegetation Inventory. I&M Program. National Park Service. Available online: <http://science.nature.nps.gov/im/inventory/veg/> (accessed October 2015).
- NatureServe. 2010. International ecological classification standard: Terrestrial ecological classifications. Vegetation Associations of Grand Canyon National Park [Draft]. Arlington, VA.
- NatureServe. 2015. An Online Encyclopedia of Life. Available online: <http://explorer.natureserve.org/> (accessed 2015).
- Navulur, K. 2007. Multispectral Image Analysis Using Object-Oriented Paradigm. CRC Press, Taylor & Francis Group, Boca Raton, FL.
- NBS/NPS Vegetation Mapping Program. 1994. U.S. Department of Interior, National Biological Survey and National Park Service.,
- NLCD. 2006. National Land Cover Database 2006. Available online: http://www.mrlc.gov/nlcd06_leg.php (accessed 2012).
- NRCS. No date. Soil Survey Geographic (SSURGO) Database. Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Available online: <http://sdmdataaccess.nrcs.usda.gov/> (accessed 2011).

- Okin, G. S., D. A. Roberts, B. Murray, and W. B. Okin. 2001. Practical limits on hyperspectral vegetation discrimination in arid and semiarid environments. *Remote Sensing of Environment* 77(2):212–225.
- Parker, A. J. 1982. The topographic relative moisture index: An approach to soil moisture assessment in mountain terrain. *Physical Geography* 3:160-168.
- Prengaman, K. A., et al. 2011. Vegetation mapping for the Mojave Network Parks: Final report for the fieldwork at Death Valley National Park, Lake Mead National Recreation Area, and Mojave National Preserve. Unpublished report. University of Nevada, Las Vegas, NV.
- Prior-Magee, J. S., et al. 2007. Southwest Regional Gap Analysis Project Final Report. U.S. Geological Survey, Gap Analysis Program, Moscow, ID.
- Sada, D. W., and D. J. Cooper. 2012. Furnace Creek springs restoration and adaptive management plan, Death Valley National Park, California. Submitted to USDI Death Valley National Park. Desert Research Institute, Reno, NV and Colorado State University, Fort Collins, CO.
- Sawyer, J. O., T. Keeleer-Wolff, and J. M. Evens. 2009. A manual of California vegetation, 2nd edition. California Native Plant Society, Sacramento, CA.
- Schulz, K. A., and M. E. Hall. 2011. Vegetation inventory project: Great Basin National Park [Draft Final Report]. Unpublished Report. Submitted to USDI, National Park Service, Mojave Desert Inventory and Monitoring Network. NatureServe, Western Regional Office, Boulder, CO.
- Stehman, S. V. 2014. Estimating area and map accuracy for stratified random sampling when the strata are different from the map classes. *International Journal of Remote Sensing* 35:13:4923-4939. DOI: 10.1080/01431161.2014.9302072014.
- SWReGAP. No date. Southwest Regional Gap Analysis Project. Available online: <http://swregap.nmsu.edu/> (accessed 2012).
- Thomas, K. A. 2006. Death Valley National Park Travertine Springs complex vegetation. Technical Report. U.S. Geological Survey, Southwest Biological Science Center, Flagstaff, AZ.
- Thomas, K. A., J. Franklin, T. Keeler-Wolff, and P. Stine. 2004. Mojave Desert ecosystem program: Central Mojave vegetation database. Final report. USGS, Western Ecological Research Center, Southwest Biological Science Center, and Colorado Plateau Field Station, Sacramento, CA and Flagstaff, AZ.
- Thomas, K. A., T. Keeler-Wolf, and P. Stine. 2004. Mojave Desert ecosystem program central Mojave vegetation database. Final report. USGS, Western Ecological Research Center and Southwest Biological Science Center, Colorado Plateau Field Station, Sacramento, CA and Flagstaff, AZ.

TNC and ESRI. 1994. NBS/NPS Vegetation Mapping Program: Standardized National Vegetation Classification System. The Nature Conservancy Report to the National Biological Survey and the National Park Service. Washington, D.C.

USDA-NRCS. No date. The PLANTS Database. Available online: <http://plants.usda.gov> (accessed from August 2010 to August 2014).

VegBank. No date. Quercus turbinella Shrubland Alliance | Western Ecology Working Group. Available online:
http://vegbank.org/vegbank/views/commconcept_detail.jsp;jsessionid=52D1E5A6459E07598FE032AD8080809?view=std&wparam=18397&entity=commconcept¶ms=18397 (accessed 13 January 2016).

VegCAMP and AIS (Vegetation Classification and Mapping Program and Aerial Information Systems). 2013. 2013 California desert vegetation map and accuracy assessment in support of the Desert Renewable Energy Conservation Plan. Unpublished report. Submitted to the California Department of Fish, Sacramento, CA.

Appendix A. Field Forms for New Vegetation Data (in Phase 2, Fall 2010 – Spring 2011)

MOJN VEGETATION CLASSIFICATION and MAPPING PROGRAM				LAME/MOJA/DEVA, 2010 - 2011	
Classification Plot Field Form, ver. 10/04/2010					
PLOT LOCATION INFORMATION					
Plot Code: _____		Survey Date: _____		Crew: _____	
Park Site Name: _____		Park (Circle one): LAME, DEVA, MOJA			
Surveyors: _____		State (Circle one): AZ, CA, NV			
Provisional Alliance: _____				Provisional Association: _____	
Datum: UTM NAD83 11/12 Other _____		Waypoint #: _____		Plot size: 1000 m2	
GPS Unit#: _____		GPS Error (+/-): _____		Plot Shape: Square <u>31.6m</u> x <u>31.6m</u> or	
ID#/BPU# _____		Grid Code _____		Rectangle: Length _____ bearing _____	
Plot Corner SW: UTM _____		UTMN _____		Width _____ bearing _____	
GPS Comments: _____				Circle: Radius 17.8 m Declination: 14 ° East	
				Monument Placed at: _____	
Directions to Plot (driving and hiking): 					
Photos: Photos are taken from the plot corners looking diagonally across the plot. Use a whiteboard to include plot #, photo direction, date taken in each photo. Include descriptions for additional photos in the 'View from Photopoint' column. Camera #: _____					
View#	Photo#	Time	Bearing	Photographer	View from Photopoint
1			SW corner → NE		
2			SE corner → NW		
3			NE corner → SW		
4			NW corner → SE		
Plot representativeness: Describe how representative the plot is of the stand surrounding it. 					
ENVIRONMENTAL DESCRIPTION					
Relative Stand Size: 1-3000m2 3000-10,000m2 (1ha) 1ha-10ha >10 ha (1-3x plot size) (3-10x plot) (10 – 100x plot) (> 100x plot)				Slope _____ (degrees) Aspect _____ (degrees- use 360 for N)	
Landform: Alluvial fan, Alluvial flat, Bajada, Badlands, Basin, Basin floor, Playa, Valley, Valley floor, Desert Pavement, Cinder cone, Lava field, Dome, Butte, Mesa, Hill, Ridge, Bench, Mountain, Mountain slope, Mountain valley, Canyon, Ravine, Sand dune, Sand sheet, Dune field, Interfluvium, Bluff, Stream terrace, Stream channel, Drainage channel, Wash, Other _____					
Topographic Position: HighLevel HighSlope MidSlope BackSlope StepinSlope LowSlope ToeSlope LowLevel Interfluvium Channel Wall Channel Bed Basin Floor					
Geology: Alluvium, <u>Igneous Plutonic</u> , Granite, Diorite, Gabbro, <u>Igneous Volcanic</u> , Andesite, Basalt, Dacite, Rhyolite, Volcanic breccia, <u>Sedimentary</u> , Conglomerate (rounded), Breccia (angular), Claystone, Mudstone, Sandstone, Siltstone, Shale, Dolostone, Limestone, Marl, Gypsum, <u>Metamorphic</u> , Gneiss, Schist, Slate, <u>Aeolian Deposit</u> , Sand dune, Sand sheets, Obscured by soil, Other _____					
Cowardin System _____ Upland _____ Palustrine		Hydrologic Regime (based on frequency and duration of flooding) _____ Permanently Flooded _____ Semi-permanently Flooded _____ Intermittently Flooded _____ Seasonally Flooded _____ Temporarily flooded _____ Saturated _____ Unknown			

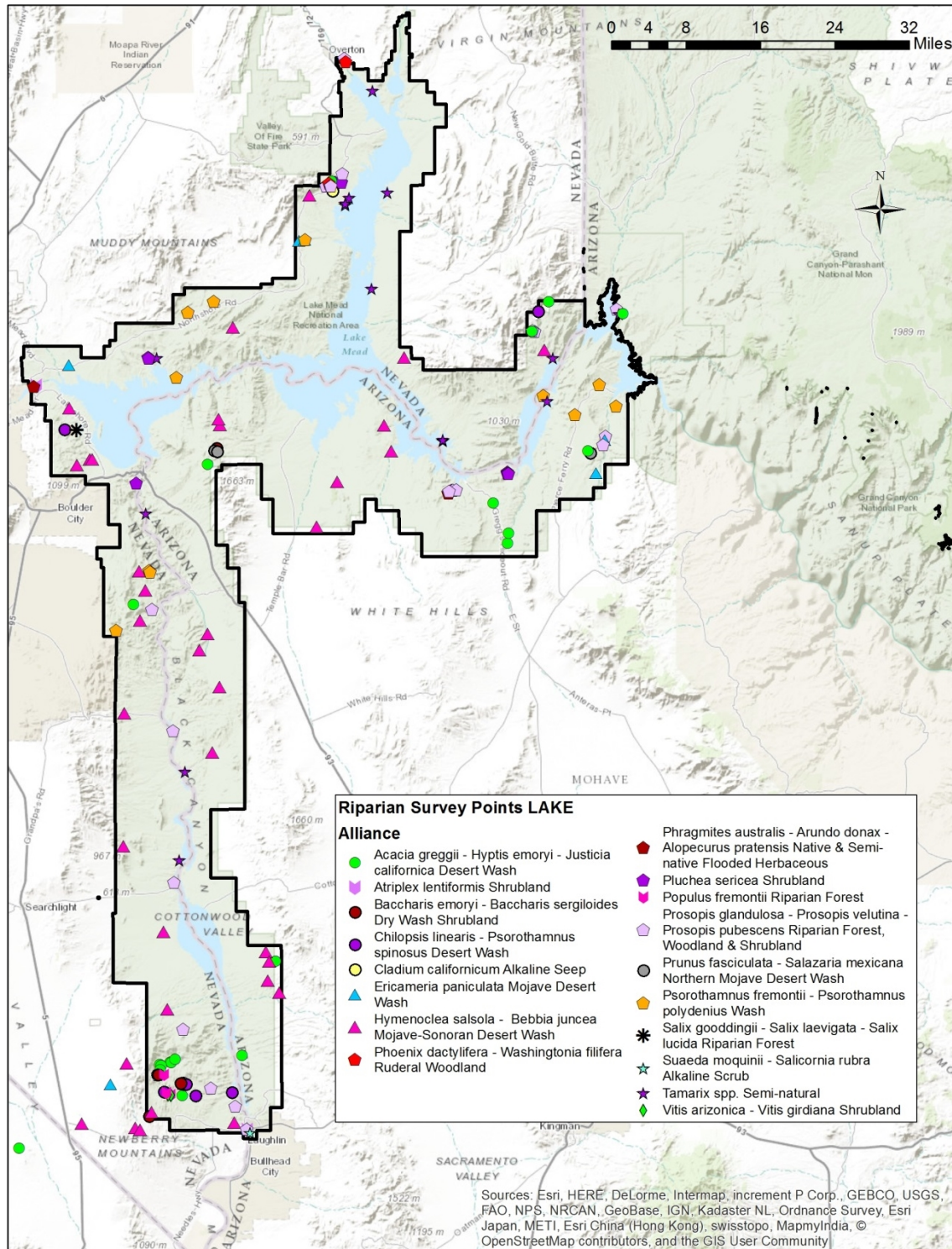
MOJN Vegetation Classification and Mapping Program, ver. 10/04/10		LAKE/MOJA/DEVA 2010-2011
PLOT CODE: _____		Date: _____
ENVIRONMENTAL DESCRIPTION (cont.)		
Non-Vegetated Surface Cover: <i>(For cover of <1% record percent cover to the nearest 0.1 percent. Sum = 100%)</i> ___ Other = Fines (<2 mm) ___ Bedrock (non-transported rock) ___ Small Rocks (2 mm – 25cm) ___ Litter/Duff (dead plant material <3 cm diameter) ___ Large Rocks (>25cm) ___ Woody debris (dead wood ≥3cm) ___ Water		
Soil Texture (see soil key): ___ sand ___ silt loam ___ sandy clay ___ silty clay ___ loamy sand ___ silt ___ clay ___ peat ___ sandy loam ___ loam ___ clay loam ___ muck	Phenology: 1-Leaf Out, 2-Flower, 3-Past Flower, 4-Winter (leafless...) Herbaceous: _____ Shrub: _____ Trees: _____	
Hydrologic Evidence <i>(More than one feature may be circled if present)</i> Surface Water w/in 25m? YES/NO Wash Seep Spring Stream River	% Soil Moisture <i>(Estimation of 3 categories should total 100%)</i> _____ % dry _____ % moist _____ % saturated	
Animal Use Evidence: ___ Burrows ___ Animal / Game Trails ___ Animal Sighting (Who? _____) ___ Scat (Whose? _____) ___ Vegetation Damage (animal) ___ Other: _____ ___ Browsing Evidence ___ Bedding Sites ___ None ___ Grazing Evidence ___ Nests (Whose? _____)		
Anthropogenic Disturbance: ___ Campsite Evidence ___ Vegetation Damage (human) ___ Trails ___ ORV Evidence ___ Rock Cairns ___ Historic Feature ___ Microbiotic Crust Damage ___ Archaeological Feature ___ Trash ___ Other: _____ ___ Developments ___ None	Natural Disturbances: ___ Drought (tree & shrub die-back) ___ Fire ___ Flood ___ Mass Wasting ___ Water gullies ___ Vegetation Damage (insects, wind) ___ Other: _____ ___ None	
Landscape Context: <i>(Narrative description of plot location within greater landscape (e.g. upper bajada slope at base of low ridge of hills))</i> <div style="height: 40px; border: 1px solid black; margin-top: 5px;"></div>		
Stand Description\General Comments: <i>Describe general vegetation conditions (e.g. healthy, large percent dead), homogeneity of the vegetation, phenological phase at time of observation, successional stage, recent fire and/or other disturbances.</i> <div style="height: 150px; border: 1px solid black; margin-top: 5px;"></div>		
Adjacent Alliances: 1. _____ Distance/Direction _____ Describe Location: _____ 2. _____ Distance/Direction _____ Describe Location: _____		

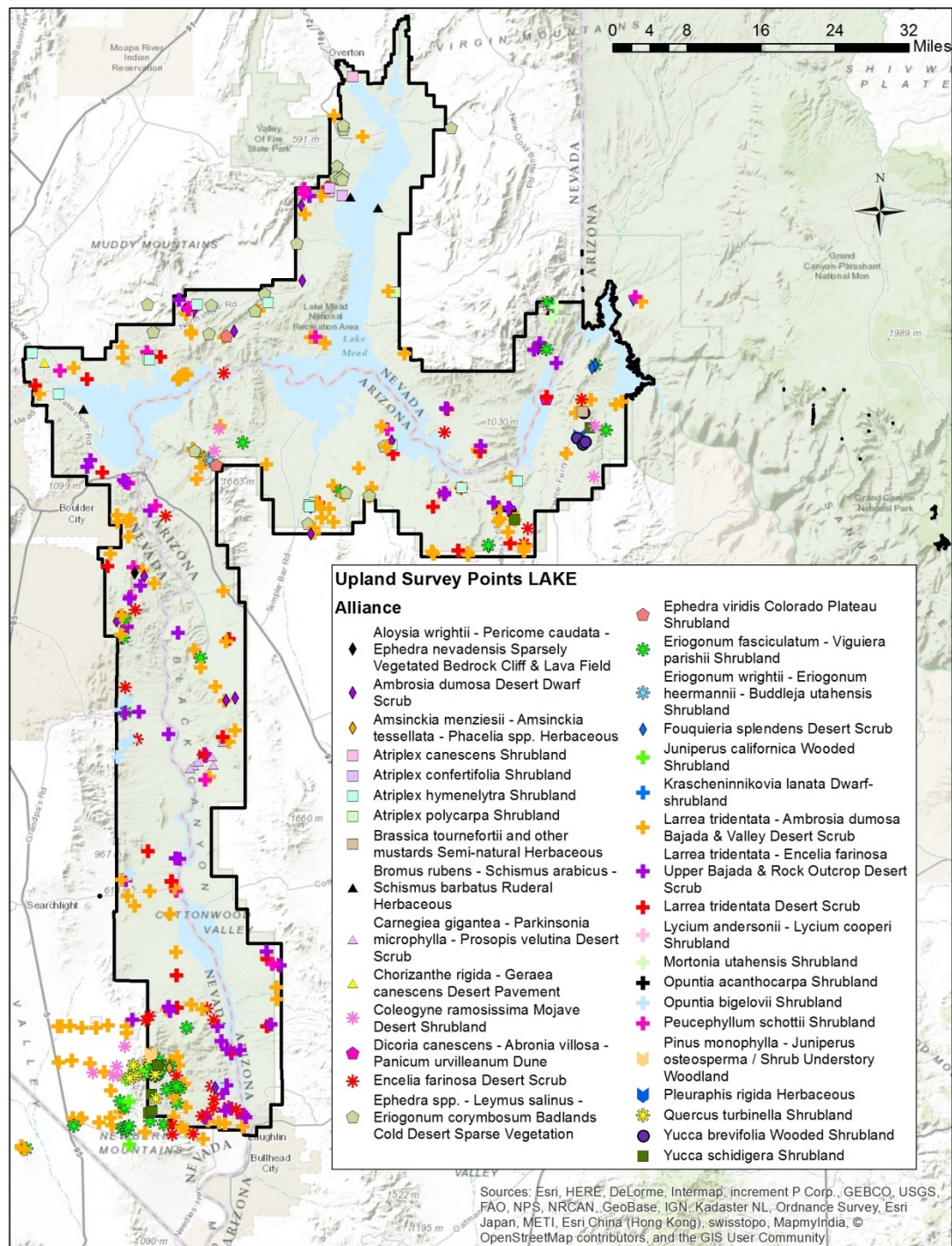
MOJN Vegetation Classification and Mapping Program, ver. 10/04/10									LAKE/MOJA/DEVA 2010-2011		
PLOT CODE: _____									Date: _____		
Vegetation Strata and Vegetation Cover											
Stratum categories: T1 – tree >10m, T2 – tree 5-10m, T3 – tree or shrub 2-5m, S1 – shrub 1-2m, S2 – shrub 50cm – 1m, S3 – shrub <50cm, H-herbaceous, N-nonvascular											
S	Species	%Cover	S	Species	%Cover	S	Species	%Cover	S	Species	%Cov
									N	CRUST	
									N		
									N		
									Species Outside Plot		
Cover Classes for reference: <1%, 1-5%, >5-15%, >15-25%, >25-50%, >50-75%, >75%											
Note: Epiphytes and vines are recorded in the stratum in which they occur											
Species Outside Plot: Record species within the stand but not within the plot.											
Percent Cover by Stratum											
Stratum	T1	T2	T3	S1	S2	S3	H	N			
% Cover											
						Total vegetation cover					

Unidentified Plants		
Unknown Plant Code:	Unknown Plant Code:	Unknown Plant Code:
Photos:	Photos:	Photos:
Grass Annual Perennial Shrub Tree	Grass Annual Perennial Shrub Tree	Grass Annual Perennial Shrub Tree
Family?	Family?	Family?
Leaves?	Leaves?	Leaves?
Flowers?	Flowers?	Flowers?
Seeds?	Seeds?	Seeds?
Other Description:	Other Description:	Other Description:
Voucher? Y/N	Voucher? Y/N	Voucher? Y/N

Observation Point Field Form, ver. 10/04/2010																	
OBSERVATION LOCATION INFORMATION																	
Plot Code: _____		Survey Date: _____		Gear#: _____		Park (Circle one): LAME, DEVA, MOJA											
Park Site Name: _____				State (Circle one): AZ, CA, NV													
Surveyors: _____				Provisional Alliance: _____													
				Provisional Association: _____													
Datum: UTM NAD83 11/ 12 Other _____		GPS Unit#: _____		Waypoint #: _____		GPS Error (+/-): _____											
ID#/BPU# _____		Grid Code _____		GPS Comments: _____													
GPS Location : UTME _____				UTMN _____		Elevation (m): _____											
Camera#: _____		Photo#: N _____ E _____ S _____ W _____		Addl. Photos (Dir/#) _____													
Site description: Describe general vegetation conditions, landscape context, homogeneity of the vegetation, successional stage, recent fire, other disturbances.																	
ENVIRONMENTAL DESCRIPTION																	
Relative Stand Size: <div style="display: flex; justify-content: space-between;"> <div> 1-3000m2 3000-10,000m2 (1ha) 1ha-10ha >10 ha 1-3x plot size (3-10x plot) (10 – 100x plot) (> 100x plot) </div> <div> Slope _____ (degrees) Aspect _____ (use 360° for N) </div> </div>																	
Landform: Alluvial fan, Alluvial flat, Bajada, Badlands, Basin, Basin floor, Playa, Valley, Valley floor, Desert Pavement, Cinder cone, Lava field, Dome, Butte, Mesa, Hill, Ridge, Bench, Mountain, Mountain slope, Mountain valley, Canyon, Ravine, Sand dune, Sand sheet, Dune field, Interfluvium, Bluff, Stream terrace, Stream channel, Drainage channel, Wash, Other _____																	
Topographic Position: HighLevel HighSlope MidSlope BackSlope StepinSlope LowSlope ToeSlope LowLevel Interfluvium Channel Wall Channel Bed Basin																	
Geology: Alluvium, <u>Igneous Plutonic</u> , Granite, Diorite, Gabbro, <u>Igneous Volcanic</u> , Andesite, Basalt, Dacite, Rhyolite, Volcanic breccia, <u>Sedimentary</u> , Conglomerate (rounded), Breccia (angular), Claystone, Mudstone, Sandstone, Siltstone, Shale, Dolostone, Limestone, Marl, Gypsum, <u>Metamorphic</u> , Gneiss, Schist, Slate, <u>Aeolian Deposit</u> , Sand dune, Sand sheets, Obscured by soil, Other _____																	
Non-Vegetated Surface Cover: <i>(For cover of <1% record percent cover to the nearest 0.1 percent. Sum = 100%)</i> <div style="display: flex; justify-content: space-between;"> <div> _____ Other = Fines (<2 mm) _____ Small Rocks (2 mm – 2.5cm) _____ Large Rocks (2.5cm+) </div> <div> _____ Bedrock (non-transported rock) _____ Litter/Duff (dead plant material <3 cm diameter) _____ Woody debris (dead wood >3cm) _____ Water </div> </div>						Phenology: 1-Leaf Out, 2-Flower, 3-Past Flower, 4-Winter (leafless ...) Herbaceous: _____ Shrub: _____ Trees: _____ Cowardin System: Upland/Palustrine											
Soil Texture (see soil key): <div style="display: flex; justify-content: space-between;"> <div> _____ sand _____ loamy sand _____ sandy loam </div> <div> _____ silt loam _____ silt _____ loam </div> <div> _____ sandy clay _____ clay _____ clay loam </div> <div> _____ silty clay _____ peat _____ muck </div> </div>						Disturbance Natural: Disturbance Anthropogenic:											
VEGETATION DESCRIPTION																	
Stratum Categories		T1 _____ >10m		T2 _____ 5-10m		T3 _____ 2-5m		S1 _____ 1-2m		S2 _____ 0.5-1m		S3 _____ <0.5m		H		N	
% Stratum Cover																	
S	Dominant Species	%	S	Dominant Species	%	S	Dominant Species	%	S	Dominant Species	%	S	Dominant Species	%			
														Total Veg. Cover			
Cover classes for reference: <1%, 1-5%, >5-15%, >15-25%, >25-50%, >50-75%, >75%																	
Adjacent Alliances																	
1. _____				Distance/Dir: _____				Describe Location: _____									
2. _____				Distance/Dir: _____				Describe Location: _____									
Initial and Date: Crew Lead Error Check _____ PDF/Basic Entry _____ Full Database Entry _____																	

Appendix B. Location of Vegetation Field Surveys for the Classification of Riparian/Wash/Wetland and Upland Alliances at Lake Mead National Recreation Area





Appendix C. Field Key to the Vegetation Alliances of Lake Mead National Recreation Area, Nevada and Arizona



October 2015



Prepared By

California Native Plant Society
2707 K Street, Suite 1
Sacramento, CA 95816

And the

Colorado Natural Heritage Program
Colorado State University
Fort Collins, Colorado 80523

In partnership with the

National Park Service
Mojave Desert Network Inventory and Monitoring Program
601 Nevada Hwy
Boulder City, NV 89005

And

NatureServe
Western Regional Office
4001 Discovery, Suite 2110
Boulder, Colorado

October 2015

Field Key to the Vegetation Alliances of Lake Mead National Recreation Area, Nevada and Arizona

Introduction

The vegetation classification and key of Lake Mead National Recreation Area (LAKE) has been developed as part of the Vegetation Classification and Mapping project being conducted at LAKE. The project is managed by the Mojave Desert Inventory & Monitoring Network (MOJN I&M) under the guidance of the National Park Service's National Vegetation Inventory Program. The field key is one of the products produced as part of the classification phase of the project. It has been developed using the compiled field data, which was analyzed to identify the vegetation types that occur within LAKE. The vegetation types identified during analysis have been classified according to the United States National Vegetation Classification (USNVC) hierarchy (FGDC 2008) and related state classifications (e.g., Peterson 2008, Sawyer et al. 2009).

This key has been written to assist users in identifying the major physiognomic units and the vegetation alliances within LAKE. The alliances are based on one or more dominant and/or diagnostic species occurring in the landscape and on environmental settings. The key will be used to distinguish formal mapping classes and to conduct the accuracy assessment of the LAKE vegetation map. This key can also be used for other projects within the park to type vegetation communities to the alliance level of the USNVC. The list of alliances and the map class within which each resides is provided at the back of the key.

The key is based on the interim classification of new data collected by the University of Nevada, Las Vegas vegetation mapping field crew in 2010 and existing legacy data, collected between 2007 and 2010 by a variety of entities, including Lake Mead National Recreation Area staff, the U.S. Geological Survey, and the Jornada Experimental Range Station with the USDA Agricultural Research Service. Some of the data used to develop the classification were collected adjacent to the Park's boundaries. Thus, some alliances identified from data collected outside the park boundary are included in this key because of their potential to occur within the park.

The key may not denote all vegetation types that occur within LAKE, nor explain the full range of variation of vegetation types as they appear on the ground. Species interact in a continuum based on a complex set of habitat preferences, and they can intermix in wide or narrow zones within the landscape. While this key attempts to reflect this complexity, unusual or site-specific assemblages of plants may exist in the landscape and may not be easily keyed.

Instructions for Users

The key has three levels: 1. Major physiognomic group, 2. Primary environmental setting (e.g., riparian or upland), and 3. Vegetation alliance.

The first level is a key to the major physiognomic groups:

Key I. Forest and Woodland Vegetation

Key II. Shrubland Vegetation

Key III. Herbaceous Vegetation

Key IV. Sparse Vegetation.

Within each of the major physiognomic groups, the second level keys group the vegetation by the major environmental settings. Key #A and Key # B are used to separate the riparian and alkaline vegetation types from the upland vegetation types. The third level keys, nested under the second level keys, use dominant and/or diagnostic species to key to alliance. The alliance names are listed with the current NVC name in bold and then former NVC name below, un-bolded. The current NVC code and former NVC code for each alliance is listed next to alliance name (e.g., A#### or A.####). If the alliance was provisional, these were coded with a “Park Special” PS number (PS. ###).

Due to the natural variation of species interacting in complex desert landscapes, some vegetation types will be keyed in more than one place, and in more than one of the physiognomic keys. If you are having difficulty reaching a comfortable solution, and the vegetation is a mix of physiognomic types, try starting in a different sub-key. Likewise, if you are having difficulty identifying what seems to be an appropriate type try starting in the key for the other environmental setting.

When using this key, you may have difficulty getting to an appropriate place in the key that describes your vegetation type. Several possible reasons exist for this problem and several solutions are provided below.

1. The vegetation appears to be a shrubland or herbaceous type but has some tree cover. In this case, try keying the vegetation through the woodland/forest section of the key as well as the other sections. For a stand to be considered a shrubland the cover of shrubs must be more than 2%. For a stand to be considered a woodland the cover of trees must be at least 3% (cf. Thomas et al. 2004). Since these low cover estimates are exceptions to the typical rule of 10% shrub or tree cover to be defined as a shrubland or woodland type, easily confused types may be included in more than one place in the key.
2. While the diagnostic layer may consist of woody plants that appear as either a shrub or a tree form, depending on stand age and site conditions, we consider some species *trees*, regardless of their height or growth form. These species include *Juniperus* spp., *Pinus monophylla*, *Parkinsonia* spp., *Prosopis* spp., and *Salix gooddingii*. The recognized life form of all species used in the key is indicated in the species list in Table 2 at the end of this document.
3. If the site appears herbaceous in nature, the perennial species will be used to determine the type, unless the site consists primarily of annuals and ephemerals or is highly disturbed in which case the annual herbs would define the type.
4. Sparsely vegetated types are defined as having total vascular plant cover that *averages* <2% absolute cover across the entire area or stand of vegetation (but that could *range* from 1–9%). They are often a mix of herbaceous and woody plants that may or may not be diagnostic of

the particular site being viewed. Gypsum soils are typically sparsely vegetated, and in some stands cryptogams and non-vascular plants such as lichens and mosses may dominate. These types are typically variable and may be borderline “sparsely” vegetated. In any case, when uncertain, you should key the stand using more than one section of the key because a stand may actually be a more open variety of woodland, shrubland or herbaceous vegetation, and will not key out as a sparse type (keeping in mind that a high degree of natural variation exists in desert landscapes). This is especially true for shrubland types that occur on harsh sites, in which case you should pay attention to dominance or the presence of characteristic species, rather than absolute cover rules.

5. You may encounter a type in the field that is not currently described in the key. Since the key was based on a sample of the vegetation in the region, this is to be expected occasionally. In this case, you should record the alliance as “Unclassified” and describe whatever type of vegetation is present (i.e. “unclassified *Artemisia tridentata*”). Be sure to note the dominant/characteristic species and cover in each layer (stratum), as well as taking detailed notes about the environmental setting. Evaluate and record topography, soils, ground cover, and hydrology.
6. Some woodland stands may be severely infested with the epiphytic parasite mistletoe (*Phoradendron californicum*), which may have greater cover than that of the host species. Assume cover of host species including the mistletoe and key the type on that basis.
7. Keep in mind that the minimum mapping unit (MMU) is 0.5 hectares and is equal to 5000 square meters, which is a circle with a radius of about 40 meters. A circle with a 4 m radius is 1% of the MMU, a circle with a ~9m radius is 5% of the MMU, and a circle with a ~13 m radius is 10% of the MMU. Remember this scale when evaluating a site and assigning vegetation cover percentages. The 0.5 ha MMU applies to all types at LAKE with the exception of fan palm woodlands which have a MMU of 0.25 ha.
8. Overstory species largely determine site ecological dynamics, and consequently, the tallest canopy is typically the defining canopy, regardless of relative cover values. Exceptions include tree cover that is less than 3% or shrub cover less than 2%.

The following terms are affixed to some vegetation alliance names:

(n=X) = sampled at LAKE, proposed or new USNVC Alliance

(Provisional) = proposed USNVC Alliance

* = Not currently sampled with classification/observation plots at LAKE, though included in the key since the type is known to occur in the region and/or has been documented in the mapping and accuracy assessment stage during the project

Key to Vegetation Types

Key to Physiognomic Groups (First Level Key)

1 Cover of vascular plant species is 2% absolute cover or greater (2)

1' Cover of vascular plant species is <2% absolute cover on average, though non-vascular species can be present and high in cover. Areas include desert pavement, sand dunes/flats, rock outcrops, gypsum hills and other areas with sparse or no vascular plant cover.

Key IV. Sparsely Vegetated and Unvegetated Areas

2 Cover of tree species is at least 3% absolute cover, though in cases with *Pinus monophylla*, *Yucca brevifolia* or wash woodlands, canopy cover may be at least 2% cover.

Key I. Forest and Woodland Vegetation

2' Trees not characteristically present in the overstory, and constitute <2–3% absolute canopy cover; shrubs and/or herbaceous species define the stands.(3)

3 Shrub species, regardless of height, comprise at least 2% absolute cover, and herbaceous cover is variable.

Key II. Shrubland Vegetation

3' Tree and/or shrub cover is less than 2% and herbaceous species comprise more than 2% absolute cover.

Key III. Herbaceous Vegetation

Key I. Woodland and Forest Vegetation

1 Mesic stands with access to surface or ground-water located along lake margin, streams, washes, floodplains, playas, montane drainage channels, lower portions of alluvial flats and basins that are strongly alkaline in nature, or other riparian or wetland sites that depend upon water...**Key I.A.**

1' Upland stands developed along flats, alluvial fans and bajadas, slopes and ridges, and other sites that are not typically riparian or ground-water dependent...**Key I.B.**

Key I.A. Riparian, Semi-Riparian, Lake Margin, Wash, Playa, and Ground-Water Dependent Woodlands/Forests

1 Lake margin, riparian, stream and spring-fed vegetation with *Salix* spp., *Populus fremontii*, *Washingtonia filifera*, *Prosopis pubescens*, or *Tamarix* spp. present. **(2)**

1' Semi-riparian desert washes, floodplains, arroyos, terraces directly above washes, and playas, not including more permanent streams or springs, with *Chilopsis linearis*, *Psoralea argophylla*, *Parkinsonia microphylla*, *Prosopis* spp., *Quercus turbinella* and/or other tree and shrub species present. **(7)**

2 *Washingtonia filifera* or *Prosopis pubescens* dominant or co-dominant in the overstory, at springs. **(3)**

2' Other species dominant in stands, at various sites. **(4)**

3 *Washingtonia filifera* dominant in the overstory, as an introduced species in the Mojave Desert. *Pluchea sericea* may be present in shrub layer.

***Phoenix dactylifera* - *Washingtonia filifera* Ruderal Woodland Alliance (A4161)**

Washingtonia filifera Seasonally Flooded Woodland Alliance (A.485)

3' *Prosopis pubescens* dominant in the overstory. Shrubs and vines, including *Baccharis sergiloides*, *Pluchea sericea* or *Vitis arizonica*, and herbs may have high cover.

***Prosopis pubescens* Shrubland Alliance (A.1042)**

4 *Tamarix* spp. overwhelmingly dominant, typically occurring along the lake margin and along tributary drainages.

***Tamarix* spp. Ruderal Temporarily Flooded Shrubland Alliance (A0842)**

Tamarix spp. Semi-natural Temporarily Flooded Shrubland Alliance (A.842)

4' Other species dominant in the overstory. **(5)**

5 *Populus fremontii* dominant or co-dominant with other trees such as *Salix* spp., along seeps, springs and streams. *Baccharis sergiloides* commonly occurs in shrub layer.

***Populus fremontii* - *Fraxinus velutina* - *Salix gooddingii* Flooded Forest & Woodland Alliance (A3803)**

Populus fremontii Temporarily Flooded Forest Alliance (A.313)

5' *Salix* spp. dominant, at various settings. *Populus fremontii*, if present, has low relative cover. **(6)**

6 *Salix gooddingii* dominant, along seeps, streams and rivers; shrub layer is variable and may include *Baccharis sergiloides*, *Pluchea sericea* and/or *Tamarix* spp.

***Salix gooddingii* - *Salix laevigata* - *Salix lucida* Riparian Forest Alliance (A3752)**

Salix gooddingii Temporarily Flooded Woodland Alliance (A.640)

6' *Salix laevigata* dominant, usually on bottoms and low to mid-slope streams and seeps. Associated shrubs may include *Baccharis* spp. and *Eriogonum fasciculatum*.

***Salix gooddingii* - *Salix laevigata* - *Salix lucida* Riparian Forest Alliance (A3752)**

Salix laevigata Temporarily Flooded Woodland Alliance*(A.646)

7 *Prosopis* spp. dominant in the overstory, along intermittent seeps and springs, reservoir shorelines, and coppice dunes where groundwater is occasionally available. *Salix exigua* and *Tamarix* spp. may be co-dominant. Shrubs and vines may be present and variable in cover, including *Atriplex* spp., *Baccharis sergiloides*, *Pluchea sericea*, *Suaeda moquinii*, and *Vitis arizonica*.

***Prosopis glandulosa* - *Prosopis velutina* - *Prosopis pubescens* Riparian Forest, Woodland & Shrubland Alliance (A3877)**

Prosopis glandulosa Shrubland Alliance (A.1031)

Prosopis pubescens Shrubland Alliance (A.1042)

7' Other plants dominant and occur in various settings. **(8)**

8 *Parkinsonia microphylla* dominant in the overstory, usually as scattered trees (or tall shrubs) with variable cover of shrubs intermixed, along washes and north-facing, lower-elevation slopes.

Understory shrub cover may be greater than overstory cover, and can include *Encelia farinosa* and/or *Larrea tridentata*.

***Carnegiea gigantea* - *Parkinsonia microphylla* - *Prosopis velutina* Desert Scrub Alliance (A3282)**

Parkinsonia microphylla Wooded Shrubland Alliance (A.883)

8' Other species dominant. **(9)**

10 *Chilopsis linearis* or *Psoralea argophylla* dominant or co-dominant in stands, along actively flooded washes, floodplains, and lower drainages of mountains. **(11)**

***Chilopsis linearis* - *Psoralea argophylla* Desert Wash Alliance (A1044)**

Chilopsis linearis Intermittently Flooded Shrubland Alliance (A.1044)

Psoralea argophylla Woodland Alliance (PS.015)

9 *Quercus turbinella* dominant or co-dominant in stands, usually in intermittently flooded drainage channels, ravines, and washes in the montane zone.

***Quercus turbinella* Shrubland Alliance (A0793)**

Quercus turbinella Shrubland Alliance (A.793)

Key I.B. Upland Woodlands/Forests

1 Deciduous trees and tall shrubs of *Fouquieria splendens* or *Parkinsonia* spp. dominant at low to mid-elevations. Usually occurs on hills and slopes in the same zone as *Larrea tridentata*, *Encelia farinosa*, *Ambrosia dumosa*, *Viguiera parishii*, etc., any of which may have high cover. **(2)**

1' Conifers, broadleaf evergreen trees (e.g. *Quercus turbinella*), and/or *Yucca brevifolia* dominant or co-dominant at mid to high-elevations. Can occur with *Juniperus californica*, *Coleogyne ramosissima*, *Ephedra* spp., and *Lycium andersonii*. **(5)**

2 *Fouquieria splendens* dominant in the overstory with sparse cover. *Encelia farinosa*, *Larrea tridentata*, and/or *Ambrosia dumosa* usually present and dominant in the shrub layer, along hills and ridges. **(3)**

2' *Parkinsonia aculeata* or *Parkinsonia microphylla* dominant in the overstory. **(4)**

3 *Fouquieria splendens* is dominant in the overstory, and *Larrea tridentata* and *Ambrosia dumosa* co-dominate in the shrub layer, commonly on bajadas and alluvial fans. Does not occur in washes.

***Larrea tridentata* - *Ambrosia dumosa* Bajada & Valley Desert Scrub Alliance (A3277)**

Larrea tridentata–*Ambrosia dumosa* Shrubland Alliance (A.2532)

3' *Fouquieria splendens* dominant in the overstory with *Encelia farinosa* or with other shrubs in the understory shrub layer, such as *Viguiera parishii* and *Ferocactus cylindraceus*. *Ambrosia dumosa* and *Larrea tridentata* may be present but do not co-dominate the shrub layer.

***Larrea tridentata* - *Encelia farinosa* - *Fouquieria splendens* Upper Bajada & Rock Outcrop Desert Scrub Alliance (A3278)**

Fouquieria splendens Shrubland Alliance (A.863)

4 *Parkinsonia aculeata* dominant in the overstory, as planted trees with an understory dominated by *Larrea tridentata* and *Encelia farinosa*, commonly on xeric bajadas and hill slopes. Does not occur in washes.

***Larrea tridentata* - *Encelia farinosa* - *Fouquieria splendens* Upper Bajada & Rock Outcrop Desert Scrub Alliance (A3278)**

Larrea tridentata–*Encelia farinosa* Shrubland Alliance (A.2533)

4' *Parkinsonia microphylla* dominant in the overstory usually as scattered trees (or tall shrubs) with variable cover of shrubs intermixed, along washes and north-facing lower-elevation slopes. Understory shrub cover may be greater than overstory cover and can include *Encelia farinosa* and/or *Larrea tridentata*.

***Carnegiea gigantea* - *Parkinsonia microphylla* - *Prosopis velutina* Desert Scrub Alliance (A3282)**

Parkinsonia microphylla Wooded Shrubland Alliance (A.883)

5 *Pinus monophylla* dominant, co-dominant or characteristically present in overstory. *P. monophylla* has at least 2% absolute cover of *Quercus turbinella*, if present. *Juniperus* spp. may also be present in stands at lower cover.

***Pinus monophylla* – *Juniperus osteosperma* / Shrub Understory Woodland Alliance (A2108)**

Pinus monophylla – (*Juniperus osteosperma*) Woodland Alliance (A.543)

5' *Pinus monophylla* has less than 2% absolute cover of *Quercus turbinella*, or other trees dominate in the overstory. **(6)**

6 *Yucca brevifolia* dominant in the overstory with sparse to intermittent cover; various shrubs such as *Coleogyne ramosissima*, *Ephedra* spp. and *Lycium andersonii* present and may have higher cover, along slopes, mesas, and other upland sites.

***Yucca brevifolia* Wooded Shrubland Alliance (A3148)**

Yucca brevifolia Wooded Shrubland Alliance (A.884)

6' Other trees dominant in the overstory. **(7)**

7. *Quercus turbinella* or *Juniperus californica* dominant in the overstory, often in rocky uplands and slopes. **(8)**

7' *Tamarix aphylla* or other trees dominant in the overstory as planted stands in ornamental settings.

Mixed Ornamental & Semi-Natural Woodland Mapping Unit* (FOR)

Tamarix spp. Planted Stands* (cf. A0842)

8 *Quercus turbinella* is dominant, co-dominant, or characteristically present in the overstory, or co-dominant with *Juniperus californica*; a variety of other smaller shrubs may also be present including *Eriogonum fasciculatum* and *E. wrightii*. *Pinus monophylla*, if present, has less than 2% absolute cover of *Q. turbinella*.

***Quercus turbinella* Shrubland Alliance (A0793)**

Quercus turbinella Shrubland Alliance (A.793)

8' *Juniperus californica* dominant in the overstory with at least 1/3 the combined cover of *Pinus monophylla*, *Quercus turbinella* or *Yucca brevifolia*, if present.

***Juniperus californica* Wooded Shrubland Alliance (A0502)**

Juniperus californica Wooded Shrubland Alliance (A.502)

Key II. Shrubland Vegetation

1 Stands dominated by *Juniperus* spp., *Pinus monophylla*, *Parkinsonia* spp., *Prosopis* spp., or *Salix gooddingii*. **Key I. Woodland and Forest Vegetation**

1' Stands not as above. **(2)**

2 Mesic stands with access to surface or ground-water located along lake margin, streams, washes, floodplains, playas, montane drainage channels, lower portions of alluvial flats and basins that are strongly alkaline in nature, or other riparian or wetland sites that depend upon water. **Key II.A.**

2' Upland stands developed on flats, alluvial fans and bajadas, slopes and ridges, and other sites not typically riparian or ground-water dependent, including sand dunes, sand flats, and gypsum hills. **Key II.B.**

Key II.A. Riparian, Semi-Riparian, Lake Margin, Wash, Playa, Ground-Water Dependent and Alkaline Shrublands

1 *Atriplex* spp. or *Suaeda moquinii* dominant or co-dominant in stands. Sites variably include valley floors, coppice dunes, drainage channels or alkaline spring sites associated with harsh soils. **(2)**

1' Stands not as above. **(8)**

2 *Suaeda moquinii* and/or *Isocoma acradenia* dominant, or *Suaeda moquinii* co-dominant with *Atriplex canescens* in stands.

Suaeda moquinii - *Salicornia rubra* Alkaline Scrub Alliance (A3880)

Suaeda moquinii Intermittently Flooded Shrubland Alliance (A.941)

2' Stands not as above.

3 *Allenrolfea occidentalis* dominant or co-dominant in stands. Often present with other alkaline/saline areas such as playas, springs among gypsum/calcareous slopes, and washes with saline overflow.

Allenrolfea occidentalis Shrubland Alliance* (A0866)

Allenrolfea occidentalis Shrubland Alliance* (A.866)

3' *Atriplex* spp. dominant in stands. **(4)**

4 *Atriplex canescens* or *A. polycarpa* dominant in stands. **(5)**

4' Other *Atriplex* spp. dominant or co-dominant in stands. **(6)**

5 *Atriplex canescens* dominant in stands, primarily along valley floors and dry washes. *Krascheninnikovia lanata* often present (not based on LAKE samples).

Atriplex canescens Shrubland Alliance (A0869)

Atriplex canescens Shrubland Alliance (A.869)

5' *Atriplex polycarpa* dominant in relatively simple shrub stands, primarily in drainages, valley floors, alluvial fans and slopes of all aspects. *Larrea tridentata* and *Ambrosia dumosa* may be present but are not dominant (not based on LAKE samples).

***Atriplex polycarpa* Shrubland Alliance (A3174)**

Atriplex polycarpa Shrubland Alliance (A0873)

6 *Atriplex confertifolia* dominant in stands from high slopes to canyon bottoms. At LAKE, *Suaeda moquinii* is typically present in shrub layer.

***Atriplex confertifolia* Shrubland Alliance (A0870)**

Atriplex confertifolia Shrubland Alliance (A.870)

6' Other *Atriplex* spp. dominant in stands. **(7)**

7 *Atriplex hymenelytra* dominant in stands on a variety of landforms and aspects. *Ambrosia dumosa* and *Larrea tridentata* may be present but not dominant.

***Atriplex hymenelytra* Shrubland Alliance (A0872)**

Atriplex hymenelytra Shrubland Alliance (A.872)

7' *Atriplex lentiformis* dominant in stands primarily found on disturbed bottomlands and channel beds on flat and south aspects. *Encelia farinosa* often present in shrub layer and *Prosopis glandulosa* can occur as emergent tree at sparse cover. Dominant herbs can include *Cryptantha* spp. and *Schismus* spp.

***Atriplex lentiformis* Shrubland Alliance (A3173)**

Atriplex lentiformis Shrubland Alliance (PS.006)

8 *Baccharis sergiloides*, *Salix exigua*, *Pluchea sericea*, *Prunus fasciculata*, *Quercus turbinella*, *Vitis arizonica*, and/or *Tamarix* spp. co-dominant to dominant in stands. **(8)**

8' *Acacia greggii*, *Bebbia juncea*, *Ericameria paniculata*, *Hyptis emoryi*, *Hymenoclea salsola*, *Larrea tridentata*, *Lycium* spp., *Eriogonum fasciculatum* and/or *Viguiera parishii* co-dominant to dominant in stands. **(15)**

9 *Salix exigua* dominant or co-dominant in stands.

***Salix exigua* Warm Desert Riparian Shrubland Alliance* (A0947)**

Salix exigua Seasonally Flooded Woodland Alliance* (A.649)

9' Species other than *Salix exigua* dominant in stands. **(10)**

10 *Pluchea sericea* or *Tamarix* spp. dominant or co-dominant in stands. **(11)**

10' *Baccharis sergiloides*, *Quercus turbinella*, *Vitis arizonica*, and/or *Prunus fasciculata* dominant or co-dominant in stands. *Pluchea sericea* may be present but at relatively low cover. *Cladium californicum* may dominate or co-dominate herbaceous layer with other herbs. **(12)**

11 *Pluchea sericea* dominant or co-dominant with species such as *Baccharis sergiloides*, *Allenrolfea occidentalis*, *Phragmites australis*, *Suaeda moquinii*, or *Tamarix* spp.

***Pluchea sericea* Shrubland Alliance (A0798)**

Pluchea sericea Seasonally Flooded Shrubland Alliance (A.798)

11' *Tamarix* spp. strongly dominant in stands at > 80% relative cover.

***Tamarix* spp. Ruderal Temporarily Flooded Shrubland Alliance (A0842)**

Tamarix spp. Semi-natural Temporarily Flooded Shrubland Alliance (A.842)

12 *Vitis arizonica* dominant in the shrub layer; *Cladium californicum* may be present and dominant or co-dominant in the herb layer along with a variety of other herbs including *Phragmites australis* and *Distichlis spicata*.

***Vitis arizonica* - *Vitis girdiana* Shrubland Alliance (A4162)**

Vitis (*arizonica*, *girdiana*) Shrubland Alliance (n=7) (PS.001)

12' *Baccharis sergiloides*, *Prunus fasciculata* or *Quercus turbinella* dominant or co-dominant in stands. **(13)**

13 *Quercus turbinella* dominant in stands or co-dominant with *Baccharis sergiloides* or other species.

***Quercus turbinella* Shrubland Alliance (A0793)**

Quercus turbinella Shrubland Alliance (A.793)

13' *Baccharis sergiloides* or *Prunus fasciculata* dominant or co-dominant together or with other species in stands. **(14)**

14 *Baccharis sergiloides* dominant or co-dominant with species such as *Prunus fasciculata* or *Vitis arizonica*.

***Baccharis emoryi* - *Baccharis sergiloides* Dry Wash Shrubland Alliance (A3874)**

Baccharis sergiloides Intermittently Flooded Shrubland Alliance (A.2531)

14' *Prunus fasciculata* or *Salazaria mexicana* dominant in stands or co-dominant with other species including *Brickellia desertorum*, *Rhus trilobata* or *Ericameria* spp.

***Prunus fasciculata* – *Salazaria mexicana* Northern Mojave Desert Wash Alliance (A4185)**

Prunus fasciculata Intermittently Flooded Shrubland Alliance (A.2519)

15 *Hyptis emoryi* dominant in stands or co-dominant with shrubs such as *Bebbia juncea*, *Acacia greggii* and *Larrea tridentata* at low cover. OR *Acacia greggii* has at least 2% cover, not exceeded by any other species of microphyllus tall shrub or tree. Smaller shrubs, such as *Hymenoclea salsola* and *Bebbia juncea*, can have higher cover but no more than twice the cover of *A. greggii*. Occurs in washes and arroyos, as well as upland valleys and bouldery slopes.

***Acacia greggii* - *Hyptis emoryi* - *Justicia californica* Desert Wash Alliance (A0842)**

Acacia greggii Shrubland Alliance (A.1036)

Hyptis emoryi Intermittently Flooded Shrubland Alliance (A.2537)

16' Plants in stands not like above. **(17)**

17 *Fallugia paradoxa* is the dominant shrub.

***Fallugia paradoxa* Wash Alliance* (A3259)**

Brickellia longifolia - *Fallugia paradoxa* - *Isocoma acradenia* Shrubland* (A.3259)

17' Plants in stands not like above. (18)

18 *Eriogonum fasciculatum* and *Viguiera parishii* co-dominant together and usually intermixed with other shrubs including *Ambrosia dumosa*, *Bebbia juncea*, and *Ephedra* spp., or *Viguiera parishii* is dominant to co-dominant with other shrubs including *Larrea tridentata* and *Salazaria mexicana*.

***Eriogonum fasciculatum* - *Viguiera parishii* Shrubland Alliance (A3150)**

Eriogonum fasciculatum–*Viguiera parishii* Shrubland Alliance (n=40) (PS.008)

18' *Ericameria paniculata*, *Bebbia juncea*, *Hymenoclea salsola*, *Lycium* spp., and/or *Larrea tridentata* dominant or co-dominant in stands. (19)

19 *Ericameria paniculata* is dominant in stands, or sometimes co-dominant with shrubs such as *Hymenoclea salsola* or *Larrea tridentata*.

***Ericameria paniculata* Mojave Desert Wash Alliance (A2509)**

Ericameria paniculata Intermittently Flooded Shrubland Alliance (A.2509)

19' *Hymenoclea salsola*, *Bebbia juncea*, *Lycium* spp., and/or *Larrea tridentata* dominant or co-dominant in stands. (20)

20 *Hymenoclea salsola* or *Bebbia juncea* dominant or co-dominant (rarely sub-dominant) together and/or with other shrubs such as *Larrea tridentata*.

***Hymenoclea salsola* – *Bebbia juncea* Mojave-Sonoran Desert Wash Alliance (A4188)**

Hymenoclea salsola Shrubland Alliance (A.2512)

21 *Lycium andersonii* or *Lycium cooperi* dominant in stands.

***Lycium andersonii* - *Lycium cooperi* Shrubland Alliance (A3142)**

21' *Larrea tridentata* dominant or co-dominant with other shrubs, in washes. (22)

22 *Larrea tridentata* dominant (with at least 2% cover) in washes.

***Larrea tridentata* Shrubland Alliance – Wash (AW.851)**

22' *Larrea tridentata* co-dominant with other shrubs in washes. (22)

23 *Larrea tridentata* co-dominant with *Ambrosia dumosa* in washes (both with at least 2% cover each, though their relative cover may vary between them across stands). No other shrub species greatly exceeds either of these species in cover.

***Larrea tridentata*–*Ambrosia dumosa* Shrubland Alliance – Wash (AW.2532)**

23' *Larrea tridentata* co-dominant with *Encelia farinosa* in washes (both with at least 2% cover each, though their relative cover may vary between them across stands). *Ambrosia dumosa* may also be present but occurs with low cover.

***Larrea tridentata*–*Encelia farinosa* Shrubland Alliance – Wash (AW.2533)**

Key II.B. Upland Shrublands

1 *Coleogyne ramosissima*, *Mortonia utahensis*, *Ephedra viridis*, *Eriogonum* spp., *Larrea tridentata*, *Acacia gregii*, *Krascheninnikovia lanata*, *Prunus fasciculata*, *Arctostaphylos* spp., *Quercus turbinella*, *Viguiera parishii*, *Yucca* spp., *Gutierrezia* spp. and/or other shrubs dominant or co-dominant, occurring in mid to higher elevation stands, steep rock outcrops, and bases of mountains along uppermost bajadas. **(2)**

1' Shrub canopy not like above. Stands dominated by species such as *Cylindropuntia* spp., *Ambrosia dumosa*, *Encelia farinosa*, *Ephedra torreyana*, *Ephedra fasciculata*, *Larrea tridentata*, and *Psoralea* spp., occurring in lower to mid elevation stands such as bajadas and basins. **(15)**

2 *Coleogyne ramosissima* or *Mortonia utahensis* dominant or co-dominant in stands, or *Gutierrezia* spp. co-occurring with species such as *Ephedra viridis* or *Mortonia utahensis*. **(3)**

2' Shrub canopy not like above. **(5)**

3 *Coleogyne ramosissima* dominant or co-dominant with shrubs such as *Larrea tridentata*, *Ephedra* spp., *Eriogonum fasciculatum*, *Gutierrezia sarothrae*, and/or *Yucca schidigera*. Found on hills, slopes, and ridges with variable parent material including granite and metamorphic substrates.

***Coleogyne ramosissima* Mojave Desert Shrubland Alliance (A3144)**

Coleogyne ramosissima Shrubland Alliance (A.874)

3' Stands not like above, and including *Mortonia utahensis*, *Gutierrezia* spp., or other shrubs. Typically on carbonate or sandstone rock outcrops. **(4)**

4 *Mortonia utahensis* dominant or co-occurring with shrubs such as *Coleogyne ramosissima* or *Gutierrezia* spp.

***Mortonia utahensis* Shrubland Alliance (A4158)**

Mortonia utahensis Shrubland Alliance (PS.009)

4' *Gutierrezia microcephala* dominant, and other plants, including *Ephedra* spp. and *Eriogonum fasciculatum* often present at lower cover. Herbs are present and include *Bromus rubens* and *Mirabilis laevis*.

***Gutierrezia sarothrae* - *Gutierrezia microcephala* Dwarf-Shrubland Alliance* (A3203)**

Gutierrezia (sarothrae, microcephala) - *Ephedra (torreyana, viridis)* Mojave Desert Shrubland Alliance* (A.2528)

5 *Yucca brevifolia* has sparse to open cover; various shrubs present and may be high in cover, including *Acamptopappus sphaerocephalus*, *Ephedra* spp., *Grusonia parishii*, *Lycium andersonii*, and *Yucca schidigera*. Found along slopes, mesas, and other upland sites.

***Yucca brevifolia* Wooded Shrubland Alliance (A3148)**

Yucca brevifolia Wooded Shrubland Alliance (A.884)

5' Stands not like above. **(6)**

6 *Quercus turbinella* or *Arctostaphylos pungens* dominant or co-dominant in stands. (7)

6' Shrub canopy not like above in stands. (8)

7. *Quercus turbinella* dominant, co-dominant, or characteristically present with a variety of other shrubs and trees in stands, including *Juniperus californica*, *Garrya flavescens*, *Ephedra* spp., *Eriogonum fasciculatum*, and *Eriogonum wrightii*. *Pinus monophylla*, if present, has less than 2% absolute cover of *Q. turbinella*.

***Quercus turbinella* Shrubland Alliance (A0793)**

Quercus turbinella Shrubland Alliance (A.793)

7' *Arctostaphylos pungens* dominant in stands.

***Arctostaphylos pungens* - *Arctostaphylos pringlei* - *Ceanothus greggii* Shrubland Alliance* (A3790)**

Arctostaphylos - *Quercus turbinella* Shrubland Alliance*

8 *Canotia holacantha* dominant in stand. *Gutierrezia* spp., *Acacia greggii*, and *Ephedra* spp. are common to co-dominant in some stands.

***Simmondsia chinensis* - *Canotia holacantha* - *Eriogonum fasciculatum*
Desert Scrub Alliance* (A3283; A.3283)**

8' Other plants dominant in stands. (9)

9 *Ephedra viridis*, *Prunus fasciculata*, or *Acacia greggii* dominant or co-dominant on rocky slopes and ridges. (10)

9' Other plants dominant in stands (12)

10 *Acacia greggii* dominant in stands primarily on flood plains and arroyos. Other shrubs are variable, and characteristic herbs include *Bromus rubens* and *Erodium cicutarium*.

***Acacia greggii* - *Hyptis emoryi* - *Justicia californica* Desert Wash Alliance (A0842)**
Acacia greggii Shrubland Alliance (A.1036)

10' *Ephedra viridis* and/or *Prunus fasciculata* dominant or co-dominant in stands. (11)

11 *Ephedra viridis* dominant in stands, or sometimes co-dominant with plants such as *Gutierrezia sarothrae*, *Prunus fasciculata*, or *Ericameria* spp.

***Ephedra viridis* Colorado Plateau Shrubland Alliance (A3201)**
Ephedra viridis Shrubland Alliance (A.858)

11' *Prunus fasciculata* dominant in stands, or co-dominant with plants such as *Brickellia* spp., *Ericameria* spp., *Keckiella antirrhinoides*, and/or *Rhus trilobata*. *Ephedra viridis*, if present, has relatively low cover.

***Prunus fasciculata* – *Salazaria mexicana* Northern Mojave Desert
Wash Alliance (A4185)**
Prunus fasciculata Intermittently Flooded Shrubland Alliance (A.2519)

12 *Krascheninnikovia lanata* dominant in stands, or co-dominant with other shrubs. Typically found on alkaline flats around playas and drainage terraces, plains and old lake beds with cryptogamic crust often present.

***Krascheninnikovia lanata* Dwarf-shrubland & Dwarf-shrub Herbaceous Alliance (A3202)**

Krascheninnikovia lanata Dwarf Shrubland Alliance (A.1104)

12' Plants in stands not like above. (13)

13 *Yucca schidigera* dominant, co-dominant, or characteristically present in stands with at least 2% cover. Other shrub species may have similar or higher cover. However, if *Viguiera parishii* and *Eriogonum fasciculatum* are present, then combined cover of these species is < 2 times the cover of *Yucca schidigera*.

***Yucca schidigera* Shrubland Alliance (A3147)**

Yucca schidigera Shrubland Alliance (A.881)

13' Plants in stands not like above. (14)

14 *Eriogonum fasciculatum* or *Viguiera parishii* dominant in stands or co-dominant with each other and/or with other plants such as *Bebbia juncea*, *Ericameria* spp., *Encelia virginensis*, and *Ephedra* spp. If *Yucca schidigera* or *Acacia greggii* is present, then combined cover of *V. parishii* and *E. fasciculatum* is >2 times the cover of the *Yucca schidigera* or *Acacia greggii*.

***Eriogonum fasciculatum*–*Viguiera parishii* Shrubland Alliance (A3150)**

Eriogonum fasciculatum–*Viguiera parishii* Shrubland Alliance (PS.011)

14' *Eriogonum heermannii* dominant in stands, though other shrubs may be present including *E. fasciculatum* at lower cover.

***Eriogonum wrightii* - *Eriogonum heermannii* - *Buddleja utahensis* Shrubland Alliance (A4167)**

Eriogonum heermannii Shrubland Alliance (PS.008)

15 *Cylindropuntia acanthocarpa* or *Cylindropuntia bigelovii* dominant, co-dominant or characteristically present in stands. Other shrubs such as *Larrea tridentata*, *Ambrosia dumosa*, *Encelia farinosa*, *Ferocactus cylindraceus* and other stem succulents (or cacti) are usually present to co-dominant. Locally found on rocky alluvial fans, southeast to southwest-facing hill slopes, and ridges. (16)

15' Plants in stands not like above. (17)

16 *Cylindropuntia bigelovii* dominant, co-dominant, or characteristically present in stands.

***Opuntia bigelovii* Shrubland Alliance (A3146)**

Cylindropuntia bigelovii Shrubland Alliance (A.877)

16' *Cylindropuntia acanthocarpa* dominant or co-dominant in stands.

***Opuntia acanthocarpa* Shrubland Alliance (A4156)**

Cylindropuntia acanthocarpa Shrubland Alliance

17 *Yucca schidigera* present with at least 2% cover. Other shrub species may have similar or higher cover, including *Ambrosia dumosa*, *Larrea tridentata*, *Ephedra nevadensis*, *Eriogonum fasciculatum*, or *Krameria* spp. Found on gravelly bajadas.

***Yucca schidigera* Shrubland Alliance (A3147)**

Yucca schidigera Shrubland Alliance (A.881)

17' Shrub canopy not like above in stands. **(18)**

18 *Ephedra fasciculata* is dominant in the shrub canopy, with *Aloysia wrightii* and *Bernardia myricifolia* sometimes present.

***Ephedra fasciculata* Shrubland Alliance* (A3139)**

Ephedra fasciculata Mojave Desert Shrubland Alliance* (A.857)

18' Plants in stands not like above. **(19)**

19 *Lycium andersonii* or *Lycium cooperi* dominant or co-dominant in stands. Often on lower montane hills, upper bajadas, and washes with alluvial, gravelly soils.

***Lycium andersonii* - *Lycium cooperi* Shrubland Alliance (A3142)**

19' Plants in stands not like above. **(20)**

20 *Ephedra torreyana*, *Atriplex* spp., *Psorothamnus fremontii* and/or *Peucephyllum schottii* dominant or co-dominant in stands. Sites are typically on gypsum or strongly rocky and harsh. **(21)**

20' *Ambrosia dumosa*, *Encelia farinosa*, *Fouquieria splendens*, *Atriplex hymenelytra*, and/or *Larrea tridentata* dominant or co-dominant in stands. Sites are variable. **(25)**

21 *Peucephyllum schottii* dominant in stands, or co-dominant with species such as *Psorothamnus fremontii* or *Pleurocoronis pluriseta*. Typically found along alluvial drainage channels or along moderately steep slopes to steep cliffs that are usually of volcanic and limestone substrates.

***Peucephyllum schottii* Shrubland Alliance (A3143)**

Peucephyllum schottii Shrubland Alliance (A.2516)

21' Plants in stands not like above. **(22)**

22 *Ephedra torreyana* dominant, co-dominant or characteristic with species such as *Atriplex* spp. and/or *Psorothamnus fremontii*. Typically on gypsum substrate.

***Ephedra* spp. - *Leymus salinus* - *Eriogonum corymbosum* Badlands Cold Desert Sparse Vegetation Alliance (A4052)**

Ephedra torreyana Sparsely Vegetated Alliance (A.2571)

22' *Psorothamnus fremontii* dominant, or co-dominant with species such as *Ambrosia dumosa*, *Amphipappus fremontii*, *Atriplex* spp., or *Dicoria canescens* **(23)**

23 *Dicoria canescens* dominant or co-dominant with *Psorothamnus fremontii* and/or *Abronia villosa*. Found on sand dunes/sheets and in coves.

***Dicoria canescens* - *Abronia villosa* - *Panicum urvilleanum* Dune Alliance (A4026)**

Dicoria canescens – *Abronia villosa* Sparsely Vegetated Alliance (PS.016)

23' Vegetation not as above. (24)

24 *Psorothamnus fremontii* characteristically present to dominant on gypsum slopes and alluvium. Low total vegetation cover.

***Ephedra* spp. - *Leymus salinus* - *Eriogonum corymbosum* Badlands Cold Desert Sparse Vegetation Alliance (A4052)**

Psorothamnus (*emoryi*, *fremontii*, *polydenius*) Sparsely Vegetated Alliance (PS.018)

24' *Psorothamnus fremontii* occurring along mixed alluvial drainage channels, sandstone or limestone rock outcrops, and other rocky slopes that are not gypsum derived.

***Psorothamnus fremontii* - *Psorothamnus polydenius* Wash Alliance (A4186)**

Psorothamnus (*arborescens*, *fremontii*, *polydenius*) Intermittently Flooded Shrubland Alliance (PS.014)

25 *Fouquieria splendens* or *Larrea tridentata* dominant with at least 2% cover, or co-dominant with *Ambrosia dumosa* or *Encelia farinosa* in stands. *Hymenoclea salsola* may be present at high cover. (26)

25' Shrub canopy not like above in stands. (30)

26 *Fouquieria splendens* dominant in the overstory with at least 2% absolute cover. *Encelia farinosa* is present and dominant in the shrub layer. Found on the Arizona side of LAKE.

***Larrea tridentata* - *Encelia farinosa* - *Fouquieria splendens* Upper Bajada & Rock Outcrop Desert Scrub Alliance (A3278)**

Fouquieria splendens Shrubland Alliance (A.863)

26' *Larrea tridentata* dominant or co-dominant with *Encelia farinosa* or *Ambrosia dumosa*. (27)

27 *Larrea tridentata* clearly exceeds cover of other shrubs (including emergent tall shrubs or small trees) except for *Hymenoclea salsola*. If *Ambrosia dumosa* is present, its cover is <3 times the cover of *L. tridentata*. Occurring on bajadas, desert pavement and erosional highlands.

***Larrea tridentata* Desert Scrub Alliance (A3277)**

Larrea tridentata Shrubland Alliance (A.851)

27' *Larrea tridentata* co-dominant with *Encelia farinosa* or *Ambrosia dumosa*. (28)

28 *Larrea tridentata* and *Encelia farinosa* occur together and co-dominate stands. Both are evenly distributed (with at least 2% cover each, though their relative cover may vary between them across stands). *Ambrosia dumosa* may also be present but occurs with low cover. Widespread on hot (southerly exposure) mountain slopes, bajadas and directly above or in washes.

***Encelia farinosa* Desert Scrub Alliance (A3278)**

Larrea tridentata-*Encelia farinosa* Shrubland Alliance (A.2533)

28' *Larrea tridentata* and *Ambrosia dumosa* occur together and co-dominate stands. Both are evenly distributed (with *at least* 2% cover each, though their relative cover may vary between them across stands). No other shrub species greatly exceeds either of these species in cover. **(29)**

29 Stand occurs on sand dunes.

***Larrea tridentata* - *Ambrosia dumosa* Bajada & Valley Desert Scrub Alliance (A3277)**

Larrea tridentata-*Ambrosia dumosa* Shrubland Alliance – Dune (PS.030)

29' Stand occurs along other settings, such as bajadas and alluvial flats.

***Larrea tridentata* - *Ambrosia dumosa* Bajada & Valley Desert Scrub Alliance (A3277)**

Larrea tridentata-*Ambrosia dumosa* Shrubland Alliance (A.2532)

30 *Ambrosia dumosa* dominant, and if *Larrea tridentata* present, *A. dumosa* has at least 2 times more cover than *L. tridentata*.

***Ambrosia dumosa* Desert Dwarf Scrub Alliance (A3279)**

Ambrosia dumosa Dwarf-Shrubland Alliance (PS.012)

30' *Encelia farinosa* or *Atriplex hymenelytra* dominant or co-dominant with other shrubs. **(31)**

31 *Encelia farinosa* dominant in stands or co-dominant with *Ambrosia dumosa*, *Bebbia juncea*, *Eriogonum fasciculatum*, *Gutierrezia* spp. and/or *Peucephyllum schottii*, while other shrubs are generally lower in cover. Also, *E. farinosa* may have greater than 5% cover, while *Larrea tridentata* has less than 1-2% cover. Other associated species often include *Acacia greggii*, *Ephedra nevadensis*, *Krameria* spp., and various cacti. If *Fouquieria splendens* is present in stands, it is scattered with <2% absolute cover.

***Encelia farinosa* Desert Scrub Alliance (A3278)**

Encelia farinosa Shrubland Alliance (PS.013)

31' *Atriplex hymenelytra* co-dominant (or sometimes sub-dominant) in stands with *Ambrosia dumosa* and/or *Larrea tridentata*.

***Atriplex hymenelytra* Shrubland Alliance (A0872)**

Atriplex hymenelytra Shrubland Alliance (A.872)

Key III. Herbaceous Vegetation

1 Mesic stands with access to surface or ground-water located along lake margin, streams, washes, floodplains, playas, montane drainage channels, lower portions of alluvial flats and basins that are strongly alkaline in nature, or other riparian or wetland sites that depend upon water. **Key III.A.**

1' Upland stands developed on flats, alluvial fans and bajadas, slopes and ridges, and other sites not typically riparian or ground-water dependent, including sand dunes, sand flats, and gypsum hills as well as desert pavement. **Key III.B.**

Key III.A. Riparian, Semi-Riparian, Lake Margin, Wash, Playa, Ground-Water Dependent and Alkaline Herbaceous Stands

1 *Cladium californicum* is present and dominant or co-dominant with *Arundo donax* or *Phragmites australis* with intermittent to dense cover along with a variety of other herbs including *Distichlis spicata*. *Vitis arizonica* or *Pluchea sericea* are often present in the shrub layer, at sparse cover. Found at springs and in stream channels.

***Cladium californicum* Alkaline Seep Alliance (A4164)**

Cladium californicum (provisional) Herbaceous Alliance (provisional) (PS.005)

1' *Distichlis spicata*, *Sporobolus airoides*, or *Phragmites australis* or other graminoids dominant or co-dominant in the herbaceous layer. Found along stream channels, lake shores, playas, and other wetland/riparian areas. **(2)**

2 *Typha* spp. (*T. domingensis* or *T. latifolia*) dominant in stands.

***Typha domingensis* - *Typha latifolia* - *Typha angustifolia* Western Herbaceous Emergent Alliance* (A3896)**

Typha (*angustifolia*, *domingensis*, *latifolia*) Herbaceous Alliance* (PS.027)

2' *Typha* spp. not dominant. **(3)**

3 *Phragmites australis* dominant in the herbaceous layer with other plants such as *Atriplex lentiformis*, *Pluchea* spp., and *Typha* spp. present at lower cover. Occurring along stream channels, playa and lake margins.

***Phragmites australis* - *Arundo donax* - *Alopecurus pratensis* Native & Semi-native Flooded Herbaceous Alliance (A3847)**

Phragmites australis Semi-permanently Flooded Herbaceous Alliance (A.1431)

3' *Phragmites australis* not dominant. **(4)**

4 Stands dominated or co-dominated by other graminoids such as *Andropogon glomeratus*, *Calamagrostis scopulorum*, or *Schoenus nigricans*.

***Calamagrostis scopulorum* – *Andropogon glomeratus* Saturated Hanging Garden Herbaceous Alliance* (A2655)**

Andropogon glomeratus Temporarily Flooded Herbaceous Alliance* (A.1338)

4' Not as above. Other graminoids dominant or co-dominant. **(5)**

5 *Distichlis spicata* dominant or co-dominant with plants such as *Juncus* spp. and commonly associated with the shrub *Suaeda moquinii*. Found on alkaline alluvial flats, playas, and areas with salt-encrusted soils.

***Distichlis spicata* Alkaline Wet Meadow Alliance* (A4164)**

Distichlis spicata Intermittently Flooded Herbaceous Alliance* (A.1332)

5' *Sporobolus airoides* dominant. Found at alkaline alluvial fan remnants, drainage channels, and sandy swale hollows, soils are typically sandy loam. A variety of other herbs and shrubs may be present, and *Yucca brevifolia* may form a sparse tree layer.

***Muhlenbergia asperifolia* - *Spartina gracilis* - *Sporobolus airoides* Alkaline Herbaceous Alliance* (A1334)**

Sporobolus airoides Herbaceous Alliance* (A.1267)

Key III.B. Upland Herbaceous Stands

1 Sites on harsh, gypsum soils with sparse cover of shrubs such as *Ephedra torreyana*, *Ambrosia dumosa*, *Atriplex confertifolia*, *A. hymenelytra* and *Psorothamnus fremontii*. Herbaceous species include *Anulocaulis leiosolenus*, *Arctomecon californica*, *Enceliopsis argophylla*, *Cryptantha* spp., *Eriogonum deflexum*, *E. inflatum*, *Phacelia pulchella*, or other herbs at variable cover. **(2)**

1' Stands not like above. **(3)**

2 *Ephedra torreyana* or *Ephedra trifurca* present at sparse cover, with *Atriplex confertifolia* and/or *A. hymenelytra* characteristically present with >2% combined total cover. Other herbs and shrubs, such as those listed above, may also be present. Soil textures are typically sand and sandy loam with cryptogamic crusts often present.

***Ephedra* spp. - *Leymus salinus* - *Eriogonum corymbosum* Badlands Cold Desert Sparse Vegetation Alliance (A4052)**

Ephedra torreyana Sparsely Vegetated Alliance (A.2571)

Ephedra trifurca Badlands Shrubland

2' *Psorothamnus fremontii* is characteristically present with other shrubs and various herbs such as those listed above. Cryptogamic crust is characteristically present and often higher in cover than the vascular plants.

***Ephedra* spp. - *Leymus salinus* - *Eriogonum corymbosum* Badlands Cold Desert Sparse Vegetation Alliance (A4052)**

Psorothamnus (*emoryi*, *fremontii*, *polydenius*) Sparsely Vegetated Alliance (n=15) (PS.018)

3 Sites with fine-textured sandy soils, including sand dunes and flats, with trace cover of herbs such as *Achnatherum hymenoides*, *Pleuraphis rigida*, *Brassica tournefortii*, *Camissonia brevipes*, *Croton californicus*, *Dicoria canescens*, *Oenothera deltoides*, *Palafoxia arida*, *Petalonyx* spp., and/or

Salsola spp. These or other herbs present with trace cover of shrubs such as *Ambrosia dumosa*, *Larrea tridentata*, and *Psoralea* spp. (4)

3' Stands not like above. (6)

4 *Pleuraphis rigida* or *Achnatherum hymenoides* dominant or co-dominant with other herbs in the herbaceous layer. (5)

4' *Croton californicus*, *Camissonia brevipes*, *Dicoria canescens*, *Psoralea fremontii*, *Palafolia arida*, *Petalonyx*, *Salsola* sp., and/or other ephemeral annual or perennial herbs dominant or co-dominant in the herbaceous layer. *Pleuraphis rigida* may be present but not dominant or co-dominant. Found on sand dunes/sheets and in coves.

***Dicoria canescens* - *Abronia villosa* - *Panicum urvilleanum* Dune Alliance (A4026)**

Dicoria canescens–*Abronia villosa* Sparsely Vegetated Alliance (n=11) (PS.016)

5 *Pleuraphis rigida* dominant or co-dominant with other herbs in the herbaceous layer. Typically found on sandy soils or on calcareous alluvial fans and slopes.

***Pleuraphis rigida* Herbaceous Alliance (A3170)**

Pleuraphis rigida Herbaceous Alliance (A.1246)

5' *Achnatherum hymenoides* dominant or co-dominant with other herbs in the herbaceous layer. Typically found on sand dunes/sheets and adjacent fine-textured surfaces.

***Achnatherum hymenoides* - *Pseudoroegneria spicata* - *Muhlenbergia pungens* Herbaceous Alliance* (A1262)**

Achnatherum hymenoides Herbaceous Alliance* (A.1262)

6 *Chorizanthe rigida*, *C. brevicornu*, and/or *Geraea canescens* often present and/or other herbs are present including *Antheropeas lanosum*, *Camissonia* spp., *Chorizanthe* spp., *Malacothrix glabrata*, *Plantago ovata*, and *Vulpia octoflora*. Found on desert pavement and alluvial flats.

***Chorizanthe rigida*–*Geraea canescens* Desert Pavement Alliance (A4024)**

Chorizanthe rigida–*Geraea canescens* Desert Pavement Alliance (n=2) (PS.017)

6' Stands not like above. (7)

7 Native herbs such as *Amsinckia tessellata*, *Cryptantha* spp., *Eriogonum* spp., *Eschscholzia* spp., *Lupinus* spp., *Salvia columbariae*, and *Sphaeralcea ambigua* dominant or co-dominant with non-native herbs. Found on various surfaces, and may be recently burned or disturbed. (8)

7' Non-native herbs such as *Bromus rubens*, *Erodium cicutarium*, *Salsola* spp., *Schismus* spp., *Brassica tournefortii*, and other mustards present and strongly dominant. Native herbs can be present though usually at low cover of (e.g., <10% relative cover). Shrubs are sparse (<2% absolute cover). Found on various surfaces, and may be recently burned. (10)

8 *Amsinckia tessellata* present as the dominant or co-dominant, though sometimes other herbs may be higher in cover such as *Phacelia* spp. or *Pectocarya* spp. Typically found on alluvial fans and lower slopes, including disturbed areas that have been recently burned.

***Amsinckia menziesii* - *Amsinckia tessellata* - *Phacelia* spp. Herbaceous Alliance (A4182)**

Amsinckia (menziesii, tessellata) Herbaceous Alliance (n=1) (PS.002)

8' *Eriogonum* spp. dominant or co-dominant with *Sphaeralcea ambigua* and/or *Schismus* spp. Other herbs may have high cover. **(9)**

9 *Eriogonum deflexum* dominant or co-dominant with other annual *Eriogonum* spp. and/or *Schismus* spp. Found on alluvial fans to rocky sites, especially in disturbed areas including road-cuts and lake shores.

***Bromus rubens* - *Schismus arabicus* - *Schismus barbatus* Ruderal Herbaceous Alliance (A4121)**

Bromus rubens–*Schismus (arabicus, barbatus)* Semi-natural Herbaceous Alliance (n=8) (PS.004)

9' *Sphaeralcea ambigua* present as the dominant or co-dominant, though sometimes other herbs may be higher in cover including *Lupinus* spp. or *Salvia columbariae*. Found on variable sites from valleys to slopes, especially in recently burned or disturbed areas.

Sphaeralcea ambigua* Herbaceous Alliance

Sphaeralcea ambigua Sparsely Vegetated Alliance* (PS.022)

10 *Bromus rubens*, *Erodium cicutarium* and/or *Schismus* spp. dominant or co-dominant in stands with non-natives or with *Eriogonum deflexum*. Other native herbs usually occur at low cover, including *Baileya multiradiata*, *Cryptantha* spp., *Eriogonum trichopes*, *Lepidium lasiocarpum*, *Phacelia fremontii*, and *Sphaeralcea ambigua*. Typically found on alluvial fans to rocky sites, especially in disturbed areas including road-cuts and lake shores.

***Bromus rubens* - *Schismus arabicus* - *Schismus barbatus* Ruderal Herbaceous Alliance (A4121)**

Bromus rubens–*Schismus (arabicus, barbatus)* Semi-natural Herbaceous Alliance (n=8) (PS.004)

10' *Brassica tournefortii*, *Malcolmia africana*, or other mustards dominant or co-dominant in stands with non-natives. Native herbs at low cover may include *Cryptantha* spp., *Eriogonum* spp. and *Plantago ovata*. Typically found on alluvial fans to mesas that have apparent disturbance.

***Brassica tournefortii* and Other Mustards Ruderal Herbaceous Alliance (A4166)**

Brassica nigra and other mustards Semi-natural Herbaceous Alliance (PS.003)

Key IV. Sparsely Vegetated and Unvegetated Areas

Note: Unvegetated areas have 0% or <1% absolute cover of vascular plant vegetation while sparsely vegetated areas have an average of <2% absolute cover of vascular plant vegetation across the entire area (though cover may range from 1–9 %, depending on rainfall/temperature each year). Non-vascular plants can be present and may be high in cover.

1 Mesic stands with access to surface or ground-water located along lake margin, streams, washes, floodplains, playas, montane drainage channels, lower portions of alluvial flats and basins that are strongly alkaline in nature, or other riparian or wetland sites that depend upon water. **Key IV.A.**

1' Areas of upland landforms that may be unvegetated or sparsely vegetated, including desert pavement on alluvial fans, sand dunes and sand flats, sandstone rock outcrops and gypsum hills with low overall cover. **Key IV.B.**

Key IV.A. Riparian, Semi-Riparian, Lake Margin, Wash, Playa, Ground-Water Dependent and Alkaline Areas with Little or No Vegetation Cover

1 Stream channels along mountain ravines, washes, and floodplains where vegetation is sparse or unvegetated. **(2)**

1' Areas of unvegetated or sparsely vegetated playas, basins, lakes, and lake margin. **(3)**

2 Rocky drainages with little or no vegetation cover typically found at higher elevations.

Montane Ravine Sparsely Vegetated (PS.020)

2' Sandy, gravelly, and/or other coarse-textured washes and floodplains with little or no vegetation cover typically found at lower elevation foothills and bajadas.

Alluvial Wash Sparsely Vegetated (PS.021)

3 Unvegetated old lake beds and basins where groundwater is close to the surface and fine-textured soils are present, and water may be present after rains.

Playa (PS.023)

3' Areas not as above. **(4)**

4 Lakes where water is present year-round.

Lake (PS.024)

4' Lake edges where water annually fluctuates in draw-down zones. On higher gradient slopes, lake margin creates a narrow strip close to lake edge. On lower gradient slopes, lake edge may extend a long distance from lake water level. Vegetation is absent or has <2% cover.

Lake Margin (PS.025)

Key IV.B. Upland Areas with Little or No Vegetation Cover

1 Areas that have recently burned where vegetation cover is sparse with plants such as *Sphaeralcea ambigua*, *Salvia columbariae* and *Eriogonum* spp.

Sphaeralcea ambigua* Herbaceous Alliance

Sphaeralcea ambigua Sparsely Vegetated Alliance* (PS.022)

1' Areas not like above. **(2)**

2 Areas of desert pavement, alluvial flats, sand dunes and sand sheets that are lacking vegetation or where ephemeral annuals are present. **(9)**

2' Areas not as above **(3)**

3 Areas of mountains and hills where little or no vegetation cover is present. **(4)**

3' Areas of bajadas, alluvial flats, and sandy areas where little or no vegetation cover is present. **(7)**

4 Rocky areas with low cover of vegetation including *Ephedra viridis* as the dominant or co-dominant with shrubs such as *Ericameria* spp., *Gutierrezia sarothrae*, or *Prunus fasciculata*.

***Ephedra viridis* Colorado Plateau Shrubland Alliance (A3201)**

Ephedra viridis Shrubland Alliance (A.858)

4' Rocky areas (including gypsum soils) with other sparse vascular vegetation or basically lacking. **(5)**

5 Rocky areas with gypsum soils. Vascular plants are sparse in cover, including herbs such as *Anulocaulis leiosolenus*, *Arctomecon californica*, *Enceliopsis argophylla*, *Cryptantha* spp., *Eriogonum deflexum*, *E. inflatum*, *Phacelia pulchella*, or others, and shrubs such as *Ambrosia dumosa*, *Atriplex confertifolia*, *Ephedra torreyana*, and *Psoralea fremontii*. Non-vascular plants may be present and high in cover. **(6)**

5' Rocky areas with other substrates, including sandstone, volcanic, and limestone. **(7)**

6 *Ephedra torreyana* present at sparse cover, with *Atriplex confertifolia* and *A. hymenelytra* characteristically present. Other herbs as shrubs, such as those listed above, may also be present. Soil textures are typically sand and sandy loam with cryptogamic crusts often present

***Ephedra* spp. - *Leymus salinus* - *Eriogonum corymbosum* Badlands Cold Desert Sparse Vegetation Alliance (A4052)**

Ephedra torreyana Sparsely Vegetated Alliance (A.2571)

6' *Psoralea fremontii* is characteristically present with other shrubs and with various herbs at sparse cover, and cryptogamic crust is characteristically present and often higher in cover than the vascular plants.

***Ephedra* spp. - *Leymus salinus* - *Eriogonum corymbosum* Badlands Cold Desert Sparse Vegetation Alliance (A4052)**

Psoralea (*emeryi*, *fremontii*, *polydenius*) Sparsely Vegetated Alliance (n=15) (PS.018)

7 *Atriplex hymenelytra* or *Peucephyllum schottii* occur at sparse cover as a dominant or co-dominant with other shrubs, and herb species may be present at sparse cover or are lacking. (8)

7' Stands without *A. hymenelytra* or *P. schottii*. Sites sparsely vegetated. Substrates typically include volcanic and sandstone outcrops.

***Aloysia wrightii* - *Pericoma caudata* - *Ephedra nevadensis* Sparsely Vegetated Bedrock Cliff & Lava Field Alliance (A4025)**

Bare Rock and Sparse Vegetation Mapping Unit / Sparsely Vegetated Rock Outcrop Alliance (PS.019)

8 *Atriplex hymenelytra* with sparse cover in stands, as a dominant or co-dominant with other species such as *Ambrosia dumosa*. Substrates are variable, including volcanic, calcareous, or alluvial slopes and cliffs.

***Atriplex hymenelytra* Shrubland Alliance (A0872)**

Atriplex hymenelytra Shrubland Alliance (A.872)

8' *Peucephyllum schottii* with sparse cover in stands, as a dominant or co-dominant with other species such as *Psoralea fremontii* or *Pleurocoronis pluriseta*. Substrates typically are volcanic, calcareous, or alluvial sideslopes and cliffs.

***Peucephyllum schottii* Shrubland Alliance (A3143)**

Peucephyllum schottii Shrubland Alliance (A.2516)

9. Areas of desert pavement and alluvial flats that are devoid of vegetation or where ephemeral annuals such as *Chorizanthe rigida*, *C. brevicornu*, and/or *Geraea canescens* are present with other herbs including *Antheropeas lanosum*, *Camissonia* spp., *Chorizanthe* spp., *Malacothrix glabrata*, *Plantago ovata*, and *Vulpia octoflora*.

***Chorizanthe rigida*–*Geraea canescens* Desert Pavement Alliance (A4024)**

Chorizanthe rigida–*Geraea canescens* Desert Pavement Alliance (n=2) (PS.017)

9' Areas of sand dunes and sand sheets that are lacking plant cover or plants are trace in cover.

Ephemeral annual plants can include *Croton californicus*, *Dicoria canescens*, and *Palafoxia arida*.

***Dicoria canescens* - *Abronia villosa* - *Panicum urvilleanum* Dune Alliance (A4026)**

Dicoria canescens–*Abronia villosa* Sparsely Vegetated Alliance (n=11) (PS.016)

Glossary of Terms Used in the Key

- **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 5% and 10% of the stand. Absolute cover of all species or groups if added in a stand or plot may total greater or less than 100% because it is not a proportional number.
- **Alluvial Fan** – A body of alluvium, with or without debris flow deposits, whose surface forms a segment of a cone that radiates downslope from the point where the stream emerges from a narrow valley onto a less sloping surface. Common longitudinal profiles are gently sloping and nearly linear. Source uplands range in relief and aerial extent from mountains and plateaus to gullied terrains on hill and piedmont slopes.
- **Alluvial Flat** – A nearly level, graded, alluvial surface
- **Arroyo** – (wash) The flat-floored channel or an ephemeral stream, commonly with very steep to vertical banks cut in alluvium.
- **Calcareous** – mostly or partly composed of calcium carbonate; containing lime, chalky texture.
- **Characteristically** – Present in >75% of the samples for that vegetation type, with no restriction on cover.
- **Co-dominant** – Must be in at least 75% of the samples, with at least 30% relative cover in all samples.
- **Coppice dune** – (Nebkha dune) Simple dunes that form around vegetation, primarily on the sand sheet. Clumps of shrubs and grass begin to gather windblown sand; as the sand gets deeper, the plants also grow taller, allowing more sand to gather around them.
- **Cover** – The primary metric used to quantify the abundance of a particular species or a particular vegetation layer within a plot. It was measured by estimating the aerial extent of the living plants, or the “bird’s-eye view” looking from above for each category.
- **Cryptogam** - Is a nonvascular plant or plant-like organism without specialized water or fluid conducting vascular tissue (i.e., xylem and phloem). Includes mosses, lichens, liverworts, hornworts, and algae
- **Dense/Continuous cover** – Used to describe individual layers of vegetation (tree, shrub, herb, or subdivisions of them) where there is greater than 66 percent absolute cover.
- **Diagnostic layer** – The layer of vegetation for which the alliance is named. Typically the uppermost or dominant strata.
- **Dominant** – Must be in at least 75% of the samples, with at least 50% relative cover in all samples.

- **Dune** – a mound, ridge or hill of loose, windblown granular material (generally sand), either bare or covered with vegetation.
- **Emergent** – A plant (or vegetation layer) is considered emergent if it includes plants that rises above a predominant vegetation layer, but that are sparse in cover. It is considered as a member of the next tallest layer, but typically has an absolute cover < 10%.
- **Floodplain** – (bottomland) The nearly level alluvial plain that borders a stream and is subject to inundation under flood-stage conditions unless protected artificially. It is usually a constructional landform built of sediment deposited during overflow and lateral migration of the stream.
- **Herb** – Is any vascular plant species that has no main woody stem-development, and includes grasses, forbs, and perennial species that die-back seasonally.
- **Intermittent cover** – Used to describe individual layers of vegetation (tree, shrub, herb, or subdivisions of them) where there is 33-66 percent absolute cover.
- **Intermittently Flooded** – Substrate is usually exposed, but surface water can be present for variable periods without detectable seasonal periodicity. Inundation is not predictable to a given season and is dependent upon highly localized rain storms. This modifier was developed for use in the arid West for water regimes of Playa lakes, intermittent streams, and dry washes. This modifier can be applied to both wetland and non-wetland situations.
- **Open** – Used to describe individual layers of vegetation (tree, shrub, herb, or subdivisions of them) where the cover is less than 33 percent absolute cover.
- **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% 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% for each stand (sample).
- **Seasonally Flooded** – Surface water is present for extended periods during the growing season, but is absent by the end of the growing season in most years. The water table after flooding ceases is very variable, extending from saturated to a water table well below the ground surface.
- **Semi-permanently Flooded** – Surface water persists throughout the growing season in most years. Land surface is normally saturated when water level drops below soil surface.
- **Shrub** – Is normally a multi-stemmed woody plant that generally has several erect, spreading, or prostrate stems and that is usually between 0.2 meters and 5 meters tall, giving it a bushy appearance. Definitions are blurred at the low and the high ends of the height scales. At the tall end, shrubs may approach trees based on disturbance frequencies (e.g., old-growth re-sprouting chaparral species such as *Quercus turbinella*, etc., may frequently attain “tree size”). At the low

end, woody perennial herbs or sub-shrubs of various species are often difficult to categorize into a single life-form; usually sub-shrubs (per USDA-NRCS 2011) were categorized in the “shrub” category.

- **Sometimes** – Present in 25 to 50% of the samples with no restriction on cover.
- **Sparse** – Used to describe individual layers of vegetation (tree, shrub, herb, or subdivisions of them) where the *average* cover value is <2% absolute cover (though the range in cover could be <1-9% cover).
- **Stand** – The basic physical unit of vegetation in a landscape. It has no set size. Some vegetation stands are very small such as wetland seeps, and some may be several square kilometers in size such as desert or forest types. A stand is defined by two main unifying characteristics:
 - 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 gradual.
 - 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 moist soil and the same species.
- **Swale** – A shallow, trough-like depression
- **Temporarily Flooded** – Surface water present for brief periods during growing season, but water table usually lies well below soil surface. Often characterizes flood-plain wetlands.
- **Terrace** – (low level) Valley floor or shoreline representing the former position of an alluvial plain, lake or shore.
- **Tree** – Is a one-stemmed woody plant that normally grows to be greater than 5 meters tall. In some cases trees may be multiple-stemmed (ramifying) after fire or other disturbance, but size of mature plants is typically greater than 5 m and undisturbed individuals of these species are usually single stemmed.
- **Usually/Often** – Present in 50 to 75% of the samples, with no restriction on cover.

Literature Cited

- Federal Geographic Data Committee (FGDC). 2008. National Vegetation Classification Standard, Version 2. FGDC-STD-005-2008. Vegetation Subcommittee, Reston, Virginia. Available online: http://usnvc.org/wp-content/uploads/2011/02/NVCS_V2_FINAL_2008-02.pdf (accessed December 2011).
- Grossman, D. H., D. Faber-Langendoen, A. S. Weakley, M. Anderson, P. Bourgeron, R. Crawford, K. Goodin, S. Landaal, K. Metzler, K. Patterson, M. Pyne, M. Reid, and L. Sneddon. 1998. International Classification of Ecological Communities: Terrestrial Vegetation of the United States. Volume 1. The National Vegetation Classification System: Development, status and applications. The Nature Conservancy, Arlington, VA.
- Peterson, E. 2008. International Vegetation Classification Alliances and Associations Occurring in Nevada with Proposed Additions (First Edition). Nevada Natural Heritage Program, Carson City, NV. Available online: <http://heritage.nv.gov/reports/ivclist.pdf> (accessed December 2011).
- Sawyer, J. O., T. Keeler-Wolf, and J. M. Evens. 2009. A manual of California vegetation. California Native Plant Society, Sacramento, CA.
- Thomas, K. A., T. Keeler-Wolf, J. Franklin, and P. Stine. 2004. Mojave Desert Ecosystem Program: Central Mojave Vegetation Database. United States Geological Survey, Western Ecological Research Center and Southwest Biological Research Center, Sacramento, CA.
- USDA-NRCS (2010-2014). The PLANTS Database. National Plant Data Team, Greensboro, NC. Available online: <http://plants.usda.gov> (accessed from August 2010 to July 2014)

Lists of Alliances and Species Used in the Keys

Table C-1 provides a list of the alliances that are recognized in the LAKE vegetation classification and are referenced in the key. Those alliances with a “PS” code were not recognized in the United States National Vegetation Classification (USNVC) when the map accuracy assessment was initiated; however, the current classification data for the MOJN I&M provides representation for them. They have been either provisionally classified by the California Native Plant Society, and the classifications have either already been accepted or will likely go into effect upon completion of NVC Alliance review. If the newly classified alliances were specifically sampled in the MOJN network (including data from LAKE and Death Valley), a sample size is listed in parenthesis next to the name. The former NVC code and current NVC code for each alliance is listed next to alliance name (e.g., A.#### or A#####). If the alliance was provisional, these were coded with a “Park Special” PS number (PS. ###). Table C-2 shows LAKE map classes and component alliances. In addition, Table C-3 provides a list of those plant taxa denoted in the keys, including their scientific and associated common names per the USDA-NRCS (2014).

Table C-1. List of alliances found in this key and the vegetation classification for LAKE, sorted by the former alliance name and including a crosswalk to the current name.

Former Alliance Name	Former Code	Current Name (NVC or other)	Alliance Code
<i>Acacia greggii</i> Shrubland	A.1036	<i>Acacia greggii</i> - <i>Hyptis emoryi</i> - <i>Justicia californica</i> Desert Wash	A4187
<i>Achnatherum hymenoides</i> Herbaceous	A.1262	<i>Achnatherum hymenoides</i> - <i>Pseudoroegneria spicata</i> - <i>Muhlenbergia pungens</i> Herbaceous	A1262
<i>Allenrolfea occidentalis</i> Shrubland	A.866	<i>Allenrolfea occidentalis</i> - <i>Isocoma acradenia</i> Shrubland	A0866
Alluvial Wash Sparsely Vegetated	PS.021	Desert Wash and River Bottom Sparsely Vegetated	na (not assigned)
<i>Ambrosia dumosa</i> Shrubland	PS.012	<i>Ambrosia dumosa</i> Desert Dwarf Scrub	A3279
<i>Amsinckia (menziesii, tessellata)</i> Herbaceous	PS.002	<i>Amsinckia menziesii</i> - <i>Amsinckia tessellata</i> - <i>Phacelia</i> spp. Herbaceous	A4182
<i>Andropogon glomeratus</i> - <i>Schoenus nigricans</i> Herbaceous*	A.1338	<i>Calamagrostis scopulorum</i> - <i>Andropogon glomeratus</i> Saturated Hanging Garden Herbaceous*	A2655
<i>Atriplex canescens</i> Shrubland	A.869	<i>Atriplex canescens</i> Shrubland	A0869
<i>Atriplex confertifolia</i> Shrubland	A.870	<i>Atriplex confertifolia</i> Shrubland	A0870
<i>Atriplex hymenelytra</i> Sparsely Vegetated	A.872	<i>Atriplex hymenelytra</i> Shrubland	A0872
<i>Atriplex lentiformis</i> Shrubland	PS.006	<i>Atriplex lentiformis</i> Shrubland	A3173
<i>Atriplex polycarpa</i> Shrubland	A.873	<i>Atriplex polycarpa</i> Shrubland	A3174
<i>Baccharis sergiloides</i> Shrubland	A.2531	<i>Baccharis emoryi</i> - <i>Baccharis sergiloides</i> Dry Wash Shrubland	A3874
<i>Brassica tournefortii</i> and other mustards Semi-natural Herbaceous	PS.003	<i>Brassica tournefortii</i> and other mustards Ruderal Herbaceous	cf. A4166
<i>Bromus rubens</i> - <i>Schismus (arabicus, barbatus)</i> Semi-natural Herbaceous	PS.004	<i>Bromus rubens</i> - <i>Schismus arabicus</i> - <i>Schismus barbatus</i> Ruderal Herbaceous	A4121
<i>Canotia holacantha</i> Shrubland Association*	CEGL 005296	<i>Simmondsia chinensis</i> - <i>Canotia holacantha</i> - <i>Eriogonum fasciculatum</i> Desert Scrub*	A3283

Table C-1. List of alliances found in this key and the vegetation classification for LAKE, sorted by the former alliance name and including a crosswalk to the current name (continued).

Former Alliance Name	Former Code	Current Name (NVC or other)	Alliance Code
<i>Chilopsis linearis</i> Woodland	A.1044	<i>Chilopsis linearis</i> - <i>Psoralea argophylla</i> Desert Wash	A1044
<i>Chorizanthe rigida</i> – <i>Geraea canescens</i> Desert Pavement Sparsely Vegetated	PS.017	<i>Chorizanthe rigida</i> - <i>Geraea canescens</i> Desert Pavement	A4024
<i>Cladium californicum</i> (provisional) Herbaceous	PS.005	<i>Cladium californicum</i> Alkaline Seep	A4164
<i>Coleogyne ramosissima</i> Shrubland	A.874	<i>Coleogyne ramosissima</i> Mojave Desert Shrubland	A3144
<i>Cylindropuntia acanthocarpa</i> Shrubland	na (not assigned)	<i>Opuntia acanthocarpa</i> Shrubland	A4156
<i>Cylindropuntia bigelovii</i> Shrubland	A.877	<i>Opuntia bigelovii</i> Shrubland	A3146
<i>Dicoria canescens</i> – <i>Abronia villosa</i> Sparsely Vegetated	PS.016	<i>Dicoria canescens</i> - <i>Abronia villosa</i> - <i>Panicum urvilleanum</i> Dune	A4026
<i>Distichlis spicata</i> Herbaceous	A.1332	<i>Distichlis spicata</i> Alkaline Wet Meadow	A1332
<i>Encelia farinosa</i> Shrubland	PS.013	<i>Encelia farinosa</i> Desert Scrub	cf. A3278
<i>Ephedra (fasciculata, nevadensis)</i> Shrubland*	A.857	<i>Ephedra fasciculata</i> Shrubland*	A3139
<i>Ephedra torreyana</i> Sparsely Vegetated	A.2571	<i>Ephedra</i> spp. - <i>Leymus salinus</i> - <i>Eriogonum corymbosum</i> Badlands Cold Desert Sparse Vegetation	A4052
<i>Ephedra viridis</i> Shrubland	A.858	<i>Ephedra viridis</i> Colorado Plateau Shrubland	A3201
<i>Ericameria paniculata</i> Shrubland	A.2509	<i>Ericameria paniculata</i> Mojave Desert Wash	A2509
<i>Eriogonum fasciculatum</i> – <i>Viguiera parishii</i> Shrubland	PS.011	<i>Eriogonum fasciculatum</i> - <i>Viguiera parishii</i> Shrubland	A3150
<i>Eriogonum heermannii</i> Shrubland	PS.008	<i>Eriogonum wrightii</i> - <i>Eriogonum heermannii</i> - <i>Buddleja utahensis</i> Shrubland	A4167
<i>Fallugia paradoxa</i> Shrubland*	A.934	<i>Fallugia paradoxa</i> Wash*	A3259
<i>Fouquieria splendens</i> Shrubland	A.863	<i>Fouquieria splendens</i> Desert Scrub	cf. A3278
<i>Gutierrezia (microcephala, sarothrae)</i> Shrubland*	A.2528	<i>Gutierrezia sarothrae</i> - <i>Gutierrezia microcephala</i> Dwarf-shrubland*	A3203
<i>Hymenoclea salsola</i> Shrubland	A.2512	<i>Hymenoclea salsola</i> - <i>Bebbia juncea</i> Mojave-Sonoran Desert Wash	A4188
<i>Hyptis emoryi</i> Shrubland	A.2537	<i>Acacia greggii</i> - <i>Hyptis emoryi</i> - <i>Justicia californica</i> Desert Wash	A4187
<i>Juniperus californica</i> Wooded Shrubland	A.502	<i>Juniperus californica</i> Wooded Shrubland	A0502
<i>Krascheninnikovia lanata</i> Shrubland	A.1104	<i>Krascheninnikovia lanata</i> Dwarf-Shrubland & Dwarf-shrub Herbaceous	A3202
Lake Margin	PS.025	Lake Margin	na (not assigned)
<i>Larrea tridentata</i> Shrubland	A.851	<i>Larrea tridentata</i> Desert Scrub	cf. A3278
<i>Larrea tridentata</i> – <i>Ambrosia dumosa</i> Dune	PS.030	<i>Larrea tridentata</i> - <i>Ambrosia dumosa</i> Bajada & Valley Desert Scrub	A3277
<i>Larrea tridentata</i> – <i>Ambrosia dumosa</i> Shrubland	A.2532	<i>Larrea tridentata</i> - <i>Ambrosia dumosa</i> Bajada & Valley Desert Scrub	A3277
<i>Larrea tridentata</i> – <i>Encelia farinosa</i> Shrubland	A.2533	<i>Larrea tridentata</i> - <i>Encelia farinosa</i> Upper Bajada & Rock outcrop Desert Scrub	cf. A3278
<i>Lycium (andersonii, cooperi)</i> Shrubland	na (not assigned)	<i>Lycium andersonii</i> - <i>Lycium cooperi</i> Shrubland	A3142

Table C-1. List of alliances found in this key and the vegetation classification for LAKE, sorted by the former alliance name and including a crosswalk to the current name (continued).

Former Alliance Name	Former Code	Current Name (NVC or other)	Alliance Code
Montane Ravine Sparsely Vegetated	PS.020	Montane Ravine Sparsely Vegetated	na (not assigned)
<i>Mortonia utahensis</i> Shrubland	PS.009	<i>Mortonia utahensis</i> Shrubland	A4158
<i>Parkinsonia microphylla</i> Shrubland	A.883	<i>Carnegiea gigantea</i> - <i>Parkinsonia microphylla</i> - <i>Prosopis velutina</i> Desert Scrub	A3282
<i>Peucephyllum schottii</i> Sparsely Vegetated	A.2516	<i>Peucephyllum schottii</i> Shrubland	A3143
<i>Phragmites australis</i> Herbaceous	A.1431	<i>Phragmites australis</i> - <i>Arundo donax</i> - <i>Alopecurus pratensis</i> Native & Semi-native Flooded Herbaceous	A3847
<i>Pinus monophylla</i> –(<i>Juniperus osteosperma</i>) Woodland	A.543	<i>Pinus monophylla</i> - <i>Juniperus osteosperma</i> / Shrub Understory Woodland	A2108
Playa Map Class	PS.023	Playa	na (not assigned)
<i>Pleuraphis rigida</i> Herbaceous	A.1246	<i>Pleuraphis rigida</i> Herbaceous	A3170
<i>Pluchea sericea</i> Shrubland	A.798	<i>Pluchea sericea</i> Shrubland	A0798
<i>Populus fremontii</i> Forest	A.313	<i>Populus fremontii</i> - <i>Fraxinus velutina</i> - <i>Salix gooddingii</i> Flooded Forest & Woodland	A3803
<i>Prosopis glandulosa</i> Woodland	A.1031	<i>Prosopis glandulosa</i> - <i>Prosopis velutina</i> - <i>Prosopis pubescens</i> Riparian Forest, Woodland & Shrubland	A3877
<i>Prosopis pubescens</i> Woodland	A.1042	<i>Prosopis glandulosa</i> - <i>Prosopis velutina</i> - <i>Prosopis pubescens</i> Riparian Forest, Woodland & Shrubland	A3877
<i>Prunus fasciculata</i> – <i>Salazaria mexicana</i> Shrubland	A.2519	<i>Prunus fasciculata</i> - <i>Salazaria mexicana</i> Northern Mojave Desert Wash	A4185
<i>Psorothamnus (arborescens, fremontii, polydenius)</i> Shrubland	PS.014	<i>Psorothamnus fremontii</i> - <i>Psorothamnus polydenius</i> Wash	A4186
<i>Psorothamnus spinosus</i> Woodland	PS.015	<i>Chilopsis linearis</i> - <i>Psorothamnus spinosus</i> Desert Wash	A1044
<i>Psorothamnus</i> spp. Sparsely Vegetated	PS.018	<i>Ephedra</i> spp. - <i>Leymus salinus</i> - <i>Eriogonum corymbosum</i> Badlands Cold Desert Sparse Vegetation	A4052
<i>Quercus turbinella</i> Shrubland	A.793	<i>Quercus turbinella</i> Shrubland	A0793
<i>Salix exigua</i> Shrubland	A.649	<i>Salix exigua</i> Warm Desert Riparian Shrubland	A0947
<i>Salix gooddingii</i> Woodland	A.640	<i>Salix gooddingii</i> - <i>Salix laevigata</i> - <i>Salix lucida</i> Riparian Forest	A3752
<i>Salix laevigata</i> Woodland	A.646	<i>Salix gooddingii</i> - <i>Salix laevigata</i> - <i>Salix lucida</i> Riparian Forest	A3752
Sparsely Vegetated rock outcrop	PS.019	<i>Aloysia wrightii</i> - <i>Pericome caudata</i> - <i>Ephedra nevadensis</i> Sparsely Vegetated Bedrock Cliff & Lava Field	A4025
<i>Sphaeralcea ambigua</i> Sparsely Vegetated	PS.022	<i>Sphaeralcea ambigua</i> Sparsely Vegetated	na (not assigned)
<i>Sporobolus airoides</i> Herbaceous	A.1267	<i>Muhlenbergia asperifolia</i> - <i>Spartina gracilis</i> - <i>Sporobolus airoides</i> Alkaline Herbaceous	A1334
<i>Suaeda moquinii</i> Shrubland	A.941	<i>Suaeda moquinii</i> - <i>Salicornia rubra</i> Alkaline Scrub	A3880
<i>Tamarix</i> spp. Planted Woodland	A.842	<i>Tamarix</i> spp. Planted Woodland	cf. A0842
<i>Tamarix</i> spp. Semi-natural Shrubland	A.842	<i>Tamarix</i> spp. Ruderal Temporarily Flooded Shrubland	cf. A0842

Table C-1. List of alliances found in this key and the vegetation classification for LAKE, sorted by the former alliance name and including a crosswalk to the current name (continued).

Former Alliance Name	Former Code	Current Name (NVC or other)	Alliance Code
<i>Typha</i> (<i>angustifolia</i> , <i>domingensis</i> , <i>latifolia</i>) Herbaceous	PS.027	<i>Typha domingensis</i> - <i>Typha latifolia</i> - <i>Typha angustifolia</i> Western Herbaceous Emergent	A3896
Urban - Land Use	LU	Urban - Land Use	na (not assigned)
<i>Vitis</i> (<i>arizonica</i> , <i>girdiana</i>) Shrubland	PS.001	<i>Vitis arizonica</i> - <i>Vitis girdiana</i> Shrubland	A4162
<i>Washingtonia filifera</i> Woodland	A.485	<i>Phoenix dactylifera</i> - <i>Washingtonia filifera</i> Ruderal Woodland	A4161
<i>Yucca brevifolia</i> Wooded Shrubland	A.884	<i>Yucca brevifolia</i> Wooded Shrubland	A3148
<i>Yucca schidigera</i> Shrubland	A.881	<i>Yucca schidigera</i> Shrubland	A3147

* = Type not sampled during the classification stage at LAKE, though included in the key since it likely occurs here, or the type was sampled during the map accuracy assessment stage, or it was mapped in along the border with Grand Canyon-Parashant National Monument

Table C-2. Map classes in LAKE Vegetation inventory map and alliance names (former scientific names used during the accuracy assessment) within each class.

LAKE Map Class Code	LAKE Map Class Name	Alliance Code	Alliance Name
BB	Black Brush Shrubland	A.874	<i>Coleogyne ramosissima</i> Shrubland Alliance
BEACH	Beach and Barren Sand Draw-down Area	PS.025	Lake Margin
CB	Creosote Bush Shrubland	A.2532	<i>Larrea tridentata</i> – <i>Ambrosia dumosa</i> Shrubland Alliance
CB	Creosote Bush Shrubland	A.2533	<i>Larrea tridentata</i> – <i>Encelia farinosa</i> Shrubland Alliance
CB	Creosote Bush Shrubland	A.851	<i>Larrea tridentata</i> Shrubland Alliance
DV	Dune Vegetation	PS.016	<i>Dicoria canescens</i> – <i>Abronia villosa</i> Sparsely Vegetated Alliance (n=11)
DV	Dune Vegetation	PS.030	<i>Larrea tridentata</i> – <i>Ambrosia dumosa</i> Shrubland Alliance – Dune
DV	Dune Vegetation	A.1246	<i>Pleuraphis rigida</i> Herbaceous Alliance*
FOR	Mixed Ornamental and Semi-natural Woodland	na	<i>Tamarix</i> spp. Planted
FP	Fan Palm Woodland	cf. A.485	<i>Washingtonia filifera</i> Woodland Alliance
GL	Disturbed Grassland	A.1262	<i>Achnatherum hymenoides</i> Herbaceous Alliance*
GL	Disturbed Grassland	PS.002	<i>Amsinckia (menziesii, tessellata)</i> Herbaceous Alliance (n=1)
GL	Disturbed Grassland	PS.003	<i>Brassica nigra</i> and other mustards Semi-natural Herbaceous Alliance
GL	Disturbed Grassland	PS.004	<i>Bromus rubens</i> – <i>Schismus (arabicus, barbatus)</i> Semi-natural Herbaceous Stands (n=8)
HG	Hanging Garden	A.1338	<i>Andropogon glomeratus</i> – <i>Schoenus nigricans</i> Herbaceous Alliance
JT	Joshua Tree Woodland	A.884	<i>Yucca brevifolia</i> Woodland Alliance
JW	Juniper Woodlands	A.502	<i>Juniperus californica</i> Wooded Shrubland Alliance
MARSH	Mixed Marsh and Wetland Herbaceous Vegetation	A.1431	<i>Phragmites australis</i> Herbaceous Alliance
MARSH	Mixed Marsh and Wetland Herbaceous Vegetation	PS.005	<i>Cladium californicum</i> (provisional) Herbaceous Alliance
MARSH	Mixed Marsh and Wetland Herbaceous Vegetation	PS.027	<i>Typha (angustifolia, domingensis, latifolia)</i> Herbaceous Alliance*
MID_MDS	Mid-Elevation Mixed Desert Scrub	A.857	<i>Ephedra (fasciculata, nevadensis)</i> Shrubland Alliance
MID_MDS	Mid-Elevation Mixed Desert Scrub	A.858	<i>Ephedra viridis</i> Shrubland Alliance
MID_MDS	Mid-Elevation Mixed Desert Scrub	PS.008	<i>Eriogonum heermannii</i> Shrubland Alliance (n=1)

Table C-2. Map classes in LAKE Vegetation inventory map and alliance names (former scientific names used during the accuracy assessment) within each class (continued).

LAKE Map Class Code	LAKE Map Class Name	Alliance Code	Alliance Name
MID_MDS	Mid-Elevation Mixed Desert Scrub	A.2528	<i>Gutierrezia (microcephala, sarothrae)</i> Shrubland Alliance
MID_MDS	Mid-Elevation Mixed Desert Scrub	na	<i>Lycium (andersonii, cooperi)</i> Shrubland Alliance
MID_MDS	Mid-Elevation Mixed Desert Scrub	PS.009	<i>Mortonia utahensis</i> Shrubland Alliance
OAK	Sonoran Live Oak Scrub Woodland	cf. A.766	<i>Arctostaphylos</i> - <i>Quercus turbinella</i> Shrubland Alliance
OAK	Sonoran Live Oak Scrub Woodland	A.793	<i>Quercus turbinella</i> Shrubland Alliance
PV	Palo Verde Woodland	A.883	<i>Parkinsonia microphylla</i> Wooded Shrubland Alliance
PW	Pinyon Pine - (Utah Juniper) Woodland	A.543	<i>Pinus monophylla</i> -(<i>Juniperus osteosperma</i>) Woodland Alliance
RWash	Riparian Wash Scrub Shrubland	A.2531	<i>Baccharis sergiloides</i> Shrubland Alliance
RWash	Riparian Wash Scrub Shrubland	A.1031	<i>Prosopis glandulosa</i> Woodland Alliance
RWash	Riparian Wash Scrub Shrubland	A.1042	<i>Prosopis pubescens</i> Woodland Alliance
RWash	Riparian Wash Scrub Shrubland	A.649	<i>Salix exigua</i> Shrubland Alliance*
RWash	Riparian Wash Scrub Shrubland	PS.001	<i>Vitis (arizonica, girdiana)</i> Shrubland Alliance (provisional) (n=7)
RWood	Riparian Woodland	A.313	<i>Populus fremontii</i> Forest Alliance
RWood	Riparian Woodland	A.640	<i>Salix gooddingii</i> Woodland Alliance
RWood	Riparian Woodland	A.646	<i>Salix laevigata</i> Woodland Alliance*
SBush	Saltbush Scrub Shrubland	A.869	<i>Atriplex canescens</i> Shrubland Alliance
SBush	Saltbush Scrub Shrubland	A.870	<i>Atriplex confertifolia</i> Shrubland Alliance
SBasin	Salt Basin Scrub Shrubland	A.866	<i>Allenrolfea occidentalis</i> Shrubland Alliance
SBasin	Salt Basin Scrub Shrubland	PS.006	<i>Atriplex lentiformis</i> Shrubland Alliance
SBasin	Salt Basin Scrub Shrubland	A.1332	<i>Distichlis spicata</i> Herbaceous Alliance*
SBasin	Salt Basin Scrub Shrubland	A.1267	<i>Sporobolus airoides</i> Herbaceous Alliance*
SBasin	Salt Basin Scrub Shrubland	A.941	<i>Suaeda moquinii</i> Shrubland Alliance
SD_WASH	Semi-Desert Wash Woodland / Scrub	A.1036	<i>Acacia greggii</i> Shrubland Alliance
SD_WASH	Semi-Desert Wash Woodland / Scrub	A.1044	<i>Chilopsis linearis</i> Woodland Alliance
SD_WASH	Semi-Desert Wash Woodland / Scrub	A.2509	<i>Ericameria paniculata</i> Shrubland Alliance
SD_WASH	Semi-Desert Wash Woodland / Scrub	A.934	<i>Fallugia paradoxa</i> Shrubland Alliance*
SD_WASH	Semi-Desert Wash Woodland / Scrub	A.2512	<i>Hymenoclea salsola</i> (= <i>Ambrosia salsola</i>) Shrubland Alliance

Table C-2. Map classes in LAKE Vegetation inventory map and alliance names (former scientific names used during the accuracy assessment) within each class (continued).

LAKE Map Class Code	LAKE Map Class Name	Alliance Code	Alliance Name
SD_WASH	Semi-Desert Wash Woodland / Scrub	A.2537	<i>Hyptis emoryi</i> Shrubland Alliance
SD_WASH	Semi-Desert Wash Woodland / Scrub	A.798	<i>Pluchea sericea</i> Shrubland Alliance
SD_WASH	Semi-Desert Wash Woodland / Scrub	A.2519	<i>Prunus fasciculata</i> Shrubland Alliance
SD_WASH	Semi-Desert Wash Woodland / Scrub	PS.015	<i>Psorothamnus spinosus</i> Woodland Alliance
SDS	Semi-Desert Scrub Shrubland	PS.012	<i>Ambrosia dumosa</i> [Dwarf-] Shrubland Alliance
SDS	Semi-Desert Scrub Shrubland	A.873	<i>Atriplex polycarpa</i> Shrubland Alliance
SDS	Semi-Desert Scrub Shrubland	CEGL005296	<i>Canotia holacantha</i> Shrubland
SDS	Semi-Desert Scrub Shrubland	na	<i>Cylindropuntia acanthocarpa</i> Shrubland Alliance
SDS	Semi-Desert Scrub Shrubland	A.877	<i>Cylindropuntia bigelovii</i> Shrubland Alliance
SDS	Semi-Desert Scrub Shrubland	PS.013	<i>Encelia farinosa</i> Shrubland Alliance
SDS	Semi-Desert Scrub Shrubland	A.863	<i>Fouquieria splendens</i> Shrubland Alliance
SDS	Semi-Desert Scrub Shrubland	A.1104	<i>Krascheninnikovia lanata</i> Shrubland Alliance
SDS	Semi-Desert Scrub Shrubland	PS.014	<i>Psorothamnus (emoryi, fremontii, polydenius)</i> Shrubland Alliance
SV	Bare Rock and Sparse Vegetation	PS.021	Alluvial Wash Sparsely Vegetated
SV	Bare Rock and Sparse Vegetation	A.872	<i>Atriplex hymenelytra</i> Shrubland Alliance
SV	Bare Rock and Sparse Vegetation	PS.017	<i>Chorizanthe rigida</i> – <i>Geraea canescens</i> Desert Pavement Alliance (n=2)
SV	Bare Rock and Sparse Vegetation	A.2571	<i>Ephedra torreyana</i> Sparsely Vegetated Alliance
SV	Bare Rock and Sparse Vegetation	na	<i>Ephedra trifurca</i> Badlands Shrubland
SV	Bare Rock and Sparse Vegetation	PS.020	Montane Ravine Sparsely Vegetated*
SV	Bare Rock and Sparse Vegetation	A.2516	<i>Peucephyllum schottii</i> Shrubland Alliance
SV	Bare Rock and Sparse Vegetation	PS.023	Playa Map Class
SV	Bare Rock and Sparse Vegetation	PS.018	<i>Psorothamnus (emoryi, fremontii, polydenius)</i> Sparsely Vegetated Alliance (n=15)
SV	Bare Rock and Sparse Vegetation	Na	Sparsely vegetated carbonate Rock Open Scrub
SV	Bare Rock and Sparse Vegetation	PS.019	Sparsely Vegetated Rock Outcrop Alliance
SV	Bare Rock and Sparse Vegetation	PS.022	<i>Sphaeralcea ambigua</i> Sparsely Vegetated Alliance*

Table C-2. Map classes in LAKE Vegetation inventory map and alliance names (former scientific names used during the accuracy assessment) within each class (continued).

LAKE Map Class Code	LAKE Map Class Name	Alliance Code	Alliance Name
TAM	Tamarisk Shrubland	A.842	<i>Tamarix</i> spp. Semi-natural Shrubland Alliance
URBAN	Urban or Developed Area	LU	Urban - Land Use
YS	Mojave Yucca Shrubland	A.881	<i>Yucca schidigera</i> Shrubland Alliance
YS	Mojave Yucca Shrubland	PS.011	<i>Eriogonum fasciculatum</i> – <i>Viguiera parishii</i> Shrubland Alliance (n=40)

* = Type not sampled during the classification stage at LAKE, though included in the key since it likely occurs here, or the type was sampled during the map accuracy assessment stage, or it was mapped in along the border with Grand Canyon-Parashant National Monument

Table C-3. Scientific and common names for the taxa denoted in the keys for the LAKE vegetation classification. The USDA-NRCS PLANTS database code for each species is listed in parenthesis next to species name.

Scientific Name	Common Name	Life Form
<i>Abronia villosa</i> (ABVI)	desert sand verbena	Herb
<i>Acacia greggii</i> (ACGR)	catclaw acacia	Shrub
<i>Achnatherum hymenoides</i> (ACHY)	Indian ricegrass	Herb
<i>Allenrolfea occidentalis</i> (ALOC2)	iodinebush	Shrub
<i>Aloysia wrightii</i> (ALWR)	Wright's beebrush	Shrub
<i>Ambrosia dumosa</i> (AMDU2)	burrobush	Shrub
<i>Ambrosia eriocentra</i> (AMER)	woolly fruit bur ragweed	Shrub
<i>Ambrosia salsola</i> (= <i>Hymenoclea salsola</i>) (HYSA)	cheesebush	Shrub
<i>Amphipappus fremontii</i> (AMFR2)	Fremont's chaffbush	Shrub
<i>Amsinckia menziesii</i> (AMME)	Menzies' fiddleneck	Herb
<i>Amsinckia tessellata</i> (AMTE3)	bristly fiddleneck	Herb
<i>Andropogon glomeratus</i> (ANGL2)	bushy bluestem	Herb
<i>Antheropeas lanosum</i> (ANLA7)	white easterbonnets	Herb
<i>Anulocalis leiosolenus</i> (ANLE5)	southwestern ringstem	Herb
<i>Arctomecon californica</i> (ARCA4)	California bearpoppy	Herb
<i>Arctostaphylos pringlei</i> (ARPR)	Pringle manzanita	Shrub
<i>Arctostaphylos pungens</i> (ARPU5)	pointleaf manzanita	Shrub
<i>Arundo donax</i> (ARDO4)	giant reed	Shrub
<i>Atriplex canescens</i> (ATCA2)	fourwing saltbush	Shrub
<i>Atriplex confertifolia</i> (ATCO)	shadscale saltbush	Shrub
<i>Atriplex hymenelytra</i> (ATHY)	desertholly	Shrub
<i>Atriplex lentiformis</i> (ATLE)	big saltbush	Shrub
<i>Atriplex polycarpa</i> (ATPO)	cattle saltbush	Shrub
<i>Baccharis sergiloides</i> (BASE)	desert baccharis	Shrub
<i>Baileya multiradiata</i> (BAMU)	desert marigold	Herb
<i>Bebbia juncea</i> (BEJU)	sweetbush	Shrub
<i>Bernardia myricifolia</i> (BEMY)	mouse's eye	Shrub
<i>Brassica tournefortii</i> (BRTO)	Asian mustard	Herb
<i>Brickellia</i> spp. (BRICK)	brickellbush	Shrub
<i>Bromus rubens</i> (BRRU2)	red brome	Herb
<i>Buddleja utahensis</i> (BUUT)	Utah butterflybush	Shrub
<i>Calamagrostis scopulorum</i> (CASC)	ditch reedgrass	Herb
<i>Camissonia brevipes</i> (CABR23)	yellow cups	Herb
<i>Canotia holacantha</i> (CAHO3)	crucifixion thorn	Shrub
<i>Chilopsis linearis</i> (CHLI2)	desert willow	Tree
<i>Chorizanthe brevicornu</i> (CHBR)	brittle spineflower	Herb
<i>Chorizanthe rigida</i> (CHRI)	devil's spineflower	Herb
<i>Cladium californicum</i> (CLCA2)	California sawgrass	Herb
<i>Coleogyne ramosissima</i> (CORA)	blackbrush	Shrub
<i>Croton californicus</i> (CRCA5)	California croton	Herb

Table C-3. Scientific and common names for the taxa denoted in the keys for the LAKE vegetation classification. The USDA-NRCS PLANTS database code for each species is listed in parenthesis next to species name (continued).

Scientific Name	Common Name	Life Form
<i>Cryptantha</i> spp. (CRYPT)	cryptantha	Herb
<i>Cylindropuntia acanthocarpa</i> (CYAC8)	buckhorn cholla	Shrub
<i>Cylindropuntia bigelovii</i> (CYBI9)	teddybear cholla	Shrub
<i>Dicoria canescens</i> (DICA4)	desert twinbugs	Herb
<i>Distichlis spicata</i> (DISP)	saltgrass	Herb
<i>Encelia farinosa</i> (ENFA)	brittlebush	Shrub
<i>Encelia resinifera</i> (ENRE)	sticky brittlebush	Shrub
<i>Encelia virginensis</i> (ENVI)	Virgin River brittlebush	Shrub
<i>Enceliopsis argophylla</i> (ENAR)	silverleaf sunray	Herb
<i>Ephedra fasciculata</i> (ERFA)	Arizona jointfir	Shrub
<i>Ephedra torreyana</i> (EPTO)	Torrey's jointfir	Shrub
<i>Ephedra trifurca</i> (EPTR)	longleaf jointfir	Shrub
<i>Ephedra viridis</i> (EPVI)	Mormon tea	Shrub
<i>Ericameria paniculata</i> (ERPA29)	Mojave rabbitbrush	Shrub
<i>Eriogonum corymbosum</i> (ERCO14)	crispleaf buckwheat	Shrub
<i>Eriogonum deflexum</i> (ERDE6)	flatcrown buckwheat	Herb
<i>Eriogonum fasciculatum</i> (ERFA2)	California buckwheat	Shrub
<i>Eriogonum heermannii</i> (ERHE)	Heerman's buckwheat	Shrub
<i>Eriogonum inflatum</i> (ERIN4)	desert trumpet	Herb
<i>Eriogonum trichopes</i> (ERTR8)	little deserttrumpet	Herb
<i>Eriogonum wrightii</i> (ERWR)	bastardsage	Shrub
<i>Erodium cicutarium</i> (ERIC16)	redstem stork's bill	Herb
<i>Eschscholzia</i> spp. (ESCHS)	eschscholzia	Herb
<i>Eucnide urens</i> (EUUR)	desert stingbush	Shrub
<i>Fallugia paradoxa</i> (FAPA)	Apache plume	Shrub
<i>Ferocactus cylindraceus</i> (FECY)	barrel cactus	Shrub
<i>Fouquieria splendens</i> (FOSP2)	ocotilla	Shrub
<i>Garrya flavescens</i> (GAFL2)	ashy silktassel	Shrub
<i>Geraea canescens</i> (GECA2)	desert sunflower	Herb
<i>Gutierrezia microcephala</i> (GUMI)	threadleaf snakeweed	Shrub
<i>Gutierrezia sarothrae</i> (GUSA2)	broom snakeweed	Shrub
<i>Hymenoclea salsola</i> (= <i>Ambrosia salsola</i>) (HYSA)	cheesebush	Shrub
<i>Hyptis emoryi</i> (HYEM)	desert lavender	Shrub
<i>Juncus</i> spp. (JUNCU)	rush	Herb
<i>Juniperus californica</i> (JUCA7)	California juniper	Tree
<i>Juniperus osteosperma</i> (JUOS)	Utah juniper	Tree
<i>Keckiella antirrhinoides</i> (KEAN)	snapdragon penstemon	Shrub
<i>Krameria erecta</i> (KRER)	littleleaf ratany	Shrub
<i>Krameria grayi</i> (KRGR)	white ratany	Shrub
<i>Krascheninnikovia lanata</i> (KRLA2)	winterfat	Shrub

Table C-3. Scientific and common names for the taxa denoted in the keys for the LAKE vegetation classification. The USDA-NRCS PLANTS database code for each species is listed in parenthesis next to species name (continued).

Scientific Name	Common Name	Life Form
<i>Larrea tridentata</i> (LATR2)	creosote bush	Shrub
<i>Lepidium lasiocarpum</i> (LELA)	shaggyfruit pepperweed	Herb
<i>Leymus salinus</i> (LESA4)	saline wildrye	Herb
<i>Lupinus</i> spp. (LUPIN)	lupine	Herb
<i>Lycium andersonii</i> (LYAN)	water jacket	Shrub
<i>Lycium cooperi</i> (LYCO2)	peach thorn	Shrub
<i>Malacothrix glabrata</i> (MAGL3)	smooth desertdandelion	Herb
<i>Malcolmia africana</i> (MAAF)	African mustard	Herb
<i>Mirabilis laevis</i> (MILA6)	desert wishbone-bush	Shrub
<i>Mortonia utahensis</i> (MOUT)	Utah mortonia	Shrub
<i>Muhlenbergia porteri</i> (MUPO2)	bush muhly	Herb
<i>Nolina bigelovii</i> (NOBI)	Bigelow's nolina	Shrub
<i>Oenothera deltoides</i> (OEDE2)	birdcage evening primrose	Herb
<i>Opuntia bigelovii</i> (OPBI)	teddybear cholla	Shrub
<i>Palafoxia arida</i> (PAAR8)	desert palafox	Herb
<i>Parkinsonia aculeata</i> (PAAC3)	Jerusalem thorn	Tree
<i>Parkinsonia microphylla</i> (PAMI5)	yellow paloverde	Tree
<i>Pectocarya</i> spp. (PECTO)	combseed	Herb
<i>Petalonyx</i> spp. (PETAL)	sandpaper plant	Herb
<i>Peucephyllum schottii</i> (PESC4)	Schott's pygmycedar	Shrub
<i>Phacelia fremontii</i> (PHFR2)	Fremont's phacelia	Herb
<i>Phacelia pulchella</i> (PHPU)	beautiful phacelia	Herb
<i>Phragmites australis</i> (PHAU7)	common reed	Herb
<i>Pinus monophylla</i> (PIMO)	singleleaf pinyon	Tree
<i>Plantago ovata</i> (PLOV)	desert Indianwheat	Herb
<i>Pleuraphis rigida</i> (PLRI3)	galleta grass	Herb
<i>Pleurocoronis pluriseta</i> (PLPL)	desert arrowleaf	Shrub
<i>Pluchea sericea</i> (PLSE)	arrowweed	Shrub
<i>Populus fremontii</i> (POFR2)	Fremont cottonwood	Tree
<i>Prosopis glandulosa</i> (PRGL2)	honey mesquite	Tree
<i>Prosopis pubescens</i> (PRPU)	screwbean mesquite	Tree
<i>Prunus fasciculata</i> (PRFA)	desert almond	Shrub
<i>Psoralea fremontii</i> (PSFR)	Fremont's dalea	Shrub
<i>Psoralea spinosa</i> (PSSP3)	smoketree	Tree
<i>Quercus turbinella</i> (QUTU2)	Sonoran scrub oak	Shrub
<i>Rhus trilobata</i> (RHTR)	skunkbush sumac	Shrub
<i>Salazaria mexicana</i> (SAME)	Mexican bladdersage	Shrub
<i>Salix exigua</i> (SAEX)	narrowleaf willow	Shrub
<i>Salix gooddingii</i> (SAGO)	black willow	Tree
<i>Salix lasiolepis</i> (SALA6)	arroyo willow	Shrub

Table C-3. Scientific and common names for the taxa denoted in the keys for the LAKE vegetation classification. The USDA-NRCS PLANTS database code for each species is listed in parenthesis next to species name (continued).

Scientific Name	Common Name	Life Form
<i>Salsola</i> spp. (SALSO)	Russian thistle	Herb
<i>Salvia columbariae</i> (SACO6)	chia	Herb
<i>Salvia dorrii</i> (SADO4)	purple sage	Shrub
<i>Schismus</i> spp. (SCHIS)	Mediterranean grass	Herb
<i>Simmondsia chinensis</i> (SICH)	jojoba	Shrub
<i>Sphaeralcea ambigua</i> (SPAM2)	desert mallow	Herb
<i>Sporobolus airoides</i> (SPAI)	alkali sacaton	Herb
<i>Suaeda moquinii</i> (SUMO)	Mojave seablight	Shrub
<i>Tamarix ramosissima</i> (TARA)	saltcedar	Tree
<i>Tamarix</i> spp.(TAMAR)	tamarisk	Tree
<i>Typha</i> spp (TYPHA)	cattail	Herb
<i>Viguiera parishii</i> (VIPA14)	Parish's goldeneye	Shrub
<i>Vitis arizonica</i> (VIAR2)	canyon grape	Shrub (vine)
<i>Vulpia octoflora</i> (VUOC)	sixweeks fescue	Herb
<i>Washingtonia filifera</i> (WAFI)	California fan palm	Tree
<i>Yucca brevifolia</i> (YUBR)	Joshua tree	Tree

Appendix D. Vegetation Alliance Descriptions for Lake Mead National Recreation Area

By

California Native Plant Society
2707 K Street, Suite 1
Sacramento, CA 95816



In partnership with the

National Park Service
Mojave Desert Network Inventory and Monitoring Program
601 Nevada Hwy
Boulder City, NV 89005

And

NatureServe
Western Regional Office
4001 Discovery, Suite 2110
Boulder, Colorado 80303

2015

Contents

1. Forest & Woodland Class

1.B.2. Cool Temperate Forest & Woodland Formation

1.B.2.Nc. Western North American Cool Temperate Woodland & Scrub Division

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

G247. Great Basin Pinyon - Juniper Woodland Group

***Pinus monophylla* - *Juniperus osteosperma* / Shrub Understory Woodland Alliance**

Common Name: Singleleaf Pinyon – Utah Juniper Woodland

Group Assignment: G247; **Alliance:** A2108

Alliance Concept

The Singleleaf Pinyon – Utah Juniper Woodland Alliance forms a sparse to continuous tree canopy with a sparse to intermittent shrub understory. Stands are wide spread in DEVA and MOJA at mid to high elevations, and localized in LAKE at high elevations. It is found from toeslopes and canyon beds to summits at all aspects, and elevations range from approximately 1160 to 2900 meters. Soils are derived from a variety of substrates and textures are variable. *Pinus monophylla* is either dominant or co-dominant in the overstory tree canopy with plants such as *Juniperus osteosperma* or *J. californica*. A commonly associated shrub is *Ephedra viridis*. Other shrubs sometimes present are *Artemisia tridentata*, *Echinocereus mojavensis*, *Ericameria linearifolia*, *Gutierrezia sarothrae*, *Opuntia polyacantha* var. *erinacea*, *Prunus fasciculata*, *Purshia stansburiana*, *Rhus trilobata*, *Thamnosma montana*, and *Yucca baccata*. *Bromus rubens* is a commonly associated herb.

Diagnostic Criteria: This alliance is characterized by a sparse to continuous tree canopy dominated or co-dominated by *Pinus monophylla*, which ranges from 1 to 81 percent cover. The overall tree cover ranges from 1 to 81 percent cover.

Alliance Distribution

The alliance is well-defined in sampling at all three Parks. It is scattered throughout DEVA and MOJA at mid to upper elevations and in LAKE in the Newberry Mountains at mid to high elevations.

States: CA, NV

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (96): 322Ab, 322Ai, 322Aj, 322Al, 322Am; Southeastern Great Basin (67): 341Fa, 341Fb, 341Fc, 341Fd, 341Ff

Park Sampling Zones: **DEVA:** CottonWood Mtns, Grapevine Mtns, Joshua Flat, Last Chance Range, Mazourka Peak, Nelson Range, Owlshead Mtns, Panamint Mtns; **LAKE:** Katherine,

Spirit Mountain; **MOJA:** Clark Mtn, Granite Mtns, Ivanpah Mtns, Ivanpah Villy, Lanfair Villy, Mid Hills, New York Mtns, Providence Mtns, Van Winkle Mtn, Woods Mtns

Associations

Association Scientific Name [NVC Code]	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Pinus monophylla</i> –(<i>Juniperus osteosperma</i>) (alliance)	6			x	x
<i>Pinus monophylla</i> / <i>Fallugia paradoxa</i> – <i>Salvia dorrii</i>	10			x	x
<i>Pinus monophylla</i> / <i>Garrya flavescens</i>	12			x	
<i>Pinus monophylla</i> / <i>Prunus fasciculata</i> – <i>Rhus trilobata</i>	22			x	
<i>Pinus monophylla</i> / <i>Ribes velutinum</i> [CEGL003153]	9		x		
<i>Pinus monophylla</i> –(<i>Juniperus osteosperma</i>) / <i>Artemisia tridentata</i> [CEGL000832]	42		x	x	x
<i>Pinus monophylla</i> –(<i>Juniperus osteosperma</i>) / <i>Cercocarpus intricatus</i> [CEGL005437]	7		x	x	
<i>Pinus monophylla</i> –(<i>Juniperus osteosperma</i>) / <i>Cercocarpus ledifolius</i> [CEGL000828]	4		x		
<i>Pinus monophylla</i> –(<i>Juniperus osteosperma</i>) / <i>Ephedra viridis</i>	5		x	x	x
<i>Pinus monophylla</i> –(<i>Juniperus osteosperma</i>) / <i>Quercus turbinella</i> [CEGL002941]	16	x		x	x
<i>Pinus monophylla</i> – <i>Juniperus californica</i>	7		x	x	
<i>Pinus monophylla</i> – <i>Juniperus osteosperma</i> / <i>Artemisia nova</i> [CEGL000831]	12		x		
<i>Pinus monophylla</i> – <i>Juniperus osteosperma</i> / <i>Coleogyne ramosissima</i> [CEGL002971]	13			x	x
<i>Pinus monophylla</i> – <i>Juniperus osteosperma</i> / <i>Purshia stansburiana</i> [CEGL005397]	6			x	
<i>Pinus monophylla</i> – <i>Juniperus osteosperma</i> / Sparse Understory [CEGL000829]	5			x	

Association notes: Six samples were classified to alliance level, including four stands with *Eriogonum fasciculatum* and *Ericameria* spp. in the understory, suggesting further variation within the alliance.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 1841.8 m, Range 1158 – 2864 m

Aspect: N (45), NE (23), E (18), NW (20), SE (12), SW (9), W (8), SW (19), S (19)

Slope: Mean 18.8 degrees, Range 1 – 45 degrees

Macro Topography: Backslope (1), Channel bed (2), Entire slope (2), High level/summit (14), Highslope (28), Low level/bottom (2), Lowslope (14), Midslope (33), Midslope to ridgetop (1), Toeslope (alluvial fan/bajada) (3)

Tree Cover: Mean 14.9%, Range 1.1 – 81.2%

Shrub Cover: Mean 17.7%, Range 1.7 – 61.3%

Herb Cover: Mean 5.1%, Range 0 – 23%

Large Rock: Mean 24.9%, Range 0 – 96%

Small Rock: Mean 48.1%, Range 0 – 97.5%
Fines Cover: Mean 8.6%, Range 0 – 80%
Litter Cover: Mean 13.4%, Range 0 – 80%

Geology: alkali-granite (alaskite) (3), alluvium (10), conglomerate (1), dolostone (dolomite) (1), gneiss (7), granodiorite (43), limestone (20), plutonic rock (phaneritic) (2), rhyolite (16), sandstone (60), schist (1), shale (2)

Soil Texture: Clay (1), Clay loam (16), Coarse sand (9), Fine silty clay (1), Loam (14), Loamy sand (20), Medium sand (9), Medium silt loam (3), Medium to very fine sandy loam (16), Moderately coarse sandy loam (1), Moderately fine sandy clay loam (1), Moderately fine silty clay loam (3), Sand (2), Sandy clay (4), Sandy loam (27), Silt loam (5), Silty clay (4)

Environment: The alliance is scattered throughout DEVA and MOJA at mid to upper elevations and in LAKE at high elevations in the Newberry Mountains. It is found at all aspects from toeslopes and canyon channel beds to summits. Soils are derived from a variety of substrates and textures are variable.

Vegetation Description

Vegetation Structure: The Alliance forms a sparse to continuous tree layer with a sparse to intermittent shrub layer and sparse or continuous herbaceous understory.

Vegetation Floristics: *Pinus monophylla* is either dominant or co-dominant in the overstory tree canopy with plants such as *Juniperus osteosperma* or *Juniperus californica*. A commonly associated shrub is *Ephedra viridis* and a commonly associated herb is *Bromus rubens*.

Dynamics: *Pinus monophylla* is a common dominant to co-dominant tree at mid to higher elevations in the desert mountains of the West. Stands in California's desert and on the eastern side of the Sierra Nevada appear as relicts from past climates. Fossil packrat middens suggest that much of the Mojave Desert ecoregion contained pinyon-juniper woodlands as recently as 7500 years ago, with recent aridity restricting its range to higher elevations in the desert.

Classification Comments

None.

Classification Confidence of Alliance: High

Conservation Status Rank

Global: G5

State (California): S4

References

cf. Evens et al. 2012, NatureServe 2012, Sawyer et al. 2009, Schulz and Hall 2011, cf. VegCAMP and AIS 2013.

Surveys (with Sample Sizes) Used in Description

MOJN: N=176

LAKE (n=3): LAKE9528, LAMEN096, LAMEN116

DEVA (n=68): DEVA0206, DEVA8010, DEVA9112, DEVA9116, DEVA9132, DEVA9151, DEVA9158, DEVA9161, DEVA9216, DEVA9239, DEVA9244, DEVA9245, DEVA9247, DEVA9248, DEVA9270, DEVA9444, DEVA9480, DEVA9485, DEVA9486, DEVA9660, DEVA9661, DEVA9820, DEVA9828, DEVAD011, DEVAD014, DEVAD060, DEVAD112, DEVAD134, DEVAD142, DEVAD149, DEVAS041, DEVAS043, DEVAS044, DEVAS049, DEVAS050, DEVAS083, DEVAS084, DEVAS085, DEVAS208, DEVAS214, DEVAS215, DEVAS256, MOJC0427, MOJC0428, MOJC0429, MOJC0430, MOJC0432, MOJC0433, MOJC0434, MOJC0435, MOJC0436, MOJC0437, MOJC0438, MOJC0439, MOJC0440, MOJC0441, MOJC0475, MOJC0476, MOJC0477, MOJC0478, MOJC0479, MOJC0480, MOJC0632, MOJC0638, MOJC0639, MOJC0640, MOJC1071, MOJC1073

MOJA (n=92): MOJA0110, MOJA0141, MOJA0148, MOJA0220, MOJA0223, MOJA0231, MOJA0232, MOJA0263, MOJA9113, MOJA9114, MOJA9126, MOJA9136, MOJA9138, MOJA9142, MOJA9149, MOJA9151, MOJA9221, MOJA9224, MOJA9225, MOJA9227, MOJA9229, MOJA9256, MOJA9260, MOJA9261, MOJA9272, MOJA9287, MOJA9332, MOJA9350, MOJA9390, MOJA9392, MOJA9410, MOJA9414, MOJA9423, MOJA9425, MOJA9426, MOJA9432, MOJA9434, MOJA9435, MOJA9436, MOJA9439, MOJA9441, MOJA9442, MOJA9445, MOJA9446, MOJA9450, MOJA9456, MOJA9458, MOJA9459, MOJA9575, MOJA9588, MOJA9589, MOJA9684, MOJA9693, MOJA9694, MOJA9695, MOJA9901, MOJA9907, MOJA9911, MOJAE001, MOJAE036, MOJAE037, MOJAE038, MOJAE039, MOJAE040, MOJAE041, MOJAE042, MOJAE043, MOJAE045, MOJAE046, MOJAE104, MOJAE105, MOJAE106, MOJAE107, MOJAE164, MOJAE165, MOJAE233, MOJAE234, MOJAE235, MOJAE236, MOJC0017, MOJC0212, MOJC0213, MOJC0947, MOJC1108, MOJC1110, MOJC1111, MOJC1112, MOJC1113, MOJC1148, MOJC1157, MOJC1158, MOJC1159

MOJN-Johnson (n=13): MOJJE045, MOJJE046, MOJJE047, MOJJE077, MOJJE085, MOJJE095, MOJJE179, MOJJE206, MOJJE420, MOJJE445, MOJJE750, MOJJE755, MOJJE935

Alliance Stand Table

Layer	Species Name	Con	Rel Cov	Avg	Min	Max	C	D	cD	Often
Tree										
	<i>Pinus monophylla</i>	85	66	10	1	74	x	x		
	<i>Juniperus osteosperma</i>	48	13	1.8	0.01	20				
Shrub										
	<i>Ephedra viridis</i>	64	6.7	1	0.1	14				x
	<i>Opuntia polyacantha</i> var. <i>erinacea</i>	41	1.3	0.2	0.1	4				
	<i>Yucca baccata</i>	38	2.5	0.4	0.2	6.5				
	<i>Artemisia tridentata</i>	36	14	2.4	0.2	42				
	<i>Purshia stansburiana</i>	29	2.8	0.5	0.1	9				
	<i>Rhus trilobata</i>	28	1.9	0.4	0.01	7.1				
	<i>Gutierrezia sarothrae</i>	28	1.2	0.2	0.04	4				
	<i>Echinocereus mojavensis</i>	28	0.4	0.1	0.2	1				
	<i>Prunus fasciculata</i>	27	2.9	0.6	0.2	10.1				
Herb										
	<i>Bromus rubens</i>	51	9.8	0.8	0.1	15				x
	<i>Elymus elymoides</i>	42	3.8	0.2	0.03	2				
	<i>Achnatherum speciosum</i>	38	4.5	0.2	0.1	6				
	<i>Sphaeralcea ambigua</i>	30	1.7	0.1	0.2	2				
	<i>Bromus tectorum</i>	26	6	0.7	0.2	35				
Non-vascular										
	Unknown Lichen	37	31	1.1	0.4	40				
	Unknown Moss	28	8.1	0.1	0.2	1				

1. Forest & Woodland Class

1.B.3. Temperate Flooded & Swamp Forest Formation

1.B.3.Nd. Interior Lowland West Flooded Forest Division

M036. Interior Warm & Cool Desert Riparian Forest Macrogroup

G797. Western Interior Riparian Forest & Woodland Group

***Populus fremontii* - *Fraxinus velutina* - *Salix gooddingii* Flooded Forest & Woodland Alliance**

Common Name: Fremont Cottonwood - Velvet Ash - Goodding's Willow Flooded Forest & Woodland

Group Assignment: G797; **Alliance Code:** A3803, cf. A0644

Alliance Concept

The Fremont Cottonwood - Velvet Ash - Goodding's Willow Flooded Forest & Woodland Alliance forms an open to continuous tree canopy with a sparse to continuous shrub understory. The alliance is found throughout the study area in seasonally flooded streams and springs in lower canyons, and alluvial fans and valleys with dependable sub-surface water supply during the growing season. It is found primarily on channel beds, bottoms, and lowslopes at all aspects. Soils are derived from a variety of substrates with variable textures. Elevations range from approximately 300 to 1600 meters. *Populus fremontii* is dominant or co-dominant in the tree layer, and it often occurs with *Salix* spp. and *Prosopis* spp. Commonly associated shrubs include *Baccharis sergiloides*, and herbs often present include *Artemisia ludoviciana*, *Bromus rubens*, and *Typha* sp.

Diagnostic Criteria: This alliance is characterized by an open to continuous tree canopy dominated or co-dominated by *Populus fremontii*, which ranges from 9 to 100 percent cover. The overall tree cover also ranges from 9 to 100 percent cover.

Alliance Distribution

The alliance was sampled at all three Parks. It is scattered throughout DEVA at low to upper elevations and in MOJA on the Granite and New York Mountains at upper elevations. It is in LAKE east of the Newberry Mountains at mid elevations.

States: CA, NV

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (8): 322Ab, 322Ae, 322Al, 322Am; Southeastern Great Basin (4): 341Fc, 341Fe

Park Sampling Zones: **DEVA:** CottonWood Mtns, Grapevine Mtns, Nelson Range, Panamint Mtns, Saline Valley; **LAKE:** Katherine; **MOJA:** Granite Mtns, Mid Hills

Associations

Association Scientific Name	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Populus fremontii</i> / <i>Baccharis emoryi</i>	1		x		
<i>Populus fremontii</i> / <i>Baccharis sergiloides</i>	5	x		x	
<i>Populus fremontii</i> – <i>Salix gooddingii</i>	3		x	x	
<i>Populus fremontii</i> – <i>Salix laevigata</i>	3		x		

Association notes: None.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 962.5 m, Range 326 – 1610 m

Aspect: Flat, Variable (2), N (2), NE (1), E (1), SE (2), W (1), S (2)

Slope: Mean 3.5 degrees, Range 0 – 12 degrees

Macro Topography: Channel bed (4), Low level/bottom (3), Lowslope (1), Midslope (1)

Tree Cover: Mean 42.6%, Range 9 – 100%

Shrub Cover: Mean 32.7%, Range 0.4 – 75%

Herb Cover: Mean 22.2%, Range 3 – 50%

Large Rock: Mean 7.1%, Range 0 – 30%

Small Rock: Mean 19.2%, Range 0 – 58%

Fines Cover: Mean 15.2%, Range 2 – 59%

Litter Cover: Mean 49.7%, Range 15 – 92%

Geology: alkali-granite (alaskite) (3), alluvium (4), granodiorite (4), limestone (1)

Soil Texture: Clay loam (2), Fine sand (1), Loam (1), Medium to very fine loamy sand (1),

Sand (3), Sandy loam (1), Silt loam (1)

Environment: *Populus fremontii* forest alliance is found in seasonally intermittent streams and springs in lower canyons, alluvial fans and valleys with dependable sub-surface water supply during the growing season. The alliance was sampled at low to upper elevations in channel beds and up to midslopes with variable aspects. Soils are derived from a variety of substrates and textures are variable.

Vegetation Description

Vegetation Structure: The Alliance forms an open to continuous tree layer with a sparse to continuous shrub layer and sparse or intermittent herbaceous understory.

Vegetation Floristics: *Populus fremontii* is dominant or co-dominant in the tree layer, and it often occurs with *Salix* and *Prosopis* spp. Commonly associated shrubs include *Baccharis*

sergiloides and *Salix exigua*, and herbs often present include *Artemisia ludoviciana*, *Bromus rubens*, and *Typha* sp.

Dynamics: *Populus fremontii* is a fast growing, short-lived shade intolerant plant. It may dominate the stand or mix with other riparian trees. Trees can regenerate vegetatively from root suckers and propagules created during flood related disturbances. Seeds germinate on recently disturbed sites where subsurface water is available during the growing season. Some low elevation stands have endured negative impacts from reduced water supplies and changes in flooding regimes from dams. Regulating stream flow below dams to mimic natural flooding regimes is critical for restoring and maintaining healthy stands. The USFWS Wetland Inventory (1996) recognizes *Populus fremontii* as a FAC+ plant.

Classification Comments

The NVC hierarchy denotes more than one alliance with *Populus fremontii* in Western Interior Riparian Forest & Woodland Group (G797), including one alliance primarily occurring in the Great Basin and another across the Southwest. For this Mojave Desert Network classification, we recognize one alliance in this G797 group.

Classification Confidence of Alliance: High

Conservation Status Rank

Global: G4

State (California): S3

References

Buck-Diaz et al. 2012, Evens and San 2006, Evens et al. 2012, Klein and Evens 2005, Klein et al. 2007, NatureServe 2012, Potter 2005, Sawyer et al. 2009, Stillwater Sciences and URS 2007, Sawyer et al. 2009

Surveys (with Sample Sizes) Used in Description

MOJN: N=12

LAKE (n=3): LAKE9431, LAKE9440, LMJOS002

DEVA (n=6): DEVA9127, DEVA9156, DEVA9275, DEVA9565, DEVA9814, MOJC1234

MOJA (n=3): MOJA9271, MOJA9910, MOJAE194

MOJN-Johnson (n=0)

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Tree										
	<i>Populus fremontii</i>	100	71	30	5	80	x	x		
	<i>Salix laevigata</i>	33.3	9.2	4.4	0.5	20				
	<i>Salix gooddingii</i>	25	5.1	3.7	4	35				
	<i>Prosopis pubescens</i>	25	3.4	1.3	0.2	10				
	<i>Prosopis glandulosa</i>	25	1.5	0.6	1	3				
Shrub										
	<i>Baccharis sergiloides</i>	58.3	29	12	7	30				x
	<i>Salix exigua</i>	41.7	8.6	2	1	20				
	<i>Rhus trilobata</i>	41.7	3.9	1.5	1	7				
	<i>Atriplex polycarpa</i>	33.3	6.4	1	0.2	10				
	<i>Acacia greggii</i>	33.3	0.9	0.5	0.2	5				
	<i>Rhamnus ilicifolia</i>	25	0.9	0.4	0.2	2				
	<i>Gutierrezia sarothrae</i>	25	0.8	0.3	0.2	2				
Herb										
	<i>Typha</i>	58.3	3.8	1.1	0.2	8				x
	<i>Bromus rubens</i>	50	14	2.6	1	20				x
	<i>Artemisia ludoviciana</i>	50	3.5	0.5	0.2	3.1				x
	<i>Polypogon monspeliensis</i>	41.7	2.3	0.4	0.2	3				
	<i>Juncus xiphioides</i>	33.3	4.8	1.4	0.2	12				
	<i>Epilobium</i>	25	5.3	1.4	0.2	12				
	<i>Mimulus guttatus</i>	25	3.5	0.5	0.5	3				
	<i>Cynodon dactylon</i>	25	1	0.3	0.5	2				
	<i>Amsinckia</i>	25	0.8	0.1	0.2	1				
	<i>Sphaeralcea ambigua</i>	25	0.5	0.1	0.2	1				
	<i>Penstemon</i>	25	0.5	0.1	0.2	0.2				
	<i>Sonchus asper</i>	25	0.2	0.1	0.2	0.2				
Non-vascular										
	Unknown Moss	25	25	0.4	0.2	4				

***Salix gooddingii* - *Salix laevigata* - *Salix lucida* Riparian Forest Alliance**

Common Name: Black Willow - Red Willow - Shining Willow Riparian Forest

Group Assignment: G797; **Alliance Code:** A3752, A3803

Alliance Concept

The Black Willow - Red Willow - Shining Willow Riparian Forest Alliance forms an open to continuous tree canopy with an open to intermittent shrub understory. Stands are local and scattered and can be found at streams and springs and along rivers including those with flood control dams. The alliance is found primarily on channel beds, bottoms and low to midslopes at variable aspects. Soils are derived from a variety of substrates and textures are variable. Elevations range from approximately 480 to 1500 meters. The dominant tree is *Salix gooddingii* or *Salix laevigata*, and *Prosopis glandulosa* is sometimes present. Shrubs that are sometimes present include *Acacia greggii*, *Atriplex polycarpa*, *Baccharis sergiloides*, *Eriogonum fasciculatum*, and *Pluchea sericea*. *Bromus rubens* is often present in the herbaceous layer.

Diagnostic Criteria: This alliance is characterized by an open to continuous tree canopy with *Salix gooddingii* dominant and ranging from 10 to 99 percent cover. Sometimes other trees including willows may be co-dominant. The overall tree cover also ranges from 10 to 99 percent cover.

Alliance Distribution

The alliance was sampled at all three Parks. It is scattered throughout DEVA at mid to upper elevations. In MOJA it is found at Pachalka Spring in the Clark Mountains and Sheep Spring in the Marl Mountains at upper elevations, and has been observed in the Granite Mountains. In LAKE it is found in Sacatone Wash and at an artificial channel bed near a water treatment facility, though other stands have been observed and mapped along Lake Mead and associated stream channels.

States: CA, NV

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (5): 322Ad, 322Aj, 322Am, (322Av,) 322Ay; Southeastern Great Basin (3): 341Fc, 341Fd, 341Fe

Park Sampling Zones: DEVA: Black Mtns, Funeral Mtns, Grapevine Mtns, Nelson Range;

LAKE: (Cottonwood Cove), Katherine, Lakeshore; **MOJA:** Clark Mtn, (Granite Mtns), Marl Mtns

Associations

Association Scientific Name	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Salix gooddingii</i>	7	x	x	x	
<i>Salix laevigata</i> / (<i>Baccharis salicifolia</i>) (provisional)	3		x		

Association notes: None.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 966.9 m, Range 480 – 1474 m

Aspect: E (2), NE (1), NW (1), SW (4), S (1)

Slope: Mean 4.7 degrees, Range 1 – 18 degrees

Macro Topography: Channel bed (1), Low level/bottom (3), Lowslope (2), Midslope (3)

Tree Cover: Mean 41.7%, Range 10.4 – 99%

Shrub Cover: Mean 24.6%, Range 0.2 – 69.9%

Herb Cover: Mean 26.5%, Range 1 – 63%

Large Rock: Mean 8.9%, Range 0 – 48%

Small Rock: Mean 4.9%, Range 1 – 10%

Fines Cover: Mean 13.4%, Range 0 – 51%

Litter Cover: Mean 52.8%, Range 6 – 94%

Geology: alkali-granite (alaskite) (1), alluvium (1), andesite (1), diorite (1), gneiss (1), limestone (1), rhyolite (2), sandstone (2)

Soil Texture: Loam (2), Loamy sand (3), Silt loam (1), Silty clay (1)

Environment: The alliance is found at all three parks at most elevations along springs and streams, in stream and channel beds, and on low and midslopes at all aspects. Soils range from loamy sand to silt loam derived from variable substrates.

Vegetation Description

Vegetation Structure: The Alliance forms an open to continuous tree layer with a sparse to intermittent shrub layer and sparse or intermittent herbaceous understory.

Vegetation Floristics: The dominant tree is *Salix gooddingii* or *Salix laevigata*, and *Prosopis glandulosa* is sometimes present. Shrubs that are sometimes present include *Acacia greggii*, *Atriplex polycarpa*, *Baccharis sergiloides*, *Eriogonum fasciculatum*, and *Pluchea sericea*. *Bromus rubens* is often present in the herbaceous layer.

Dynamics: *Salix gooddingii* and *S. laevigata* stands are common in the southwest United States. In the Mojave Desert, stands are local and scattered and can be found at streams and springs and along rivers including those with flood control dams. Disturbance during winter and spring floods modify and create riparian stands with successful seedling establishment determined by timing of dispersal and flood patterns. Established plants tolerate inundation, and plants sprout from a root crown in lighted conditions. Altered hydrologic regimes, flood control projects, and the presence of invasive plants may pose a threat to *S. gooddingii* stands.

Classification Comments

Currently, the NVC hierarchy includes associations with *Salix gooddingii* dominant in two different alliances, including this mixed tree *Salix* spp. alliance and another mixed with *Populus fremontii*

and *Fraxinus velutina*. For this Mojave Network classification, we have placed all tree willow-dominated associations into this mixed willow alliance; however, further review and analysis is needed to determine if these types should all be merged into one alliance or kept split.

Classification Confidence of Alliance: Moderate

Conservation Status Rank

Global: G4

State (California): S3

References

Buck-Diaz et al. 2012, Evens et al. 2012, Klein and Evens 2005, Klein et al. 2007, NatureServe 2012, Sawyer et al. 2009, VegCAMP and AIS 2013

Surveys (with Sample Sizes) Used in Description

MOJN: N=10

LAKE (n=2): LAKE9421, LMFMH071

DEVA (n=6): DEVA9155, DEVA9373, DEVA9466, DEVA9538, DEVA9921, DEVAS079

MOJA (n=2): MOJA0346, MOJA9155

MOJN-Johnson (n=0)

Alliance Stand Table

Layer	SpeciesName	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Tree										
	<i>Salix gooddingii</i>	70	68	26	10	99				x
	<i>Salix laevigata</i>	30	30	14	25	60				
	<i>Prosopis glandulosa</i>	30	2	0.4	0.2	3				
Shrub										
	<i>Baccharis sergiloides</i>	40	15	5.1	0.2	35				
	<i>Pluchea sericea</i>	40	21	3.2	2	15				
	<i>Atriplex polycarpa</i>	30	6.5	2.3	0.01	20				
	<i>Acacia greggii</i>	30	1.5	0.2	0.2	1				
	<i>Eriogonum fasciculatum</i>	30	0.2	0.1	0.11	0.2				
Herb										
	<i>Bromus rubens</i>	70	7.8	1.3	0.2	5				x
	<i>Phragmites australis</i>	40	15	6.9	1	60				
	<i>Typha</i>	40	16	3.7	3	25				
	<i>Anemopsis californica</i>	30	3.1	2.1	0.2	20				
	<i>Nasturtium officinale</i>	30	8	2.1	0.2	20				
	<i>Unknown Graminoid (grass or grasslike)</i>	30	2.2	1	0.33	6.6				
	<i>Polypogon monspeliensis</i>	30	3.5	0.6	0.11	3				
	<i>Bromus tectorum</i>	30	2.6	0.4	0.2	3				
	<i>Eriogonum inflatum</i>	30	0.3	0.1	0.2	0.2				
Non-vasc										
	<i>Unknown Moss</i>	30	30	0.5	0.2	5				

1. Forest & Woodland Class

1.B.3. Temperate Flooded & Swamp Forest Formation

1.B.3.Nd. Interior Lowland West Flooded Forest Division

M298. Interior West Ruderal Flooded & Swamp Forest Macrogroup

G510. Interior West Ruderal Riparian Forest & Scrub Group

***Phoenix dactylifera* - *Washingtonia filifera* Ruderal Woodland**

Common Name: Ruderal Date Palm - California Fan Palm Stands

Group Assignment: G510; **Alliance Code:** A4161

Alliance Concept

The Ruderal Date Palm - California Fan Palm Stands forms an open to continuous tree canopy with an open to intermittent shrub understory. *Phoenix dactylifera* and/or *Washingtonia filifera* is dominant or co-dominant together in localized patches in DEVA, LAKE and MOJA. Elevations range from approximately 2 to 500 meters. The alliance is found primarily on stream bottoms and lowslopes springs at variable aspects. Stands occurring in the study area in the Mojave Desert and Great Basin are non-native, where the palms have been naturalizing in alkali spring and stream areas, typically from cultural plantings. Soils can be clay and are derived typically from alluvium, limestone, and sandstone. This alliance was described using some incomplete map data and classification sampling data.

Diagnostic Criteria: This alliance is characterized by an intermittent to continuous tree canopy with *Phoenix dactylifera* and/or *Washingtonia filifera* dominant or co-dominant, and ranging from 2.2 to 95 percent cover. The overall tree cover also ranges from 2.2 to 95 percent cover.

Alliance Distribution

The alliance was sampled at low elevations in DEVA at the southern end of the Black Mountains, in Saline Valley at Lower Warm Springs, and along and near Cow Creek, including at Nevares, Ratatat, Shoot-me-up Springs, and Travertine East springs, and in LAKE at the top of Rogers Wash near Echo Bay and in the Overton Wash basin. These stands are ruderal/semi-natural and typically have naturalized from cultural plantings in spring and stream areas. The palms have been mapped as individuals and as stands at the Travertine Springs complex in DEVA (Thomas 2006), where exotic palms dominated the riparian vegetation at these springs until early 2011 when the palms were mechanically removed following an autumn 2010 fire (Sada and Cooper 2012).

States: CA, NV

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (20): 322Ab, 322Ad, 322Az; Southeastern Great Basin (1): 341Fc

Park Sampling Zones: **DEVA:** Black Mtns, Death Valley, Saline Valley; **LAKE:** Echo Bay, Overton; **MOJA:** (Soda Lake)

Associations

Association Scientific Name [NVC Code]	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Washingtonia filifera</i> / spring Semi-Natural	13	x	x		
<i>Phoenix dactylifera</i> Semi-Natural [cf. CEPS009664]	8		x		

Association notes: None.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 214.1 m, Range 2 – 476 m
Aspect: Flat, Variable (1), SW (1), S (1)
Slope: Mean 5 degrees, Range 0 – 10 degrees
Macro Topography: Low level/bottom (1), Lowslope (2)

Tree Cover: Mean 64%, Range 2.2 – 95%
Shrub Cover: Mean 25.1%, Range 2.4 – 51%
Herb Cover: Mean 12.2%, Range 3 – 27%

Large Rock: 0%
Small Rock: Mean 31%, Range 3 – 80%
Fines Cover: Mean 2.6%, Range 0 – 27%
Litter Cover: Mean 5.5%, Range 0 – 61%

Geology: alluvium (17), limestone (1), sandstone (1)
Soil Texture: Clay (1)

Environment: The alliance was sampled along stream bottoms, lowslope springs, and sometimes in or near ponds or playas at low elevations with variable aspects in DEVA and LAKE. It also has been observed planted along Soda Lake and the Desert Studies Center in MOJA. Soils include clay, and they are derived from alluvium, limestone, and sandstone.

Vegetation Description

Vegetation Structure: The Alliance forms an open to continuous tree layer.

Vegetation Floristics: The dominant tree is *Phoenix dactylifera* and/or *Washingtonia filifera* in the overstory, and *Prosopis* spp. are sometimes present. The shrub layer is open to intermittent, and the herbaceous understory is sparse to open. *Pluchea sericea* and other various shrubs are sometimes present in the shrub layer.

Dynamics: More than 75 stands of *Washingtonia filifera* occur naturally in California in springs and along fault lines where water is continuously available. *Washingtonia filifera* in the three Parks was planted, and it has been naturalizing in various spring-fed and stream areas where

water is perennially available. *Phoenix dactylifera* is marginally naturalizing in riparian areas in southern California, and can draw upon limited water resources, including rare desert spring aquifers. In DEVA, date palm trees were planted in the early 1900's when Furnace Creek was diverted for ranching, and efforts to remove these trees from the Travertine Springs complex have been undertaken recently (Thomas 2006, Sada and Cooper 2012).

Classification Comments

Native stands of *Washingtonia filifera* in the Sonoran Desert are placed in the Western Interior Riparian Forest & Woodland (G797). We have placed the non-native and naturalizing stands of palm trees from the Mojave Desert and southeastern Great Basin in the Interior West Ruderal Riparian Forest & Scrub Group (G510).

Classification Confidence of Alliance: Moderate

Conservation Status Rank

Global: GNR

State (California): GNR

References

Evens et al. 2012, Keeler-Wolf et al. 1998b, Sawyer et al. 2009, Thomas 2006, VegCAMP and AIS 2013

Surveys (with Sample Sizes) Used in Description

MOJN: N=21

LAKE (n=2): LAKE9298, LAKE9414

DEVA (n=11): DEVA8011, DEVA8012, DEVA8013, DEVA8014, DEVA8015, DEVA8016, DEVA8017, DEVA8018, DEVA8019, DEVA8021, DEVA8022, DEVA8023, DEVA8024, DEVA8025, DEVA8026, DEVA8027, DEVA8028, DEVA8029, DEVA9283

MOJA (n=0)

MOJN-Johnson (n=0)

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Tree										
	<i>Washingtonia filifera</i>	67	47	24	2	95	x			x
	<i>Phoenix dactylifera</i>	43	35	30	1	95	x			
Shrub										
	<i>Pluchea sericea</i>	24	14.5	3.8	2	50				

***Tamarix* spp. Ruderal Temporarily Flooded Shrubland Alliance**

Common Name: Ruderal Tamarisk Temporarily Flooded Shrubland

Group Assignment: G510; **Alliance Code:** A0842

Alliance Concept

The Ruderal Tamarisk Temporarily Flooded Shrubland Alliance forms an open to continuous shrub layer. The emergent tree layer is typically sparse to open, and the herbaceous layer is sparse to intermittent. The alliance is found primarily along lake margins and drainage channel beds at variable aspects. Soils are derived from a variety of substrates including water and textures are variable. Elevations range from approximately 0 to 1250 meters. This alliance is defined by a non-native, naturalizing *Tamarix* species as the strong dominant in the shrub layer. Characteristic herbs include *Schismus* spp. and those often present are *Bromus rubens* and *Eriogonum deflexum*.

Diagnostic Criteria: This alliance is characterized by an open to continuous shrub layer with *Tamarix ramosissima* strongly dominant, or another naturalizing shrub *Tamarix* species may be dominant. The overall shrub cover ranges from 4.8 to 70.2 percent.

Alliance Distribution

The alliance was sampled at LAKE, DEVA and MOJA at low to high elevation riparian and wetland areas. It occurs commonly in LAKE along the edges of Lake Mead in drawdown zones and along Lake Mohave, which is a long stretch of the Colorado River behind Davis Dam. It occurs scattered in DEVA, including along Saline Valley and at a spring area (named the Cow Creek Urban site I), and scattered in MOJA including along a wash channel with former settling ponds for a mine.

States: AZ, CA, NV

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (17): 322Ab, 322Al, 322At, 322Av, 322Ay, 322Az; Southeastern Great Basin (1): 341Fc

Park Sampling Zones: **LAKE:** Callville, Cottonwood Cove, Echo Bay, Gold Butte, Overton, Parashant, Pearce Ferry, Willow Beach; **MOJA:** New York Mtns; **DEVA:** Death Valley, Saline Valley

Associations

Association Scientific Name [NVC Code]	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Tamarix</i> spp. Temporarily Flooded Ruderal [CEGL003114]	18	x	x	x	

Association Notes: None.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 357.2 m, Range 1 – 1233 m

Aspect: E (2), Flat, Variable (1), W (2), SW (4), S (3)

Slope: Mean 3.8 degrees, Range 1 – 15 degrees

Macro Topography: Channel bed (2), Lake bottom (7), Lowslope (1), Midslope (2)

Tree Cover: Mean 0.3%, Range 0 – 3%

Shrub Cover: Mean 20.1%, Range 4.8– 70.2%

Herb Cover: Mean 10.6%, Range 0.3 – 39%

Large Rock: Mean 2.6%, Range 0 – 13%

Small Rock: Mean 35%, Range 3 – 85%

Fines Cover: Mean 35.1%, Range 0 – 89%

Litter Cover: Mean 15.7%, Range 0 – 59%

Geology: alluvium (1), conglomerate (1), dacite (1), gneiss (1), limestone (1), sandstone (2), water (9)

Soil Texture: Clay (1), Loamy sand (1), Sand (3), Silty clay (1)

Environment: The alliance occurs in riparian and wetland settings in LAKE, DEVA and MOJA, including lake margins, drainage channels, and settling ponds in at low to high elevations. It often occurs in unnatural and disturbed settings such as along the drawdown zones of Lake Mead and along Lake Mojave, and disturbed stream channels and springs. Soils are derived from a variety of substrates including water and soil textures are variable.

Vegetation Description

Vegetation Structure: The Alliance forms an open to continuous shrub layer and the overall shrub cover ranges from 4.8 to 70.2 percent. The tree layer is typically sparse to open, and the herb layer is sparse to intermittent. Non-vascular plants are typically sparse.

Vegetation Floristics: A non-native naturalizing *Tamarix* species is strongly dominant in the shrub layer, especially *Tamarix ramosissima*. Other native shrubs can include *Larrea tridentata*, *Encelia farinosa*, and *Pluchea sericea*. Characteristic herbs include *Schismus* spp. and those often present are *Bromus rubens*, and *Eriogonum deflexum*.

Dynamics: *Tamarix ramosissima* and related tamarisk are highly invasive; they can develop dense stands across floodplains, stream channels, lake margins, marshy areas, and other wetlands. In the Mojave Desert, it invades native stands of *Hymenoclea salsola*, *Prosopis glandulosa*, *Pluchea sericea*, *Salix exigua*, and other shrubs. Many interacting factors facilitate tamarisk invasion, including intentional plantings for erosion control, reduced flood frequencies upon damming rivers, changing and stabilizing water flows and rates downstream from reservoirs, and increased salinity levels along the lakes and rivers from evaporating reservoirs.

The invasive stands pose significant risk to habitats and vegetation. They can form dense thickets and exclude light, nutrients, and water from other plants. Tamarisk is exceptional at drawing up and consuming water, which can lower ground water levels, and it also can cause more flooding by choking streambeds with its extensive root systems.

Classification Comments

Shrubland stands of *Tamarix* spp. that are ruderal/semi-natural and invasive have been categorized separately from the relatively non-invasive, culturally planted tree stands of *Tamarix aphylla*.

Classification Confidence of Alliance: High

Conservation Status Rank

Global: GNR

State (California): GNR

References

Buck-Diaz et al. 2012, Evens et al. 2012, Keeler-Wolf et al. 1998b, NatureServe 2012, Sawyer et al. 2009, VegCAMP and AIS 2013

Surveys (with Sample Sizes) Used in Description

MOJN: N=18

LAKE (n=15): ERVIGHav, LAKE0390, LAKE0412, LAKE0510, LAKE9217, LAKE9221, LAKE9275, LAKE9278, LAKE9405, LAKE9509, LAKE9604, LAKE9631, LMJOA044, LMJOA045, LMJOA046

DEVA (n=2): DEVA8061, DEVA8062

MOJA (n=1): MOJA9314

MOJN-Johnson (n=0)

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Shrub	<i>Tamarix ramosissima</i>	100	84	18	2	70	x	x		
	<i>Larrea tridentata</i>	38.9	1.2	0.1	0.1	0.79				
	<i>Encelia farinosa</i>	27.8	0.3	0.1	0.2	1				
	<i>Stephanomeria pauciflora</i>	27.8	0.8	0.1	0.1	0.2				
Herb	<i>Schismus</i>	72.2	21	1.8	0.2	13.8				x
	<i>Bromus rubens</i>	50	6.4	1.2	0.2	15				x
	<i>Eriogonum deflexum</i>	44.4	11	0.7	0.2	7.3				
	<i>Brassica tournefortii</i>	33.3	5	0.4	0.2	4				
	<i>Salsola</i>	33.3	5	0.3	0.2	3				
	<i>Chaenactis fremontii</i>	33.3	1	0.1	0.2	1				
	<i>Cryptantha pterocarya</i>	33.3	0.7	0.1	0.04	0.2				
	<i>Camissonia brevipes</i>	27.8	0.8	0.1	0.2	0.34				
	<i>Cryptantha barbigera</i>	27.8	0.7	0.1	0.13	0.2				
	<i>Heliotropium curassavicum</i>	27.8	0.5	0	0.02	0.2				

2. Shrub & Herb Vegetation Class

2.B.1. Mediterranean Scrub & Grassland Formation

2.B.1.Nb. California Grassland & Meadow Division

M045. California Annual & Perennial Grassland Macrogroup

G766. California Annual Grassland Group

***Amsinckia menziesii* - *Amsinckia tessellata* - *Phacelia* spp. Herbaceous Alliance**

Common Name: Fiddleneck Fields

Group Assignment: G766; **Alliance Code:** A4182

Alliance Concept

The Fiddleneck Fields Alliance forms an intermittent to continuous herbaceous layer. The shrub layer is open and the tree layer, when present, is sparse. The alliance was sampled once on a low slope with east aspect and soils derived from alkali-granite (alaskite). Elevation is 874 meters. The dominant herb is an *Amsinckia* species, including *Amsinckia tessellata*. Other herbs include *Asclepias subulata*, *Chamaesyce polycarpa*, *Chorizanthe brevicornu*, *Erodium cicutarium*, *Eschscholzia minutiflora*, *Leptosiphon aureus*, *Lupinus sparsiflorus*, *Mirabilis laevis*, *Pectocarya recurvata*, *Phacelia distans*, *Physalis hederifolia*, *Plagiobothrys* spp., *Porophyllum gracile*, *Schismus* spp., and *Stillingia linearifolia*. Associated emergent shrubs at open percent cover include *Hymenoclea salsola*, *Acamptopappus sphaerocephalus*, *Ambrosia dumosa*, *Encelia farinosa*, *Eriogonum plumatella*, *Larrea tridentata*, *Salazaria mexicana*, *Stephanomeria pauciflora*, *Tetradymia stenolepis*, *Viguiera parishii*, and *Yucca schidigera*.

Diagnostic Criteria: This alliance is characterized by an intermittent to continuous herbaceous layer with an *Amsinckia* species dominant or co-dominant, including *Amsinckia tessellata* and *A. menziesii*. The overall herbaceous cover is 67 percent cover in the one stand sampled.

Alliance Distribution

The alliance was sampled once in the study area at LAKE in the south east of Spirit Mountain at mid elevation. Other stands have been observed in lower elevations of DEVA, but have not been sampled.

States: NV, (CA)

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (1): 322Am

Park Sampling Zones: LAKE: Katherine

Associations

Association Scientific Name [NVC Code]	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Amsinckia tessellata</i>	1	x			

Association Notes: None.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: 874 m

Aspect: E (1)

Slope: 3 degrees

Macro Topography: Lowslope (1)

Tree Cover: 0%

Shrub Cover: 4%

Herb Cover: 67%

Large Rock: 0%

Small Rock: 85%

Fines Cover: 4%

Litter Cover: 6%

Geology: alkali-granite (alaskite) (1)

Soil Texture: (unknown)

Environment: The alliance was sampled once at mid elevations in LAKE in a burn scar on a lowslope with an east aspect. Soils are derived from alkali-granite (alaskite).

Vegetation Description

Vegetation Structure: The alliance forms a continuous herbaceous layer, and the overall herbaceous cover is 67 percent cover. The shrub layer is sparse to open. The tree layer and non-vascular plants, when present, are sparse.

Vegetation Floristics: The dominant herb is an *Amsinckia* species, *A. tessellata*, and other herbs include *Asclepias subulata*, *Chamaesyce polycarpa*, *Chorizanthe brevicornu*, *Erodium cicutarium*, *Eschscholzia minutiflora*, *Leptosiphon aureus*, *Lupinus sparsiflorus*, *Mirabilis laevis*, *Pectocarya recurvata*, *Phacelia distans*, *Physalis hederifolia*, *Plagiobothrys* spp., *Porophyllum gracile*, *Schismus* spp., and *Stillingia linearifolia*. Associated emergent shrubs at open percent cover include *Hymenoclea salsola*, *Acamptopappus sphaerocephalus*, *Ambrosia dumosa*, *Encelia farinosa*, *Eriogonum plumatella*, *Larrea tridentata*, *Salazaria mexicana*, *Stephanomeria pauciflora*, *Tetradymia stenolepis*, *Viguiera parishii*, and *Yucca schidigera*.

Dynamics: *Amsinckia tessellata* is well-adapted to disturbance and climate fluctuations due to its ability to bank seeds and germinate quickly during high rainfall years. Stand size and appearance may vary depending on the amount and timing of precipitation.

Classification Comments

Further review of NVC groups is necessary to determine the best placement of annual herbaceous types since three groups of ruderal (semi-natural) herbaceous stands exist with related concepts: California Ruderal Grassland & Forb Meadow Group (G497), North American Warm Desert Ruderal Scrub & Grassland Group (G677), and Great Basin & Intermountain Ruderal Dry Shrubland & Grassland Group (G600).

Classification Confidence of Alliance: Moderate

Conservation Status Rank

Global: G4

State (California): S4

References

Buck-Diaz et al. 2012, Evens et al. 2012, Sawyer et al. 2009, VegCAMP and AIS 2013

Surveys (with Sample Sizes) Used in Description

MOJN: N=1

LAKE (n=1): LAKE9524

DEVA (n=0)

MOJA (n=0)

MOJN-Johnson (n=0)

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Shrub	<i>Hymenoclea salsola</i>	100	50	2	2	2	x	x		
	<i>Acamptopappus sphaerocephalus</i>	100	5	0.2	0.2	0.2	x			
	<i>Ambrosia dumosa</i>	100	5	0.2	0.2	0.2	x			
	<i>Encelia farinosa</i>	100	5	0.2	0.2	0.2	x			
	<i>Eriogonum plumatella</i>	100	5	0.2	0.2	0.2	x			
	<i>Larrea tridentata</i>	100	5	0.2	0.2	0.2	x			
	<i>Salazaria mexicana</i>	100	5	0.2	0.2	0.2	x			
	<i>Stephanomeria pauciflora</i>	100	5	0.2	0.2	0.2	x			
	<i>Tetradymia stenolepis</i>	100	5	0.2	0.2	0.2	x			
	<i>Viguiera parishii</i>	100	5	0.2	0.2	0.2	x			
	<i>Yucca schidigera</i>	100	5	0.2	0.2	0.2	x			
Herb	<i>Amsinckia tessellata</i>	100	88	60	60	60	x	x		
	<i>Erodium cicutarium</i>	100	4.4	3	3	3	x			
	<i>Lupinus sparsiflorus</i>	100	1.5	1	1	1	x			
	<i>Pectocarya recurvata</i>	100	1.5	1	1	1	x			
	<i>Schismus</i>	100	1.5	1	1	1	x			
	<i>Asclepias subulata</i>	100	0.3	0.2	0.2	0.2	x			
	<i>Chamaesyce polycarpa</i>	100	0.3	0.2	0.2	0.2	x			
	<i>Chorizanthe brevicornu</i>	100	0.3	0.2	0.2	0.2	x			
	<i>Eschscholzia minutiflora</i>	100	0.3	0.2	0.2	0.2	x			
	<i>Leptosiphon aureus</i>	100	0.3	0.2	0.2	0.2	x			
	<i>Mirabilis laevis</i>	100	0.3	0.2	0.2	0.2	x			
	<i>Phacelia distans</i>	100	0.3	0.2	0.2	0.2	x			
	<i>Physalis hederifolia</i>	100	0.3	0.2	0.2	0.2	x			
	<i>Plagiobothrys</i>	100	0.3	0.2	0.2	0.2	x			
	<i>Porophyllum gracile</i>	100	0.3	0.2	0.2	0.2	x			
	<i>Stillingia linearifolia</i>	100	0.3	0.2	0.2	0.2	x			

2. Shrub & Herb Vegetation Class

2.B.2. Temperate Grassland & Shrubland Formation

2.B.2.Nd. Western North American Interior Sclerophyllous Chaparral Division

M091. Warm Interior Chaparral Macrogroup

G281. Western Madrean Chaparral Group

***Quercus turbinella* Shrubland Alliance**

Common Name: Sonoran Scrub Oak Chaparral

Group Assignment: G281; **Alliance Code:** A0793

Alliance Concept

The Sonoran Live Oak Scrub Alliance forms an open to intermittent shrub layer. The emergent tree layer is typically sparse to open, and the herbaceous layer is sparse to open. The alliance is found primarily in rocky boulder outcrops, channel beds, and midslopes at all aspects, often in areas with exposed bedrock and boulders. Soils are derived from alkali-granite (alaskite) and granodiorite, and textures include medium to coarse sand. Elevations range from approximately 950 to 1850 meters. Dominant and characteristic shrubs include *Gutierrezia sarothrae* and *Quercus turbinella*. Those often present include *Eriogonum wrightii*, *Ericameria linearifolia*, *Lotus rigidus*, and *Eriogonum fasciculatum*. The tree layer is emergent and often includes *Juniperus californica*, *Pinus edulis*, or *Pinus monophylla*. The herbaceous layer includes *Achnatherum speciosum*, *Artemisia ludoviciana*, and *Sphaeralcea ambigua*.

Diagnostic Criteria: This alliance is characterized by an open to intermittent shrub layer with *Quercus turbinella* as the dominant. The overall shrub cover ranges from 3.6 to 59 percent.

Alliance Distribution

The alliance was sampled in the Newberry Mountains in LAKE and in the New York Mountains in MOJA at high elevations and at mid to high elevations. Stands also have been observed in the Mid Hills in MOJA, and stands were mapped as an alliance complex with *Arctostaphylos* in LAKE along the border with Grand Canyon - Parashant National Monument.

States: (AZ), CA, NV

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (19): 322Al, 322Am, (322Av)

Park Sampling Zones: **LAKE:** Bridge Canyon, Juniper Mine, Katherine, (Parashant), Searchlight SE, Spirit Mountain; **MOJA:** New York Mtns (and Mid Hills from observations)

Associations

Association Scientific Name	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Quercus turbinella</i> – <i>Baccharis sergiloides</i>	8			x	
<i>Quercus turbinella</i> – <i>Juniperus californica</i> – <i>Eriogonum</i> spp.	11	x			

Association Notes: None.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 1332.9 m, Range 988 – 1834 m

Aspect: N (7), NNW (1), NE (2), NW (3), V (1), WSW (1), S (4)

Slope: Mean 17.1 degrees, Range 2 – 40 degrees

Macro Topography: Channel bed (2), Midslope (3)

Tree Cover: Mean 3.1%, Range 0 – 15%

Shrub Cover: Mean 19.7%, Range 3.6 – 59%

Herb Cover: Mean 5.5%, Range 0.7 – 10.4%

Large Rock: Mean 54.4%, Range 0 – 76%

Small Rock: Mean 34.7%, Range 7 – 86%

Fines Cover: Mean 3.6%, Range 1 – 10%

Litter Cover: Mean 4.9%, Range 1.2 – 14%

Geology: alkali-granite (alaskite) (11), granodiorite (8)

Soil Texture: Coarse sand (1), Medium sand (5), Sand (2)

Environment: The alliance occurs at all aspects in rocky boulder outcrops, intermittently flooded canyons and drainages at mid to high elevations, often in areas with exposed bedrock. Soils are medium to coarse sand derived from alkali-granite (alaskite) and granodiorite.

Vegetation Description

Vegetation Structure: The Alliance forms an open to intermittent shrub layer and the overall shrub cover ranges from 3.6 to 59 percent. The tree layer is typically sparse to open, and the herb layer is sparse to open. Non-vascular plants are typically sparse to open.

Vegetation Floristics: Dominant and characteristic shrubs include *Gutierrezia sarothrae* and *Quercus turbinella*. Those often present include *Eriogonum wrightii*, *Ericameria linearifolia*, *Lotus rigidus*, and *Eriogonum fasciculatum*. The tree layer is emergent and typically or often includes *Juniperus californica*. The herbaceous layer often includes *Achnatherum speciosum*, *Artemisia ludoviciana*, and *Sphaeralcea ambigua*.

Dynamics: *Quercus turbinella* occurs in desert mountain areas with pronounced summer rainfall, including disjunct stands in the New York Mountains and Mid Hills at MOJA and Newberry Mountains at LAKE. Stands can recover after fire with vigorous resprouting, as are seen in stands along the Mid Hills after the Hackberry Complex Fire.

Classification Comments

None.

Classification Confidence of Alliance: High

Conservation Status Rank

Global: G4

State (California): S1

References

Evens 2000, NatureServe 2012, Sawyer et al. 2009, Thomas et al. 2004

Surveys (with Sample Sizes) Used in Description

MOJN: N=19

LAKE (n=11): LAKE9518, LAKE9520, LAKE9620, LAMEN094, LAMEN095, LAMEN099, LAMEN100, LAMEN102, LAMEN108, LAMEN114, LAMEN115

DEVA (n=0)

MOJA (n=8): MOJA9685, MOJA9686, MOJAE140, MOJAE141, MOJAE143, MOJAE144, MOJAE145, MOJAE146

MOJN-Johnson (n=0)

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Tree										
	<i>Juniperus californica</i>	57.9	54	2.4	0.24	15				x
	<i>Pinus monophylla</i>	31.6	14	0.2	0.03	1				
	<i>Pinus edulis</i>	26.3	14	0.2	0.2	1.1				
Shrub										
	<i>Quercus turbinella</i>	100	38	7.9	0.59	40	x		x	
	<i>Gutierrezia sarothrae</i>	84.2	2.1	0.4	0.11	2	x			
	<i>Eriogonum wrightii</i>	73.7	2.6	0.3	0.05	1.82				x
	<i>Ericameria linearifolia</i>	68.4	2.4	0.4	0.2	2.17				x
	<i>Lotus rigidus</i>	68.4	0.8	0.1	0.06	0.53				x
	<i>Eriogonum fasciculatum</i>	57.9	9	1.3	0.2	4.84				x
	<i>Baccharis sergiloides</i>	47.4	9.8	1.9	0.2	10				
	<i>Rhus trilobata</i>	47.4	4.3	0.8	0.2	3				
	<i>Yucca schidigera</i>	36.8	2.5	0.3	0.2	2.51				
	<i>Ephedra nevadensis</i>	36.8	1.2	0.2	0.05	1.25				
	<i>Viguiera parishii</i>	36.8	1	0.1	0.2	0.99				
	<i>Prunus fasciculata</i>	36.8	0.6	0.1	0.05	1.1				
	<i>Cylindropuntia acanthocarpa</i>	36.8	0.5	0.1	0.03	1				
	<i>Yucca baccata</i>	36.8	0.7	0.1	0.2	0.2				
	<i>Ericameria cuneata</i>	36.8	0.3	0	0.04	0.2				
	<i>Keckiella antirrhinoides</i>	31.6	4.8	0.9	0.45	12				
	<i>Fallugia paradoxa</i>	31.6	2.7	0.6	0.2	4				
	<i>Ferocactus cylindraceus</i>	31.6	1.4	0.2	0.2	1.32				
	<i>Opuntia basilaris</i>	31.6	0.3	0	0.03	0.2				
	<i>Eriogonum heermannii</i>	26.3	1.2	0.2	0.2	3.01				
	<i>Nolina bigelovii</i>	26.3	1.6	0.2	0.2	2.07				
Herb										
	<i>Achnatherum speciosum</i>	73.7	29	0.5	0.19	2.53				x
	<i>Artemisia ludoviciana</i>	57.9	5.8	0.2	0.03	1.1				x
	<i>Sphaeralcea ambigua</i>	52.6	5.8	0.1	0.07	0.2				x
	<i>Bromus rubens</i>	47.4	5.6	0.2	0.2	2				
	<i>Elymus elymoides</i>	47.4	6.1	0.1	0.03	0.51				
	<i>Bouteloua curtipendula</i>	36.8	3	0.1	0.08	0.2				
	<i>Aristida purpurea</i>	36.8	1.9	0	0.01	0.2				
	<i>Bromus diandrus</i>	31.6	2.7	0.1	0.2	0.2				
	<i>Pellaea mucronata</i>	26.3	1.6	0.1	0.2	0.2				
	<i>Cirsium neomexicanum</i>	26.3	1	0	0.01	0.2				
	<i>Arabis perennans</i>	26.3	1.1	0	0.01	0.2				
	<i>Porophyllum gracile</i>	26.3	1.3	0	0.01	0.2				
Non-vascular										
	Standing snag	42.1	42	0.5	0.29	3.49				
	Unknown Lichen	42.1	24	0.2	0.4	0.4				
	Unknown Moss	36.8	10	0.1	0.2	1				

2. Shrub & Herb Vegetation Class

2.C.4. Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland Formation

2.C.4.Nb. Western North American Freshwater Shrubland, Wet Meadow & Marsh Division

M301. Western North American Ruderal Wet Shrubland, Meadow & Marsh

G524. Western North American Ruderal Wet Shrubland, Meadow & Marsh

***Phragmites australis* - *Arundo donax* - *Alopecurus pratensis* Native & Semi-native Flooded Herbaceous Alliance**

Common Name: Western Common Reed Marsh

Group Assignment: G524; **Alliance Code:** A3847

Alliance Concept

The Western Common Reed Marsh Alliance forms an open to continuous herbaceous layer. The shrub and tree layers are open. The alliance is typically found in washes and wetlands at low elevations. It is found primarily on low levels and bottoms at northeast to south aspects. Soils are derived from a variety of substrates including alluvium, sandstone and schist and textures are variable. Elevations range from approximately 190 to 500 meters. The dominant herb is *Phragmites australis*, and *Distichlis spicata* is often present. Commonly associated emergent shrubs at sparse cover include *Suaeda moquinii*.

Diagnostic Criteria: This alliance is characterized by an open to continuous herbaceous layer dominated by *Phragmites australis*. The overall herbaceous cover ranges from 23 to 90 percent cover.

Alliance Distribution

The alliance was sampled at all three Parks at low elevations. Small native stands occur in the Argus and Coso Ranges. It was sampled near Salt Lake and Saratoga Spring in DEVA and at the edge of Soda Lake in MOJA. In LAKE a stand sampled occurs in a concrete channel at the west end of the lake near Northshore Rd. and near Salt Spring, and other stands have been observed along Las Vegas Wash.

States: AZ, CA, NV

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (5): 322Ab, 322Ad, 322Ai, 322Av, 322Az; Southeastern Great Basin (1): 341Fc

Park Sampling Zones: **DEVA:** Black Mtns, Saline Valley, Shoshone; **LAKE:** Lakeshore, Temple Bar; **MOJA:** Soda Lake

Associations

Association Scientific Name [NVC Code]	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Phragmites australis</i> Mojave [cf. CEGLO01475]	6	x	x	x	

Association Notes: None.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 351.8 m, Range 191 – 499 m
Aspect: NE (1), E (3), S (2)
Slope: Mean 1.3 degrees, Range 1 – 2 degrees
Macro Topography: Low level/bottom (3)

Tree Cover: Mean 0.4%, Range 0 – 2%
Shrub Cover: Mean 1.7%, Range 0 – 6.4%
Herb Cover: Mean 70.2%, Range 23 – 90%

Large Rock: Mean 0%, Range 0 – 0.2%
Small Rock: Mean 0.2%, Range 0 – 1%
Fines Cover: Mean 67.3%, Range 4 – 87.5%
Litter Cover: Mean 14%, Range 0 – 40%

Geology: alluvium (4), sandstone (1), schist (1)
Soil Texture: Clay (1), Medium silt (2), Sandy loam (2)

Environment: The alliance is typically found at low elevations in washes and wetlands, which have high water tables. It is often found in semi-permanently flooded and slightly brackish marsh areas and spring sites. It is primarily found on low levels and bottoms with a northeast to south aspect. The soil is derived from alluvium, sandstone and schist with variable textures.

Vegetation Description

Vegetation Structure: The alliance forms an open to continuous herbaceous layer, and the overall herbaceous cover ranges from 23 to 90 percent cover. The tree and shrub layers are typically sparse to open. Non-vascular plants, when present, are sparse.

Vegetation Floristics: The dominant herb is *Phragmites australis*. Those often present include *Distichlis spicata*. The shrub layer is emergent and typically or often includes *Suaeda moquinii*.

Dynamics: *Phragmites australis* is dominant in the herbaceous layer in wetland areas. The USFWS Wetland Inventory Recognizes *Phragmites australis* as a FACW plant. The alliance is wide spread and acts differently in various regions. In the study area, stands are native and limited to naturally occurring, unmanaged freshwater and alkaline wetland sites.

Classification Comments

Most *Phragmites australis* associations are currently listed in the Western North American Ruderal Wet Shrubland, Meadow & Marsh Group (G524) in the NVC hierarchy. However, we have classified the associations in the Mojave Desert Network of parks in the Arid West Interior

Freshwater Emergent Marsh Group (G531) because these associations appear to be native and naturally occurring in this region.

Classification Confidence of Alliance: High

Conservation Status Rank

Global: G5

State (California): S4?

References

Hickson and Keeler-Wolf 2007, Keeler-Wolf and Vaghti 2000, NatureServe 2012, Sawyer et al. 2009, VegCAMP and AIS 2013

Surveys (with Sample Sizes) Used in Description

MOJN: N=6

LAKE (n=2): LAKE9537, LAKE9638

DEVA (n=3): DEVA9620, MOJC0045, MOJC0052

MOJA (n=1): MOJC0056

MOJN-Johnson (n=0)

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Shrub	<i>Suaeda moquinii</i>	50	26	0.2	0.2	0.5				x
Herb	<i>Phragmites australis</i>	100	81	62	15	90	x	x		
	<i>Distichlis spicata</i>	50	12	5.7	2	20				x
	<i>Juncus cooperi</i>	33	3.4	2.5	5	10				
	<i>Typha</i>	33	1.4	1.2	2	5				
	<i>Sporobolus airoides</i>	33	1.3	0.8	1.5	3				
	<i>Nitrophila occidentalis</i>	33	0.2	0.1	0.2	0.5				
	<i>Schismus</i>	33	0.1	0.1	0.2	0.2				

2. Shrub & Herb Vegetation Class

2.C.4. Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland Formation

2.C.4.Nb. Western North American Freshwater Shrubland, Wet Meadow & Marsh Division

M888. Arid West Interior Freshwater Emergent Marsh Macrogroup

G531. Arid West Interior Freshwater Emergent Marsh Group

***Cladium californicum* Alkaline Seep Alliance**

Common Name: California Sawgrass Alkaline Seep

Group Assignment: G531; **Alliance Code:** A4164

Alliance Concept

The California Sawgrass Alkaline Seep Alliance forms an intermittent to continuous herbaceous layer. The shrub layer is open and the tree layer, when present, is sparse. Soils are alluvium or derived from sandstone. Stands occur in alkali springs along slopes and alkali marshes and washes with carbonate rock water discharges at low elevation. Elevation ranges from approximately 220 to 440 meters. The dominant herb is *Cladium californicum*, and other herbs include *Anemopsis californica*, *Cirsium neomexicanum*, *Distichlis spicata*, *Eleocharis rostellata*, *Juncus arcticus*, *Samolus valerandi* ssp. *parviflorus*, *Schoenoplectus americanus*, and *Solidago spectabilis*. Associated emergent shrubs at sparse to open cover include *Pluchea sericea*, *Allenrolfea occidentalis*, and *Vitis arizonica*.

Diagnostic Criteria: This alliance is characterized by a continuous herbaceous layer dominated by *Cladium californicum*. Other herbs present in one sample include *Anemopsis californica*, *Cirsium neomexicanum*, *Distichlis spicata*, *Eleocharis rostellata*, *Juncus arcticus*, *Samolus valerandi* ssp. *parviflorus*, *Schoenoplectus americanus*, and *Solidago spectabilis*. The overall herbaceous cover ranges from 85 to 97 percent cover.

Alliance Distribution

The alliance was sampled at low elevations, including at Rogers Wash near Echo Bay in LAKE and at Ratat Spring in DEVA.

States: CA, NV

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (2): 322Ab, 322Az

Park Sampling Zones: LAKE: Echo Bay; DEVA: Death Valley

Associations

Association Scientific Name [NVC Code]	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Cladium californicum</i> Seep (provisional) [CEGL009683]	2	x	x		

Association Notes: None.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 331.7 m, Range 220 – 443 m

Aspect: (unknown)

Slope: (unknown)

Macro Topography: (unknown)

Tree Cover: Mean 0%, Range 0 – 0%

Shrub Cover: Mean 3.0%, Range 0 – 6.1%

Herb Cover: Mean 91.2%, Range 85 – 97.4%

Large Rock: Mean %, Range – % (unknown)

Small Rock: Mean %, Range – % (unknown)

Fines Cover: Mean 0%, Range 0 – 0%

Litter Cover: Mean 0%, Range 0 – 0%

Geology: sandstone (1)

Soil Texture: (unknown)

Environment: The alliance occurs at low elevations at alkali springs along slopes and alkali marshes and washes, which have water discharges from carbonate rock aquifers. Soils are alluvium or derived from sandstone.

Vegetation Description

Vegetation Structure: The alliance forms a continuous herbaceous layer and the overall herbaceous cover ranges from 85 to 97 percent cover. The shrub layer is sparse to open. The tree layer and non-vascular plants, when present, are sparse.

Vegetation Floristics: The dominant herb is *Cladium californicum*, and other herbs present in one sample include *Anemopsis californica*, *Cirsium neomexicanum*, *Distichlis spicata*, *Eleocharis rostellata*, *Juncus arcticus*, *Samolus valerandi* ssp. *parviflorus*, *Schoenoplectus americanus*, and *Solidago spectabilis*. The shrub layer is emergent, sparse, and can include *Pluchea sericea*, *Allenrolfea occidentalis*, and *Vitis arizonica*.

Dynamics: *Cladium californicum* is tolerant of alkalinity, occurring along alkali springs and washes with calcareous water discharges as small stands in fine-scale mosaics with other herbs, shrubs and trees. However, it also is found in freshwater seeps, along with *Schoenoplectus americanus*.

Classification Comments

Stands of *Cladium californicum* are rare, and occur in a matrix with other wetland herbaceous and shrubland vegetation. The placement of this alliance in the NVC hierarchy is uncertain

because of its rarity and discontinuous distribution in desert seeps and spring-fed washes of Arizona to California and Nevada.

Classification Confidence of Alliance: Low

Conservation Status Rank

Global: G2

State (California): S1?

References

cf. NatureServe 2010

Surveys (with Sample Sizes) Used in Description

MOJN: N=2

LAKE (n=1): LMJOA033

DEVA (n=1): DEVA8051

MOJA (n=0)

MOJN-Johnson (n=0)

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Shrub	<i>Pluchea sericea</i>	50	30	1.9	3.7	3.7				x
	<i>Allenrolfea occidentalis</i>	50	14	0.9	1.7	1.7				x
	<i>Vitis arizonica</i>	50	5.7	0.3	0.7	0.7				x
Herb	<i>Cladium californicum</i>	100	97	88	85	91	x	x		
	<i>Distichlis spicata</i>	50	0.7	0.6	1.3	1.3				x
	<i>Eleocharis rostellata</i>	50	0.5	0.5	1	1				x
	<i>Anemopsis californica</i>	50	0.4	0.3	0.7	0.7				x
	<i>Cirsium neomexicanum</i>	50	0.4	0.3	0.7	0.7				x
	<i>Juncus arcticus</i>	50	0.4	0.3	0.7	0.7				x
	<i>Samolus valerandi</i> ssp. <i>parviflorus</i>	50	0.4	0.3	0.7	0.7				x
	<i>Solidago spectabilis</i> var. <i>confinis</i>	50	0.4	0.3	0.7	0.7				x
	<i>Schoenoplectus americanus</i>	50	0.2	0.2	0.3	0.3				x

***Typha domingensis* - *Typha latifolia* - *Typha angustifolia* Western Herbaceous Emergent Alliance**

Common Name: Western Emergent Cattail Marsh

Group Assignment: G531; **Alliance Code:** A3896

Alliance Concept

The Western Emergent Cattail Marsh Alliance forms a continuous herbaceous layer. The emergent shrub and tree layers, when present, are sparse to open. The alliance occurs in semi-permanently flooded marshes, drainage channels, and spring sites. It was sampled on low levels and bottoms to high slopes at east and southeast aspects. Soils are derived from alluvium, and textures include clay and muck. Elevations range from approximately -80 to 1500 meters. A *Typha* species is dominant or co-dominant in the herbaceous layer, and herbs often present include *Sporobolus airoides*. Those herbs sometimes present are *Anemopsis californica*, *Artemisia ludoviciana*, *Distichlis spicata*, *Juncus cooperi*, and *Polypogon monspeliensis*. Emergent trees at sparse cover sometimes include *Yucca brevifolia*, and emergent shrubs at sparse to open cover sometimes include *Baccharis sergiloides*, *Gutierrezia sarothrae*, and *Tamarix ramosissima*.

Diagnostic Criteria: This alliance is characterized by a continuous herbaceous layer with *Typha* spp. dominant or co-dominant. The overall herbaceous cover ranges from 71 to 98 percent cover.

Alliance Distribution

The alliance was sampled east of the Panamint Range at the end of Borax Well Road in DEVA, and in a small valley in the New York Mountains in MOJA. It also was mapped and described at the Travertine Springs complex and at various other springs including at Cow Creek Urban, Nevares, and Unnamed Well A springs in DEVA (Dilts and Weisberg 2010, Sada and Cooper 2012, Thomas 2006), and it has been observed in the Granite Mountains in MOJA. Small stands have also been observed during map accuracy assessment training at LAKE in riparian washes, including at Roger's Wash. It is found at low to upper elevations.

States: CA, (NV)

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (3): 322Ab, 322Al, (322Az); Southeastern Great Basin (1): 341Fc

Park Sampling Zones: **DEVA:** Saline Valley, Death Valley; **MOJA:** New York Mtns (Granite Mtns); **LAKE:** (Echo Bay)

Associations

Association Scientific Name [NVC Code]	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Typha domingensis</i> [CEGL001845]	3		x		
<i>Typha latifolia</i> [CEGL002010]	1			x	

Association Notes: None.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 702 m, Range -80 – 1484 m
Aspect: E (1), SE (1)
Slope: Mean 1 degrees, Range 1 – 1 degrees
Macro Topography: High slope (1), Low level/bottom (1)

Tree Cover: Mean 0.1%, Range 0 – 0.5%
Shrub Cover: Mean 0.7%, Range 0 – 2.6%
Herb Cover: Mean 85.5%, Range 71 – 98%

Large Rock: Mean 0.5%, Range 0 – 1%
Small Rock: Mean 5.1%, Range 0.2 – 10%
Fines Cover: Mean 33.6%, Range 0.2 – 67%
Litter Cover: Mean 60.7%, Range 22 – 99.4%

Geology: alluvium (2)
Soil Texture: Clay (1), Muck (1)

Environment: The alliance occurs in seasonally wet and saturated areas, including at alkaline springs and drainage channels in DEVA, LAKE, and MOJA. Water can be ponded or slow-moving along channels dominated by *Typha* spp. The alliance is found at low to upper elevations on low to high slopes with east to southeast aspects. Soils are clay and derived from alluvium.

Vegetation Description

Vegetation Structure: The alliance forms a continuous herbaceous layer and the overall herbaceous cover ranges from 71 to 90 percent cover. The shrub and tree layers, when present, are typically sparse to open. Non-vascular plants, when present, are sparse.

Vegetation Floristics: A *Typha* species is dominant or co-dominant in the herbaceous layer, and those herbs often present include *Sporobolus airoides*. Herbs sometimes present are *Anemopsis californica*, *Artemisia ludoviciana*, *Distichlis spicata*, *Juncus cooperi*, and *Polypogon monspeliensis*. The tree layer is emergent and sometimes includes *Yucca brevifolia*. The shrub layer is emergent and sometimes includes *Baccharis sergiloides*, *Gutierrezia sarothrae*, and *Tamarix ramosissima*.

Dynamics: *Typha domingensis* can tolerate deeper and more saline soils than *T. latifolia*. Stands with *Typha domingensis* occur in DEVA and LAKE, and stands with both *T. domingensis* and *T. latifolia* occur in MOJA.

Classification Comments

None.

Classification Confidence of Alliance: High

Conservation Status Rank

Global: G5

State (California): S5

References

Buck-Diaz et al. 2012, Dilts and Weisberg 2010, Junak et al. 2007, Sada and Cooper 2012, Sawyer et al. 2009, VegCAMP and AIS 2013

Surveys (with Sample Sizes) Used in Description

MOJN: N=4

LAKE (n=0)

DEVA (n=3): DEVA0399, DEVA8095, DEVA8096

MOJA (n=1): MOJA9235

MOJN-Johnson (n=0)

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Tree	<i>Yucca brevifolia</i>	25	25	0.1	0.5	0.5				
Shrub	<i>Tamarix ramosissima</i>	25	38	0.4	2	2				
	<i>Baccharis sergiloides</i>	25	5.7	0.04	0.2	0.2				
	<i>Gutierrezia sarothrae</i>	25	5.7	0.04	0.2	0.2				
Herb	<i>Typha</i>	100	96.5	81.2	65	97	x	x		
	<i>Sporobolus airoides</i>	50	1.8	1.5	0.2	6				x
	<i>Distichlis spicata</i>	25	1.0	0.8	3	3				
	<i>Anemopsis californica</i>	25	0.6	0.5	2	2				
	<i>Artemisia ludoviciana</i>	25	0.01	0.04	0.2	0.2				
	<i>Juncus cooperi</i>	25	0.01	0.04	0.2	0.2				
	<i>Polypogon monspeliensis</i>	25	0.01	0.04	0.2	0.2				x

2. Shrub & Herb Vegetation Class

2.C.4. Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland Formation

2.C.4.Nc. Southwestern North American Warm Desert Freshwater Bosque & Marsh Division

M076. Warm Desert Lowland Freshwater Shrubland, Meadow & Marsh Macrogroup

G533. North American Warm Desert Riparian Low Bosque & Shrubland Group

***Baccharis emoryi* - *Baccharis sergiloides* Dry Wash Shrubland**

Common Name: Baccharis Dry Wash Shrubland

Group Assignment: G533; **Alliance Code:** A3874

Alliance Concept

The Baccharis Dry Wash Shrubland Alliance forms an open to continuous shrub layer. The emergent tree layer is typically sparse to open, and the herbaceous layer is sparse to continuous. The alliance is found primarily on seasonally flooded channel beds but can also be found on spring-fed midslopes to summits at all aspects. Soils are derived from a variety of and textures are variable ranging from sand to clay. Elevations range from approximately 550 to 1550 meters. *Baccharis sergiloides* is dominant or co-dominant in the shrub layer, and those that are often present include *Acacia greggii*, *Eriogonum fasciculatum*, and *Lotus rigidus*. Herbs that are often present are *Bromus rubens* and *Erodium cicutarium*. Commonly associated non-vascular plants include mosses.

Diagnostic Criteria: This alliance is characterized by an open to continuous shrub layer with *Baccharis sergiloides* dominant or co-dominant. The overall shrub cover ranges from 9 to 91 percent.

Alliance Distribution

The alliance is well-defined in sampling at all three Parks. It is scattered throughout MOJA in the Granite, Providence, and New York Mountains and in DEVA in the Funeral and Grapevine mountains at mid to high elevations. It also occurs in the Black Mountains and Newberry Mountains of LAKE.

States: AZ, CA, NV

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (34): 322Ab, 322Ad, 322Af, 322Ai, 322Al, 322Am, 322Av; Southeastern Great Basin (1): 341Fd

Park Sampling Zones: **DEVA:** Death Valley, Funeral Mtns, Grapevine Mtns, Owlshead Mtns; **LAKE:** Katherine, Temple Bar; **MOJA:** Granite Mtns, New York Mtns, Providence Mtns, Van Winkle Mtn, Woods Mtns

Associations

Association Scientific Name [NVC Code]	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Baccharis sergiloides</i> [CEGL002953]	20	x	x	x	
<i>Baccharis sergiloides</i> (alliance)	2	x			
<i>Baccharis sergiloides</i> / <i>Muhlenbergia rigens</i>	4			x	
<i>Baccharis sergiloides</i> / <i>Typha domingensis</i> (provisional)	2		x	x	
<i>Baccharis sergiloides</i> – <i>Prunus fasciculata</i> – <i>Rhus trilobata</i>	7			x	

Association Notes: Two samples were classified to the alliance level only in which *Sporobolus airoides* occurred with *Baccharis sergiloides*.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 1118.2 m, Range 578 – 1508 m

Aspect: N (2), NE (2), E (4), NW (5), SE (4), SW (7), S (5)

Slope: Mean 6.5 degrees, Range 1 – 20 degrees

Macro Topography: Channel bed (11), High level/summit (1), High slope (3), Midslope (4)

Tree Cover: Mean 0.7%, Range 0 – 5%

Shrub Cover: Mean 44.0%, Range 9.2 – 91.2%

Herb Cover: Mean 17.4%, Range 1 – 80%

Large Rock: Mean 26%, Range 0.2 – 80%

Small Rock: Mean 33.4%, Range 3 – 76%

Fines Cover: Mean 18.4%, Range 1 – 62%

Litter Cover: Mean 19%, Range 1 – 81%

Geology: alkali-granite (alaskite) (8), alluvium (1), conglomerate (1), gneiss (2), granodiorite (16), plutonic rock (phaneritic) (1), rhyolite (2), sandstone (3), schist (1)

Soil Texture: Clay (1), Clay loam (3), Coarse sand (3), Loamy sand (4), Medium sand (6), Medium to very fine sandy loam (1), Sand (8), Sandy loam (1), Silty clay (1)

Environment: The alliance occurs in springs, streams, washes, and drainages at mid to high elevations. The alliance is found primarily on channel beds but can also be found on spring-fed midslopes to summits at all aspects. Soils are derived from a variety of and textures are variable ranging from sand to clay.

Vegetation Description

Vegetation Structure: The Alliance forms an open to continuous shrub layer and the overall shrub cover ranges from 9.2 to 91.2 percent. The tree layer is typically sparse to open, and the herb layer is sparse to continuous. Non-vascular plants are typically sparse to open.

Vegetation Floristics: *Baccharis sergiloides* is the dominant and characteristic shrub, and those that are often present include *Acacia greggii*, *Eriogonum fasciculatum*, and *Lotus rigidus*. Herbs that are often present are *Bromus rubens* and *Erodium cicutarium*. Commonly associated non-vascular plants include unknown moss.

Dynamics: *Baccharis sergiloides* occurs commonly in the Mojave Desert and adjacent semi-desert ecoregions of California along streams, seeps, and springs where water is seasonally present and available year-round with ground water close to the ground.

Classification Comments

None.

Classification Confidence of Alliance: High

Conservation Status Rank

Global: G4

State (California): S3

References

Evens 2000, Evens et al. 2012, Keeler-Wolf 2007b, Keeler-Wolf and Thomas 2000, Keeler-Wolf et al. 1998b, Sawyer et al. 2009, VegCAMP and AIS 2013

Surveys (with Sample Sizes) Used in Description

MOJN: N=35

LAKE (n=9): LAKE0619, LAKE9525, LAKE9708, LMFMH065, LMJOS026, LMJOS027, LMJOS030, LMJOS031, LMJOS032

DEVA (n=5): DEVA9189, DEVA9614, DEVA9630, DEVA9920, DEVA9925

MOJA (n=21): MOJA0428, MOJA0919, MOJA0925, MOJA9132, MOJA9413, MOJA9418, MOJA9421, MOJA9452, MOJA9590, MOJA9908, MOJA9917, MOJAE003, MOJAE008, MOJAE196, MOJAE198, MOJAE201, MOJAE203, MOJAE204, MOJAE237, MOJAE238, MOJAE239

MOJN-Johnson (n=0)

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Shrub										
	<i>Baccharis sergiloides</i>	100	69	30	5.6	75	x	x		
	<i>Acacia greggii</i>	74.3	4.4	1.9	0.2	13				x
	<i>Eriogonum fasciculatum</i>	54.3	1.6	0.8	0.2	12				x
	<i>Lotus rigidus</i>	54.3	1	0.5	0.2	4				x
	<i>Prunus fasciculata</i>	42.9	4	1.2	0.2	8				
	<i>Rhus trilobata</i>	42.9	2.9	0.9	0.2	5				
	<i>Tamarix ramosissima</i>	37.1	0.4	0.1	0.1	1				
	<i>Gutierrezia microcephala</i>	34.3	1.5	0.3	0.2	2				
	<i>Phoradendron californicum</i>	31.4	0.3	0.1	0.2	2				
	<i>Larrea tridentata</i>	28.6	0.5	0.3	0.01	8				
	<i>Ericameria linearifolia</i>	28.6	0.4	0.1	0.2	1.1				
	<i>Hymenoclea salsola</i>	25.7	0.8	0.4	0.2	5				
	<i>Cylindropuntia acanthocarpa</i>	25.7	0.3	0.1	0.2	1.1				
	<i>Ephedra viridis</i>	25.7	0.3	0.1	0.2	1				
	<i>Brickellia californica</i>	25.7	0.2	0.1	0.2	0.2				
Herb										
	<i>Bromus rubens</i>	74.3	25	3.4	0.2	15				x
	<i>Erodium cicutarium</i>	51.4	1.6	0.2	0.2	2				x
	<i>Sphaeralcea ambigua</i>	48.6	1.1	0.1	0.2	0.2				
	<i>Artemisia ludoviciana</i>	48.6	1.1	0.3	0.2	2.1				
	<i>Achnatherum speciosum</i>	37.1	1.4	0.2	0.2	4				
	<i>Amsinckia</i>	37.1	1.2	0.1	0.2	2				
	<i>Typha</i>	34.3	6.1	0.9	0.2	7.1				
	<i>Schismus</i>	34.3	3.5	0.6	0.2	7				
	<i>Bromus tectorum</i>	28.6	6.8	1.3	0.2	10				
	<i>Oenothera caespitosa</i>	28.6	0.5	0.1	0.2	2				
	<i>Polypogon monspeliensis</i>	28.6	0.6	0.1	0.2	1				
	<i>Aristida purpurea</i>	28.6	0.5	0.1	0.2	0.2				
	<i>Muhlenbergia rigens</i>	25.7	4.5	1.1	0.2	22				
	<i>Mimulus guttatus</i>	25.7	1.5	0.3	0.2	6				
	<i>Juncus macrophyllus</i>	25.7	1	0.2	0.2	3.1				
Non-vascular										
	Unknown Moss	54.3	24	0.2	0.2	2				x
	Unknown Algae	28.6	24	1.8	0.4	20				

***Prosopis glandulosa* - *Prosopis velutina* - *Prosopis pubescens* Riparian Forest, Woodland & Shrubland Alliance**

Common Name: Mesquite Riparian Forest, Woodland & Shrubland Alliance

Group Assignment: G533, G299; **Alliance Code:** A3877, A3153

Alliance Concept

The Mesquite Riparian Forest, Woodland & Shrubland Woodland Alliance forms a sparse to continuous tree canopy with a shrub understory, when present, that is sparse to continuous. It is found primarily on lowslopes and channel bottoms at a variety of aspects. Soils are derived from a variety of substrates but primarily on alluvium, and have a range of textures from sand to clay. Elevations range from approximately -88 to 1383 meters. The dominant tree is *Prosopis glandulosa* and/or *Prosopis pubescens*. *Pluchea sericea* is a commonly associated shrub.

Diagnostic Criteria: This alliance is characterized by an open to continuous tree canopy of *Prosopis* spp, which ranges from 0.5 to 81 percent cover. The overall tree cover ranges from 0.5 to 80.5 percent cover.

Alliance Distribution

The alliance is well-defined in sampling at all three Parks (LAKE, DEVA and MOJA), where stands are scattered throughout in low to mid elevations.

States: AZ, CA, NV

Ecoregion Sections and Subsection Codes: Mojave Desert (77): 322Ab, 322Ad, 322Ae, 322Af, 322Ai, 322Aj, 322Al, 322Am, 322At, 322Av, 322Ay, 322Az; Southeastern Great Basin (7): 341Fc

Park Sampling Zones: **DEVA:** Ballarat, Black Mtns, Death Valley, Funeral Mtns, Grapevine Mtns, Green Water Rng/Vlly, Jail Canyon, Panamint Mtns, Saline Valley; **LAKE:** Boulder City, Cottonwood Cove, Echo Bay, Gold Butte, Katherine, Overton, Parashant, Pearce Ferry, Temple Bar; **MOJA:** Granite Mtns, Marl Mtns, New York Mtns, Piute Range, Soda Lake South

Associations

Association Scientific Name	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Prosopis glandulosa</i> (alliance)	6		x	x	
<i>Prosopis glandulosa</i> / (<i>Atriplex</i> spp.– <i>Suaeda moquinii</i>)	17	x	x	x	
<i>Prosopis glandulosa</i> / <i>Pluchea sericea</i>	13		x		
<i>Prosopis glandulosa</i> / <i>Sporobolus airoides</i>	4	X			
<i>Prosopis glandulosa</i> var. <i>torreyana</i>	17	X	x	x	
<i>Prosopis glandulosa</i> –(<i>Salix exigua</i> – <i>Salix lasiolepis</i>)	3	X		X	
<i>Prosopis glandulosa</i> – <i>Tamarix ramosissima</i>	5	X			
<i>Prosopis pubescens</i> / <i>Baccharis sergiloides</i>	4	X	X		
<i>Prosopis pubescens</i> / <i>Pluchea sericea</i> alkaline spring	17	x	x		

Association notes: One sample was classified to alliance level only in which *Prosopis glandulosa* was co-dominant with *Acacia gregii*, and *Bromus rubens* was the dominant herb. Four additional samples were classified to the alliance level from the Root (1978) data set with *Prosopis* having variable cover.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 440.3m, Range -88 – 1383 m

Aspect: N (4), NE (6), E (8), NW (8), SE (7), Flat, Variable (6), SW (3), W (1), SW (4), S (2)

Slope: Mean 5.7 degrees, Range 0 – 25 degrees

Macro Topography: Basin floor/wetland (1), Channel bed (11), Entire slope (1), High slope (1), Low level/bottom (11), Lowslope (10), Midslope (7)

Tree Cover: Mean 24.5%, Range 0.5 – 80.5%

Shrub Cover: Mean 26.8%, Range 0 – 94%

Herb Cover: Mean 17.4%, Range 0 – 84%

Large Rock: Mean 8.1%, Range 0 – 91%

Small Rock: Mean 17.9%, Range 0 – 84%

Fines Cover: Mean 33.6%, Range 0 – 94%

Litter Cover: Mean 20.6%, Range 0 – 96%

Geology: alkali-granite (alaskite) (7), alluvium (38), basalt (1), conglomerate (2), dune sand (5), gneiss (1), granite (2), granodiorite (3), gravel (1), limestone (6), rhyolite (2), sandstone (11), schist (4), water (1)

Soil Texture: Clay (2), Clay loam (5), Coarse sand (1), Fine silty clay (1), Loam (1), Loamy sand (4), Medium loam (1), Medium silt (2), Moderately fine sandy clay loam (2), Sand (9), Sandy loam (4), Silt loam (1), Silty clay (3)

Environment: The alliance was sampled in all three parks primarily on channel beds, bottoms, and lowslopes. It can also be found on midslopes and highslopes where water is readily available, such as from seeps and springs. It occurs at all elevations and aspects. Soils are derived from a variety of substrates and textures are variable.

Vegetation Description

Vegetation Structure: The Alliance forms a sparse to continuous tree layer with a sparse to continuous shrub layer and sparse or continuous herbaceous understory.

Vegetation Floristics: The dominant tree is *Prosopis glandulosa* and/or *Prosopis pubescens*. *Pluchea sericea* is a commonly associated shrub.

Dynamics: *Prosopis pubescens* is commonly found in other desert wetland alliances. However, *Prosopis pubescens* associations are relatively rare in Arizona, California, and Nevada. It is

more restricted to riparian areas and springs than is the *Prosopis glandulosa* alliance. The most extensive stands of *P. pubescens* in California are along the Armagosa River drainage and the northern most stands occur in the Saline Valley in DEVA, and they are localized in LAKE such as along Roger's Wash. Stands are typically adjacent to *Atriplex canescens*, *Distichlis spicata*, *Sporobolus airoides*, and *Suaeda moquinii* alliances.

Prosopis glandulosa occurs reliably where it can access permanent underground water, up to 15 m below the surface. The northern most stands of *P. glandulosa* in California are in the Saline Valley. *Tamarix* is invading and replacing stands especially along rivers and lake margins.

The alliance is restricted to relatively sensitive sites, some of which have been degraded by wood cutting, invasion of *Tamarix* and other non-natives, groundwater pumping, and water diversion, and livestock also pose as threats to stands outside of the Parks.

Classification Comments

Prosopis glandulosa associations are currently placed in the North American Warm Desert Riparian Low Bosque & Shrubland Group (G533) and Chihuahuan Mesquite Upland Scrub (G289) of the NVC hierarchy. For the Mojave Network classification, we have placed these associations into the G533 group. While some associations of both *Prosopis glandulosa* and *Prosopis pubescens* are denoted as shrubland and others as woodland in the NVC, we have chosen woodland due to the plant's tall tree-like stature.

Classification Confidence: High

Conservation Status Rank

Global: G5

State (California): S3

References

Buck-Diaz et al. 2012, cf. Keeler-Wolf et al. 1998b, Sawyer et al. 2009, VegCAMP and AIS 2013

Surveys (with Sample Sizes) Used for Description

MOJN: N=86

LAKE (n=36): LAKE0211, LAKE0415, LAKE0639, LAKE9120, LAKE9167, LAKE9171, LAKE9181, LAKE9256, LAKE9263, LAKE9296, LAKE9316, LAKE9404, LAKE9435, LAKE9501, LAKE9533, LAKE9534, LAKE9641, LAKE9642, LAKE9643, LMFMH064, LMFMH066, LMFMH067, LMFMH068, LMJOS013, LMJOS014, LMJOS015, LMJOS016, LMJOS017, LMJOS019, LMJOS020, LMJOS021, LMJOS022, LMJOS024, LMJOS025, LMJOS028, LMJOS029

DEVA (n=41): DEVA0434, DEVA0519, DEVA8020, DEVA8075, DEVA8076, DEVA8077, DEVA8078, DEVA8079, DEVA8080, DEVA8081, DEVA8082, DEVA8083, DEVA8084, DEVA8085, DEVA8086, DEVA8087, DEVA9412, DEVA9435, DEVA9470, DEVA9564, DEVA9566, DEVA9567, DEVA9621, DEVA9811, DEVA9813, DEVA9815, DEVA9818, DEVA9916, DEVAD037, DEVAD192, DEVAR041, DEVAR102, DEVAR116, DEVAR147, DEVAR151, MOJC0040, MOJC0041, MOJC0048, MOJC0051, MOJC0551, MOJC0733

MOJA (n=9): MOJA9130, MOJA9152, MOJA9190, MOJA9193, MOJA9195, MOJA9453, MOJA9646, MOJAE010, MOJC0007

MOJN-Johnson (n=0):

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Tree	<i>Prosopis glandulosa</i>	74.4	69	19	0.2	80.5				x
	<i>Prosopis pubescens</i>	27.9	23	3.8	1	40				
Shrub	<i>Pluchea sericea</i>	51.2	27	7.3	0.1	63				x
	<i>Suaeda moquinii</i>	31.4	6.9	1.2	0.2	17				
	<i>Larrea tridentata</i>	26.7	5.1	0.8	0.1	35				

***Salix exigua* Warm Desert Riparian Shrubland Alliance**

Common Name: Narrowleaf Willow Warm Desert Riparian Shrubland

Group Assignment: G533, G526; **Alliance Code:** A0947, A3800

Alliance Concept

The Sandbar Willow Thickets Shrubland Alliance forms an open to continuous shrub layer. The emergent tree layer is typically sparse to open, and the herbaceous layer is sparse to continuous. The alliance is found primarily on channel beds and midslopes at northeast to southwest aspects. Soils are derived from a variety of substrates including and textures range from coarse sand to clay loam. Elevations range from approximately 500 to 2250 meters. *Salix exigua* is dominant or co-dominant in the shrub layer, and those shrubs often present include *Acacia greggii*, *Baccharis sergiloides*, *Eriogonum fasciculatum*, and *Lotus rigidus*. Herbs that are often present include *Bromus rubens*, *Erodium cicutarium*, and *Achnatherum speciosum*. Commonly associated non-vascular plants include unknown mosses.

Diagnostic Criteria: This alliance is characterized by an open to continuous shrub layer with *Salix exigua* dominant or co-dominant with shrubs such as *Baccharis sergiloides*. The overall shrub cover ranges from 17 to 95 percent.

Alliance Distribution

The alliance was sampled at low to high elevations in two of the parks. It is scattered throughout DEVA and in MOJA it occurs in the Granite and Providence Mountains. The alliance is also likely to occur at LAKE in riparian channels such as at Grapevine Canyon in the Newberry Mountains.

States: CA, NV

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (8): 322Ab, 322Al, (322Am); Southeastern Great Basin (4): 341Fc, 341Fd

Park Sampling Zones: **DEVA:** CottonWood Mtns, Craig Canyon, Grapevine Mtns; **MOJA:** Granite Mtns, Providence Mtns, Van Winkle Mtn; **LAKE:** (Katherine)

Associations

Association Scientific Name [NVC Code]	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Salix exigua</i> (alliance)	1			x	
<i>Salix exigua</i> / Mesic graminoids [CEGL001203]	2		x		
<i>Salix exigua</i> Temporarily Flooded [CEGL001197]	3		x	x	
<i>Salix exigua</i> – <i>Baccharis sergiloides</i>	6		x	x	

Association Notes: One sample of *Salix exigua* stands was classified to alliance level only in which *Salix exigua* was co-dominant with *Frangula californica*. *Fallugia paradoxa* also had high cover in this sample.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 1404.6 m, Range 505 – 2215 m
Aspect: NE (1), E (4), SE (1), SW (4), S (1)
Slope: Mean 6.7 degrees, Range 1 – 14 degrees
Macro Topography: Channel bed (3), Midslope (4)

Tree Cover: Mean 2.5%, Range 0 – 7%
Shrub Cover: Mean 61.9%, Range 17.6 – 95%
Herb Cover: Mean 12.25%, Range 0 – 90%

Large Rock: Mean 19.6%, Range 0 – 70.2%
Small Rock: Mean 19.3%, Range 0 – 65%
Fines Cover: Mean 11.8%, Range 0 – 40%
Litter Cover: Mean 44%, Range 0.2 – 98%

Geology: alluvium (2), granodiorite (5), limestone (1), rhyolite (3), shale (1)
Soil Texture: Clay loam (3), Coarse sand (1), Loam (1), Loamy sand (1), Medium sand (3), Medium to very fine sandy loam (1), Sand (1), Sandy loam (1)

Environment: The alliance occurs in or along streams, springs, and washes, and in wet meadows. It occurs at low to high elevations in channel beds to midslopes at northeast to southwest aspects. Soils range from coarse sand to clay loam derived from a variety of substrates.

Vegetation Description

Vegetation Structure: The Alliance forms an open to continuous shrub layer and the overall shrub cover ranges from 17.6 to 95 percent. The tree layer is typically sparse to open, and the herb layer is sparse to continuous. Non-vascular plants are typically sparse to open.

Vegetation Floristics: *Salix exigua* is dominant or co-dominant in the shrub layer, and those shrubs often present include *Acacia greggii*, *Baccharis sergiloides*, *Eriogonum fasciculatum*, and *Lotus rigidus*. Herbs that are often present include *Bromus rubens*, *Erodium cicutarium*, and *Achnatherum speciosum*. Commonly associated non-vascular plants include unknown mosses.

Dynamics: *Salix exigua* stands in the desert occur at springs and in seasonally flooded streams along with other riparian shrubs. They occur in similar habitats to *Salix lasiolepis* stands, though

S. exigua has wider ecological amplitude in the Mojave Desert and Great Basin from low to high elevations.

Classification Comments

Salix exigua associations are currently placed within the North American Warm Desert Riparian Low Bosque & Shrubland (G533) and Rocky Mountain & Great Basin Lowland & Foothill Riparian Shrubland (G526) groups of the NVC hierarchy. For the Mojave Network classification we have combined these associations into one alliance description and group (G533).

Classification Confidence of Alliance: High

Conservation Status Rank

Global: G5

State (California): S4

References

Buck-Diaz et al. 2012, Evens 2000, Keeler-Wolf and Thomas 2000, Klein et al. 2007, NatureServe 2012, Sawyer et al. 2009, Vaghti 2003, VegCAMP and AIS 2013

Surveys (with Sample Sizes) Used in Description

MOJN: N=12

LAKE (n=0)

DEVA (n=5): DEVA9235, DEVA9563, DEVA9583, DEVA9655, MOJC1237

MOJA (n=7): MOJA0912, MOJA9574, MOJA9698, MOJAE009, MOJAE195, MOJAE199, MOJAE202

MOJN-Johnson (n=0)

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Tree	<i>Pinus monophylla</i>	50	32	0.6	0.2	3				x
	<i>Prosopis glandulosa</i>	25	20	0.8	1	7				
Shrub	<i>Salix exigua</i>	100	56	39	4.6	95	x	x		
	<i>Acacia greggii</i>	58.3	1.7	0.4	0.2	3.1				x
	<i>Baccharis sergiloides</i>	50	13	6.4	4	32				x
	<i>Eriogonum fasciculatum</i>	50	0.3	0.1	0.2	0.2				x
	<i>Lotus rigidus</i>	50	0.3	0.1	0.2	0.2				x
	<i>Rhus trilobata</i>	41.7	1.4	1.1	1	5				
	<i>Prunus fasciculata</i>	41.7	0.6	0.5	0.2	3				
	<i>Brickellia californica</i>	41.7	0.4	0.2	0.2	1				
	<i>Ericameria linearifolia</i>	41.7	0.3	0.1	0.2	0.2				
	<i>Tamarix ramosissima</i>	33.3	0.9	0.6	0.2	7				
	<i>Ephedra viridis</i>	33.3	0.8	0.2	0.2	2				
	<i>Ferocactus cylindraceus</i>	33.3	0.1	0.1	0.2	0.2				
	<i>Viguiera parishii</i>	33.3	0.3	0.1	0.2	0.2				
	<i>Rhamnus ilicifolia</i>	25	0.9	0.8	2	6				
	<i>Rosa woodsii</i>	25	0.8	0.6	0.5	5				
	<i>Phoradendron californicum</i>	25	0.9	0.2	0.2	2.1				
	<i>Gutierrezia microcephala</i>	25	0.9	0.2	0.2	1.1				
	<i>Eriogonum wrightii</i>	25	0.1	0.1	0.2	0.2				
	<i>Opuntia chlorotica</i>	25	0.1	0.1	0.2	0.2				
	<i>Stephanomeria pauciflora</i>	25	0.2	0.1	0.2	0.2				
	<i>Yucca schidigera</i>	25	0.2	0.1	0.2	0.2				
Herb	<i>Bromus rubens</i>	66.7	23	2.5	0.2	8				x
	<i>Erodium cicutarium</i>	50	1.9	0.3	0.2	2				x
	<i>Achnatherum speciosum</i>	50	2.3	0.1	0.2	0.2				x
	<i>Juncus mexicanus</i>	41.7	6.5	1	0.2	6				
	<i>Bromus tectorum</i>	41.7	4.7	0.1	0.2	0.2				
	<i>Artemisia ludoviciana</i>	41.7	4.7	0.3	0.2	2.1				
	<i>Mirabilis laevis</i>	41.7	0.9	0.1	0.2	0.2				
	<i>Sphaeralcea ambigua</i>	41.7	0.8	0.1	0.2	0.2				
	<i>Muhlenbergia rigens</i>	33.3	3.9	0.8	0.2	7				
	<i>Epilobium</i>	33.3	1	0.2	0.2	1				
	<i>Cirsium neomexicanum</i>	33.3	0.6	0.1	0.2	0.2				
	<i>Sonchus oleraceus</i>	33.3	0.5	0.1	0.2	0.2				
	<i>Polypogon monspeliensis</i>	25	1.3	0.2	0.2	2				
	<i>Dudleya pulverulenta</i>	25	0.4	0.1	0.2	0.2				
	<i>Juncus macrophyllus</i>	25	0.3	0.1	0.2	0.2				
	<i>Melica frutescens</i>	25	0.4	0.1	0.2	0.2				
	<i>Oenothera caespitosa</i>	25	0.3	0.1	0.2	0.2				
	<i>Schismus</i>	25	0.3	0.1	0.2	0.2				
	<i>Euphorbia</i>	25	0.2	0	0.01	0.2				
Non-vascular	Unknown Moss	50	38	0.5	0.2	3				x
	Unknown Lichen	25	22	0.1	0.4	0.4				

***Vitis arizonica* - *Vitis girdiana* Shrubland Alliance**

Common Name: Wild Grape Desert Shrubland

Group Assignment: G533; **Alliance Code:** A4162

Alliance Concept

The Wild Grape Desert Shrubland Alliance forms an open to continuous shrub layer. The emergent tree layer is typically not present, and the herbaceous layer is sparse to intermittent. The alliance is found localized along mountain drainages, seasonal riparian streams, washes, and spring areas in the desert west at various aspects. Soils are alluvial and derived from a variety of substrates including alkali-granite, and sandstone. Elevations range from approximately 450 to 1500 meters. The dominant and characteristic shrubs in this alliance are either *Vitis arizonica* or *Vitis girdiana*, and those that are sometimes present include *Baccharis sergiloides*, *Pluchea sericea*, *Salix exigua*, and *Salix laevigata*. Sometimes *Salix exigua* may be co-dominant with *Vitis*. The herbaceous layer may be well-developed or open with *Phragmites australis* often present at variable cover, and *Cladium californicum*, *Marah macrocarpus*, *Bromus tectorum*, *Schismus* spp. and *Amsinckia* spp. sometimes present.

Diagnostic Criteria: This alliance is characterized by an open to continuous shrub layer with either *Vitis arizonica* or *V. girdiana* dominant. Sometimes *Salix exigua* may be co-dominant. The overall shrub cover ranges from 26 to 92 percent. The herbaceous layer can be well-developed or open, including *Phragmites australis*, *Cladium californicum*, *Marah macrocarpus*, and others.

Alliance Distribution

The alliance is localized in mountain drainages, seasonal streams, washes, and springs. Sites from LAKE include Grapevine Canyon in the Newberry Mountains and at Rogers Wash in the Echo Bay area. Sites from DEVA include the Panamint Range along Johnson Canyon and Warm Spring Canyon, and observations in Grapevine Canyon of the Grapevine Mountains.

States: CA, NV

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (14): 322Ab, 322Af, 322Am, 322Az (and 322Ab); Southeastern Great Basin (4): 341Fc, 341Fd, 341Ff

Park Sampling Zones: **LAKE:** Echo Bay, Katherine; **DEVA:** Grapevine Mtns., Panamint Mtns., Nelson Range

Associations

Association Scientific Name [NVC Code]	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Vitis arizonica</i> (provisional) [CEPS009693]	8	x			
<i>Vitis arizonica</i> / <i>Cladium californicum</i> (provisional)	4	x		x	
<i>Vitis girdiana</i>	6		x		

Association Notes: None.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 745.6 m, Range 470 – 1529 m
Aspect: Variable including North (1), South (4), East-southeast (9)
Slope: (unknown)
Macro Topography: (unknown)

Tree Cover: 0%
Shrub Cover: Mean 47%, Range 26 – 92%
Herb Cover: Mean 26.8%, Range 0 – 44%

Large Rock: (unknown)
Small Rock: (unknown)
Fines Cover: (unknown)
Litter Cover: (unknown)

Geology: (unknown)
Soil Texture: (unknown))

Environment: The alliance is found primarily in perennial riparian areas at various aspects. Soils are derived from a variety of substrates including alkali-granite, and sandstone. The elevations range from mid to high.

Vegetation Description

Vegetation Structure: The Alliance forms an open to continuous shrub layer and the overall shrub cover ranges from 26 to 92 percent. The tree layer is typically not present, and the herb layer is sparse to intermittent. Non-vascular plants are typically not present.

Vegetation Floristics: Dominant and characteristic shrubs include *Vitis arizonica* or *V. girdiana*, and those that are sometimes present include *Baccharis sergiloides*, *Pluchea sericea*, *Salix exigua*, and *Salix laevigata*. *Phragmites australis* is often present in the herbaceous layer, and is often accompanied by *Amsinckia* spp., *Bromus tectorum*, *Cladium californicum*, *Marah macrocarpus*, and *Schismus* spp.

Dynamics: *Vitis arizonica* and *Vitis girdiana* form dense, thick mats of shrubby vines that are almost impenetrable. They may be present as the only shrub or clambering along with other shrubs including willows in localized ravines and washes, especially in the Mojave Desert and southeastern Great Basin.

Classification Comments

None.

Classification Confidence of Alliance: Moderate

Conservation Status Rank

Global: G3?

State (California): S3?

References

NatureServe 2010

Surveys (with Sample Sizes) Used in Description

MOJN: N=18

LAKE (n=12): LMJOS001, LMJOS003, LMJOS004, LMJOS005, LMJOS006, LMJOS007, LMJOS008, LMJOS009, LMJOS010, LMJOS011, LMJOS012, LMJOS018

DEVA (n=6): DEVA8057, DEVA8058, DEVA8091, DEVA8092, DEVA8093, DEVA8094

MOJA (n=0)

MOJN-Johnson (n=0)

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Shrub	<i>Vitis arizonica</i>	67	44	36	26	92				X
	<i>Pluchea sericea</i>	39	2.3	1.7	0.2	17				
	<i>Vitis girdiana</i>	33	33	27	65	98				
	<i>Salix exigua</i>	33	10	12	10	58				
	<i>Baccharis sergiloides</i>	33	2.2	2	0.2	19				
Herb	<i>Phragmites australis</i>	44	19	6.8	1	33				
	<i>Schismus</i>	33	3.2	1	1	4				
	<i>Amsinckia</i>	28	3.8	0.6	0.2	6				
	<i>Cladium californicum</i>	22	16	5.3	20	30				
	<i>Marah macrocarpus</i>	22	9.3	1.8	3	10				
	<i>Bromus tectorum</i>	22	3.5	1.4	1	16				

2. Shrub & Herb Vegetation Class

2.C.4. Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland Formation

2.C.4.Nc. Southwestern North American Warm Desert Freshwater Bosque & Marsh Division

M076. Warm Desert Lowland Freshwater Shrubland, Meadow & Marsh Macrogroup

G545. Colorado Plateau Hanging Garden Seep

***Calamagrostis scopulorum*–*Andropogon glomeratus* Saturated Hanging Garden Herbaceous Alliance**

Common Name: Arid West Saturated Hanging Garden

Group Assignment: G545; **Alliance Code:** A2655

Alliance Concept

The Arid West Saturated Hanging Garden Herbaceous Alliance forms an intermittent to continuous herbaceous layer. The shrub layer is open and the tree layer, when present, is sparse. Stands are found in low elevation alkali calcareous springs, wetland seeps in alcoves and in horizontal fractures in limestone or sandstone canyon walls, or other bedrock springs. Elevations range from approximately 100 to 300 meters. *Schoenus nigricans* and/or *Andropogon glomeratus* is dominant or co-dominant in the herbaceous layer, or other herbaceous plants such as *Calamagrostis scopulorum*, *Cladium californicum*, and *Muhlenbergia utilis* can occur. The shrub *Baccharis sergiloides* is also sometimes present.

Diagnostic Criteria: This alliance is characterized by an intermittent to continuous herbaceous layer with *Schoenus nigricans* and/or *Andropogon glomeratus* dominant or co-dominant with other herbs. The overall herbaceous cover ranges from 34 to 75 percent cover.

Alliance Distribution

The alliance was sampled and mapped at low elevations in DEVA west of the Amargosa Range in the Big Horn Springs, Ratat Spring, and Travertine Springs complex. It is also noted as occurring in the Nevares Springs. The hanging garden seep group was also mapped at LAKE along the border with Grand Canyon - Parashant National Monument.

States: (AZ); CA

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (6): 322Ab, (322Av)

Park Sampling Zones: **DEVA:** Death Valley, **LAKE:** (Parashant)

Associations

Association Scientific Name [NVC Code]	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Andropogon glomeratus</i> - <i>Schoenus nigricans</i> [CEGL005466]	6	(x)	x		

Association Notes: A similar association of *Eleocharis rostellata* – *Schoenus nigricans* community has been noted by Sada and Cooper (2012).

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 237 m, Range 123 – 290 m
Aspect: (unknown)
Slope: Mean 10.7 degrees, Range 4.5 – 17.2 degrees (GIS derived)
Macro Topography: (unknown)

Tree Cover: Mean 0%, Range 0 – 0%
Shrub Cover: Mean 6.2%, Range 0 – 29%
Herb Cover: Mean 52.3%, Range 34 – 75%

Large Rock: Mean %, Range – % (unknown)
Small Rock: Mean %, Range – % (unknown)
Fines Cover: Mean 0%, Range 0 – 0% (unknown)
Litter Cover: Mean 0%, Range 0 – 0% (unknown)

Geology: (unknown)
Soil Texture: (unknown)

Environment: The alliance occurs in low elevation alkali calcareous springs, wetland seeps in alcoves and in horizontal fractures in limestone or sandstone canyon walls, or other bedrock springs. It was sampled at DEVA at Big Horn Spring, Ratatat Spring, and Travertine Springs complex, and was mapped at LAKE along the border with Grand Canyon - Parashant National Monument.

Vegetation Description

Vegetation Structure: The alliance forms an intermittent to continuous herbaceous layer, and the overall herbaceous cover ranges from 34 to 75 percent cover. The tree layer, when present is typically sparse, and the shrub layer is sparse to open. Non-vascular plants, when present are typically sparse.

Vegetation Floristics: The dominant or co-dominant herb is *Schoenus nigricans* and/or *Andropogon glomeratus*. The shrub *Baccharis sergiloides* is also sometimes present.

Dynamics: *Andropogon glomeratus* and *Schoenus nigricans* are both tolerant of alkalinity, and are found in the southeastern United States in brackish, freshwater and calcareous wetland sites. In DEVA, stands occur in a fine-scale mosaic with other herbs, shrubs, and trees in alkali calcareous springs, including the rare sedge *Fimbristylis thermalis* (CNPS List 2B.2).

Classification Comments

Some of the grass species occurring in this alliance are wide-ranging in the United States, and other associations and alliances have been defined for them. Stands are rare, and occur in a matrix with other wetland herbaceous and shrubland vegetation. The placement of this alliance in the NVC hierarchy is uncertain because of its rarity and discontinuous distribution in desert seeps and hanging gardens of Arizona, California, Nevada, as well as Colorado and Utah. Also, the *Cladium californicum* Alkaline Seep Alliance is related, though currently in a different NVC group.

Classification Confidence of Alliance: Low

Conservation Status Rank

Global: G2

State (California): S2

References

Thomas 2006, cf. NatureServe 2012

Surveys (with Sample Sizes) Used in Description

MOJN: N=6

LAKE (n=0)

DEVA (n=6): DEVA8043, DEVA8044, DEVA8045, DEVA8046, DEVA8088, DEVA8089

MOJA (n=0)

MOJN-Johnson (n=0)

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Shrub										
	<i>Baccharis sergiloides</i>	33.3	33	6.2	8	29				
Herb										
	<i>Schoenus nigricans</i>	83.3	34	18	21	62	x		x	
	<i>Andropogon glomeratus</i>	33.3	21	9.8	21	38				

2. Shrub & Herb Vegetation Class

2.C.5. Salt Marsh Formation

2.C.5.Nd. North American Western Interior Brackish Marsh Division

M082. Warm & Cool Desert Alkali-Saline Wetland Macrogroup

G537. North American Desert Alkaline-Saline Shrub Wetland Group

***Allenrolfea occidentalis* Shrubland Alliance**

Common Name: Iodinebush Scrub

Group Assignment: G537; **Alliance Code:** A0866

Alliance Concept

The Iodinebush Scrub Alliance forms an open to continuous shrub layer. The emergent tree layer is typically sparse, and the herbaceous layer is sparse to continuous. The alliance is found primarily on playas, valley bottoms and alkaline wetlands with little or no slope. Soils are derived from alluvium and sandstone and textures are variable. Elevations range from approximately - 93 to 1300 meters. *Allenrolfea occidentalis* is dominant or co-dominant in the shrub layer. *Distichlis spicata* is sometimes present in the herb layer.

Diagnostic Criteria: This alliance is characterized by an open to continuous shrub layer with *Allenrolfea occidentalis* dominant or co-dominant. The overall shrub cover ranges from 2 to 85 percent.

Alliance Distribution

The alliance was sampled at two of the parks at low to high elevations. It is scattered throughout DEVA and near Soda Dry Lake in MOJA. The alliance was also found during map accuracy assessment field sampling at LAKE in the Overton Wash/Muddy River basin along with other alkaline-wet shrubland alliances.

States: CA, (NV)

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (21): 322Ab, 322Ai, (322Az); Southeastern Great Basin (6): 341Fc, 341Ff

Park Sampling Zones: **DEVA:** Black Mtns, Death Valley, Jail Canyon, Saline Valley; **(LAKE:** Overton); **MOJA:** Soda Lake South

Associations

Association Scientific Name [NVC Code]	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Allenrolfea occidentalis</i> [CEGL000988]	13		x	x	
<i>Allenrolfea occidentalis</i> (alliance)	3	(x)	x		
<i>Allenrolfea occidentalis</i> / <i>Distichlis spicata</i>	8		x		
<i>Allenrolfea occidentalis</i> – <i>Suaeda moquinii</i>	3		x		

Association Notes: None.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 165.2 m, Range -93 – 1274 m

Aspect: Flat, Variable (7), N (1), E (4), W (1), SW (2)

Slope: Mean 0.8 degrees, Range 0 – 3 degrees

Macro Topography: Basin floor/wetland (2), Low level/bottom (6), Midslope (1)

Tree Cover: Mean 0%, Range 0 – 0.2%

Shrub Cover: Mean 23.6%, Range 2 – 85%

Herb Cover: Mean 8.4%, Range 0 – 84%

Large Rock: Mean 0%, Range 0 – 0%

Small Rock: Mean 3.1%, Range 0 – 30%

Fines Cover: Mean 45%, Range 0 – 99.8%

Litter Cover: Mean 5.8%, Range 0 – 91.2%

Geology: alluvium (19), conglomerate (2), sandstone (6)

Soil Texture: Clay (3), Clay loam (1), Fine silty clay (2), Loam (1), Medium silt (1), Sand (4), Sandy loam (1)

Environment: The alliance occurs on playas, valley bottoms, and salt marsh wetlands at low to high elevations with little or no slope. Soils are derived from alluvium and sandstone and textures are variable.

Vegetation Description

Vegetation Structure: The Alliance forms an open to continuous shrub layer and the overall shrub cover ranges from 2 to 85 percent. The tree layer is typically sparse, and the herb layer is sparse to continuous. Non-vascular plants, if present, are sparse.

Vegetation Floristics: *Allenrolfea occidentalis* is dominant or co-dominant in the shrub layer. *Distichlis spicata* is sometimes present in the herb layer. Stands typically are simplistic in species composition and often monotypic.

Dynamics: *Allenrolfea occidentalis* is tolerant of high salinity and heavy clay soils, which tend to exclude other species, and it often forms the lowest ring of perennial vegetation around desert salt flats and alkaline terraces that receive intermittent saturation.

Classification Comments

None.

Classification Confidence of Alliance: High

Conservation Status Rank

Global: G4

State (California): S3

References

Bradley 1970, Buck-Diaz et al. 2012, Evens and Hartman 2007, Keeler-Wolf and Thomas 2000, McHargue 1973, NatureServe 2012, Odion et al. 1992a, Root 1978, Sawyer et al. 2009, VegCAMP and AIS 2013

Surveys (with Sample Sizes) Used in Description

MOJN: N=27

LAKE (n=0)

DEVA (n=26): DEVA0516, DEVA0810, DEVA8063, DEVA8064, DEVA8065, DEVA8066, DEVA8067, DEVA8068, DEVA8069, DEVA8070, DEVA9179, DEVA9384, DEVA9812, DEVAD083, DEVAD189, DEVAD190, DEVAR013, DEVAR014, DEVAR063, MOJC0039, MOJC0044, MOJC0049, MOJC0050, MOJC0054, MOJC0726, MOJC0727

MOJA (n=1): MOJA0196

MOJN-Johnson (n=0)

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Shrub	<i>Allenrolfea occidentalis</i>	100	94	20	0.5	85	x	x		
Herb	<i>Distichlis spicata</i>	37	32	3.3	5	15				

***Atriplex lentiformis* Shrubland Alliance**

Common Name: Big Saltbush Scrub

Group Assignment: G537; **Alliance Code:** A3173

Alliance Concept

The Big Saltbush Scrub Alliance forms an open to intermittent shrub layer. The emergent tree layer is typically sparse, and the herbaceous layer is sparse to open. The alliance is found primarily on disturbed bottomlands and channel beds at flat and south aspects. Soils are derived from alluvium and texture is silty clay. Elevations range from approximately 150 to 400 meters. *Atriplex lentiformis* is dominant and characteristic in the shrub layer, and *Encelia farinosa* is often present. *Prosopis glandulosa* is commonly an emergent tree at sparse cover. Dominant and characteristic herbs include *Cryptantha* spp., and *Schismus* spp., and those often present are *Amsinckia* spp., *Bassia scoparia*, *Bromus rubens*, *Bromus tectorum*, *Camissonia brevipes*, *Chaenactis fremontii*, *Chorizanthe brevicornu*, *Cryptantha pterocarya*, *Eriogonum deflexum*, *Malacothrix glabrata*, *Phacelia crenulata*, *Plantago ovata*, and *Salsola* spp.

Diagnostic Criteria: This alliance is characterized by an open to intermittent shrub layer with *Atriplex lentiformis* dominant. The overall shrub cover ranges from 4 to 55 percent.

Alliance Distribution

The alliance was sampled in LAKE on the shore line near Lake Las Vegas and along the road near Davis Dam. The alliance was also found during map accuracy assessment field sampling at LAKE at Overton Wash/Muddy River along with other alkaline-wet shrubland alliances.

States: AZ, NV

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (2): 322Ay, 322Az

Park Sampling Zones: LAKE: Lakeshore, Katherine, (Overton)

Associations

Association Scientific Name	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Atriplex lentiformis</i>	2	x			

Association Notes: None.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 261 m, Range 152 – 370 m
Aspect: Flat, Variable (1), S (1)
Slope: Mean 0.5 degrees, Range 0 – 1 degrees
Macro Topography: Channel bed (1), Low level/bottom (1)

Tree Cover: Mean 0.1%, Range 0 – 0.2%
Shrub Cover: Mean 29.5%, Range 4 – 55%
Herb Cover: Mean 10.5%, Range 0 – 21%

Large Rock: Mean 1.5%, Range 0 – 3%
Small Rock: Mean 39%, Range 35 – 43%
Fines Cover: Mean 33.5%, Range 15 – 52%
Litter Cover: Mean 23.5%, Range 2 – 45%

Geology: alluvium (2)
Soil Texture: Silty clay (1)

Environment: The alliance is found primarily on disturbed bottomlands and channel beds at flat and south aspects. Soils are derived from alluvium and texture is silty clay. The elevation is low.

Vegetation Description

Vegetation Structure: The Alliance forms an open to intermittent shrub layer and the overall shrub cover ranges from 4 to 55 percent. The tree layer is typically sparse, and the herb layer is sparse to open. Non-vascular plants, if present, are typically sparse.

Vegetation Floristics: *Atriplex lentiformis* is the dominant and characteristic shrub, and *Encelia farinosa* is often present. *Prosopis glandulosa* is commonly an emergent tree at sparse cover. Dominant and characteristic herbs include *Cryptantha* spp., and *Schismus* spp., and those often present are *Amsinckia* spp., *Bassia scoparia*, *Bromus rubens*, *Bromus tectorum*, *Camissonia brevipes*, *Chaenactis fremontii*, *Chorizanthe brevicornu*, *Cryptantha pterocarya*, *Eriogonum deflexum*, *Malacothrix glabrata*, *Phacelia crenulata*, *Plantago ovata*, and *Salsola* spp.

Dynamics: *Atriplex lentiformis* has been planted in various saline and alkaline wetlands and wash terraces to increase scrub cover for wildlife and for erosion control on disturbed riparian sites.

Classification Comments

None.

Classification Confidence of Alliance: Moderate

Conservation Status Rank

Global: G4

State (California): S4

References

Buck-Diaz et al. 2012, Keeler-Wolf and Evens 2006, Keeler-Wolf et al. 1998b, Sawyer et al. 2009, VegCAMP and AIS 2013

Surveys (with Sample Sizes) Used in Description

MOJN: N=2

LAKE (n=2): LAKE0187, LAKE9170

DEVA (n=0)

MOJA (n=0)

MOJN-Johnson (n=0)

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Tree	<i>Prosopis glandulosa</i>	50	50	0.1	0.2	0.2				x
Shrub	<i>Atriplex lentiformis</i>	100	99	29	4	54	x	x		
	<i>Encelia farinosa</i>	50	0.9	0.5	1	1				x
Herb	<i>Cryptantha</i>	100	39	0.6	0.6	0.6	x		x	
	<i>Schismus</i>	100	13	0.2	0.2	0.2	x			
	<i>Eriogonum deflexum</i>	50	42	10	20	20				x
	<i>Salsola</i>	50	2.1	0.5	1	1				x
	<i>Amsinckia</i>	50	0.4	0.1	0.2	0.2				x
	<i>Bassia scoparia</i>	50	0.4	0.1	0.2	0.2				x
	<i>Bromus rubens</i>	50	0.4	0.1	0.2	0.2				x
	<i>Bromus tectorum</i>	50	0.4	0.1	0.2	0.2				x
	<i>Camissonia brevipes</i>	50	0.4	0.1	0.2	0.2				x
	<i>Chaenactis fremontii</i>	50	0.4	0.1	0.2	0.2				x
	<i>Chorizanthe brevicornu</i>	50	0.4	0.1	0.2	0.2				x
	<i>Cryptantha pterocarya</i>	50	0.4	0.1	0.2	0.2				x
	<i>Malacothrix glabrata</i>	50	0.4	0.1	0.2	0.2				x
	<i>Phacelia crenulata</i>	50	0.4	0.1	0.2	0.2				x
	<i>Plantago ovata</i>	50	0.4	0.1	0.2	0.2				x

***Pluchea sericea* Shrubland Alliance**

Common Name: Arrow Weed Thickets

Group Assignment: G537; **Alliance Code:** A0798

Alliance Concept

The Arrow Weed Thickets Shrubland Alliance forms an open to continuous shrub layer. The emergent tree layer is typically sparse to open, and the herbaceous layer is sparse to continuous. The alliance is found on playas, basin floors, channel beds, and spring-fed slopes with variable or no aspect. Soils are alluvial and derived from a variety of substrates, and textures are variable. Elevations range from approximately -82 to 950 meters. *Pluchea sericea* is dominant and characteristic in the shrub layer, which is sometimes accompanied by *Allenrolfea occidentalis*. The herbaceous layer often includes *Phragmites australis* and sometimes includes *Distichlis spicata*.

Diagnostic Criteria: This alliance is characterized by an open to continuous shrub layer with *Pluchea sericea* dominant. The overall shrub cover ranges from 2.5 to 92 percent.

Alliance Distribution

The alliance was sampled at two of the parks at low to mid elevations. It is scattered throughout DEVA across various sites and in LAKE around the perimeter of the lake and in spring-fed washes.

States: AZ, CA, NV

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (25): 322Ab, 322Ad, 322Am, 322Av, 322Ay, 322Az; Southeastern Great Basin (4): 341Fc, 341Fd

Park Sampling Zones: **DEVA:** Death Valley, Funeral Mountains, Grapevine Mtns, Last Chance Vlly, Saline Valley; **LAKE:** Boulder City, Callville, Echo Bay, Katherine, Temple Bar

Associations

Association Scientific Name [NVC Code]	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Pluchea sericea</i> / (<i>Distichlis spicata</i> , <i>Sporobolus airoides</i>) [cf. CEG003080]	7		x		
<i>Pluchea sericea</i> (alliance)	1		x		
<i>Pluchea sericea</i> / <i>Phragmites australis</i>	10	x			
<i>Pluchea sericea</i> Seasonally Flooded [CEGL003080]	11	x	x		

Association Notes: None.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 393.8 m, Range -82 – 935 m
Aspect: NE (2), E (3), SE (3), SW (1), W (2), S (2)
Slope: Mean 5.9 degrees, Range 1 – 32 degrees
Macro Topography: Channel bed (1), Channel wall (1), High level/summit (1), Low level/bottom (3), Lowslope (1), Midslope (2)

Tree Cover: Mean 0.2%, Range 0 – 5%
Shrub Cover: Mean 26.8%, Range 2.5 – 87%
Herb Cover: Mean 25.4%, Range 0 – 94%

Large Rock: Mean 6.1%, Range 0 – 72%
Small Rock: Mean 7.8%, Range 0 – 70%
Fines Cover: Mean 47%, Range 0 – 93%
Litter Cover: Mean 14.4%, Range 0 – 95.8%

Geology: alkali-granite (alaskite) (3), alluvium (10), basalt (1), dune sand (2), granodiorite (4), limestone (1), sandstone (6), schist (1), sedimentary (gypsum) (1)
Soil Texture: Clay (1), Clay loam (1), Fine sand (1), Loamy sand (1), Medium silt (1), Medium to very fine sandy loam (2), Sandy clay (1), Sandy loam (1), Silt loam (1)

Environment: The alliance occurs from low to mid elevations at springs, spring-fed slopes, seasonally flooded stream channels, playas, and basin floors that have subterranean water. Access to moisture is essential, in which ground water is available year-round and typically within 1–3 m of the ground surface. Aspect is variable. Soils are alluvial and derived from a variety of substrates, and soil textures are variable.

Vegetation Description

Vegetation Structure: The alliance forms an open to continuous shrub layer and the overall shrub cover ranges from 2.5 to 92 percent. The tree layer is typically sparse to open, and the herb layer is sparse to continuous. Non-vascular plants are typically sparse to open.

Vegetation Floristics: *Pluchea sericea* is dominant and characteristic in the shrub layer, which is sometimes accompanied by *Allenrolfea occidentalis*. The herbaceous layer often includes *Phragmites australis* and sometimes includes *Distichlis spicata*.

Dynamics: *Pluchea sericea* stands form thickets along permanent springs and slow-flowing streams or occur in vegetation mosaics surrounding alkali springs and marshes. It can tolerate strongly alkaline/saline conditions, and invasion by *Tamarix* is a concern since it and *P. sericea* have similar water requirements as phreatophytes.

Classification Comments

None.

Classification Confidence of Alliance: Moderate

Conservation Status Rank

Global: G3

State (California): S3

References

Buck-Diaz et al. 2012, Cogan et al. 2004, Keeler-Wolf and Thomas 2000, NatureServe 2012, Root 1978, Sawyer et al. 2009, VegCAMP and AIS 2013

Surveys (with Sample Sizes) Used in Description

MOJN: N=29

LAKE (n=16): LAKE0387, LAKE9386, LAKE9500, LAKE9625, LAKE9640, LMFMH056, LMFMH057, LMFMH058, LMFMH059, LMFMH060, LMFMH061, LMFMH062, LMFMH063, LMFMH069, LMFMH070, LMJOS023

DEVA (n=13): DEVA0600, DEVA0816, DEVA8071, DEVA8072, DEVA8073, DEVA8074, DEVA9596, DEVA9826, DEVAR064, MOJC0047, MOJC0552, MOJC0732, MOJC0734

MOJA (n=0)

MOJN-Johnson (n=0)

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Shrub	<i>Pluchea sericea</i>	100	75	23	0.5	88	x	x		
	<i>Allenrolfea occidentalis</i>	27.6	7.5	1.3	1	13				
Herb	<i>Phragmites australis</i>	44.8	30	14	0.2	90				
	<i>Distichlis spicata</i>	37.9	16	1.2	0.2	10				

***Suaeda moquinii* - *Salicornia rubra* Alkaline Scrub Shrubland Alliance**

Common Name: Mojave Seablite - Red Swampfire Alkaline Scrub

Group Assignment: G537; **Alliance Code:** A3880

Alliance Concept

The Mojave Seablite - Red Swampfire Alkaline Scrub Shrubland Alliance forms an open shrub layer. The emergent tree layer is typically sparse, and the herbaceous layer is sparse to open. The alliance is found primarily in low lying places, but also found on slopes at a variety of aspects, but often in flats. Soils are derived primarily from alluvium and dune sand and textures range from very sandy to silty clay. Elevations range from approximately -5 to 883 meters. *Suaeda moquinii* is the dominant shrub, and *Schismus* spp. are often present.

Diagnostic Criteria: This alliance is characterized by an open shrub layer of *Suaeda moquinii*, *Suaeda moquinii*. The overall shrub cover ranges from 0 to 15 percent cover.

Alliance Distribution

The alliance is well-defined in sampling at all three Parks (LAKE, DEVA, and MOJA), though scattered within basins of low to mid elevations. The alliance was also found during map accuracy assessment field sampling at LAKE in the Overton Wash/Muddy River basin along with other alkaline-wet shrubland alliances.

States: AZ, CA, (NV)

Ecoregion Sections and Subsection Codes: Mojave Desert (16): 322Ab, 322Ae, 322Ai, (322Az), 322Ay; Southeastern Great Basin (6): 341Fc

Park Sampling Zones: **DEVA:** Black Mtns, Death Valley, Eureka Valley, Panamint Dunes, Saline Valley; **LAKE:** Katherine, (Overton); **MOJA:** Soda Lake, Soda Lake South, Zzyzx

Associations

Association Scientific Name	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Isocoma acradenia</i>	2			x	
<i>Suaeda moquinii</i>	16	x	x	x	
<i>Suaeda moquinii</i> - <i>Atriplex canescens</i>	4		x		

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 358 m, Range -5 – 883 m

Aspect: Flat, Variable (11), N (1), NE (1), E (2), NW (1), SE (1), W (2), SW (1)

Slope: Mean 1.1 degrees, Range 0 – 3 degrees

Macro Topography: High slope (2), Low level/bottom (7), Lowslope (3), Midslope (2),

Toeslope (alluvial fan/bajada) (3)

Tree Cover: Mean 3.6 %, Range 0 – 0.6%

Shrub Cover: Mean 7.3%, Range 2 – 15%

Herb Cover: Mean 3.5%, Range 0 – 15%

Large Rock: Mean 0.1%, Range 0 – 2%

Small Rock: Mean 7.1%, Range 0 – 84%

Fines Cover: Mean 88.1%, Range 15 – 99.6%

Litter Cover: Mean 2.5%, Range 0.2 – 15%

Geology: alluvium (16), dune sand (5), sand (1)

Soil Texture: Clay loam (1), Fine sand (1), Loamy sand (2), Medium sand (3), Sand (3), Silt loam (2), Silty clay (5)

Environment: The alliance is found on playas, sand dunes/flats, and alkaline washes that have low to high slopes at all aspects. Soils are derived from primarily alluvium including sand and dune sand. Soil textures are variable. The alliance is found at low to mid elevation.

Vegetation Description

Vegetation Structure: The Alliance forms an open shrub layer, and the overall shrub cover ranges from 2 to 15 percent cover. The tree layer is typically sparse, and the herb layer is sparse to open. Non-vascular plants, if present, are sparse.

Vegetation Floristics: *Suaeda moquinii* is the dominant shrub, and *Schismus* spp. are often present.

Dynamics: : Both *Suaeda moquinii* and *Isocoma acradenia* are common shrubs around alkaline basins and adjacent sand dunes and washes in a fine-scale matrix with other related alkaline sink scrub alliances. They appear to tolerate less flooding and salinity than *Allenrolfea occidentalis* in desert and semi-desert settings, though shrubs appear to tap into available water tables.

Classification Comments

The *Isocoma acradenia* association found in this desert region at MOJA had trace cover of *Suaeda moquinii*, while another association sampled in alkaline areas of cismontane California include co-dominance of these two species.

Classification Confidence: Moderate

Conservation Status Rank

Global: G5

State (California): S3

References

Buck-Diaz and Evens 2011, Buck-Diaz et al. 2012, NatureServe 2012, VegCAMP and AIS 2013

Surveys (with Sample Sizes) Used for Description

MOJN: N=22

LAKE (n=1): LAKE9172

DEVA (n=12): DEVA9422, DEVA9639, DEVA9641, DEVA9642, DEVA9817, DEVAS020, DEVAS026, DEVAS063, DEVAS180, MOJC0720, MOJC0721, MOJC0722

MOJA (n=9): MOJA0194, MOJA0554, MOJA0637, MOJA0644, MOJA9187, MOJA9647, MOJA9648, MOJA9652, MOJC0024

MOJN-Johnson (n=0):

Alliance Stand Table

Layer	SpeciesName	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Shrub	<i>Suaeda moquinii</i>	100	66	4.7	0.2	15	x	x		
	<i>Atriplex canescens</i>	36.4	9.1	0.6	0.2	7				
	<i>Atriplex polycarpa</i>	31.8	3.1	0.2	0.01	2				
Herb	<i>Schismus</i>	50	14	1	0.2	5				x
	<i>Cryptantha</i>	31.8	5.6	0.3	0.03	3				
	<i>Unknown Forb (herbaceous, not grass nor grasslike)</i>	31.8	12	0.3	0.44	2				

2. Shrub & Herb Vegetation Class

2.C.5. Salt Marsh Formation

2.C.5.Nd. North American Western Interior Brackish Marsh Division

M082. Warm & Cool Desert Alkali-Saline Wetland Macrogroup

G538. North American Desert Alkaline-Saline Herbaceous Wetland & Playa Group

***Distichlis spicata* Alkaline Wet Meadow Alliance**

Common Name: Saltgrass Alkaline Wet Meadow

Group Assignment: G538; **Alliance Code:** A1332

Alliance Concept

The Saltgrass Alkaline Wet Meadow Alliance forms an open to continuous herbaceous layer. The shrub layer is open and the tree layer is sparse. The alliance is found primarily from basin floor wetlands to lowslopes at all aspects. Soils are derived from alluvium and felsic volcanic rock and textures are variable. Soils are typically deep, alkaline and poorly drained. Elevations range from approximately -80 to 1100 meters. The dominant or co-dominant herb is *Distichlis spicata*. Commonly associated emergent shrubs at sparse to open cover include *Suaeda moquinii*.

Diagnostic Criteria: This alliance is characterized by an open to continuous herbaceous layer with *Distichlis spicata* dominant or co-dominant with plants such as *Juncus* spp. The overall herbaceous cover ranges from 4 to 95 percent cover.

Alliance Distribution

The alliance was sampled at DEVA and MOJA. It is scattered throughout DEVA at low to upper elevations and in MOJA near Zzyzx Rd at low elevations. Small stands have also been observed during map accuracy assessment at LAKE in alkaline/salt basin areas.

States: CA

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (7): 322Ab, 322Ai

Park Sampling Zones: **DEVA:** Black Mtns, Death Valley, Last Chance Villy; **MOJA:** Soda Lake, Zzyzx

Associations

Association Scientific Name [NVC Code]	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Distichlis spicata</i> [CEGL001770]	4		x	x	
<i>Distichlis spicata</i> – <i>Juncus arcticus</i> var. <i>littoralis</i>	2		x	x	
<i>Distichlis spicata</i> – <i>Juncus cooperi</i>	1		x		

Association Notes: None.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 258.4 m, Range -82 – 950 m

Aspect: Flat, Variable (1), NE (2), SW (1), Flat, Variable (1), S (2)

Slope: Mean 1.3 degrees, Range 0 – 3 degrees

Macro Topography: Basin floor/wetland (1), Low level/bottom (4), Lowslope (1)

Tree Cover: Mean 0.1%, Range 0 – 1%

Shrub Cover: Mean 1.7%, Range 0 – 6.2%

Herb Cover: Mean 30.2%, Range 4 – 95%

Large Rock: Mean 0%, Range 0 – 0%

Small Rock: Mean 1.6%, Range 0 – 10%

Fines Cover: Mean 81.7%, Range 5 – 100%

Litter Cover: Mean 2.7%, Range 0 – 10%

Geology: alluvium (6), felsic volcanic rock (1)

Soil Texture: Clay (2), Loamy sand (2), Medium silt (1), Muck (1), Silty clay (1)

Environment: The alliance occurs at low to upper elevations primarily on bottoms, wetlands, lowslope springs, and playas that are typically intermittently and seasonally flooded. It is particularly found in areas with high water tables (within 1–2 m of the ground surface). The alliance can be found at all aspects. Soils are derived from alluvium and felsic volcanic rock and textures are variable. Soils are typically deep, alkaline and poorly drained.

Vegetation Description

Vegetation Structure: The alliance forms an open to continuous herbaceous layer, and the overall herbaceous cover ranges from 4 to 95 percent cover. The tree layer is typically sparse and the shrub layer is sparse to open. Non-vascular plants, when present, are sparse.

Vegetation Floristics: Dominant herbs include *Distichlis spicata*. The shrub layer is emergent and typically or often includes *Suaeda moquinii*.

Dynamics: *Distichlis spicata*, once established, can grow in soils that vary greatly in salinity. However, seedling establishment requires high temperature, moist soil, and low salinity. *Distichlis spicata* has a high ability to sprout after disturbance. Adjacent alliances include *Atriplex canescens*, *Atriplex polycarpa*, *Atriplex spinifera*, *Juncus cooperi*, *Phragmites australis*, *Pluchea sericea*, *Prosopis glandulosa*, *Prosopis pubescens*, *Sarcobatus vermiculatus*, *Schoenoplectus americanus*, and *Sporobolus airoides*. Stands may decrease in cover due to groundwater pumping during droughts in this region.

Classification Comments

None.

Classification Confidence of Alliance: High

Conservation Status Rank

Global: G5

State (California): S4

References

Atwater et al. 1979, Bradley 1970, Buck-Diaz et al. 2012, Ferren and Davis 1991, Hickson and Keeler-Wolf 2007, Junak et al. 2007, Keeler-Wolf and Evens 2006, Keeler-Wolf and Vaghti 2000, Keeler-Wolf et al. 2003a, NatureServe 2007b, Newton 1989, Odion et al. 1992a, Peinado et al. 1994, Pickart 2006, Sawyer et al. 2009, Solomeshch and Barbour 2006, VegCAMP and AIS 2013

Surveys (with Sample Sizes) Used in Description

MOJN: N=7

LAKE (n=0)

DEVA (n=4): DEVA0617, DEVA9193, DEVA9451, MOJC0053

MOJA (n=3): MOJA9185, MOJA9186, MOJA9198

MOJN-Johnson (n=0)

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Shrub	<i>Suaeda moquinii</i>	57.1	13	0.2	0.2	1				x
	<i>Tamarix ramosissima</i>	42.9	27	0.3	0.2	1				
	<i>Isocoma acradenia</i>	28.6	10	0.2	0.5	1				
Herb	<i>Distichlis spicata</i>	100	68	17	4	35	x	x		
	<i>Phragmites australis</i>	28.6	5.2	2.9	3	17				
	<i>Juncus cooperi</i>	28.6	5.4	1.9	3	10.5				
	<i>Nitrophila occidentalis</i>	28.6	2.8	1.6	0.2	11				
	<i>Atriplex phyllostegia</i>	28.6	0.3	0.1	0.2	0.2				
	<i>Schismus</i>	28.6	0.3	0.1	0.2	0.2				

***Muhlenbergia asperifolia* - *Spartina gracilis* - *Sporobolus airoides* Alkaline Herbaceous Alliance**

Common Name: Scratchgrass - Alkali Cordgrass - Alkali Sacaton Alkaline Grassland

Group Assignment: G538; **Alliance Code:** A1334

Alliance Concept

The Scratchgrass - Alkali Cordgrass - Alkali Sacaton Alkaline Grassland Alliance forms an open to intermittent herbaceous layer. The shrub layer is open and the tree layer is sparse. The alliance is found primarily on low level bottoms and valleys. It occurs along alkaline meadow margins, washes, springs, and playa bottoms. Soils are derived from alluvium or aeolian sand deposits, and texture is sandy loam. Elevations range from approximately 100 to 1500 meters. The dominant herb is *Sporobolus airoides*. Other herbs present at lower cover include *Achnatherum hymenoides*, *Bromus rubens*, *Bouteloua eriopoda*, *Bouteloua gracilis*, *Lupinus* spp., *Amsinckia* spp., *Calochortus* spp., *Chaetopappa ericoides*, *Eriastrum* spp., *Gaura coccinea*, *Lepidium lasiocarpum*, *Salsola* spp., and *Sphaeralcea ambigua*. Commonly associated emergent shrubs at sparse to open cover include *Gutierrezia sarothrae*, *Lycium cooperi*, *Ephedra nevadensis*, *Ericameria cooperi*, *Lycium andersonii*, *Opuntia polyacantha* var. *erinacea*, *Psilostrophe cooperi*, and *Stephanomeria pauciflora*. In the tree layer, *Yucca brevifolia* may be present at sparse cover.

Diagnostic Criteria: This alliance is characterized by an open to intermittent herbaceous layer dominated by *Sporobolus airoides*. The overall herbaceous cover ranges from 21 to 66 percent cover.

Alliance Distribution

The alliance was sampled at low elevations such as at the Travertine East spring area in DEVA and at small seasonally wet site in a higher elevation valley in the New York Mountains in MOJA. It also was mapped in the Travertine Springs complex (Thomas 2006). Stands are likely to be found also at LAKE in alkaline basin areas, and it was sampled once during map accuracy assessment in a seasonally wet wash.

States: CA, (NV)

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (2): 322Ab, 322Al, (322Am)

Park Sampling Zones: **DEVA:** Death Valley; (**LAKE:** Katherine), **MOJA:** New York Mtns

Associations

Association Scientific Name [NVC Code]	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Sporobolus airoides</i> [CEGL001688]	2	(x)	x	x	

Association Notes: None.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 802 m, Range 123 – 1481 m

Aspect: SW (1)

Slope: Mean 1 degrees, Range 0 – 1 degrees

Macro Topography: Low level/bottom (1)

Tree Cover: Mean 0.5%, Range 0 – 1%

Shrub Cover: Mean 2.3%, Range 0 – 4.7%

Herb Cover: Mean 43.5%, Range 21 – 66%

Large Rock: Mean 0%, Range 0 – 0%

Small Rock: Mean 24%, Range 24 – 24%

Fines Cover: Mean 37.5%, Range 0 – 75%

Litter Cover: Mean 0.5%, Range 0 – 1%

Geology:

Soil Texture: Sandy loam (1)

Environment: The alliance occurs at low to high elevations typically in valley bottoms or lower level sites with minor or variable aspect. It typically occurs along alkaline meadow margins, washes, springs, and playa bottoms. Stands occur where subterranean water is present year-round. Soils are sand or sandy loam, derived from alluvium or aeolian sand deposits.

Vegetation Description

Vegetation Structure: The alliance forms an open to intermittent herbaceous layer, and the overall herbaceous cover ranges from 21 to 66 percent cover. The tree layer is typically sparse, and the shrub layer is sparse to open. Non-vascular plants, if present, are sparse.

Vegetation Floristics: The dominant herb is *Sporobolus airoides*. Other herbs present include *Achnatherum hymenoides*, *Bromus rubens*, *Bouteloua eriopoda*, *Bouteloua gracilis*, *Lupinus* spp., *Amsinckia* spp., *Calochortus* spp., *Chaetopappa ericoides*, *Eriastrum* spp., *Gaura coccinea*, *Lepidium lasiocarpum*, *Salsola* spp., and *Sphaeralcea ambigua*. Commonly associated emergent shrubs at sparse to open cover include *Gutierrezia sarothrae*, *Lycium cooperi*, *Ephedra nevadensis*, *Ericameria cooperi*, *Lycium andersonii*, *Opuntia polyacantha* var. *erinacea*, *Psilostrophe cooperi*, and *Stephanomeria pauciflora*. In the tree layer *Yucca brevifolia* can be present at sparse cover.

Dynamics: *Sporobolus airoides* is dominant in the herbaceous layer. Many non-native species are also generally present in the herbaceous layer threatening this rare and declining alliance in

California. Shrubs may be emergent and at low cover. Stands are sometimes surrounded by stands of *Atriplex canescens*. Groundwater pumping lowers water tables and can cause stands to transition into a shrub dominated stand.

Classification Comments

Sporobolus airoides associations in our area are grouped into either the North American Desert Alkaline-Saline Herbaceous Wetland & Playa Group (G538) or the Intermountain Semi-Desert Grassland Group (G311). We have placed associations into one group of G538, since stands occurred in alkaline basins.

Classification Confidence of Alliance: High

Conservation Status Rank

Global: G4

State (California): S2

References

Buck-Diaz et al. 2012, Keeler-Wolf and Thomas 2000, NatureServe 2012, Sawyer et al. 2009, Solomeshch and Barbour 2006, VegCAMP and AIS 2013

Surveys (with Sample Sizes) Used in Description

MOJN: N=2

LAKE (n=0)

DEVA (n=1): DEVA8090

MOJA (n=1): MOJA0234

MOJN-Johnson (n=0)

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Tree										
	<i>Yucca brevifolia</i>	50	50	0.5	1	1				x
Shrub										
	<i>Gutierrezia sarothrae</i>	50	32	1.5	3	3				x
	<i>Lycium cooperi</i>	50	5.3	0.3	0.5	0.5				x
	<i>Ephedra nevadensis</i>	50	2.1	0.1	0.2	0.2				x
	<i>Ericameria cooperi</i>	50	2.1	0.1	0.2	0.2				x
	<i>Lycium andersonii</i>	50	2.1	0.1	0.2	0.2				x
	<i>Opuntia polyacantha</i> var. <i>erinacea</i>	50	2.1	0.1	0.2	0.2				x
	<i>Psilostrophe cooperi</i>	50	2.1	0.1	0.2	0.2				x
	<i>Stephanomeria pauciflora</i>	50	2.1	0.1	0.2	0.2				x
Herb										
	<i>Sporobolus airoides</i>	100	96	42	21	62	x	x		
	<i>Achnatherum hymenoides</i>	50	0.7	0.5	1	1				x
	<i>Bromus rubens</i>	50	0.7	0.5	1	1				x
	<i>Bouteloua eriopoda</i>	50	0.4	0.3	0.5	0.5				x
	<i>Bouteloua gracilis</i>	50	0.4	0.3	0.5	0.5				x
	<i>Lupinus</i>	50	0.3	0.2	0.4	0.4				x
	<i>Amsinckia</i>	50	0.1	0.1	0.2	0.2				x
	<i>Calochortus</i>	50	0.1	0.1	0.2	0.2				x
	<i>Chaetopappa ericoides</i>	50	0.1	0.1	0.2	0.2				x
	<i>Eriastrum</i>	50	0.1	0.1	0.2	0.2				x
	<i>Gaura coccinea</i>	50	0.1	0.1	0.2	0.2				x
	<i>Lepidium lasiocarpum</i>	50	0.1	0.1	0.2	0.2				x
	<i>Salsola</i>	50	0.1	0.1	0.2	0.2				x
	<i>Sphaeralcea ambigua</i>	50	0.1	0.1	0.2	0.2				x

3. Desert & Semi-Desert Class

3.A.2. Warm Desert & Semi-Desert Scrub & Grassland Formation

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

M088. Mojave-Sonoran Semi-Desert Scrub Macrogroup

G293. Sonoran Paloverde - Mixed Cacti Desert Scrub Group

***Carnegiea gigantea* - *Parkinsonia microphylla* - *Prosopis velutina* Desert Scrub**

Common Name: Saguaro - Yellow Paloverde - Velvet Mesquite Desert Scrub

Group Assignment: G293; **Alliance Code:** A3282

Alliance Concept

The Saguaro - Yellow Paloverde - Velvet Mesquite Desert Scrub Alliance forms a sparse to intermittent shrub canopy and a sparse to intermittent herbaceous understory. It is found primarily on channel beds and walls and lowslopes to summits at all aspects. Soils are derived from a variety of substrates including conglomerate, dacite, and gravel. Soil texture ranges from sand to clay loam. Elevations range from approximately 200 to 600 meters. The dominant tall shrub is *Parkinsonia microphylla*. Commonly associated sub-canopy shrubs include *Encelia farinosa*, *Larrea tridentata*, *Acacia greggii*, and *Ambrosia dumosa*. Commonly associated herbs include *Amsinckia* spp., *Cryptantha* spp., *Gilia* spp., *Phacelia* spp., *Schismus* spp., *Camissonia* spp., *Chaenactis* spp., *Chamaesyce* spp., *Eriogonum inflatum*, *Lupinus* spp., and *Plantago ovata*.

Diagnostic Criteria: This alliance is characterized by a sparse to open tall shrub (or low tree) canopy of *Parkinsonia microphylla*, which ranges from 1 to 7 percent cover. The overall tall shrub cover ranges from 1 to 7 percent cover, and the understory shrub cover is variable and sometimes higher than the tall shrub cover.

Alliance Distribution

The alliance was sampled at low elevations in LAKE west of the Black Mountains.

States: AZ

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (8): 322Av, 322Ay

Park Sampling Zones: LAKE: Willow Beach

Associations

Association Scientific Name [NVC Code]	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Parkinsonia microphylla</i> – <i>Larrea tridentata</i> [CEGL001375]	8	x			

Association notes: An existing provisional association of *Parkinsonia microphylla* – *Larrea tridentata* exists in the NVC, though no current description exists through NatureServe (2012+); thus, this local alliance description serves as one representation of this association.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 395.3 m, Range 242 – 604 m

Aspect: NE (1), NW (2), SE (1), W (2), S (2)

Slope: Mean 20.1 degrees, Range 2 – 53 degrees

Macro Topography: Channel bed (1), Channel wall (2), High level/summit (1), Highslope (1), Lowslope (2), Midslope (1)

Tall Shrub Cover: Mean 2.6%, Range 1 – 7%

Subcanopy Shrub Cover: Mean 5.3%, Range 0.8 – 9.4%

Herb Cover: Mean 3.75%, Range 1 – 7%

Large Rock: Mean 24.625%, Range 0 – 89%

Small Rock: Mean 69.625%, Range 10 – 96%

Fines Cover: Mean 3.25%, Range 0 – 5%

Litter Cover: Mean 1.375%, Range 0 – 3%

Geology: conglomerate (5), dacite (1), gravel (2)

Soil Texture: Clay loam (1), Loamy sand (2), Sand (2), Sandy loam (2)

Environment: The alliance was sampled at low elevations in LAKE west of the Black Mountains. It is found from channel beds to summits at all aspects. Soils range from sand to clay loam derived from conglomerate, dacite, and gravel.

Vegetation Description

Vegetation Structure: The Alliance forms a sparse to open tall shrub layer with a sparse to open subcanopy shrub layer and sparse or open herbaceous understory.

Vegetation Floristics: The dominant tall shrub is *Parkinsonia microphylla* in the overstory. Understory shrubs that are characteristic or often present include *Larrea tridentata*, *Acacia greggii*, and *Ambrosia dumosa*. Herbs that are characteristic or often present include *Amsinckia* spp., *Cryptantha* spp., *Gilia* spp., *Phacelia* spp., *Schismus* spp., *Camissonia* spp., *Chaenactis* spp., *Chamaesyce* spp., *Eriogonum inflatum*, *Lupinus* spp., and *Plantago ovata*.

Dynamics: *Parkinsonia microphylla* occurs extensively in Arizona's Sonoran Desert and occurs minimally in the Mojave Desert of western Arizona and southeastern California along the Colorado River where precipitation is bimodal (winter and summer). *Larrea tridentata* and a diversity of other shrubs occur with *P. microphylla*.

Classification Comments

The NVC currently recognizes this as a shrubland alliance, though field observers collecting data for this project identified *Parkinsonia microphylla* as a low tree. Since this plant has taller stature and appears tree-like, we have described it as forming a tall shrub canopy.

Classification Confidence of Alliance: Moderate

Conservation Status Rank

Global: G4

State (California): S1

References

Sawyer et al. 2009

Surveys (with Sample Sizes) Used in Description

MOJN: N=8

LAKE (n=8): LAKE0104, LAKE0203, LAKE0205, LAKE0302, LAKE0633, LAKE9103, LAKE9630, LAKE9632

DEVA (n=0)

MOJA (n=0)

MOJN-Johnson (n=0)

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Shrub	<i>Parkinsonia microphylla</i>	100	100	2.6	1	7	x	x		
	<i>Encelia farinosa</i>	100	38	2.2	0.2	7	x		x	
	<i>Larrea tridentata</i>	100	24	1.2	0.2	3	x			
	<i>Ambrosia dumosa</i>	62	9.4	0.4	0.2	1				x
	<i>Acacia greggii</i>	62	5.4	0.1	0.2	0.2				x
	<i>Krameria erecta</i>	38	1.2	0.1	0.2	0.2				
	<i>Peucephyllum schottii</i>	25	10	0.5	0.2	4				
	<i>Ephedra nevadensis</i>	25	3.4	0.3	1	1				
	<i>Hymenoclea salsola</i>	25	2.7	0.1	0.2	0.5				
	<i>Eriogonum fasciculatum</i>	25	0.7	0.1	0.2	0.2				
	<i>Eucnide urens</i>	25	1.2	0.1	0.2	0.2				
	<i>Psoralea fremontii</i>	25	0.7	0.1	0.2	0.2				
Herb	<i>Amsinckia</i>	88	8.4	0.7	0.2	2	x			
	<i>Cryptantha</i>	75	21	1.7	0.6	3	x			
	<i>Gilia</i>	75	10	0.6	0.6	1.8	x			
	<i>Phacelia</i>	75	6.7	0.4	0.4	0.8	x			
	<i>Schismus</i>	75	3	0.2	0.2	0.2	x			
	<i>Plantago ovata</i>	62	8.1	0.6	0.2	2				x
	<i>Chaenactis</i>	62	4.3	0.3	0.4	0.4				x
	<i>Lupinus</i>	62	3.8	0.3	0.4	0.4				x
	<i>Camissonia</i>	50	3.3	0.2	0.4	0.4				x
	<i>Chamaesyce</i>	50	1.6	0.1	0.2	0.2				x
	<i>Eriogonum inflatum</i>	50	1.5	0.1	0.2	0.2				x
	Unknown Forb	38	6.1	0.7	1.6	2.4				
	<i>Erodium cicutarium</i>	38	0.8	0.1	0.2	0.2				
	<i>Eschscholzia</i>	38	1.5	0.1	0.2	0.2				
	<i>Lepidium lasiocarpum</i>	38	1.2	0.1	0.2	0.2				
	<i>Phacelia crenulata</i>	38	0.6	0.1	0.2	0.2				
	<i>Sphaeralcea ambigua</i>	38	1.6	0.1	0.2	0.2				
	<i>Mentzelia</i>	25	1.4	0.1	0.4	0.4				
	<i>Astragalus</i>	25	0.5	0.1	0.2	0.2				
	<i>Eriogonum deflexum</i>	25	1.3	0.1	0.2	0.2				
	<i>Perityle emoryi</i>	25	1.9	0.1	0.2	0.2				
	<i>Salvia columbariae</i>	25	1.1	0.1	0.2	0.2				
	<i>Xylorhiza tortifolia</i>	25	0.5	0.1	0.2	0.2				

3. Desert & Semi-Desert Class

3.A.2. Warm Desert & Semi-Desert Scrub & Grassland Formation

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

M088. Mojave-Sonoran Semi-Desert Scrub Macrogroup

G295. Mojave-Sonoran Bajada & Valley Desert Scrub Group

***Ambrosia dumosa* Desert Dwarf Scrub Alliance**

Common Name: White Bursage Scrub

Group Assignment: G295; **Alliance Code:** A3279

Alliance Concept

The White Bursage Scrub Alliance forms an open to intermittent shrub layer. The emergent tree layer is typically not present, and the herbaceous layer is sparse to open. The alliance is found primarily on rocky slopes and alluvial fans at all aspects. Soils are derived from a variety of substrates including sandstone, rhyolite, basalt, and alluvium, and textures are variable. Elevations range from approximately 250 to 1600 meters. *Ambrosia dumosa* is dominant and characteristic in the shrub layer, and those that are often present include *Larrea tridentata*, *Bromus rubens*, *Schismus* spp., and *Eriogonum inflatum* are often present in the herbaceous layer. Cryptogamic crust is frequently associated with this alliance.

Diagnostic Criteria: This alliance is characterized by an open to intermittent shrub layer with *Ambrosia dumosa* dominant. The overall shrub cover ranges from 4 to 34 percent.

Alliance Distribution

The alliance is well-defined in sampling at all three Parks. It is scattered throughout the parks at low to high elevation.

States: AZ, CA, NV

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (26): 322Ab, 322Ac, 322Ad, 322Af, 322Ai, 322Al, 322Am, 322At, 322Av, 322Ay, 322Az; Southeastern Great Basin (4): 341Fc, 341Ff

Park Sampling Zones: **DEVA:** CottonWood Mtns, East of Chloride City, Last Chance Range, Last Chance Vly, Owlshead Mtns, Panamint Mtns; **LAKE:** Boulder City, Callville, Echo Bay, Gold Butte, Katherine, Senator Mountain NW, Temple Bar, Willow Beach; **MOJA:** Devil's Playground, HackberryVontraigger

Associations

Association Scientific Name [NVC Code]	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Ambrosia dumosa</i> [CEGL005074]	42	x	x	x	x
<i>Ambrosia dumosa</i> (alliance)	1		x		
<i>Ambrosia dumosa</i> – <i>Ephedra torreyana</i> (– <i>Psoralea thymoides</i> <i>fremontii</i>)	7	x			

Association Notes: Another stand was sampled with *Ambrosia dumosa* dominant in the shrub layer by Root (1978), displaying additional variation than the associations listed.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 845.9 m, Range 264 – 1615 m

Aspect: N (5), NE (3), E (7), NW (2), SE (6), SW (4), W (9), S (11)

Slope: Mean 11.75 degrees, Range 0 – 36 degrees

Macro Topography: Channel bed (4), High level/summit (3), High slope (4), Low level/bottom (4), Lowslope (2), Midslope (6), Toeslope (alluvial fan/bajada) (1)

Tree Cover: Mean 0%, Range 0 – 0%

Shrub Cover: Mean 10.8%, Range 4.2 – 33.5%

Herb Cover: Mean 5.4%, Range 0 – 27%

Large Rock: Mean 14.5%, Range 0 – 92%

Small Rock: Mean 60.6%, Range 8 – 100%

Fines Cover: Mean 22.9%, Range 0 – 87%

Litter Cover: Mean 1.0%, Range 0 – 5%

Geology: alkali-granite (alaskite) (1), alluvium (3), basalt (3), claystone (1), conglomerate (2), dolostone (dolomite) (1), dune sand (1), gneiss (2), granodiorite (1), gravel (1), rhyolite (3), sandstone (10), sedimentary (gypsum) (1)

Soil Texture: Clay loam (2), Fine sandy clay (1), Loamy sand (5), Medium to very fine sandy loam (2), Moderately fine silty clay loam (1), Sand (4), Sandy clay (1), Sandy loam (2)

Environment: The alliance is found primarily on rocky slopes and alluvial fans at all aspects. Soils are derived from a variety of substrates including sandstone, rhyolite, and basalt and textures are variable. The alliance is found from low to high elevation.

Vegetation Description

Vegetation Structure: The Alliance forms an open to intermittent shrub layer and the overall shrub cover ranges from 4 to 34 percent. The tree layer is typically not present, and the herb layer is sparse to open. Non-vascular plants are typically sparse to open.

Vegetation Floristics: Elevations range from approximately 250 to 1600 meters. The dominant and characteristic shrub is *Ambrosia dumosa*, and those that are often present at lower cover include *Larrea tridentata*. *Bromus rubens*, *Schismus* spp., and *Eriogonum inflatum* are often present. Cryptogamic crust is frequently associated with this alliance.

Dynamics: *Ambrosia dumosa* is a relatively short-lived shrub with shallow roots. It tends to replace *Larrea tridentata* on soils with high clay content and with strong caliche layers, and it can colonize and dominate recently disturbed upland sites.

Classification Comments

None.

Classification Confidence of Alliance: High

Conservation Status Rank

Global: G5

State (California): S4

References

Evens and Hartman 2007, Evens et al. 2012, Keeler-Wolf and Thomas 2000, Keeler-Wolf et al. 1998b, Root 1978, Sawyer et al. 2009, VegCAMP and AIS 2013

Surveys (with Sample Sizes) Used in Description

MOJN: N=50

LAKE (n=19): LAKE0126, LAKE0148, LAKE0207, LAKE0208, LAKE0233, LAKE0234, LAKE0322, LAKE0325, LAKE9136, LAKE9145, LAKE9186, LAKE9210, LAKE9279, LAKE9323, LAKE9324, LAKE9344, LAKE9361, LAKE9402, LMJOA042

DEVA (n=8): DEVA0312, DEVA0821, DEVA9311, DEVA9426, DEVA9544, DEVAR087, MOJC0375, MOJC0691

MOJA (n=3): MOJA9547, MOJC1203, MOJC1204

MOJN-Johnson (n=20): MOJJE107, MOJJE123, MOJJE138, MOJJE139, MOJJE141, MOJJE162, MOJJE212, MOJJE233, MOJJE302, MOJJE343, MOJJE351, MOJJE443, MOJJE492, MOJJE493, MOJJE494, MOJJE526, MOJJE599, MOJJE5T3, MOJJE914, MOJJE918

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Shrub										
	<i>Ambrosia dumosa</i>	100	54	6	0.5	24	x	x		
	<i>Larrea tridentata</i>	76.7	3.9	0.4	0.2	2	x			
	<i>Krameria erecta</i>	46.7	2.8	0.3	0.2	2				
	<i>Opuntia basilaris</i>	36.7	1.5	0.1	0.2	1				
	<i>Stephanomeria pauciflora</i>	33.3	0.9	0.1	0.1	0.5				
	<i>Amphipappus fremontii</i>	30	2.3	0.3	0.2	3				
	<i>Psoralea fremontii</i>	26.7	3.2	0.3	0.2	3				
	<i>Eriogonum fasciculatum</i>	26.7	1.4	0.1	0.2	1				
Herb										
	<i>Bromus rubens</i>	56.7	8.1	0.3	0.2	3				x
	<i>Eriogonum inflatum</i>	53.3	4.3	0.1	0.1	0.5				x
	<i>Schismus</i>	50	6.7	0.5	0.2	5				x
	<i>Xylorhiza tortifolia</i>	40	3.9	0.1	0.2	1				
	<i>Cryptantha</i>	36.7	6.8	0.3	0.6	3				
	<i>Erodium cicutarium</i>	33.3	3.1	0.2	0.2	2				
	<i>Gilia</i>	33.3	3.7	0.2	0.6	1.2				
	<i>Pleuraphis rigida</i>	33.3	4.4	0.2	0.2	2				
	<i>Mentzelia</i>	33.3	2	0.1	0.4	0.4				
	<i>Sphaeralcea ambigua</i>	33.3	1.7	0.1	0.2	0.5				
	<i>Rafinesquia neomexicana</i>	33.3	1.3	0.1	0.2	0.2				
	<i>Plantago ovata</i>	26.7	3.7	0.3	0.2	3.7				
Non-vasc										
	Cryptogamic crust	53.3	52	0.9	0.2	5				x

***Encelia farinosa* Desert Scrub Alliance**

Common Name: Brittle Bush Scrub

Group Assignment: G295; **Alliance Code:** cf. A3278

Alliance Concept

The Brittle Bush Scrub Alliance forms sparse to intermittent shrub layer. The emergent tree layer is typically sparse to open, and the herbaceous layer is sparse to intermittent. The alliance is found on various landforms, and is often found on south to west-facing aspects along upper bajadas and lower mountain slopes. Substrates are usually rocky. Soils are derived from a variety of substrates including alkali-granite (alaskite), alluvium, volcanic, and sandstone, and textures are variable. Elevations range from approximately 200 to 1000 meters. The dominant and characteristic shrub is *Encelia farinosa*. Characteristic shrubs include *Larrea tridentata* at low cover, and often present is *Ambrosia dumosa*. *Eriogonum inflatum*, *Schismus* spp., and *Cryptantha* spp. are sometimes present in the herbaceous layer.

Diagnostic Criteria: This alliance is characterized by a sparse to intermittent shrub layer with *Encelia farinosa* dominant or co-dominant with other short shrubs including *Ambrosia dumosa*. The overall shrub cover ranges from 1 to 36 percent.

Alliance Distribution

The alliance is well-defined in sampling at LAKE, and is more scattered in the western portion of MOJA and the southern portion of DEVA. It occurs at low to mid elevations.

States: AZ, CA, NV

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (46): 322Ab, 322Ad, 322Af, 322Ai, 322Aj, 322Al, 322Am, 322At, 322Av, 322Ay, 322Az; Southeastern Great Basin (3): 341Fe, 341Ff

Park Sampling Zones: **DEVA:** Black Mtns, Death Valley, Funeral Mtns, Nelson Range, Owshead Mtns, Panamint Mtns; **LAKE:** Boulder City, Bridge Canyon, Callville, Cottonwood Cove, Gold Butte, Katherine, Pearce Ferry, Spirit Mountain, Temple Bar, Willow Beach; **MOJA:** Granite Mtns, Halloran Spring, Old Dad Mtns, Piute Range, Zzyzx

Associations

Association Scientific Name [NVC Code]	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Encelia farinosa</i> [CEGL001251]	22	x	x	x	x
<i>Encelia farinosa</i> – <i>Ambrosia dumosa</i> [CEGL002955]	18	x	x	x	x
<i>Encelia farinosa</i> – <i>Peucephyllum schottii</i>	12	x	x		

Association Notes: None.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 574.1 m, Range 226 – 991 m

Aspect: N (4), NE (4), E (10), NW (1), SE (9), SW (7), W (4), S (11)

Slope: Mean 23.7 degrees, Range 1 – 70 degrees

Macro Topography: Channel bed (3), Entire slope (1), High level/summit (2), High slope (4), Low level/bottom (2), Lowslope (1), Midslope (13), Toeslope (alluvial fan/bajada) (1)

Tree Cover: Mean 0.1%, Range 0 – 3%

Shrub Cover: Mean 11.9%, Range 1.1 – 35.5%

Herb Cover: Mean 5.1%, Range 0 – 38%

Large Rock: Mean 42.5%, Range 0 – 96%

Small Rock: Mean 48.4%, Range 2 – 98%

Fines Cover: Mean 5.7%, Range 0 – 89%

Litter Cover: Mean 1.8%, Range 0 – 14.1%

Geology: alkali-granite (alaskite) (9), alluvium (6), basalt (3), conglomerate (3), dacite (2), felsic volcanic rock (1), gneiss (4), granite (2), granodiorite (1), limestone (1), rhyolite (1), sandstone (10), schist (4), sedimentary (gypsum) (1), water (1)

Soil Texture: Clay (1), Clay loam (2), Coarse sand (1), Loam (1), Loamy sand (4), Medium silt loam (2), Medium to very fine sandy loam (5), Sand (1), Sandy clay (1), Sandy loam (2), Silty clay (1)

Environment: The alliance is found on various landforms and is often found on south to west facing aspects. Substrates are usually rocky. Soils are derived from a variety of substrates including alkali-granite (alaskite), alluvium, volcanic, and sandstone, and textures are variable. The elevations range from low to mid.

Vegetation Description

Vegetation Structure: The Alliance forms a sparse to intermittent shrub layer and the overall shrub cover ranges from 1 to 36 percent. The tree layer is typically sparse to open, and the herb layer is sparse to intermittent. Non-vascular plants are typically sparse to open.

Vegetation Floristics: Dominant and characteristic shrubs include *Encelia farinosa*, characteristic shrubs include *Larrea tridentata*, and those that are often present include *Ambrosia dumosa*. *Eriogonum inflatum*, *Schismus* spp., and *Cryptantha* spp. are sometimes present in the herbaceous layer.

Dynamics: *Encelia farinosa* is a relatively short-lived shrub that does not tolerate sandy or clay-rich soils; it is often found dominating steep, rocky sites, especially south to west-facing aspects along upper bajadas and lower mountain slopes.

Classification Comments

Stands of *Encelia farinosa* that are co-dominant with *Ambrosia dumosa* are placed in this alliance. Stands with *Cylindropuntia bigeolvii* are placed in that alliance.

Classification Confidence of Alliance: High

Conservation Status Rank

Global: G5

State (California): S4

References

Evens and Hartman 2007, Evens et al. 2012, Keeler-Wolf and Thomas 2000, Minnich et al. 1993, Sawyer et al. 2009, VegCAMP and AIS 2013

Surveys (with Sample Sizes) Used in Description

MOJN: N=52

LAKE (n=30): LAKE0257, LAKE0281, LAKE0393, LAKE0436, LAKE9154, LAKE9159, LAKE9162, LAKE9226, LAKE9265, LAKE9291, LAKE9304, LAKE9351, LAKE9363, LAKE9441, LAKE9504, LAKE9707, LAMEN009, LAMEN011, LAMEN015, LAMEN022, LAMEN026, LAMEN027, LAMEN051, LAMEN054, LAMEN056, LAMEN059, LAMEN060, LAMEN070, LAMEN112, LAMEN113

DEVA (n=13): DEVA9282, DEVA9409, DEVA9411, DEVA9433, DEVAD043, DEVAS072, DEVAS164, MOJC0489, MOJC0516, MOJC0517, MOJC0576, MOJC0577, MOJC0927

MOJA (n=6): MOJA0923, MOJA9166, MOJA9551, MOJA9658, MOJC0010, MOJC1050

MOJN-Johnson (n=3): MOJJE251, MOJJE288, MOJJE594

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Shrub	<i>Encelia farinosa</i>	100	53	6	0.5	18	x	x		
	<i>Larrea tridentata</i>	75.5	5.5	0.6	0.05	3.7	x			
	<i>Ambrosia dumosa</i>	67.3	11	1.6	0.1	16				x
	<i>Eriogonum fasciculatum</i>	42.9	3.3	0.4	0.09	3.67				
	<i>Bebbia juncea</i>	40.8	3.1	0.3	0.2	3				
	<i>Opuntia basilaris</i>	36.7	0.7	0.1	0.06	0.5				
	<i>Ferocactus cylindraceus</i>	32.7	1.1	0.1	0.03	1				
	<i>Peucephyllum schottii</i>	28.6	2.9	0.3	0.19	3				
	<i>Krameria erecta</i>	28.6	0.7	0.1	0.11	0.95				
	<i>Ephedra nevadensis</i>	26.5	1.8	0.2	0.13	2.06				
	<i>Krameria grayi</i>	26.5	1.3	0.2	0.07	1.68				
Herb	<i>Eriogonum inflatum</i>	49	15	0.1	0.02	0.53				
	<i>Cryptantha</i>	30.6	7.9	0.2	0.33	3				
	<i>Schismus</i>	30.6	3.1	0.1	0.11	2				

***Fouquieria splendens* Desert Scrub Alliance**

Common Name: Ocotillo Desert Scrub

Group Assignment: G295; **Alliance Code:** cf. A3278

Alliance Concept

The Ocotillo Desert Scrub Alliance forms an open shrub layer. The emergent tree layer is typically sparse to open, and the herbaceous layer is open. The alliance is found on a variety of landforms, though often on older and xeric rocky bajadas and lower to mid-slopes that are exposed and rocky, in both the Sonoran Desert and southern Mojave Desert. Soils are derived from a variety of substrates including sandstone and schist and textures include clay loam, loamy sand, and sandy loam. Elevations range from approximately 600 to 750 meters.

Fouquieria splendens is the dominant overstory plant of this alliance. Other characteristic shrubs include *Ambrosia dumosa*, *Ferocactus cylindraceus*, *Opuntia polyacantha* var. *erinacea*, and *Tiquilia canescens*, and those that are often present include *Cylindropuntia acanthocarpa*, *Echinocereus engelmannii*, *Encelia farinosa*, *Eriogonum fasciculatum*, and *Krameria erecta*. Characteristic herbs include *Bromus rubens*, *Eriogonum inflatum*, and *Sphaeralcea ambigua*, and often occurring herbs include *Antheropeas*, *Argythamnia neomexicana*, *Chorizanthe brevicornu*, *Cryptantha* sp., *Dasyochloa pulchella*, *Erodium cicutarium*, *Gilia* sp., *Lepidium lasiocarpum*, *Porophyllum gracile*, *Vulpia*, and *Xylorhiza tortifolia*. Commonly associated non-vascular plants include cryptogammic crust.

Diagnostic Criteria: This alliance is characterized by an open tree or tall-shrub layer of *Fouquieria splendens* as the dominant overstory plant. The shorter shrub layer is variable and includes *Ambrosia dumosa*, *Cylindropuntia acanthocarpa*, *Echinocereus engelmannii*, *Encelia farinosa*, *Eriogonum fasciculatum*, *Ferocactus cylindraceus*, *Krameria erecta*, *Opuntia polyacantha* var. *erinacea*, and/or *Tiquilia canescens*. The overall taller shrub to low tree cover ranges from 2 to 3%, and the lower shrub cover ranges from 5 to 12 percent.

Alliance Distribution

The alliance was found only at the eastern edge of LAKE at mid elevations.

States: AZ

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (5): 322Av

Park Sampling Zones: LAKE: Parashant, Pearce Ferry, Temple Bar

Associations

Association Scientific Name [NVC Code]	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Fouquieria splendens</i> [CEGL001168]	3	x			
<i>Fouquieria splendens</i> / <i>Encelia</i> (<i>farinosa</i> , <i>resinifera</i>) [CEGL005118]	2	x			

Association Notes: None

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 674.4 m, Range 632 – 735 m
Aspect: E (1), N (1), SE (1), SW (2)
Slope: Mean 17.4 degrees, Range 10 – 40 degrees
Macro Topography: High level/summit (1), Midslope (4)

Tree Cover: Mean 2.4%, Range 2 – 3%
Shrub Cover: Mean 7.6%, Range 5.4 – 12.4%
Herb Cover: Mean 4.8%, Range 2 – 7%

Large Rock: Mean 34.8%, Range 0 – 94%
Small Rock: Mean 59.8%, Range 4 – 95%
Fines Cover: Mean 2.8%, Range 0 – 2%
Litter Cover: Mean 0.8%, Range 0 – 2%

Geology: conglomerate (1), sandstone (2), schist (2)
Soil Texture: Clay loam (1), Loamy sand (1), Sandy loam (1)

Environment: The alliance is found on a variety of landforms, though is often on older and xeric, rocky upper bajadas and lower to mid-slopes that are exposed and rocky. Soils are derived from a variety of substrates including sandstone and schist and textures include clay loam, loamy sand, and sandy loam.

Vegetation Description

Vegetation Structure: The Alliance forms an open shrub layer and the overall shrub cover ranges from 5 to 12 percent. The tree layer is typically sparse to open, and the herb layer is sparse to open. Non-vascular plants are typically not present.

Vegetation Floristics: *Fouquieria splendens* is the dominant overstory plant of this alliance, and often considered a tall shrub. Other characteristic shrubs include *Ambrosia dumosa*, *Ferocactus cylindraceus*, *Opuntia polyacantha* var. *erinacea*, and *Tiquilia canescens*, and those that are often present include *Cylindropuntia acanthocarpa*, *Echinocereus engelmannii*, *Encelia farinosa*, *Eriogonum fasciculatum*, and *Krameria erecta*. Characteristic herbs include *Bromus rubens*, *Eriogonum inflatum*, and *Sphaeralcea ambigua*, and often occurring herbs include *Antheropeas*, *Argythamnia neomexicana*, *Chorizanthe brevicornu*, *Cryptantha* sp., *Dasyochloa pulchella*, *Erodium cicutarium*, *Gilia* sp., *Lepidium lasiocarpum*, *Porophyllum gracile*, *Vulpia*, and *Xylorhiza tortifolia*. Commonly associated non-vascular plants include cryptogamic crust.

Dynamics: *Fouquieria splendens* is a common shrubland associate in the Sonoran Desert and rare in the Mojave Desert.

Classification Comments

Since the LAKE vegetation map placed stands with *Fouquieria splendens* dominant or co-dominant in a separate map class from stands with *Larrea tridentata* - *Encelia farinosa* Upper Bajada & Rock Outcrop Desert Scrub Alliance, we have described these *Fouquieria* associations separate from that alliance. However, the NVC currently places stands with *Fouquieria splendens* dominant or co-dominant within the *Larrea tridentata* - *Encelia farinosa* Upper Bajada & Rock Outcrop Desert Scrub Alliance.

Some uncertainty exists whether these Mojavean stands with *Fouquieria splendens* dominant should be pulled out as a separate alliance, as it is closely related to others in this Mojave-Sonoran Bajada & Valley Desert Scrub Group, including the *Encelia farinosa* Scrub Alliance, *Larrea tridentata* - *Encelia farinosa* Scrub Alliance, and *Parkinsonia microphylla* Wooded Shrubland Alliance. Stands with *Fouquieria splendens* characteristically present and/or dominant in the overstory only occur in relatively hot desert areas with high summer rainfall, including the Sonoran Desert and western Grand Canyon, while the *Larrea tridentata* - *Encelia farinosa* Upper Bajada & Rock Outcrop Desert Scrub Alliance is much more wide-ranging into the Mojave Desert.

Classification Confidence of Alliance: Low

Conservation Status Rank

Global: GNR

State (California): GNR

References

NatureServe 2010, NatureServe 2012

Surveys (with Sample Sizes) Used in Description

MOJN: N=5

LAKE (n=5): LAKE0163, LAKE0373, LAKE0408, LAKE9260, LAKE9261

DEVA (n=0)

MOJA (n=0)

MOJN-Johnson (n=0)

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Tree										
	<i>Fouquieria splendens</i>	100	100	2.4	2	3	x	x		
Shrub										
	<i>Ferocactus cylindraceus</i>	100	6.4	0.5	0.2	1	x			
	<i>Tiquilia canescens</i>	80	8.3	0.7	0.2	3	x			
	<i>Ambrosia dumosa</i>	80	4.9	0.3	0.2	1	x			
	<i>Opuntia polyacantha</i> var. <i>erinacea</i>	80	1.5	0.1	0.2	0.2				
	<i>Encelia farinosa</i>	60	16	1	0.2	4				x
	<i>Eriogonum fasciculatum</i>	60	7.6	0.7	0.2	3				x
	<i>Cylindropuntia acanthocarpa</i>	60	1.8	0.1	0.2	0.2				x
	<i>Echinocereus engelmannii</i>	60	1.8	0.1	0.2	0.2				x
	<i>Krameria erecta</i>	60	1.6	0.1	0.2	0.2				x
	<i>Psoralea fremontii</i>	40	9.2	0.6	0.2	0.2				
	<i>Viguiera parishii</i>	40	8	0.4	0.2	2				
	<i>Bebbia juncea</i>	40	4.3	0.2	0.2	1				
	<i>Larrea tridentata</i>	40	3.6	0.2	0.2	1				
	<i>Stephanomeria pauciflora</i>	40	3.2	0.2	0.2	0.2				
	<i>Gutierrezia sarothrae</i>	40	3.1	0.2	0.2	0.8				
	<i>Ephedra</i>	40	2.3	0.1	0.2	0.5				
	<i>Acacia greggii</i>	40	1.2	0.1	0.2	0.2				
	<i>Echinocactus polycephalus</i>	40	1.1	0.1	0.2	0.2				
	<i>Ephedra nevadensis</i>	40	1	0.1	0.2	0.2				
	<i>Ephedra torreyana</i>	40	0.9	0.1	0.2	0.2				
	<i>Machaeranthera pinnatifida</i>	40	1.3	0.1	0.2	0.2				
	<i>Mammillaria tetrancistra</i>	40	1.1	0.1	0.2	0.2				
	<i>Opuntia basilaris</i>	40	1.3	0.1	0.2	0.2				
	<i>Yucca schidigera</i>	40	1.0	0.1	0.2	0.2				
Herb										
	<i>Bromus rubens</i>	100	22	1.1	0.2	3	x			
	<i>Sphaeralcea ambigua</i>	100	4.1	0.4	0.2	1	x			
	<i>Eriogonum inflatum</i>	80	1.3	0.2	0.2	0.2	x			
	<i>Antheropeas</i>	60	6.9	0.8	0.2	3	x			
	<i>Gilia</i>	60	4.1	0.5	0.6	1.2	x			
	<i>Cryptantha</i>	60	3.1	0.4	0.6	0.6	x			
	<i>Erodium cicutarium</i>	60	2.3	0.3	0.2	1	x			
	<i>Vulpia</i>	60	2.4	0.3	0.2	1	x			
	<i>Argythamnia neomexicana</i>	60	1	0.1	0.2	0.2	x			
	<i>Chorizanthe brevicornu</i>	60	1	0.1	0.2	0.2	x			
	<i>Dasyochloa pulchella</i>	60	1.5	0.1	0.2	0.2				x
	<i>Lepidium lasiocarpum</i>	60	1	0.1	0.2	0.2	x			
	<i>Porophyllum gracile</i>	60	1	0.1	0.2	0.2	x			
	<i>Xylorhiza tortifolia</i>	60	1.5	0.1	0.2	0.2				x
	<i>Eucrypta micrantha</i>	40	2.6	0.2	0.2	1				
	<i>Chaenactis</i>	40	1.4	0.2	0.4	0.4				x
	<i>Linanthus</i>	40	1.3	0.2	0.4	0.4				x
	<i>Adenophyllum porophylloides</i>	40	0.6	0.1	0.2	0.2				x
	<i>Allionia incarnata</i>	40	1.1	0.1	0.2	0.2				x

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
	<i>Aristida purpurea</i>	40	0.6	0.1	0.2	0.2				x
	<i>Astragalus nuttallianus</i>	40	0.7	0.1	0.2	0.2				x
	<i>Cryptantha pterocarya</i>	40	1.2	0.1	0.2	0.2				
	<i>Gilia scopulorum</i>	40	1.1	0.1	0.2	0.2				
	<i>Lotus</i>	40	0.6	0.1	0.2	0.2				x
	<i>Lupinus sparsiflorus</i>	40	0.6	0.1	0.2	0.2				x
	<i>Phacelia crenulata</i>	40	0.6	0.1	0.2	0.2				x
	<i>Phacelia rotundifolia</i>	40	0.7	0.1	0.2	0.2				x
	<i>Pterostegia drymarioides</i>	40	0.7	0.1	0.2	0.2				x
	<i>Rafinesquia neomexicana</i>	40	0.6	0.1	0.2	0.2				x
	<i>Schismus</i>	40	0.6	0.1	0.2	0.2				x
	<i>Thysanocarpus curvipes</i>	40	1.2	0.1	0.2	0.2				
	<i>Tridens muticus</i>	40	0.7	0.1	0.2	0.2				x
Non-vascular										
	Cryptogamic crust	60	48	0.7	0.2	3				x

***Larrea tridentata* Desert Scrub Alliance**

Common Name: Creosote Bush Desert Scrub

Group Assignment: G295, G296; **Alliance Code:** cf. A3278

Alliance Concept

The Creosote Bush Desert Scrub Alliance forms a sparse to intermittent shrub layer. The emergent tree layer is sparse, when present, and the herbaceous layer is sparse to open. The alliance is found primarily on alluvial fans and bajadas at all aspects. Soils are derived from a variety of substrates including alluvium, dune sand, rhyolite, and sandstone and textures are highly variable. Elevations range from approximately -10 to 1500 meters, though stands are typically found at lower to mid-elevations. *Larrea tridentata* is the dominant and characteristic shrub of this alliance. *Ambrosia dumosa* is sometimes present at significantly lower cover. *Plantago ovata*, *Chorizanthe rigida*, *Eriogonum inflatum*, *Cryptantha* spp., *Amsinkia* spp., and *Schismus* spp. are all sometimes present in this alliance.

Diagnostic Criteria: This alliance is characterized by a sparse to intermittent shrub layer with *Larrea tridentata* typically dominant or sometimes co-dominant with shrubs such as *Atriplex polycarpa*. The overall shrub cover ranges from 1 to 34 percent.

Alliance Distribution

The alliance is well-defined in sampling at all three Parks typically at lower to mid elevations.

States: AZ, CA, NV

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (113): 322Ab, 322Ac, 322Ad, 322Ae, 322Af, 322Ai, 322Aj, 322Ak, 322Al, 322Am, 322At, 322Av, 322Ay, 322Az, 341Fc; Southeastern Great Basin (30): 341Fe, 341Ff

Park Sampling Zones: **DEVA:** Black Mtns, CottonWood Mtns, Death Valley, Eureka Valley, Green Water Rng/Vlly, Joshua Flat, Last Chance Range, Last Chance Vlly, Nelson Range, Nevada Triangle, Owlshead Mtns, Panamint Dunes, Panamint Mtns, Ryan, Saline Valley; **LAKE:** Boulder City, Callville, Cottonwood Cove, Echo Bay, Gold Butte, Government Wash, Katherine, Lakeshore, Pearce Ferry, Temple Bar, Willow Beach; **MOJA:** Cima Dome NW, Cinder Cones, Clipper Vlly, Crucero Hill, Devil's Playground, Fenner Vlly, Ivanpah Vlly, Lanfair Vlly, Piute Range, Zzyzx

Associations

Association Scientific Name [NVC Code]	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Larrea tridentata</i> [CEGL005145]	115	x	x	x	x
<i>Larrea tridentata</i> (alliance)	11	x	x		x
<i>Larrea tridentata</i> (sparse post-burn / herbaceous)	7		x		
<i>Larrea tridentata</i> / <i>Pleuraphis rigida</i>	13			x	x
<i>Larrea tridentata</i> – <i>Atriplex polycarpa</i>	10		x	x	
<i>Larrea tridentata</i> – <i>Ephedra nevadensis</i> [CEGL001268]	17		x	x	x

Association Notes: Three samples were classified only to alliance level, suggesting further variation in our study area, including stands with *Larrea tridentata* co-dominating with *Petalonyx thurberi* and other mixtures of shrubs.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 713.4 m, Range -10 – 1497 m

Slope: Mean 5.3 %, Range 0 – 30%

Aspect: N (16), NE (23), E (25), NW (10), SE (28), Flat (2), Flat, Variable (8), W (13), SW (13), S (23)

Macro Topography: Backslope (1), Basin floor/wetland (1), Channel bed (5), Entire slope (5), High level/summit (7), High slope (7), Low level/bottom (15), Lowslope (22), Midslope (14), Toeslope (alluvial fan/bajada) (21)

Tree Cover: Mean 0%, Range 0 – 1%

Shrub Cover: Mean 7.2%, Range 0 – 65.2%

Herb Cover: Mean 4.1%, Range 0 – 34%

Large Rock: Mean 9.0%, Range 0 – 97%

Small Rock: Mean 63.0%, Range 0 – 100%

Fines Cover: Mean 24.0%, Range 0 – 99%

Litter Cover: Mean 2.0%, Range 0 – 20%

Geology: alkali-granite (alaskite) (1), alluvium (82), basalt (2), conglomerate (3), dolostone (dolomite) (1), dune sand (9), granite (1), gravel (4), limestone (7), rhyolite (17), sand (1), sandstone (11), schist (2), tephrite (basanite) (1)

Soil Texture: Clay loam (6), Coarse sand (2), Fine sand (3), Fine sandy clay (1), Loam (2), Loamy sand (9), Medium sand (4), Medium silt loam (3), Medium to very fine sandy loam (8), Moderately coarse loamy sand (1), Moderately fine clay loam (1), Moderately fine sandy clay loam (5), Sand (12), Sandy clay (1), Sandy loam (17), Silty clay (1)

Environment: The alliance is found primarily on alluvial fans and bajadas at all aspects. Soils are derived from a variety of substrates including alluvium, dune sand, rhyolite, and sandstone and textures are highly variable. Elevations range from low to high.

Vegetation Description

Vegetation Structure: The Alliance forms a sparse to intermittent shrub layer and the overall shrub cover ranges from 1 to 65 percent. The tree layer is sparse, when present, and the herb layer is sparse to intermittent. Non-vascular plants are typically sparse to open.

Vegetation Floristics: *Larrea tridentata* is typically the sole dominant and characteristic shrub of this alliance, though sometimes other shrubs such as *Atriplex polycarpa* can be co-dominant.

Ambrosia dumosa is sometimes present at low cover. *Plantago ovata*, *Chorizanthe rigida*, *Eriogonum inflatum*, *Cryptantha* spp., *Amsinkia* spp., and *Schismus* spp. are all sometimes present in this alliance.

Dynamics: Associations may vary based on soil texture, alkalinity, and disturbance regimes. For example, in sandy situations, *Larrea tridentata* often co-occurs with perennial grasses including *Pleuraphis rigida*; along certain washes and terraces with somewhat alkaline soils, it co-dominates with *Atriplex polycarpa*. In areas with disturbance, including grazing and post-burn, the *Larrea tridentata* may be the only shrub present but at low cover.

Classification Comments

The NVC classification for this alliance is under evaluation as to whether it will be separated out from those with *Larrea tridentata* co-dominant with *Ambrosia dumosa* and/or *Encelia farinosa*. Site history and environmental settings do predict the variation in (co-)dominant shrubs. For example, stands with *Larrea tridentata* solely dominant are often found on desert pavements and younger alluvial fans and aeolian soils that have variable or deeper soils, in which the deep, spreading roots of *Larrea tridentata* can penetrate (Hamerlynck et al. 2002), and is not as well adapted to bajadas with older alluvium and well-developed caliche layer where *Ambrosia dumosa* can co-dominate (with *Larrea tridentata*) or predominate. At least one association with *Larrea tridentata* dominant (i.e., *Larrea tridentata* - *Coleogyne ramosissima* Shrubland Association), which was not sampled in this study, can be found in the G296 group.

Classification Confidence of Alliance: High

Conservation Status Rank

Global: G5

State (California): S5

References

Annable 1985, Evens and Hartman 2007, Evens et al. 2012, Keeler-Wolf and Thomas 2000, Keeler-Wolf et al. 1998b, Minnich et al. 1993, NatureServe 2012, Peterson 1984a, Root 1978, Sawyer et al. 2009, VegCAMP and AIS 2013

Surveys (with Sample Sizes) Used in Description

MOJN: N=173

LAKE (n=25): LAKE0129, LAKE0134, LAKE0157, LAKE0190, LAKE0237, LAKE0315, LAKE0329, LAKE0337, LAKE0338, LAKE0347, LAKE0376, LAKE0522, LAKE9204, LAKE9314, LAKE9349, LAKE9355, LAKE9389, LAKE9502, LAKE9507, LAKE9602, LAKE9636, LAKE9712, LAMEN002, LAMEN030, LMJOA040

DEVA (n=102): DEVA0297, DEVA0421, DEVA0908, DEVA9129, DEVA9130, DEVA9177, DEVA9242, DEVA9273, DEVA9278, DEVA9281, DEVA9293, DEVA9299, DEVA9388, DEVA9417, DEVA9420, DEVA9423, DEVA9430, DEVA9461, DEVA9557, DEVA9624, DEVA9625, DEVA9900, DEVAD071, DEVAD088, DEVAD089, DEVAD193, DEVAD194, DEVAD198, DEVAD209, DEVAR018, DEVAR052, DEVAR075, DEVAR089, DEVAR090, DEVAR092, DEVAR095, DEVAR098, DEVAS001, DEVAS002, DEVAS003, DEVAS012, DEVAS015, DEVAS017, DEVAS018, DEVAS024, DEVAS027, DEVAS029, DEVAS030, DEVAS032, DEVAS073, DEVAS075, DEVAS078, DEVAS080, DEVAS093, DEVAS128, DEVAS129, DEVAS130, DEVAS133, DEVAS137, DEVAS140, DEVAS142, DEVAS143, DEVAS156, DEVAS157, DEVAS158, DEVAS163, DEVAS167, DEVAS168, DEVAS172, DEVAS173, DEVAS177, DEVAS183, DEVAS191, DEVAS195, DEVAS202, DEVAS207, MOJC0483, MOJC0490, MOJC0491, MOJC0493, MOJC0521, MOJC0561, MOJC0565, MOJC0581, MOJC0582, MOJC0583, MOJC0628, MOJC0643, MOJC0664, MOJC0666, MOJC0667, MOJC0668, MOJC0669, MOJC0675, MOJC0678, MOJC0679, MOJC0694, MOJC0751, MOJC0752, MOJC0912, MOJC0956, MOJC0971

MOJA (n=17): MOJA0105, MOJA0203, MOJA0619, MOJA0926, MOJA9101, MOJA9202, MOJA9297, MOJA9398, MOJA9553, MOJA9700, MOJA9970, MOJC0203, MOJC0210, MOJC0856, MOJC0857, MOJC0865, MOJC1225

MOJN-Johnson (n=29): MOJJE009, MOJJE019, MOJJE038, MOJJE114, MOJJE185, MOJJE193, MOJJE223, MOJJE323, MOJJE366, MOJJE380, MOJJE398, MOJJE532, MOJJE537, MOJJE541, MOJJE542, MOJJE547, MOJJE551, MOJJE554, MOJJE688, MOJJE697, MOJJE717, MOJJE719, MOJJE727, MOJJE735, MOJJE737, MOJJE741, MOJJE742, MOJJE833, MOJJE844

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Shrub	<i>Larrea tridentata</i>	100	78	5.5	0.5	65	x	x		
	<i>Ambrosia dumosa</i>	38.9	3.3	0.2	0.1	3				
Herb	<i>Plantago ovata</i>	34	12	0.7	0.1	11				
	<i>Chorizanthe rigida</i>	31.9	5.4	0.1	0.1	3				
	<i>Cryptantha</i>	31.3	5.6	0.3	0.3	9				
	<i>Eriogonum inflatum</i>	29.2	6.9	0.4	0.01	37.5				
	<i>Schismus</i>	25	4.9	0.3	0.11	10				

***Larrea tridentata* – *Ambrosia dumosa* Bajada & Valley Desert Scrub Alliance**

Common Name: Creosotebush - Burrobush Bajada & Valley Desert Scrub

Group Assignment: G295; **Alliance Code:** A3277

Alliance Concept

The Creosotebush - Burrobush Bajada & Valley Desert Scrub Alliance forms an open to intermittent shrub layer. The emergent tree layer is typically sparse to open, and the herbaceous layer is sparse to continuous. The alliance is found on a variety of landforms, but is especially common on bajadas and alluvial fans in valleys. It occurs at all aspects. The alliance is primarily found on alluvial soils, but also occurs on a variety of other substrates. Soil texture is highly variable. Elevations range from approximately 25 to 1750 meters. *Larrea tridentata* and *Ambrosia dumosa* are co-dominant in this alliance. *Krameria erecta* and *Opuntia basilaris* are sometimes present. *Eriogonum inflatum* is often present in the herbaceous layer and is sometimes accompanied by *Schismus* spp., *Amsinkia* spp., *Cryptantha* spp., and *Bromus rubens*. Cryptogamic crust is sometimes associated with this vegetation alliance.

Diagnostic Criteria: This alliance is characterized by an open to intermittent shrub layer with *Ambrosia dumosa* and *Larrea tridentata* co-dominant. Sometimes either shrub may be higher in cover, but not more than 2x the cover of the other. The overall shrub cover ranges from 2 to 41 percent.

Alliance Distribution

The alliance is well-defined in sampling at all three Parks. It occurs throughout the parks at low to high elevations with the majority of samples in the mid to low elevations range.

States: AZ, CA, NV

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (438):

322Ab, 322Ac, 322Ad, 322Ae, 322Af, 322Ai, 322Aj, 322Ak, 322Al, 322Am, 322Ar, 322At, 322Av, 322Ay, 322Az; Southeastern Great Basin (90): 341Fc, 341Fd, 341Fe, 341Ff

Park Sampling Zones: **DEVA:** Black Mtns, Cottonwood Mtns, Death Valley, Devil's Hole, East of Chloride City, East of Deadman Pass, East of Ryan, Eureka Valley, Funeral Mtns, Grapevine Mtns, Green Water Rng/Vlly, Joshua Flat, Last Chance Range, Last Chance Vly, Nelson Range, Nevada Triangle, Owlshead Mtns, Panamint Dunes, Panamint Mtns, Ryan, Saline Valley, West of Eagle Mountain; **LAKE:** Boulder City, Bridge Canyon, Callville, Cottonwood Cove, Echo Bay, Gold Butte, Government Wash, Juniper Mine, Katherine, Lakeshore, Moapa East, Overton, Parashant, Pearce Ferry, Searchlight SE, Temple Bar, Valley of Fire East, Willow Beach; **MOJA:** Baker-Halloran, Cima Dome NW, Cima Dome SE, Cinder Cones, Clark Mtn West, Clipper Vly, Devil's Playground, Fenner Vly, Fenner Vly West, Goffs, Granite Mtns, Halloran Spring, Ivanpah Mtns, Ivanpah Vly, Kelso Dunes, Kelso Mtns, Kelso-Cima, Lanfair Vly, Marl Mtns, Nipton, Old Dad Mtns, Piute Range, Providence Mtns, Turquoise Mountain, Valley Wells, Van Winkle Mtn, Vulcan Mine, West of Juniper Mine, Zzyzx

Associations

Association Scientific Name	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Larrea tridentata</i> – <i>Ambrosia dumosa</i> [CEGL002954]	168	x	x	x	x
<i>Larrea tridentata</i> – <i>Ambrosia dumosa</i> / (<i>Oenothera deltooides</i> – <i>Palafoxia arida</i>)	10	x			
<i>Larrea tridentata</i> – <i>Ambrosia dumosa</i> / Cryptogamic Crust	13	x	x	x	
<i>Larrea tridentata</i> – <i>Ambrosia dumosa</i> / <i>Pleuraphis rigida</i>	47	x		x	x
<i>Larrea tridentata</i> – <i>Ambrosia dumosa</i> –(<i>Echinocactus polycephalus</i> – <i>Opuntia basilaris</i>)	6		x	x	x
<i>Larrea tridentata</i> – <i>Ambrosia dumosa</i> –(<i>Ephedra nevadensis</i> – <i>Lycium andersonii</i>)	87	x	x	x	x
<i>Larrea tridentata</i> – <i>Ambrosia dumosa</i> – <i>Amphipappus fremontii</i>	17	x	x	x	x
<i>Larrea tridentata</i> – <i>Ambrosia dumosa</i> – <i>Atriplex confertifolia</i>	51		x		x
<i>Larrea tridentata</i> – <i>Ambrosia dumosa</i> – <i>Atriplex hymenelytra</i>	27	x	x		x
<i>Larrea tridentata</i> – <i>Ambrosia dumosa</i> – <i>Cylindropuntia (acanthocarpa, ramosissima)</i>	16				x
<i>Larrea tridentata</i> – <i>Ambrosia dumosa</i> – <i>Ephedra californica</i>	6				x
<i>Larrea tridentata</i> – <i>Ambrosia dumosa</i> – <i>Ephedra funerea</i>	25		x	x	x
<i>Larrea tridentata</i> – <i>Ambrosia dumosa</i> – <i>Eriogonum fasciculatum</i>	31	x	x	x	x
<i>Larrea tridentata</i> – <i>Ambrosia dumosa</i> – <i>Fouquieria splendens</i> [CEGL005136]	9	x			
<i>Larrea tridentata</i> – <i>Ambrosia dumosa</i> – <i>Hymenoclea salsola</i>	40	x	x	x	x
<i>Larrea tridentata</i> – <i>Ambrosia dumosa</i> – <i>Krameria (erecta, grayi)</i> [CEGL005137]	153	x	x	x	x
<i>Larrea tridentata</i> – <i>Ambrosia dumosa</i> – <i>Psoralea arborescens</i>	28		x		
<i>Larrea tridentata</i> – <i>Ambrosia dumosa</i> – <i>Psoralea fremontii</i>	21	x	x		x
<i>Larrea tridentata</i> – <i>Ambrosia dumosa</i> – <i>Senna armata</i>	10				x
<i>Larrea tridentata</i> – <i>Ambrosia dumosa</i> – <i>Yucca schidigera</i>	30	x		x	x

Association Notes: None.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 836.9 m, Range 26 – 1743 m

Aspect: Flat, Variable (3), N (57), NE (67), E (87), NW (89), SE (125), SW (111), W (108), SW (85), S (107)

Slope: Mean 7.2 degrees, Range 0 – 40 degrees

Macro Topography: Basin floor/wetland (2), Channel bed (16), Channel wall (1), Entire slope (14), High level/summit (22), High slope (43), Low level/bottom (30), Low- to midslope (1), Lowslope (52), Midslope (95), Step in slope (3), Toeslope (alluvial fan/bajada) (20)

Tree Cover: Mean 0.1%, Range 0 – 8%

Shrub Cover: Mean 12.3%, Range 2 – 41.3%

Herb Cover: Mean 5.1%, Range 0 – 83.5%

Large Rock: Mean 7.4%, Range 0 – 88%

Small Rock: Mean 69.3%, Range 0 – 100%

Fines Cover: Mean 19.1%, Range 0 – 95%

Litter Cover: Mean 1.8%, Range 0 – 20%

Geology: alkali-granite (alaskite) (11), alluvium (247), andesite (2), basalt (26), claystone (1), conglomerate (19), dacite (6), dolostone (dolomite) (2), dune sand (10), gneiss (6), granite (5), granodiorite (21), gravel (7), limestone (6), plutonic rock (phaneritic) (3), rhyolite (29), sand (13), sandstone (93), schist (13), sedimentary (gypsum) (2), shale (2), tephrite (basanite) (4)

Soil Texture: Clay (1), Clay loam (26), Coarse loamy sand (2), Coarse sand (12), Fine sand (14), Fine sandy clay (1), Fine silty clay (4), Loam (15), Loamy sand (44), Medium sand (18), Medium silt (5), Medium silt loam (8), Medium to very fine sandy loam (55), Moderately coarse loamy sand (1), Moderately fine clay loam (4), Moderately fine sandy clay loam (9), Moderately fine silty clay loam (3), Sand (42), Sandy clay (10), Sandy loam (59), Silt loam (3), Silty clay (2)

Environment: The alliance is found on a variety of landforms, but is especially common on bajadas and alluvial fans in valleys and lower slopes. It occurs at all aspects. The alliance is primarily found on alluvial soils, but also occurs on a variety of other substrates. Soil texture is highly variable. The alliance occurred from low to high elevations; however the majority of samples were at low to mid elevation.

Vegetation Description

Vegetation Structure: The Alliance forms an open to intermittent shrub layer and the overall shrub cover ranges from 2 to 41 percent. The tree layer is typically sparse to open, and the herb layer is sparse to continuous. Non-vascular plants are typically sparse to open, though sometimes cryptogamic crust is well-developed.

Vegetation Floristics: *Larrea tridentata* and *Ambrosia dumosa* are co-dominant in this alliance. *Krameria erecta* and *Opuntia basilaris* are sometimes present. *Eriogonum inflatum* is often present in the herbaceous layer and is sometimes accompanied by *Schismus* spp., *Amsinkia* spp., *Cryptantha* spp., and *Bromus rubens*. Cryptogamic crust is sometimes associated with this alliance.

Dynamics: This alliance quintessentially covers vast portions of the Mojave Desert across alluvial fans and lower slopes. The variation in associations is based on soil texture and substrate, disturbance regimes, alkalinity and moisture availability. For example, associations on sandy substrates include the *Larrea tridentata*–*Ambrosia dumosa* / *Pleuraphis rigida* and *Larrea tridentata*–*Ambrosia dumosa* / (*Oenothera deltoidea*–*Palafoxia arida*) Associations.

Associations on strongly rocky slopes, ridges, alluvial drainages and often on carbonate or other metamorphic substrates include the *Larrea tridentata*–*Ambrosia dumosa*–*Amphipappus fremontii* and *Larrea tridentata*–*Ambrosia dumosa*–*Ephedra funerea* Associations.

Classification Comments

This alliance is the modal type in the North American hot deserts and has been differentiated from the others with *Larrea tridentata* and *Ambrosia dumosa* dominant based on soil and substrate, disturbance regimes, and moisture availability (Hamerlynck et al. 2002). For example, in younger to mid-aged bajadas with low to moderate clay content, *Ambrosia dumosa* co-dominates with *Larrea tridentata*. When soils have strongly developed clay or caliche layers, *Ambrosia dumosa* is well-adapted with its shallow root system and can dominate or co-dominate with other shrubs.

Classification Confidence of Alliance: High

Conservation Status Rank

Global: G5

State (California): S5

References

Annable 1985, Evens and Hartman 2007, Evens et al. 2012, Keeler-Wolf and Thomas 2000, Keeler-Wolf et al. 1998b, Keeler-Wolf et al. 2005, NatureServe 2012, Peterson 1984a, Sawyer et al. 2009, VegCAMP and AIS 2013

Surveys (with Sample Sizes) Used in Description

MOJN: N=825

LAKE (n=151): ASGEE1av, ASGEE2av, ASGES2av, ASGES3av, ASGES4av, ASGES5av, ASGES6av, ASGES7av, ASGES8av, ASGEW1av, ASGEW2av, LAKE0101, LAKE0102, LAKE0114, LAKE0117, LAKE0179, LAKE0189, LAKE0193, LAKE0198, LAKE0200, LAKE0201, LAKE0202, LAKE0227, LAKE0232, LAKE0239, LAKE0241, LAKE0244, LAKE0249, LAKE0266, LAKE0268, LAKE0269, LAKE0273, LAKE0292, LAKE0293, LAKE0301, LAKE0312, LAKE0317, LAKE0320, LAKE0368, LAKE0375, LAKE0378, LAKE0380, LAKE0381, LAKE0382, LAKE0383, LAKE0384, LAKE0385, LAKE0396, LAKE0399, LAKE0407, LAKE0428, LAKE0445, LAKE0448, LAKE0600, LAKE0605, LAKE0606, LAKE0635, LAKE0637, LAKE9105, LAKE9107, LAKE9108, LAKE9113, LAKE9118, LAKE9131, LAKE9142, LAKE9143, LAKE9146, LAKE9147, LAKE9151, LAKE9158, LAKE9160, LAKE9165, LAKE9174, LAKE9178, LAKE9184, LAKE9191, LAKE9206, LAKE9230, LAKE9245, LAKE9247, LAKE9250, LAKE9251, LAKE9252, LAKE9254, LAKE9274, LAKE9290, LAKE9306, LAKE9311, LAKE9326, LAKE9330, LAKE9333, LAKE9339, LAKE9342, LAKE9346, LAKE9348, LAKE9354, LAKE9356, LAKE9360, LAKE9362, LAKE9365, LAKE9366, LAKE9371, LAKE9395, LAKE9416, LAKE9417, LAKE9505, LAKE9506, LAKE9634, LAMEN004, LAMEN006, LAMEN007, LAMEN008, LAMEN014, LAMEN016, LAMEN017, LAMEN018, LAMEN020, LAMEN028, LAMEN029, LAMEN032, LAMEN033, LAMEN034, LAMEN035, LAMEN036, LAMEN037, LAMEN038, LAMEN039, LAMEN041, LAMEN048, LAMEN052, LAMEN053, LAMEN055, LAMEN063, LAMEN065, LAMEN068, LAMEN069, LAMEN071, LAMEN072, LAMEN075, LAMEN076, LAMEN080, LAMEN082, LAMEN083, LAMEN084, LAMEN086, LAMEN104, LMJOA036, LMJOA037, LMJOA041, LMJOA043, LMJOA048

DEVA (n=275): DEVA0209, DEVA0285, DEVA0300, DEVA0366, DEVA0559, DEVA0598, DEVA0666, DEVA0902, DEVA9105, DEVA9120, DEVA9124, DEVA9154, DEVA9159, DEVA9172, DEVA9181, DEVA9185, DEVA9186, DEVA9187, DEVA9192, DEVA9202, DEVA9226, DEVA9259, DEVA9271, DEVA9272, DEVA9279, DEVA9288, DEVA9307, DEVA9308,

DEVA9310, DEVA9313, DEVA9314, DEVA9320, DEVA9334, DEVA9338, DEVA9344, DEVA9349, DEVA9358, DEVA9359, DEVA9364, DEVA9367, DEVA9405, DEVA9419, DEVA9436, DEVA9448, DEVA9452, DEVA9459, DEVA9511, DEVA9512, DEVA9514, DEVA9524, DEVA9526, DEVA9536, DEVA9539, DEVA9545, DEVA9556, DEVA9606, DEVA9622, DEVA9623, DEVA9629, DEVA9631, DEVA9632, DEVA9636, DEVA9640, DEVA9643, DEVA9644, DEVA9645, DEVA9647, DEVA9800, DEVA9808, DEVA9819, DEVA9909, DEVA9922, DEVA9963, DEVA9964, DEVAD001, DEVAD002, DEVAD008, DEVAD010, DEVAD017, DEVAD019, DEVAD031, DEVAD032, DEVAD044, DEVAD049, DEVAD054, DEVAD063, DEVAD067, DEVAD078, DEVAD086, DEVAD091, DEVAD092, DEVAD095, DEVAD096, DEVAD097, DEVAD165, DEVAD176, DEVAD182, DEVAD222, DEVAR001, DEVAR002, DEVAR005, DEVAR006, DEVAR016, DEVAR019, DEVAR020, DEVAR021, DEVAR023, DEVAR024, DEVAR029, DEVAR032, DEVAR046, DEVAR047, DEVAR048, DEVAR058, DEVAR068, DEVAR077, DEVAR085, DEVAR103, DEVAR112, DEVAR113, DEVAR115, DEVAR118, DEVAR136, DEVAR137, DEVAR138, DEVAR139, DEVAR141, DEVAR144, DEVAS021, DEVAS023, DEVAS025, DEVAS028, DEVAS031, DEVAS033, DEVAS034, DEVAS035, DEVAS036, DEVAS045, DEVAS053, DEVAS056, DEVAS060, DEVAS061, DEVAS062, DEVAS066, DEVAS067, DEVAS069, DEVAS077, DEVAS087, DEVAS089, DEVAS095, DEVAS097, DEVAS101, DEVAS102, DEVAS104, DEVAS105, DEVAS109, DEVAS113, DEVAS114, DEVAS117, DEVAS118, DEVAS123, DEVAS125, DEVAS132, DEVAS151, DEVAS152, DEVAS155, DEVAS159, DEVAS160, DEVAS162, DEVAS166, DEVAS187, DEVAS189, DEVAS192, DEVAS193, MOJC0172, MOJC0362, MOJC0373, MOJC0376, MOJC0377, MOJC0414, MOJC0415, MOJC0416, MOJC0417, MOJC0418, MOJC0421, MOJC0456, MOJC0457, MOJC0470, MOJC0484, MOJC0498, MOJC0500, MOJC0501, MOJC0502, MOJC0503, MOJC0504, MOJC0505, MOJC0507, MOJC0508, MOJC0509, MOJC0518, MOJC0519, MOJC0520, MOJC0537, MOJC0538, MOJC0539, MOJC0544, MOJC0545, MOJC0546, MOJC0547, MOJC0548, MOJC0549, MOJC0550, MOJC0558, MOJC0570, MOJC0572, MOJC0573, MOJC0575, MOJC0578, MOJC0579, MOJC0580, MOJC0589, MOJC0614, MOJC0615, MOJC0616, MOJC0617, MOJC0620, MOJC0621, MOJC0622, MOJC0623, MOJC0624, MOJC0625, MOJC0629, MOJC0630, MOJC0642, MOJC0646, MOJC0647, MOJC0651, MOJC0652, MOJC0653, MOJC0656, MOJC0661, MOJC0685, MOJC0686, MOJC0687, MOJC0688, MOJC0693, MOJC0708, MOJC0710, MOJC0767, MOJC0768, MOJC0769, MOJC0873, MOJC0874, MOJC0911, MOJC0957, MOJC0959, MOJC0960, MOJC0961, MOJC0991, MOJC0993, MOJC1013, MOJC1014, MOJC1015, MOJC1016, MOJC1035, MOJC1036, MOJC1037, MOJC1038, MOJC1042, MOJC1053, MOJC1054, MOJC1055, MOJC1056, MOJC1057, MOJC1104

MOJA (n=109): MOJA0101, MOJA0156, MOJA0168, MOJA0192, MOJA0264, MOJA0281, MOJA0300, MOJA0375, MOJA0403, MOJA0517, MOJA09102, MOJA09103, MOJA09157, MOJA09164, MOJA09165, MOJA09167, MOJA09169, MOJA09191, MOJA09199, MOJA09206, MOJA09209, MOJA09265, MOJA09302, MOJA09304, MOJA09305, MOJA09308, MOJA09309, MOJA09363, MOJA09369, MOJA09370, MOJA09377, MOJA09384, MOJA09462, MOJA09513, MOJA09524, MOJA09540, MOJA09543, MOJA09546, MOJA09557, MOJA09567, MOJA09606, MOJA09612, MOJA09620, MOJA09638, MOJA09650, MOJA09656, MOJA09659, MOJA09661, MOJA09663, MOJA09665, MOJA09676, MOJA09680, MOJA09681, MOJA09682, MOJA09803, MOJA09804, MOJA09806, MOJA09914, MOJA09920, MOJA09922, MOJC0076, MOJC0086, MOJC0087, MOJC0114, MOJC0130, MOJC0148, MOJC0149, MOJC0150, MOJC0151, MOJC0152, MOJC0220, MOJC0221, MOJC0222, MOJC0223, MOJC0224, MOJC0225, MOJC0226, MOJC0227, MOJC0228, MOJC0229, MOJC0230, MOJC0231, MOJC0240, MOJC0241, MOJC0243, MOJC0255, MOJC0296, MOJC0342, MOJC0343, MOJC0345, MOJC0737, MOJC0798, MOJC0800, MOJC0815, MOJC0816, MOJC0817, MOJC1051, MOJC1119, MOJC1120, MOJC1121, MOJC1217, MOJC1218, MOJC1219, MOJC1220, MOJC1224, MOJC1228, MOJC1229, MOJC1232, MOJC1233

MOJN-Johnson (n=290): MOJJE000, MOJJE024, MOJJE027, MOJJE028, MOJJE029, MOJJE031, MOJJE032, MOJJE034, MOJJE035, MOJJE036, MOJJE037, MOJJE039, MOJJE041, MOJJE044, MOJJE049, MOJJE050, MOJJE051, MOJJE052, MOJJE053, MOJJE054, MOJJE055, MOJJE058, MOJJE059, MOJJE063, MOJJE064, MOJJE065, MOJJE066, MOJJE067, MOJJE069, MOJJE070, MOJJE072, MOJJE075, MOJJE076, MOJJE103, MOJJE104, MOJJE108, MOJJE110, MOJJE111, MOJJE112, MOJJE115, MOJJE122, MOJJE124, MOJJE125, MOJJE127, MOJJE128, MOJJE129, MOJJE130, MOJJE132, MOJJE142, MOJJE143, MOJJE145, MOJJE147, MOJJE148, MOJJE150, MOJJE157, MOJJE158, MOJJE159, MOJJE160, MOJJE161, MOJJE163, MOJJE166, MOJJE167, MOJJE168, MOJJE169, MOJJE170, MOJJE171, MOJJE172, MOJJE174, MOJJE177, MOJJE178, MOJJE180, MOJJE183, MOJJE184, MOJJE186, MOJJE187, MOJJE189, MOJJE190, MOJJE192, MOJJE197, MOJJE198, MOJJE201, MOJJE202, MOJJE203, MOJJE209, MOJJE210, MOJJE211, MOJJE213, MOJJE214, MOJJE215, MOJJE216, MOJJE219, MOJJE220, MOJJE222, MOJJE224, MOJJE225, MOJJE226, MOJJE227, MOJJE228, MOJJE229, MOJJE231, MOJJE232, MOJJE234, MOJJE235, MOJJE236, MOJJE252, MOJJE253, MOJJE254, MOJJE256, MOJJE257, MOJJE260, MOJJE261, MOJJE264, MOJJE265, MOJJE268, MOJJE269, MOJJE275, MOJJE276, MOJJE280, MOJJE282, MOJJE283, MOJJE284, MOJJE285, MOJJE286, MOJJE289, MOJJE295, MOJJE296, MOJJE298, MOJJE299, MOJJE300, MOJJE301, MOJJE303, MOJJE304, MOJJE305, MOJJE307, MOJJE308, MOJJE309, MOJJE310, MOJJE311, MOJJE312, MOJJE313, MOJJE314, MOJJE316, MOJJE317, MOJJE318, MOJJE319, MOJJE320, MOJJE322, MOJJE324, MOJJE326, MOJJE328, MOJJE332, MOJJE333, MOJJE334, MOJJE335, MOJJE336, MOJJE337, MOJJE339, MOJJE342, MOJJE344, MOJJE346, MOJJE348, MOJJE349, MOJJE350, MOJJE353, MOJJE354, MOJJE356, MOJJE357, MOJJE359, MOJJE360, MOJJE361, MOJJE362, MOJJE363, MOJJE364, MOJJE365, MOJJE373, MOJJE374, MOJJE375, MOJJE381, MOJJE382, MOJJE389, MOJJE395, MOJJE399, MOJJE410, MOJJE495, MOJJE496, MOJJE497, MOJJE499, MOJJE500, MOJJE502, MOJJE504, MOJJE508, MOJJE511, MOJJE513, MOJJE514, MOJJE515, MOJJE516, MOJJE517, MOJJE518, MOJJE520, MOJJE521, MOJJE522, MOJJE523, MOJJE525, MOJJE528, MOJJE549, MOJJE561, MOJJE565, MOJJE573, MOJJE574, MOJJE575, MOJJE576, MOJJE577, MOJJE578, MOJJE579, MOJJE580, MOJJE581, MOJJE583, MOJJE585, MOJJE590, MOJJE591, MOJJE592, MOJJE593, MOJJE595, MOJJE5T1, MOJJE5T2, MOJJE610, MOJJE612,

MOJJE613, MOJJE614, MOJJE640, MOJJE641, MOJJE659, MOJJE660, MOJJE661, MOJJE662, MOJJE664, MOJJE672, MOJJE673, MOJJE676, MOJJE718, MOJJE720, MOJJE728, MOJJE729, MOJJE730, MOJJE731, MOJJE732, MOJJE733, MOJJE734, MOJJE747, MOJJE748, MOJJE751, MOJJE766, MOJJE771, MOJJE800, MOJJE801, MOJJE802, MOJJE803, MOJJE804, MOJJE805, MOJJE806, MOJJE810, MOJJE811, MOJJE814, MOJJE815, MOJJE816, MOJJE817, MOJJE818, MOJJE827, MOJJE84a, MOJJE84b, MOJJE87a, MOJJE87b, MOJJE89a, MOJJE89b, MOJJE903, MOJJE909, MOJJE910, MOJJE911, MOJJE913, MOJJE915, MOJJE923, MOJJE925, MOJJE926, MOJJE927, MOJJE928, MOJJE931, MOJJE933, MOJJE934, MOJJE96a, MOJJE96b

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Shrub	<i>Larrea tridentata</i>	99.8	35	3.9	0.1	25	x		x	
	<i>Ambrosia dumosa</i>	98.9	35	4.1	0.08	20	x		x	
	<i>Opuntia basilaris</i>	38.7	1.3	0.1	0.03	3				
	<i>Krameria erecta</i>	31	1.9	0.2	0.08	4				
Herb	<i>Eriogonum inflatum</i>	50.7	8.5	0.2	0.01	3				x
	<i>Schismus</i>	37.9	8.2	0.6	0.11	35				
	<i>Bromus rubens</i>	35.3	5.8	0.4	0.01	25				
	<i>Cryptantha</i>	34.4	6.2	0.3	0.17	9				
	<i>Amsinckia</i>	30.5	1.8	0.2	0.03	13.7				
	<i>Chorizanthe rigida</i>	26.7	1.8	0.1	0.1	10				
	<i>Plantago ovata</i>	26.5	4.5	0.3	0.08	5.3				
Non-vasc	Cryptogamic crust	36.6	33	0.3	0.01	6				

***Larrea tridentata* – *Encelia farinosa* Desert Scrub Alliance**

Common Name: Creosotebush – Brittlebush Scrub

Group Assignment: G295; **Alliance Code:** cf. A3278

Alliance Concept

The Creosote Bush–Brittlebush Scrub Alliance forms a sparse to intermittent shrub layer. The emergent tree layer is typically sparse to open, and the herbaceous layer is sparse to intermittent. The alliance is found on a variety of landforms and aspects, though it is more often found on xeric bajadas and south to west facing hillslopes, or on cooler slopes with highly rocky substrates. Soils are derived from a broad variety of substrates and have a broad variety of textures. Elevations range from approximately 150 to 1050 meters. *Larrea tridentata* and *Encelia farinosa* are the co-dominant shrubs of this association. *Ambrosia dumosa* is characteristically present. The herbaceous layer often includes *Eriogonum inflatum*, and sometimes includes *Cryptantha* spp., *Plantago ovata*, *Bromus rubens*, *Amsinkia* spp., and *Schismus* spp. Cryptogamic crust is also sometimes present.

Diagnostic Criteria: This alliance is characterized by a sparse to open shrub layer with *Encelia farinosa* and *Larrea tridentata* co-dominant together and often co-dominant with other shrubs including *Ambrosia dumosa*. The overall shrub cover ranges from 1.5 to 33 percent.

Alliance Distribution

The alliance is well-defined in sampling at LAKE, MOJA, and southern DEVA. It is scattered throughout the parks at low to mid elevation.

States: AZ, CA, NV

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (68): 322Ab, 322Ad, 322Af, 322Ai, 322Aj, 322Al, 322Am, 322At, 322Av, 322Ay, 322Az; Southeastern Great Basin (5): 341Fe, 341Ff

Park Sampling Zones: **DEVA:** CottonWood Mtns, Death Valley, Funeral Mtns, Green Water Rng/Vlly, Nelson Range, Owlshead Mtns, Panamint Mtns; **LAKE:** Boulder City, Callville, Cottonwood Cove, Echo Bay, Gold Butte, Katherine, Lakeshore, Searchlight SE, Temple Bar, Willow Beach; **MOJA:** Baker-Halloran, Cow Hole Mtns, Devil's Playground, Fenner Vlly West, Goffs, Granite Mtns, Marl Mtns, Old Dad Mtns, Piute Range

Associations

Association Scientific Name [NVC Code]	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Larrea tridentata</i> – <i>Encelia farinosa</i> [CEGL002955]	36	x	x	x	
<i>Larrea tridentata</i> – <i>Encelia farinosa</i> (alliance)	1	x			
<i>Larrea tridentata</i> – <i>Encelia farinosa</i> – <i>Ambrosia dumosa</i>	22	x	x	x	x
<i>Larrea tridentata</i> – <i>Encelia farinosa</i> – <i>Bebbia juncea</i>	8	x	x	x	
<i>Larrea tridentata</i> – <i>Encelia farinosa</i> – <i>Pleurocoronis pluriseta</i>	10	x	x	x	

Association Notes: One sample was classified to the alliance level in LAKE with *Larrea tridentata* and *Encelia farinosa* was co-dominant with *Parkinsonia aculeata* (non-native in the area).

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 557.3 m, Range 159 – 1046 m

Aspect: N (4), NE (7), E (14), NW (3), SE (10), W (3), SW (14), S (16), SSE (1)

Slope: Mean 17.0 degrees, Range 1 – 48 degrees

Macro Topography: Backslope (1), Basin floor/wetland (1), Channel bed (3), Channel wall (1), High slope (8), Low level/bottom (4), Lowslope (3), Midslope (26), Step in slope (1)

Tree Cover: Mean 0.1%, Range 0 – 7.4%

Shrub Cover: Mean 10.8%, Range 1.5 – 33.4%

Herb Cover: Mean 5.1%, Range 0 – 37%

Large Rock: Mean 30.5%, Range 0 – 93%

Small Rock: Mean 57.3%, Range 0 – 100%

Fines Cover: Mean 7.6%, Range 0 – 57%

Litter Cover: Mean 1.3%, Range 0 – 10%

Geology: alkali-granite (alaskite) (8), alluvium (13), basalt (4), conglomerate (2), dacite (5), dolostone (dolomite) (1), dune sand (1), gneiss (8), granite (5), granodiorite (3), gravel (1), orthoquartzite (1), rhyolite (6), sandstone (8), schist (5), sedimentary (gypsum) (1), water (1)
Soil Texture: Clay loam (2), Coarse sand (1), Fine sand (1), Fine silty clay (1), Loam (2), Loamy sand (3), Medium sand (1), Medium silt loam (1), Medium to very fine sandy loam (2), Moderately coarse loamy sand (1), Moderately fine sandy clay loam (1), Moderately fine silty clay loam (1), Sand (2), Sandy loam (7), Silt loam (1), Silty clay (1)

Environment: This alliance is able to grow on a wide variety of landforms, soils, and substrates at low to mid elevations in all three parks. It is more often found on xeric bajadas and south to west facing hillslopes, or on cooler slopes that with highly rocky substrates.

Vegetation Description

Vegetation Structure: The Alliance forms a sparse to intermittent shrub layer and the overall shrub cover ranges from 1.5 to 33 percent. The tree layer is typically sparse to open, and the herb layer is sparse to intermittent. Non-vascular plants are typically sparse to open.

Vegetation Floristics: *Larrea tridentata* and *Encelia farinosa* are the co-dominant shrubs of this association. *Ambrosia dumosa* is characteristically present. The herbaceous layer sometimes includes *Cryptantha* spp., *Eriogonum inflatum*, *Plantago ovata*, *Bromus rubens*, *Amsinkia* spp., and *Schismus* spp. Cryptogamic crust is also sometimes present.

Dynamics: The associations may vary based on substrate, aspect, and disturbance regimes. For example, the *Larrea tridentata*–*Encelia farinosa* Association occurs as the driest, hottest expression of the alliance including steep south-facing slopes, while the *Larrea tridentata*–*Encelia farinosa*–*Ambrosia dumosa* occurs on more neutral steep slopes. The *Larrea tridentata*–*Encelia farinosa*–*Bebbia juncea* association occurs in washes in alluvial fans.

Classification Comments

This alliance represents the drought-tolerant expression of stands where *Larrea tridentata* co-dominants with shrubs. It is found on hotter, rockier, and often steeper sites without well-developed sand or clay as compared to the *Larrea tridentata*–*Ambrosia dumosa* alliance. It is more widespread in hotter, drier portions of the Mojave Desert (i.e., found more often at LAKE as compared to the DEVA and MOJA, which have relatively cooler and higher elevations).

Classification Confidence of Alliance: High

Conservation Status Rank

Global: G5

State (California): S4

References

Evens and Hartman 2007, Evens et al. 2012, Keeler-Wolf and Thomas 2000, Keeler-Wolf et al. 2005, Root 1978, Sawyer et al. 2009, VegCAMP and AIS 2013

Surveys (with Sample Sizes) Used in Description

MOJN: N=77

LAKE (n=47): LAKE0119, LAKE0135, LAKE0194, LAKE0222, LAKE0309, LAKE9122, LAKE9128, LAKE9137, LAKE9140, LAKE9155, LAKE9156, LAKE9164, LAKE9169, LAKE9173, LAKE9214, LAKE9218, LAKE9219, LAKE9224, LAKE9235, LAKE9238, LAKE9255, LAKE9277, LAKE9280, LAKE9303, LAKE9305, LAKE9307, LAKE9318, LAKE9321, LAKE9335, LAKE9336, LAKE9370, LAKE9391, LAKE9410, LAKE9503, LAKE9508, LAKE9526, LAKE9624, LAMEN001, LAMEN010, LAMEN021, LAMEN023, LAMEN024, LAMEN025, LAMEN057, LAMEN058, LAMEN061, LAMEN111

DEVA (n=12): DEVA9191, DEVA9347, DEVA9410, DEVA9531, DEVAD085, DEVAR070, DEVAS174, MOJC0563, MOJC0645, MOJC0926, MOJC1043, MOJC1044

MOJA (n=14): MOJA9184, MOJA9361, MOJA9558, MOJA9559, MOJA9561, MOJA9563, MOJA9640, MOJC0115, MOJC0116, MOJC0128, MOJC0129, MOJC0207, MOJC0254, MOJC1223

MOJN-Johnson (n=4): MOJJE033, MOJJE263, MOJJE291, MOJJE809

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Shrub	<i>Larrea tridentata</i>	100	30	3	0.2	10	x		x	
	<i>Encelia farinosa</i>	98.6	41	4.5	0.2	20	x		x	
	<i>Ambrosia dumosa</i>	75.3	7.7	0.8	0.09	8	x			
	<i>Ferocactus cylindraceus</i>	38.4	1.3	0.2	0.01	3				
	<i>Opuntia basilaris</i>	32.9	1.4	0.1	0.06	1				
	<i>Eriogonum fasciculatum</i>	31.5	1.2	0.1	0.2	1				
	<i>Bebbia juncea</i>	30.1	1.8	0.3	0.07	7				
Herb	<i>Cryptantha</i>	45.2	16	1.2	0.33	12				
	<i>Eriogonum inflatum</i>	42.5	8.1	0.1	0.01	0.5				
	<i>Amsinckia</i>	41.1	6.2	0.7	0.2	30				
	<i>Schismus</i>	39.7	3.7	0.2	0.2	3				
	<i>Plantago ovata</i>	35.6	7.7	0.6	0.2	18				
	<i>Bromus rubens</i>	34.2	3.2	0.3	0.2	15				
Non-vasc	Cryptogamic crust	42.5	38	0.2	0.2	3				

***Opuntia bigelovii* Shrubland Alliance**

Common Name: Teddy-bear Cholla Shrubland

Group Assignment: G295; **Alliance Code:** A3146

Alliance Concept

The Teddy-bear Cholla Shrubland Alliance forms an open shrub layer. The emergent tree layer is typically sparse, and the herbaceous layer is open. The alliance is found primarily on rocky slopes and flat lands at various aspects. Soils are derived from a variety of substrates including alkali-granite (alaskite), gneiss, and rhyolite and textures include clay loam, sand, and silt loam. Elevations range from approximately 400 to 700 meters. This alliance is characterized by *Cylindropuntia bigelovii* (= *Opuntia bigelovii*) dominant or co-dominant with *Ambrosia dumosa*, *Encelia farinosa*, and *Larrea tridentata*. Also, *Eriogonum fasciculatum*, *Bebbia juncea*, *Ferocactus cylindraceus*, *Krameria erecta*, and *Opuntia basilaris* are characteristic at low cover and are often accompanied by *Acacia greggii*. Dominant and characteristic herbs include *Amsinckia* spp., *Chorizanthe brevicornu*, *Eriogonum inflatum*, *Phacelia crenulata*, *Plantago ovata*, and *Schismus* spp., and those often present are *Chaenactis* spp., *Cryptantha* spp., *Gilia* spp., *Lepidium lasiocarpum*. Cryptogammic crust is often present in the alliance.

Diagnostic Criteria: This alliance is characterized by an open shrub layer with *Cylindropuntia bigelovii* (= *Opuntia bigelovii*) dominant or co-dominant with other shrubs including *Ambrosia dumosa*, *Encelia farinosa*, *Eriogonum fasciculatum*, *Ferocactus cylindraceus*, and *Larrea tridentata*. The overall shrub cover ranges from 10 to 13 percent.

Alliance Distribution

This alliance is localized to the Newberry and El Dorado Mountains of western LAKE, especially the Cottonwood Cove region at low to mid elevations.

States: NV

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (8): 322Am, 322Ay, 322Az

Park Sampling Zones: LAKE: Cottonwood Cove, Katherine

Associations

Association Scientific Name [NVC Code]	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Cylindropuntia bigelovii</i> –(<i>Encelia farinosa</i>) [CEGL003065]	8	x			

Association Notes: None.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 547 m, Range 439 – 670 m
Aspect: N (1), E (2), SE (2), W (1), SW (1), S (1)
Slope: Mean 13.0 degrees, Range 3 – 35 degrees
Macro Topography: High level/summit (1), High slope (5), Midslope (2)

Tree Cover: Mean 0%, Range 0 – 0%
Shrub Cover: Mean 11.6%, Range 9.8 – 12.8%
Herb Cover: Mean 3.1%, Range 2 – 4%

Large Rock: Mean 11.5%, Range 0 – 40%
Small Rock: Mean 83.6%, Range 57.0 – 96.0%
Fines Cover: Mean 1.5%, Range 0 – 3.0%
Litter Cover: Mean 2.4%, Range 1.0 – 5.0%

Geology: alkali-granite (alaskite) (2), andesite (1), gneiss (4), rhyolite (1)
Soil Texture: Clay loam (2), Sand (1), Sandy loam (1), Silt loam (1)

Environment: The alliance is found primarily on rocky slopes and flat lands at various aspects. Soils are derived from a variety of substrates including alkali-granite (alaskite), gneiss, and rhyolite and textures include clay loam, sand, and silt loam. The alliance was found at low to mid elevation.

Vegetation Description

Vegetation Structure: The Teddy Bear Cholla Patches Shrubland Alliance forms an open shrub layer, and the overall shrub cover ranges from 10 to 13 percent. The tree layer is typically not present and the herb layer is sparse to open. Non-vascular plants are typically sparse.

Vegetation Floristics This alliance is characterized by stands of *Cylindropuntia bigelovii* (= *Opuntia bigelovii*), *Ambrosia dumosa*, *Encelia farinosa*, and *Larrea tridentata* at >1 percent cover with *Cylindropuntia bigelovii* dominant or co-dominant. *Eriogonum fasciculatum*, *Bebbia juncea*, *Ferocactus cylindraceus*, *Krameria erecta*, and *Opuntia basilaris* are also characteristic at low cover and are often accompanied by *Acacia greggii*. Dominant and characteristic herbs include *Amsinckia* spp., *Chorizanthe brevicornu*, *Eriogonum inflatum*, *Phacelia crenulata*, *Plantago ovata*, and *Schismus* spp., and those often present are *Chaenactis* spp., *Cryptantha* spp., *Gilia* spp., *Lepidium lasiocarpum*. Cryptogammic crust is often present in the alliance.

Dynamics: *Cylindropuntia bigelovii* occurs on exposed rocky rolling hills, ridges, and flats in localized settings of the warmest southerly subsections of the Mojave Desert into the adjacent Colorado and Sonoran Deserts.

Classification Comments

Encelia farinosa and *Larrea tridentata* are common associates in the *Cylindropuntia bigelovii* (= *Opuntia bigelovii*) Shrubland Alliance, and the mixed alliance of these two species are typically found adjacent to this cholla alliance.

Classification Confidence of Alliance: Moderate

Conservation Status Rank

Global: G4

State (California): S3

References

Evens and Hartman 2007, Evens et al. 2012, Keeler-Wolf and Thomas 2000, Keeler-Wolf et al. 2005, Sawyer et al. 2009

Surveys (with Sample Sizes) Used in Description

MOJN: N=8

LAKE (n=8): LAKE0216, LAKE0258, LAKE0300, LAKE0442, LAKE0611, LAKE0626, LAKE9434, LAKE9612

DEVA (n=0)

MOJA (n=0)

MOJN-Johnson (n=0)

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Shrub	<i>Cylindropuntia bigelovii</i>	100	33	3.9	2	7	x		x	
	<i>Encelia farinosa</i>	100	29	3.3	1	5	x			
	<i>Larrea tridentata</i>	100	14	1.7	0.2	4	x			
	<i>Ambrosia dumosa</i>	87.5	10	1.2	0.2	5	x			
	<i>Ferocactus cylindraceus</i>	87.5	1.6	0.2	0.2	0.2	x			
	<i>Krameria erecta</i>	87.5	1.6	0.2	0.2	0.2	x			
	<i>Opuntia basilaris</i>	87.5	1.5	0.2	0.2	0.2	x			
	<i>Bebbia juncea</i>	75	1.3	0.2	0.2	0.2	x			
	<i>Eriogonum fasciculatum</i>	75	1.4	0.2	0.2	0.2	x			
	<i>Acacia greggii</i>	50	0.9	0.1	0.2	0.2				x
	<i>Amphipappus fremontii</i>	25	0.5	0.1	0.2	0.2				
	<i>Ephedra nevadensis</i>	25	0.5	0.1	0.2	0.2				
	<i>Psoralea fremontii</i>	25	0.5	0.1	0.2	0.2				
	<i>Stephanomeria pauciflora</i>	25	0.5	0.1	0.2	0.2				
Herb	<i>Plantago ovata</i>	87.5	3.7	0.2	0.2	0.5	x			
	<i>Amsinckia</i>	87.5	3	0.2	0.2	0.2	x			

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
	<i>Eriogonum inflatum</i>	87.5	3.4	0.2	0.2	0.2	x			
	<i>Schismus</i>	87.5	3.5	0.2	0.2	0.2	x			
	<i>Phacelia crenulata</i>	75	6.8	0.4	0.2	1	x			
	<i>Chorizanthe brevicornu</i>	75	4.6	0.3	0.2	1	x			
	<i>Cryptantha</i>	50	6.8	0.4	0.6	1.2				x
	<i>Gilia</i>	50	5.9	0.4	0.6	1.2				x
	<i>Chaenactis</i>	50	3.6	0.2	0.4	0.4				x
	<i>Lepidium lasiocarpum</i>	50	1.5	0.1	0.2	0.2				x
	<i>Phacelia</i>	37.5	9.6	0.6	0.4	4				
	<i>Antheropeas</i>	37.5	1.1	0.1	0.2	0.2				
	<i>Bromus rubens</i>	37.5	1.4	0.1	0.2	0.2				
	<i>Camissonia refracta</i>	37.5	1.3	0.1	0.2	0.2				
	<i>Chaenactis fremontii</i>	37.5	1.1	0.1	0.2	0.2				
	<i>Chamaesyce</i>	37.5	1.2	0.1	0.2	0.2				
	<i>Chorizanthe rigida</i>	37.5	1.5	0.1	0.2	0.2				
	<i>Cryptantha pterocarya</i>	37.5	1.2	0.1	0.2	0.2				
	<i>Eriogonum deflexum</i>	37.5	1.7	0.1	0.2	0.2				
	<i>Erodium cicutarium</i>	37.5	1.5	0.1	0.2	0.2				
	<i>Lotus</i>	37.5	1.3	0.1	0.2	0.2				
	<i>Pectocarya recurvata</i>	37.5	1.2	0.1	0.2	0.2				
	<i>Rafinesquia neomexicana</i>	37.5	1.1	0.1	0.2	0.2				
	<i>Vulpia</i>	37.5	1.2	0.1	0.2	0.2				
	<i>Cryptantha nevadensis</i>	25	2.6	0.2	0.2	1				
	<i>Camissonia</i>	25	1.9	0.1	0.4	0.4				
	<i>Lupinus</i>	25	1.2	0.1	0.4	0.4				
	<i>Mentzelia</i>	25	1.6	0.1	0.4	0.4				
	<i>Camissonia brevipes</i>	25	1	0.1	0.2	0.2				
	<i>Chaenactis carphoclinia</i>	25	1	0.1	0.2	0.2				
	<i>Chamaesyce polycarpa</i>	25	0.6	0.1	0.2	0.2				
	<i>Cryptantha angustifolia</i>	25	0.9	0.1	0.2	0.2				
	<i>Draba cuneifolia</i>	25	0.8	0.1	0.2	0.2				
	<i>Mirabilis laevis</i>	25	1.2	0.1	0.2	0.2				
	<i>Salvia columbariae</i>	25	1.2	0.1	0.2	0.2				
	<i>Sphaeralcea ambigua</i>	25	0.8	0.1	0.2	0.2				
	<i>Stylocline</i>	25	0.9	0.1	0.2	0.2				
Non-vasc										
	Cryptogamic crust	50	50	0.2	0.2	1				x

3. Desert & Semi-Desert Class

3.A.2. Warm Desert & Semi-Desert Scrub & Grassland Formation

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

M088. Mojave-Sonoran Semi-Desert Scrub Macrogroup

G675. North American Warm Semi-Desert Dunes & Sand Flats Group

***Dicoria canescens* - *Abronia villosa* - *Panicum urvilleanum* Dune Alliance**

Common Name: Mojave-Sonoran Sparsely Vegetated Dune

Group Assignment: G675; **Alliance Code:** A4026

Alliance Concept

The Desert Dunes Sparsely Vegetated Alliance forms sparse to open herbaceous layer. The shrub layer is open and the tree layer is absent or sparse. The alliance is found on dunes (active to stable) and sand fields on basin floors and entire slopes from toeslope to summits at all aspects. Soils are derived primarily from dune sand but substrates also include alluvium, dolostone (dolomite), and sandstone. Soil textures range from fine and medium sand to medium to very fine sandy loam. Elevations range from approximately 50 to 1300 meters. *Dicoria canescens* is often present but not necessarily dominant. Shrubs that are sometimes present include *Petalonyx thurberi* and *Larrea tridentata*. However, the presence of sand sheets, flats, and dunes more reliably characterize this alliance than does any set of species.

Diagnostic Criteria: This alliance is characterized by a sparse to open herbaceous layer with scattered annual plants that usually have a combined absolute cover of less than 10% cover. Various psammophytic herbs may be present, while perennial plants such as *Achnatherum hymenoides*, *Larrea tridentata*, *Pleuraphis rigida*, and *Swallenia alexandrae* have less than 2% absolute cover. The overall herbaceous cover ranges from 0 to 31 percent cover.

Alliance Distribution

The alliance is well-defined in sampling at all three Parks. It is scattered throughout DEVA and MOJA in low to upper elevation dunes and sand flats, and scattered on dune fields bordering the shores of Lake Mead. The alliance was also found during map accuracy assessment field sampling at LAKE along dunes bordering Lake Mead.

States: AZ, CA, (NV)

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (24): 322Ab, 322Ae, 322Ai, 322Av, (322Az); Southeastern Great Basin (6): 341Fc

Park Sampling Zones: **DEVA:** Black Mtns, Eureka Valley, Joshua Flat, Panamint Dunes, Saline Valley; **LAKE:** (Cottonwood Cove, Katherine,) Pearce Ferry; **MOJA:** Devil's Playground, Kelso Dunes, Zzyzx

Associations

Association Scientific Name	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Croton californicus</i> – <i>Palafoxia arida</i> (provisional)	1	x			
<i>Dicoria canescens</i>	13		x	x	
<i>Dicoria canescens</i> – <i>Abronia villosa</i> (alliance)	9		x	x	
<i>Petalonyx thurberi</i> (provisional)	7		x	x	

Association Notes: Nine samples were classified to alliance level only. These plots did not contain *Dicoria canescens* or *Abronia villosa*, but are dune plant communities.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 629.9 m, Range 63 – 1285 m

Aspect: N (3), NE (1), E (3), NW (3), SE (7), SW (1), W (2), SW (3), S (4)

Slope: Mean 4.9 degrees, Range 1 – 30 degrees

Macro Topography: Basin floor/wetland (1), Entire slope (3), High level/summit (2), Low level/bottom (3), Lowslope (5), Midslope (2), Toeslope (alluvial fan/bajada) (1)

Tree Cover: Mean 0%, Range 0 – 0.5%

Shrub Cover: Mean 1.7%, Range 0 – 20%

Herb Cover: Mean 4.9%, Range 0 – 31%

Large Rock: Mean 0.7%, Range 0 – 15%

Small Rock: Mean 3.3%, Range 0 – 37.5%

Fines Cover: Mean 90.7%, Range 62.5 – 100%

Litter Cover: Mean 0.6%, Range 0 – 2.5%

Geology: alluvium (6), dolostone (dolomite) (1), dune sand (22), sandstone (1)

Soil Texture: Fine sand (7), Medium sand (2), Medium to very fine sandy loam (1), Sand (9)

Environment: The alliance is found primarily on sand dunes, flats and ramps at low to upper elevations. It occurs on basin floors and entire slopes from toeslopes to summits at all aspects. Soils are derived primarily from aeolian sand. Soil textures range from sand to sandy loam.

Vegetation Description

Vegetation Structure: The alliance forms a sparse to open herbaceous layer, and the overall herbaceous cover ranges from 0 to 31 percent cover. The tree layer is typically sparse, and the shrub layer is sparse to open. Non-vascular plants, if present are sparse.

Vegetation Floristics: Annual plants on dune systems and flats vary with presence and cover of annual plants. *Dicoria canescens* is often present as a summer annual. Shrubs that are sometimes present at sparse cover include *Petalonyx thurberi* and *Larrea tridentata*.

Dynamics: The presence of sand sheets and sand dunes more reliably characterize this alliance than does any set of plant species. Plant species composition and abundance are driven mostly by annual rainfall, temperature variation, and seasonality. *Salsola tragus*, a non-native herb, can invade these sites and sometimes has higher cover than the native plants, but its cover also varies spatially and temporarily.

Classification Comments

None.

Classification Confidence of Alliance: High

Conservation Status Rank

Global: G3

State (California): S2

References

Evens et al. 2012, Sawyer et al. 2009, VegCAMP and AIS 2013

Surveys (with Sample Sizes) Used in Description

MOJN: N=30

LAKE (n=1): LAKE0601

DEVA (n=17): DEVA0540, DEVA9562, DEVAD024, DEVAD025, DEVAD027, DEVAD191, DEVAD213, DEVAS022, DEVAS176, DEVAS178, DEVAS179, DEVAS181, DEVAS182, DEVAS184, DEVAS185, MOJC0445, MOJC0692

MOJA (n=12): MOJA9188, MOJA9197, MOJC0346, MOJC0347, MOJC0348, MOJC0349, MOJC0731, MOJC0855, MOJC0858, MOJC0859, MOJC0860, MOJC0862

MOJN-Johnson (n=0)

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Shrub	<i>Petalonyx thurberi</i>	33	28	1.4	0.5	20				
	<i>Larrea tridentata</i>	27	15	0.2	0.1	1.5				
Herb	<i>Dicoria canescens</i>	50	19	1.5	0.1	27				x
	<i>Salsola</i>	37	21	1.2	0.2	15				

***Pleuraphis rigida* Herbaceous Alliance**

Common Name: Big Galleta Herbaceous Scrub

Group Assignment: G675, (G295); **Alliance Code:** A3170, (A3281)

Alliance Concept

The Big Galleta Herbaceous Scrub Alliance forms an open to intermittent herbaceous layer. The shrub layer is open and the tree layer is sparse. The alliance is found from bottoms to summits at all aspects along dune fields, sand sheets, and sandy valley floors. Soils are derived from a variety of substrates and texture is primarily sand but can range from medium sand to loam to sandy clay. Elevations range from approximately 250 to 1600 meters. *Pleuraphis rigida* is dominant or co-dominant in the herbaceous layer, and *Schismus* spp. are characteristically present. Those often present are *Oenothera deltoidea* and *Stephanomeria exigua*. *Larrea tridentata* is often associated as an emergent shrub at sparse to open cover.

Diagnostic Criteria: This alliance is characterized by an open to intermittent herbaceous layer with *Pleuraphis rigida* dominant or co-dominant. The overall herbaceous cover ranges from 2 to 39 percent cover.

Alliance Distribution

The alliance is well-defined in sampling at MOJA and is also found uncommonly in LAKE, often in sand dune/flat areas. It is scattered throughout MOJA in low to upper elevations. The alliance was also found during map accuracy assessment field sampling at LAKE primarily at low elevation sandy/dune areas adjacent to Lake Mead.

States: AZ, CA

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (22): 322Ai, 322Aj, 322Ak, 322Al, 322Av, (322Ay)

Park Sampling Zones: **LAKE:** Pearce Ferry; **MOJA:** Devil's Playground, HackberryVotrigger, Kelso Dunes, Lanfair Vly, Mid Hills, Old Dad Mtns, Zzyzx; **LAKE:** (Cottonwood Cove, Katherine)

Associations

Association Scientific Name [NVC Code]	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Pleuraphis rigida</i> / (<i>Acamptopappus sphaerocephalus</i> – <i>Ericameria cooperi</i>)	23	x		x	x
<i>Pleuraphis rigida</i> / <i>Ambrosia dumosa</i> [cf. CEG000955]	6			x	x
<i>Pleuraphis rigida</i> sand dunes/flats [cf. CEG003051]	21	(x)		x	x

Association Notes: The *Pleuraphis rigida* / (*Acamptopappus sphaerocephalus*–*Ericameria cooperi*) Association appears to be associated more with shrubland associations within the Mojave Mid-Elevation Mixed Desert Scrub Group (G296) in areas that may have had potential past disturbance or grazing, while the *Pleuraphis rigida* / *Ambrosia dumosa* and *Pleuraphis rigida* sand dunes/flats Associations are associated with sand dune/flat environments.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 968.7 m, Range 284 – 1566 m

Aspect: Flat, Variable (1), N (6), E (4), NW (9), SE (8), SW (5), W (4), SW (4), S (7)

Slope: Mean 3.1 degrees, Range 0 – 18 degrees

Macro Topography: High level/summit (2), High slope (4), Low level/bottom (4), Lowslope (3), Midslope (3)

Tree Cover: Mean 0%, Range 0 – 0.2%

Shrub Cover: Mean 2.7%, Range 0 – 11.6%

Herb Cover: Mean 17.6%, Range 2 – 32%

Large Rock: Mean 1.4%, Range 0 – 27%

Small Rock: Mean 14.2%, Range 0 – 94%

Fines Cover: Mean 80.3%, Range 2 – 100%

Litter Cover: Mean 2.3%, Range 0 – 6%

Geology: alluvium (6), dune sand (11), granodiorite (1), gravel (1), rhyolite (2), sandstone (1)

Soil Texture: Fine sand (2), Loam (2), Loamy sand (3), Medium sand (2), Medium to very fine sandy loam (2), Sand (10), Sandy clay (1)

Environment: The alliance occurs at low to upper elevations, from bottoms to summits at all aspects along dune fields, sand sheets, and sandy valley bottoms. Soils are primarily sand but can range from medium sand to loam to sandy clay derived from a variety of substrates.

Vegetation Description

Vegetation Structure: The alliance forms an open to intermittent herbaceous layer, and the overall herbaceous cover ranges from 2 to 39 percent cover. The tree layer is typically sparse, and the shrub layer is sparse to open. Non-vascular plants are typically sparse to open.

Vegetation Floristics: *Pleuraphis rigida* is dominant or co-dominant in the herbaceous layer, and *Schismus* spp. are characteristically present. Those often present are *Oenothera deltoides* and *Stephanomeria exigua*. *Larrea tridentata* is a commonly associated emergent shrub at sparse to open cover.

Dynamics: The alliance is relatively rare in the Mojave and Sonoran deserts. It occurs as open stands around dune margins and other sandy areas at low to mid-elevations. It also occurs on upland lower slopes, bajadas, and valleys at mid-elevations in post-fire, grazed, and other disturbance situations where shrubs and trees are recovering and sparse in cover.

Classification Comments

Pleuraphis rigida associations previously were placed in the Mojave Mid-Elevation Mixed Desert Scrub Group (G296), while related sand dune associations of *Pleuraphis rigida* now occur in North American Warm Semi-Desert Dunes & Sand Flats (G675) in the NVC hierarchy. However, one association is still listed under the Mojave-Sonoran Bajada & Valley Desert Scrub (G295). Currently, we have placed this alliance in the G675 group based on the results of the classification and ordination analyses, though in the future, it may be useful in the future to place the *Pleuraphis rigida* / (*Acamptopappus sphaerocephalus*–*Ericameria cooperi*) Association in a different group.

Classification Confidence of Alliance: High

Conservation Status Rank

Global: G3

State (California): S2

References

Evens et al. 2012, Keeler-Wolf and Thomas 2000, Matthews 2000, NatureServe 2012, Sawyer et al. 2009, VegCAMP and AIS 2013

Surveys (with Sample Sizes) Used in Description

MOJN: N=50

LAKE (n=1): LAKE0177

DEVA (n=0)

MOJA (n=21): MOJA0159, MOJA0400, MOJA0549, MOJA0654, MOJA9189, MOJA9408, MOJA9556, MOJA9562, MOJA9616, MOJA9617, MOJA9627, MOJA9657, MOJA9660, MOJA9662, MOJA9679, MOJC0202, MOJC0205, MOJC0728, MOJC0729, MOJC0730, MOJC0736

MOJN-Johnson (n=28): MOJJE144, MOJJE175, MOJJE238, MOJJE293, MOJJE321, MOJJE327, MOJJE431, MOJJE530, MOJJE534, MOJJE536, MOJJE545, MOJJE553, MOJJE555, MOJJE557, MOJJE558, MOJJE634, MOJJE635, MOJJE649, MOJJE650, MOJJE651, MOJJE652, MOJJE667, MOJJE689, MOJJE690, MOJJE702, MOJJE744, MOJJE892, MOJJE897

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Shrub										
	<i>Larrea tridentata</i>	50	27	0.5	0.2	2				x
	<i>Petalonyx thurberi</i>	27.3	11	0.1	0.1	1.5				
Herb										
	<i>Pleuraphis rigida</i>	100	57	11	3	25	x	x		
	<i>Schismus</i>	86.4	7.3	1.4	0.2	10	x			
	<i>Oenothera deltoides</i>	50	1	0.2	0.2	3				x
	<i>Stephanomeria exigua</i>	50	0.6	0.1	0.2	0.5				x
	<i>Panicum urvilleanum</i>	36.4	2.6	0.4	0.2	3				
	<i>Cryptantha</i>	36.4	1.9	0.3	0.6	1.5				
	<i>Cryptantha pterocarya</i>	36.4	0.6	0.1	0.2	0.5				
	<i>Rafinesquia neomexicana</i>	36.4	0.4	0.1	0.2	0.2				
	<i>Chaenactis stevioides</i>	31.8	0.6	0.1	0.2	1				
	<i>Malacothrix glabrata</i>	31.8	0.4	0.1	0.2	0.5				
	<i>Erodium cicutarium</i>	27.3	8	2.2	0.5	20				
	<i>Amsinckia</i>	27.3	0.4	0.1	0.2	1				

3. Desert & Semi-Desert Class

3.A.2. Warm Desert & Semi-Desert Scrub & Grassland Formation

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

M092. North American Warm-Desert Xeric-Riparian Scrub Macrogroup

G541. Warm Semi-Desert Shrub & Herb Dry Wash & Colluvial Slope Group

***Acacia greggii* - *Hyptis emoryi* - *Justicia californica* Desert Wash Alliance**

Common Name: Catclaw Acacia - Desert-lavender - Beloperone Desert Wash

Group Assignment: G541; **Alliance Code:** A4187

Alliance Concept

The Catclaw Acacia Thorn Scrub Alliance forms an open to continuous shrub layer. The emergent tree layer is typically sparse to open, and the herbaceous layer is sparse to continuous. The alliance is found primarily in arroyos and floodplains at all aspects. Soils are derived from a variety of substrates including alluvium, gneiss and sandstone, and textures are highly variable. Elevations range from approximately 150 to 1600 meters. *Acacia greggii* is dominant or co-dominant in the shrub layer, and those that are often present include *Cylindropuntia acanthocarpa*, *Ephedra nevadensis*, *Eriogonum fasciculatum*, *Hymenoclea salsola*, *Larrea tridentata*, *Salazaria mexicana*, and *Stephanomeria pauciflora*. Dominant and characteristic herbs include *Bromus rubens* and *Erodium cicutarium*, and those often present include *Sphaeralcea ambigua*.

Diagnostic Criteria: This alliance is characterized by an open to continuous shrub layer with *Acacia greggii* dominant or co-dominant. The overall shrub cover ranges from 5 to 74 percent.

Alliance Distribution

The alliance is well-defined in sampling at MOJA and LAKE, but was not found in DEVA. It is scattered throughout MOJA and LAKE in low to high elevations.

States: AZ, CA, NV

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (106): 322Ai, 322Aj, 322Ak, 322Al, 322Am, 322At, 322Av, 322Ay, 322Az

Park Sampling Zones: **LAKE:** Boulder City, Echo Bay, Gold Butte, Katherine, Parashant, Pearce Ferry, Temple Bar, Willow Beach; **MOJA:** Baker-Halloran, Cima Dome SE, Clark Mountain, Clark Mtn, Clark Mtn West, Clipper Villy, Fenner Villy, Fenner Villy West, Granite Mtns, Hackberry/Vontrigger, Ivanpah Villy, Kelso Mtns, Lanfair Villy, Mid Hills, Pachalka Spring, Piute Range, Providence Mtns, Turquoise Mountain, Vulcan Mine, West of Juniper Mine, Woods Mtns

Associations

Association Scientific Name [NVC Code]	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Acacia greggii</i> Wash	11	x		x	x
<i>Acacia greggii</i> –(<i>Ambrosia eriocentra</i> – <i>Salvia dorrii</i>)	26	x		x	x
<i>Acacia greggii</i> – <i>Eriogonum fasciculatum</i>	7	x		x	x
<i>Acacia greggii</i> – <i>Hymenoclea salsola</i> [cf. CEPS009522]	39	x		x	x
<i>Acacia greggii</i> – <i>Prunus fasciculata</i>	22			x	x
<i>Acacia greggii</i> – <i>Viguiera parishii</i>	14	x		x	

Association Notes: None.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 1131 m, Range 196 – 1572 m

Aspect: Flat, Variable (1), N (14), NE (3), E (3), NW (21), SE (20), SW (30), W (4), S (16)

Slope: Mean 5.9 degrees, Range 0 – 40 degrees

Macro Topography: Channel bed (9), Channel wall (1), High level/summit (2), High slope (2), Low level/bottom (4), Lowslope (1), Midslope (24)

Tree Cover: Mean 0.3%, Range 0 – 2.7%

Shrub Cover: Mean 19.8%, Range 4.8 – 74.2%

Herb Cover: Mean 9.1%, Range 1 – 92.5%

Large Rock: Mean 12.7%, Range 0 – 72%

Small Rock: Mean 66.2%, Range 6 – 98.1%

Fines Cover: Mean 17.0%, Range 0 – 93%

Litter Cover: Mean 2.8%, Range 0 – 24%

Geology: alkali-granite (alaskite) (6), alluvium (35), basalt (1), conglomerate (1), dacite (1), dolostone (dolomite) (1), gneiss (11), granite (1), granodiorite (13), limestone (4), plutonic rock (phaneritic) (5), rhyolite (8), sand (3), sandstone (15), schist (1)

Soil Texture: Clay loam (3), Coarse sand (9), Fine sand (7), Loamy sand (14), Medium sand (38), Medium to very fine sandy loam (3), Sand (9), Sandy loam (10), Silty clay (1)

Environment: The alliance is found primarily in arroyos and floodplains at all aspects. Soils are derived from a variety of substrates including alluvium, gneiss and sandstone, and textures are highly variable. The alliance is found from low to high elevation.

Vegetation Description

Vegetation Structure: The Alliance forms an open to continuous shrub layer and the overall shrub cover ranges from 5 to 74 percent. The tree layer is typically sparse to open, and the herb layer is sparse to continuous. Non-vascular plants are typically sparse.

Vegetation Floristics: *Acacia greggii* is dominant or co-dominant in the shrub layer, and those that are often present include *Cylindropuntia acanthocarpa*, *Ephedra nevadensis*, *Eriogonum fasciculatum*, *Hymenoclea salsola*, *Larrea tridentata*, *Salazaria mexicana*, and *Stephanomeria pauciflora*. Dominant and characteristic herbs include *Bromus rubens* and *Erodium cicutarium*, and those often present include *Sphaeralcea ambigua*.

Dynamics: *Acacia greggii* is adapted to disturbance, and it occurs in areas with either alluvial or colluvial disturbance including intermittently flooded washes and rocky slopes above washes. Most stands are described from braided washes and slopes with intermittent drainages.

Classification Comments

Acacia greggii associations are currently placed in the Warm Semi-Desert Shrub & Herb Dry Wash & Colluvial Slope Group (G541) as well as other upland and riparian alliances of the NVC hierarchy. For this Mojave Desert Network classification, we have described associations in one alliance in the G541 group.

Classification Confidence of Alliance: High

Conservation Status Rank

Global: G5

State (California): S4

References

Evens 2000, Evens et al. 2012, Keeler-Wolf and Thomas 2000, Keeler-Wolf et al. 1998b, Keeler-Wolf et al. 2005, NatureServe 2012, Sawyer et al. 2009, VegCAMP and AIS 2013

Surveys (with Sample Sizes) Used in Description

MOJN: N=119

LAKE (n=18): LAKE0138, LAKE0236, LAKE0297, LAKE0616, LAKE9225, LAKE9328, LAKE9369, LAKE9372, LAKE9406, LAKE9426, LAKE9439, LAKE9444, LAKE9535, LMJOA034, LMJOA035, LMJOA052, LMJOA053, LMJOA054

DEVA (n=0)

MOJA (n=88): MOJA0200, MOJA0289, MOJA0303, MOJA0438, MOJA0509, MOJA0541, MOJA0691, MOJA9172, MOJA9215, MOJA9250, MOJA9335, MOJA9374, MOJA9401, MOJA9412, MOJA9416, MOJA9433, MOJA9460, MOJA9511, MOJA9522, MOJA9539, MOJA9573, MOJA9581, MOJA9583, MOJA9624, MOJA9626, MOJA9633, MOJA9697, MOJA9805, MOJA9900, MOJA9916, MOJAE002, MOJAE004, MOJAE005, MOJAE006, MOJAE007, MOJAE050, MOJAE053, MOJAE055, MOJAE057, MOJAE059, MOJAE060, MOJAE061, MOJAE062,

MOJAE063, MOJAE064, MOJAE065, MOJAE066, MOJAE067, MOJAE068, MOJAE069, MOJAE070, MOJAE076, MOJAE080, MOJAE082, MOJAE083, MOJAE089, MOJAE119, MOJAE120, MOJAE121, MOJAE122, MOJAE123, MOJAE124, MOJAE152, MOJAE153, MOJAE155, MOJAE156, MOJAE157, MOJAE158, MOJAE159, MOJAE168, MOJAE170, MOJAE172, MOJAE173, MOJAE174, MOJAE187, MOJAE188, MOJAE197, MOJC0096, MOJC0192, MOJC0239, MOJC0797, MOJC0940, MOJC1133, MOJC1134, MOJC1153, MOJC1155, MOJC1226, MOJC1227

MOJN-Johnson (n=13): MOJJE007, MOJJE016, MOJJE083, MOJJE098, MOJJE099, MOJJE221, MOJJE230, MOJJE347, MOJJE454, MOJJE503, MOJJE543, MOJJE588, MOJJE696

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Shrub										
	<i>Acacia greggii</i>	100	28	5.4	1	25	x			
	<i>Hymenoclea salsola</i>	69.8	10	1.9	0.2	15				x
	<i>Ephedra nevadensis</i>	60.4	1.9	0.4	0.2	6				x
	<i>Eriogonum fasciculatum</i>	58.5	3.1	0.7	0.2	7.3				x
	<i>Larrea tridentata</i>	56.6	5.8	1.2	0.2	21.7				x
	<i>Salazaria mexicana</i>	55.7	3.1	0.5	0.2	5.6				x
	<i>Cylindropuntia acanthocarpa</i>	55.7	1.5	0.3	0.1	4.5				x
	<i>Stephanomeria pauciflora</i>	51.9	0.9	0.2	0.2	2.1				x
	<i>Phoradendron californicum</i>	49.1	1.6	0.3	0.2	7				
	<i>Salvia dorrii</i>	46.2	5.3	1.1	0.1	8				
	<i>Prunus fasciculata</i>	43.4	4.9	1	0.2	9.1				
	<i>Yucca schidigera</i>	41.5	0.9	0.2	0.2	2				
	<i>Thamnosma montana</i>	40.6	0.7	0.1	0.2	1.5				
	<i>Viguiera parishii</i>	39.6	4.2	0.8	0.2	18				
	<i>Ambrosia eriocentra</i>	37.7	4	0.7	0.2	6.5				
	<i>Encelia virginensis</i>	34.9	1	0.2	0.2	4.7				
	<i>Lycium andersonii</i>	34.9	0.8	0.1	0.2	2				
	<i>Echinocereus engelmannii</i>	33	0.4	0.1	0.2	0.5				
	<i>Gutierrezia microcephala</i>	26.4	0.7	0.1	0.2	2				
Herb										
	<i>Bromus rubens</i>	82.1	20	2	0.2	35	x			
	<i>Erodium cicutarium</i>	80.2	12	0.9	0.2	6	x			
	<i>Sphaeralcea ambigua</i>	53.8	4.5	0.3	0.1	7				x
	<i>Eriogonum inflatum</i>	41.5	3.2	0.1	0.2	1				
	<i>Achnatherum speciosum</i>	36.8	2.9	0.2	0.2	5				
	<i>Dasyochloa pulchella</i>	35.8	3.1	0.1	0.2	0.2				
	<i>Amsinckia</i>	33	3	0.8	0.2	27				
	<i>Schismus</i>	33	3.8	0.6	0.2	19.7				
	<i>Mirabilis laevis</i>	31.1	1.5	0.1	0.2	1				
	<i>Penstemon palmeri</i>	28.3	2.8	0.1	0.2	1				
	<i>Adenophyllum cooperi</i>	27.4	3.5	0.1	0.1	1.5				
	<i>Muhlenbergia porteri</i>	26.4	2	0.1	0.2	0.5				
Non-vascular										
	Cryptogamic crust	29.2	25	0.1	0.2	1				

***Chilopsis linearis* - *Psorothamnus spinosus* Desert Wash Woodland Alliance**

Common Name: Desert-willow - Smoketree Desert Wash Alliance

Group Assignment: G541; **Alliance Code:** A1044

Alliance Concept

The Desert-willow - Smoketree Desert Wash Woodland Alliance forms a sparse to intermittent tree canopy with a sparse to intermittent shrub understory. It is found primarily on channel beds and bottoms where flooding is infrequent but subterranean water is available based on preferred paths of subsurface moisture. It is found at all aspects. Soils are derived from a variety of substrates and textures. Elevations range from approximately 201 to 1506 meters. The dominant and characteristic tree is *Chilopsis linearis*. Commonly associated shrubs include *Acacia greggii*, *Hymenoclea salsola*, and *Stephanomeria pauciflora*, and commonly associated herbs include *Bromus rubens* and *Erodium cicutarium*.

Diagnostic Criteria: This alliance is characterized by a sparse to intermittent tree canopy of *Chilopsis linearis*, which ranges from 1.1 to 37 percent cover. The overall tree cover ranges from 1.1 to 37 percent cover.

Alliance Distribution

The alliance is well-defined in sampling at all LAKE and MOJA. It is scattered throughout LAKE and MOJA at low to mid elevation.

States: CA, NV

Ecoregion Sections and Subsection Codes: Mojave Desert (91): 322Ai, 322Aj, 322Ak, 322Al, 322Am, 322At, 322Ay

Park Sampling Zones: **LAKE:** Gold Butte, Katherine, Lakeshore; **MOJA:** Brown Buttes, Cima Dome NW, Cinder Cones, Clark Mtn, Clipper Vly, Devil's Playground, Fenner Vly West, Granite Mtns, Ivanpah Vly, Kelso Dunes, Kelso Mtns, Mid Hills, New York Mtns, Piute Range, Providence Mtns, Van Winkle Mtn, Vulcan Mine, Zzyzx

Associations

Association Scientific Name	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Chilopsis linearis</i>	12		x		
<i>Chilopsis linearis</i> / (<i>Ambrosia eriocentra</i> – <i>Salvia dorrii</i>)	14	x		x	
<i>Chilopsis linearis</i> / <i>Ericameria paniculata</i>	17				
<i>Chilopsis linearis</i> / <i>Hymenoclea salsola</i>	25				
<i>Chilopsis linearis</i> / <i>Prunus fasciculata</i>	17				
<i>Psorothamnus spinosus</i>	1				
<i>Psorothamnus spinosus</i> / <i>Acacia greggii</i> – <i>Chrysothamnus</i> sp.	1				
<i>Psorothamnus spinosus</i> / <i>Ephedra californica</i> – <i>Hymenoclea salsola</i>	2		x	x	
<i>Psorothamnus spinosus</i> / <i>Hymenoclea salsola</i> – <i>Bebbia</i>	10		x		

Association Scientific Name	Sample Size	LAKE	DEVA	MOJA	Johnson
juncea					

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 993.9 m, Range 201 – 1506 m

Aspect: N (9), NE (1), E (9), NW (18), SE (19), Flat, Variable (1), SW (21), SW (6), S (14)

Slope: Mean 3.3 degrees, Range 0 – 8 degrees

Macro Topography: Channel bed (11), High level/summit (1), Low level/bottom (4),
Lowslope (2), Midslope (8)

Tree Cover: Mean 8.3%, Range 1.1 – 37.1%

Shrub Cover: Mean 11.9%, Range 1.6 – 33%

Herb Cover: Mean 2.8%, Range 0.2 – 23%

Large Rock: Mean 7.4%, Range 0 – 50%

Small Rock: Mean 70.5%, Range 0 – 99%

Fines Cover: Mean 17.4%, Range 0 – 90%

Litter Cover: Mean 3.8%, Range 0 – 23%

Geology: alkali-granite (alaskite) (3), alluvium (48), dune sand (1), gneiss (2), granodiorite (13), limestone (6), rhyolite (1), sandstone (15), schist (1), tephrite (basanite) (1)

Soil Texture: Coarse sand (21), Fine sand (2), Loam (1), Loamy sand (3), Medium sand (42), Sand (20)

Environment: The alliance occurs primarily in channel beds and bottoms where flooding is intermittent but subterranean water is typically available. It is found throughout MOJA at mid to upper elevations, and it is found scattered in LAKE at low to mid elevations. It occurs at all aspects. Soils range from sand, loamy sand to loam derived from a variety of substrates.

Vegetation Description

Vegetation Structure: The Alliance forms a sparse to intermittent tree layer with a sparse to intermittent shrub layer and sparse or open herbaceous understory.

Vegetation Floristics: The dominant and characteristic tree is *Chilopsis linearis*. Commonly associated shrubs include *Acacia greggii*, *Hymenoclea salsola*, and *Stephanomeria pauciflora*, and commonly associated herbs include *Bromus rubens* and *Erodium cicutarium*.

Dynamics: *Chilopsis linearis* and/or *Psoralea argophylla* is dominant or co-dominant in a two-tiered canopy. Stands typically occur in washes with wide flood paths and natural “narrows” in valleys. Large-stature stands are found often within the active wash channel or directly above.

Although the alliance is widely distributed, stands are localized and absent in many suitable habitats. The presence of faults in very old alluvium that create preferred paths for moisture and thus root systems have been found as optimum sites for *Chilopsis linearis* (Lancaster et al. 2014). The USFWS Wetland Inventory (1996) recognizes *Chilopsis linearis* as a FACW+ plant.

Psoralea argophylla is dependant on flooding for seedling establishment and adults are relatively short-lived. Thus, larger washes and fluvial disturbances are needed to maintain this alliance.

Classification Comments

The *Chilopsis linearis* and *Psoralea argophylla* associations are classified as both shrubland and woodland types in the NVC hierarchy. For this Mojave Desert Network classification, we have classified the alliance as a woodland type due to its tall tree-like stature.

Classification Confidence: Moderate

Conservation Status Rank

Global: G4

State (California): S3

References

Evens 2000, Evens et al. 2012, Evens and Hartman 2007, Keeler-Wolf and Thomas 2000, Keeler-Wolf et al. 1998b, Keeler-Wolf et al. 2005, NatureServe 2012, Sawyer et al. 2009, VegCAMP and AIS 2013

Surveys (with Sample Sizes) Used for Description

MOJN: N=99

LAKE (n=6): LAKE0411, LAKE0430, LAKE0447, LAKE0617, LAKE9422, LAKE9433

MOJA (n=85): MOJA0158, MOJA0326, MOJA0351, MOJA0555, MOJA0566, MOJA0649, MOJA0801, MOJA0906, MOJA0927, MOJA9379, MOJA9431, MOJA9440, MOJA9508, MOJA9521, MOJA9530, MOJA9564, MOJA9591, MOJA9664, MOJA9915, MOJA9924, MOJAE011, MOJAE012, MOJAE047, MOJAE048, MOJAE049, MOJAE052, MOJAE054, MOJAE056, MOJAE058, MOJAE077, MOJAE078, MOJAE079, MOJAE090, MOJAE092, MOJAE096, MOJAE097, MOJAE098, MOJAE099, MOJAE100, MOJAE101, MOJAE102, MOJAE108, MOJAE109, MOJAE110, MOJAE111, MOJAE112, MOJAE113, MOJAE114, MOJAE115, MOJAE116, MOJAE117, MOJAE118, MOJAE125, MOJAE126, MOJAE127, MOJAE128, MOJAE129, MOJAE130, MOJAE131, MOJAE132, MOJAE133, MOJAE147, MOJAE148, MOJAE149, MOJAE150, MOJAE151, MOJAE154, MOJAE200, MOJAE206, MOJAE207, MOJAE209, MOJAE212, MOJAE213, MOJAE214, MOJAE216, MOJAE217, MOJAE218, MOJAE219, MOJAE231, MOJAE232, MOJAE242, MOJAE246, MOJAE249, MOJAE250, MOJC0009

MOJN-Johnson (n=8): MOJJE043, MOJJE255, MOJJE258, MOJJE259, MOJJE355, MOJJE358, MOJJE582, MOJJE597

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Tree										
	<i>Chilopsis linearis</i>	92.3	92	7.9	2	37.1	x	x		
Shrub										
	<i>Acacia greggii</i>	71.4	10	1.3	0.2	8.1				x
	<i>Hymenoclea salsola</i>	68.1	17	1.7	0.2	10				x
	<i>Stephanomeria pauciflora</i>	52.7	1.6	0.1	0.2	1.1				x
	<i>Larrea tridentata</i>	46.2	4.8	0.5	0.2	5				
	<i>Ambrosia eriocentra</i>	40.7	7.4	0.9	0.2	10				
	<i>Viguiera parishii</i>	39.6	4	0.6	0.2	7.1				
	<i>Cylindropuntia acanthocarpa</i>	38.5	0.9	0.1	0.01	3				
	<i>Eriogonum fasciculatum</i>	38.5	0.9	0.1	0.01	1.1				
	<i>Prunus fasciculata</i>	37.4	7.2	1.3	0.2	20				
	<i>Brickellia incana</i>	33	2.4	0.3	0.2	3.6				
	<i>Phoradendron californicum</i>	33	0.8	0.1	0.2	1				
	<i>Bebbia juncea</i>	31.9	3.6	0.3	0.01	3.6				
	<i>Gutierrezia sarothrae</i>	30.8	1.4	0.1	0.2	2				
	<i>Salvia dorrii</i>	27.5	2.5	0.4	0.1	6				
	<i>Ericameria paniculata</i>	26.4	11	1.2	0.2	16				
	<i>Senecio flaccidus</i>	25.3	2.6	0.2	0.2	4				
Herb										
	<i>Bromus rubens</i>	84.6	17	0.7	0.2	7	x			
	<i>Erodium cicutarium</i>	74.7	9.4	0.4	0.01	12				x
	<i>Schismus</i>	48.4	16	0.6	0.2	8				
	<i>Sphaeralcea ambigua</i>	47.3	3.9	0.1	0.2	0.2				
	<i>Penstemon palmeri</i>	34.1	5.4	0.2	0.01	1.5				
	<i>Oenothera caespitosa</i>	28.6	3.1	0.1	0.2	0.2				
	<i>Eriogonum inflatum</i>	27.5	3.4	0.1	0.2	1				
	<i>Mirabilis laevis</i>	26.4	2.1	0.1	0.01	0.5				
	<i>Dasyochloa pulchella</i>	26.4	2.9	0.1	0.2	0.2				
Non-vasc										
	<i>Cryptogamic crust</i>	30.8	28	0.1	0.2	0.2				

Desert Wash and River Bottom Sparsely Vegetated Alliance

Common Name: Desert Wash (Sparsely Vegetated with Shrubs)

Group Assignment: G541; **Alliance Code:** None

Alliance Concept

The Desert Wash (Sparsely Vegetated with Shrubs) Alliance forms a sparse herbaceous layer and sparse shrub layer. The tree layer, if present, is sparse. Stands are found on along intermittently flooded washes and river channels. The soil substrates include alluvial sand, gravel and rock fragments, and soil textures are typically sandy. Various shrubs can occur at sparse cover including *Ambrosia eriocentra*, *Bebbia juncea*, *Brickellia atractyloides*, *Brickellia desertorum*, *Eriogonum fasciculatum*, *Acacia greggii*, *Gutierrezia sarothrae*, *Lepidium fremontii*, *Lycium andersonii*, and *Prunus fasciculata*. Herbs can include *Achnatherum speciosum*, *Amsinckia* spp., *Bromus rubens*, *Eriogonum deflexum*, *Eriogonum inflatum*, *Erodium cicutarium*, *Penstemon* spp., *Acourtia wrightii*, *Dasyochloa pulchella*, *Physalis* spp., and *Thelypodium integrifolium*. Unknown lichens also can occur at sparse cover.

Diagnostic Criteria: This alliance is characterized by a sparse cover of vascular plants and non-vascular plants including wash-related shrub species such as *Ambrosia eriocentra*, *Bebbia juncea*, and *Brickellia* spp. Scattered trees, shrubs and herbs have an average of <3% absolute cover and are unevenly distributed.

Alliance Distribution

This type occurs throughout the three park areas, though it was sampled only once in the study area in the Piute Range of MOJA at mid elevation.

States: CA (AZ and NV)

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (1): 322AI (Expected across Mojave Desert 322Ab-322Az and Great Basin 341Fa-341Ff)

Park Sampling Zones: **MOJA:** Piute Range (**DEVA**, **LAKE**, and **MOJA:** throughout)

Associations

Association Scientific Name	Sample Size	LAKE	DEVA	MOJA	Johnson
Desert Wash (Sparsely vegetated with <i>Ambrosia eriocentra</i> , <i>Brickellia</i> spp.) Association	1			x	

Association Notes: None.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: 919 m

Aspect: E (1)

Slope: 7 degrees

Macro Topography: Midslope (1)

Tree Cover: 0%

Shrub Cover: 1.5%

Herb Cover: 0.5%

Large Rock: 60%

Small Rock: 15%

Fines Cover: 25%

Litter Cover: 0%

Geology: rhyolite (1)

Soil Texture: Sand (1)

Environment: The alliance occurs along intermittently flooded washes. One stand samples was found at a mid-elevation slope with an east aspect and a soil texture of sand.

Vegetation Description

Vegetation Structure: The alliance forms a sparse herbaceous layer and sparse shrub layer. The tree layer, if present, is sparse and the shrub layer is sparse to open. Both vascular plants and non-vascular plants are sparse overall in cover (e.g., <3% absolute cover).

Vegetation Floristics: Various shrubs occur at sparse cover, including *Ambrosia eriocentra*, *Bebbia juncea*, *Brickellia atrectyloides*, *Brickellia desertorum*, *Eriogonum fasciculatum*, *Acacia greggii*, *Gutierrezia sarothrae*, *Lepidium fremontii*, *Lycium andersonii*, and *Prunus fasciculata*. Herbs can include *Achnatherum speciosum*, *Amsinckia* spp., *Bromus rubens*, *Eriogonum deflexum*, *Eriogonum inflatum*, *Erodium cicutarium*, *Penstemon* spp., *Acourtia wrightii*, *Dasyochloa pulchella*, *Physalis* spp., and *Thelypodium integrifolium*.

Dynamics: Open washes with sparse cover of vegetation occur throughout the region, especially in areas with high intensity, large flooding events and/or in areas with irregular flooding frequencies. Depending upon site history and flooding events, these sparsely vegetated river and wash channels can change quickly and become vegetated by native herb and shrub species.

Classification Comments

Stands have typically low cover (<3%) in this defined type, though the shrub cover including *Brickellia* spp. can vary in cover depending on amount of flooding and disturbance.

Classification Confidence of Alliance: Low

Conservation Status Rank

Global: GNR

State (California): GNR

References

AIS and VegCAMP 2013

Surveys (with Sample Sizes) Used in Description

MOJN: N=1

LAKE (n=0)

DEVA (n=0)

MOJA (n=1): MOJA9621

MOJN-Johnson (n=0)

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Shrub	<i>Brickellia desertorum</i>	100	43	2	2	2	x		x	
	<i>Eriogonum fasciculatum</i>	100	11	0.5	0.5	0.5	x			
	<i>Acacia greggii</i>	100	4.3	0.2	0.2	0.2	x			
	<i>Ambrosia eriocentra</i>	100	4.3	0.2	0.2	0.2	x			
	<i>Bebbia juncea</i>	100	4.3	0.2	0.2	0.2	x			
	<i>Brickellia atractyloides</i>	100	4.3	0.2	0.2	0.2	x			
	<i>Gutierrezia sarothrae</i>	100	4.3	0.2	0.2	0.2	x			
	<i>Lepidium fremontii</i>	100	4.3	0.2	0.2	0.2	x			
	<i>Lycium andersonii</i>	100	4.3	0.2	0.2	0.2	x			
	<i>Prunus fasciculata</i>	100	4.3	0.2	0.2	0.2	x			
	<i>Ephedra nevadensis</i>	100	2.1	0.1	0.1	0.1	x			
	<i>Ephedra viridis</i>	100	2.1	0.1	0.1	0.1	x			
	<i>Galium stellatum</i>	100	2.1	0.1	0.1	0.1	x			
	<i>Lotus rigidus</i>	100	2.1	0.1	0.1	0.1	x			
	<i>Salvia dorrii</i>	100	2.1	0.1	0.1	0.1	x			
	<i>Viguiera parishii</i>	100	2.1	0.1	0.1	0.1	x			
Herb	<i>Achnatherum speciosum</i>	100	24	0.5	0.5	0.5	x			
	<i>Amsinckia</i>	100	9.5	0.2	0.2	0.2	x			
	<i>Bromus rubens</i>	100	9.5	0.2	0.2	0.2	x			
	<i>Eriogonum deflexum</i>	100	9.5	0.2	0.2	0.2	x			
	<i>Eriogonum inflatum</i>	100	9.5	0.2	0.2	0.2	x			
	<i>Erodium cicutarium</i>	100	9.5	0.2	0.2	0.2	x			
	<i>Penstemon</i>	100	9.5	0.2	0.2	0.2	x			
	<i>Acourtia wrightii</i>	100	4.8	0.1	0.1	0.1	x			
	<i>Dasyochloa pulchella</i>	100	4.8	0.1	0.1	0.1	x			
	<i>Physalis</i>	100	4.8	0.1	0.1	0.1	x			
	<i>Thelypodium integrifolium</i>	100	4.8	0.1	0.1	0.1	x			
Non-vascular	Unknown Lichen	100	100	0.4	0.4	0.4	x	x		

***Ericameria paniculata* Mojave Desert Wash Alliance**

Common Name: Mojave Rabbitbrush Mojave Desert Wash

Group Assignment: G541; **Alliance Code:** A2509

Alliance Concept

The Black-Stem Rabbitbrush Scrub Alliance forms an open to intermittent shrub layer. The emergent tree layer is typically sparse, and the herbaceous layer is sparse to open. The alliance is found primarily in wash bottoms and on alluvial fans. Soils are derived from a variety of substrates and soils are generally sandy in texture. Elevations range from approximately 400 to 2050 meters. *Ericameria paniculata* is the dominant and characteristic shrub of this alliance and *Hymenoclea salsola* is often present. *Bromus rubens* is often present in this alliance.

Diagnostic Criteria: This alliance is characterized by an open to intermittent shrub layer with *Ericameria paniculata* dominant or co-dominant. The overall shrub cover ranges from 4 to 65 percent.

Alliance Distribution

The alliance is well-defined in sampling at all three Parks. It is scattered throughout DEVA and MOJA primarily at mid to high elevations, but occasionally at low elevations, and in LAKE at low to mid elevations.

States: AZ, CA, NV

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (41):

322Ab, 322Ae, 322Af, 322Ai, 322Aj, 322Ak, 322Al, 322Am, 322Av, 322Ay, 322Az;

Southeastern Great Basin (17): 341Fa, 341Fc, 341Fd, 341Ff

Park Sampling Zones: **DEVA:** CottonWood Mtns, Death Valley, Grapevine Mtns, Last Chance Range, Last Chance Vly, Owlshead Mtns, Panamint Mtns, Saline Valley; **LAKE:** Echo Bay, Government Wash, Juniper Mine, Pearce Ferry; **MOJA:** Baker-Halloran, Cima Dome NW, Cinder Cones, Clipper Vly, Devil's Playground, Fenner Vly West, HackberryVontrigger, Kelso Dunes, Kelso-Cima, Lanfair Vly, New York Mtns, Old Dad Mtns, Providence Mtns, Van Winkle Mtn, Woods Mtns

Associations

Association Scientific Name [NVC Code]	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Ericameria paniculata</i> Wash [CEGL002706]	49	x	x	x	x
<i>Ericameria paniculata</i> – <i>Hymenoclea salsola</i>	19	x	x	x	x

Association Notes: None.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 1025 m, Range 403 – 2028 m

Aspect: (1), Flat, Variable (1), N (3), NE (4), E (8), NW (5), SE (13), SW (12), W (2), S (18)

Slope: Mean 5.0 degrees, Range 0 – 43 degrees

Macro Topography: Channel bed (18), Entire slope (1), High slope (1), Low level/bottom (7), Low- to midslope (1), Lowslope (2), Midslope (15)

Tree Cover: Mean 0.1%, Range 0 – 1.5%

Shrub Cover: Mean 15.7%, Range 4 – 65.2%

Herb Cover: Mean 2.5%, Range 0 – 11.2%

Large Rock: Mean 2.0%, Range 0 – 20%

Small Rock: Mean 57.1%, Range 3 – 96%

Fines Cover: Mean 36.3%, Range 0 – 95.6%

Litter Cover: Mean 2.8%, Range 0 – 16%

Geology: alluvium (25), conglomerate (4), dolostone (dolomite) (5), dune sand (2), gneiss (2), granite (1), granodiorite (3), limestone (1), mudstone (1), rhyolite (3), sandstone (10), tephrite (basanite) (1)

Soil Texture: Coarse loamy sand (1), Coarse sand (1), Fine sand (2), Loamy sand (7), Medium sand (8), Sand (21), Sandy loam (6)

Environment: Black-Stem Rabbitbrush Scrub Alliance occurs at low to high elevations primarily in dry washes. The soils are derived from a variety of substrates (and are usually sandy in texture), though they are often calcareous. The alliance occurs at all aspects.

Vegetation Description

Vegetation Structure: The alliance forms an open to intermittent shrub layer and the overall shrub cover ranges from 4 to 65 percent. The tree layer is typically sparse, and the herb layer is sparse to open. Non-vascular plants are typically sparse to open.

Vegetation Floristics: The dominant and characteristic shrub is *Ericameria paniculata*. Those often present include *Hymenoclea salsola*. The herbaceous layer often includes *Bromus rubens*.

Dynamics: *Ericameria paniculata* occurs in actively flooded portions of gravelly and cobbelly washes that receive intermittent and/or seasonal flows.

Classification Comments

None.

Classification Confidence of Alliance: High

Conservation Status Rank

Global: G4

State (California): S3

References

Evens 2000, Evens et al. 2012, Keeler-Wolf and Thomas 2000, NatureServe 2012, Sawyer et al. 2009, VegCAMP and AIS 2013

Surveys (with Sample Sizes) Used in Description

MOJN: N=68

LAKE (n=6): LAKE0264, LAKE0514, LAKE0704, LAKE9182, LAKE9705, LAMEN081

DEVA (n=26): DEVA0109, DEVA0126, DEVA0203, DEVA0224, DEVA9118, DEVA9190, DEVA9211, DEVA9258, DEVA9266, DEVA9350, DEVA9418, DEVA9457, DEVA9646, DEVA9669, DEVAD009, DEVAD038, DEVAD058, DEVAD065, DEVAD073, DEVAD079, DEVAD081, DEVAD100, DEVAD160, DEVAS038, MOJC0644, MOJC0702

MOJA (n=26): MOJA0145, MOJA9162, MOJA9239, MOJA9317, MOJA9372, MOJA9382, MOJA9402, MOJA9501, MOJA9515, MOJA9527, MOJA9601, MOJA9630, MOJA9631, MOJA9639, MOJA9670, MOJA9677, MOJAE091, MOJAE094, MOJAE095, MOJAE223, MOJC0012, MOJC0196, MOJC0204, MOJC0251, MOJC0344, MOJC0738

MOJN-Johnson (n=10): MOJJE188, MOJJE267, MOJJE274, MOJJE306, MOJJE394, MOJJE498, MOJJE524, MOJJE616, MOJJE646, MOJJE917

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Shrub	<i>Ericameria paniculata</i>	98.3	56	8.5	1.68	50	x	x		
	<i>Hymenoclea salsola</i>	74.1	10	1.3	0.1	10				x
	<i>Stephanomeria pauciflora</i>	44.8	1.5	0.3	0.1	5				
	<i>Larrea tridentata</i>	43.1	2.6	0.3	0.1	4				
	<i>Ambrosia dumosa</i>	39.7	2	0.3	0.1	5				
	<i>Eriogonum fasciculatum</i>	31	1.3	0.2	0.1	5				
	<i>Ambrosia eriocentra</i>	29.3	1.8	0.3	0.2	4				
	<i>Acacia greggii</i>	27.6	2	0.2	0.2	3				
Herb	<i>Bromus rubens</i>	75.9	14	0.6	0.1	6	x			
	<i>Erodium cicutarium</i>	48.3	6.2	0.2	0.1	2				
	<i>Schismus</i>	41.4	7.5	0.3	0.2	3				
	<i>Eriogonum inflatum</i>	32.8	4.4	0.1	0.1	0.5				
	<i>Cryptantha</i>	31	4.5	0.2	0.3	1.2				
	<i>Amsinckia</i>	31	2.6	0.1	0.1	2				
	<i>Sphaeralcea ambigua</i>	31	3.1	0.1	0.1	2				

***Fallugia paradoxa* Wash Alliance**

Common Name: Apache Plume Desert Wash

Group Assignment: G541; **Alliance Code:** A3259

Alliance Concept

The Apache Plume Shrubland Alliance forms an open shrub layer. The emergent tree layer, when present, is typically sparse, when present, and the herbaceous layer is usually open. The alliance is found primarily in washes at various aspects. Soils are derived from a variety of substrates including calcareous and volcanic alluvium, and textures include loam, loamy sand, and sandy loam. Elevations range from approximately 1450 to 1600 meters. The dominant or co-dominant shrub is *Fallugia paradoxa*, and characteristic shrubs include *Prunus fasciculata*. Shrubs that are often present include *Cylindropuntia acanthocarpa* and *Ephedra nevadensis*. Characteristic herbs include *Bromus rubens* and *Sphaeralcea ambigua*, and those often present are *Bromus tectorum* and *Elymus elymoides*.

Diagnostic Criteria: This alliance is characterized by an open to continuous shrub layer with *Fallugia paradoxa* dominant or co-dominant. The overall shrub cover ranges from 13 to 95 percent.

Alliance Distribution

The alliance is represented by three samples in MOJA and one sample in DEVA at high elevations. This alliance was not sampled in LAKE but was mapped along the border area with Grand Canyon-Parashant National Monument.

States: (AZ); CA

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (4): 322Ad, 322AI, (322Av)

Park Sampling Zones: **DEVA:** Funeral Mtns; **LAKE:** (Parashant); **MOJA:** Lanfair Villy, New York Mtns, Providence Mtns

Associations

Association Scientific Name [NVC Code]	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Fallugia paradoxa</i> Desert Wash [CEGL005298]	4	(x)	x	x	

Association Notes: None.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 1525 m, Range 1498 – 1600 m

Aspect: E (1), SW (1), S (2)

Slope: Mean 5 degrees, Range 2 – 12 degrees

Macro Topography: Channel bed (1), Low level/bottom (1), Lowslope (1), Midslope (1)

Tree Cover: Mean 0.1%, Range 0 – 0.2%

Shrub Cover: Mean 36.6%, Range 13.43 – 95.4%

Herb Cover: Mean 6%, Range 2 – 14%

Large Rock: Mean 2.5%, Range 0 – 6%

Small Rock: Mean 40.5%, Range 5 – 81.8%

Fines Cover: Mean 29%, Range 1 – 60%

Litter Cover: Mean 27.8%, Range 4 – 87.8%

Geology: alluvium (1), dolostone (dolomite) (1), rhyolite (2)

Soil Texture: Loam (1), Loamy sand (2), Sandy loam (1)

Environment: The Apache Plume Shrubland Alliance grows in high elevation, mountain washes in DEVA and MOJA at a variety of aspects. Soils are derived from a variety of substrates including calcareous and volcanic alluvium, and textures include loamy sand to loam.

Vegetation Description

Vegetation Structure: The alliance forms an open to continuous shrub layer and the overall shrub cover ranges from 13 to 95 percent. The tree layer, when present, is typically sparse, and the herb layer is sparse to open. Non-vascular plants are typically sparse.

Vegetation Floristics: *Fallugia paradoxa* is dominant or co-dominant in the shrub layer, and *Prunus fasciculata* is characteristically present. Those often present include *Cylindropuntia acanthocarpa* and *Ephedra nevadensis*. The herbaceous layer typically or often includes *Bromus rubens* and *Sphaeralcea ambigua*, and those that are often present include *Bromus tectorum* and *Elymus elymoides*.

Dynamics: *Fallugia paradoxa* stands occur in washes and wash terraces of higher elevation mountain drainages. They typically occur on nutrient-poor limestone and volcanic substrates.

Classification Comments

None.

Classification Confidence of Alliance: High

Conservation Status Rank

Global: G4?

State (California): S3?

References

NatureServe 2012

Surveys (with Sample Sizes) Used in Description

MOJN: N=4

LAKE (n=0)

DEVA (n=1): DEVA9396

MOJA (n=3): MOJA0127, MOJA0273, MOJA9699

MOJN-Johnson (n=0)

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Tree	<i>Pinus monophylla</i>	25	25	0.1	0.2	0.2				
	<i>Yucca brevifolia</i>	25	25	0.1	0.2	0.2				
	<i>Juniperus osteosperma</i>	25	25	0	0.01	0.01				
Shrub	<i>Fallugia paradoxa</i>	100	32	15	3	45	x		x	
	<i>Prunus fasciculata</i>	100	6.3	2.4	0.2	6	x			
	<i>Ephedra nevadensis</i>	75	9.1	1.5	2	2	x			
	<i>Cylindropuntia acanthocarpa</i>	75	0.7	0.2	0.2	0.2	x			
	<i>Gutierrezia sarothrae</i>	50	6.2	1.1	0.2	4				x
	<i>Lycium andersonii</i>	50	3.5	0.6	0.5	2				x
	<i>Ambrosia eriocentra</i>	50	2.6	0.4	0.5	1				x
	<i>Lycium cooperi</i>	50	1.8	0.3	0.2	1				x
	<i>Rhus trilobata</i>	50	0.2	0.3	0.01	1				x
	<i>Atriplex canescens</i>	50	1.2	0.2	0.2	0.5				x
	<i>Salvia dorrii</i>	50	1.2	0.2	0.2	0.5				x
	<i>Ericameria linearifolia</i>	50	0.3	0.1	0.2	0.2				x
	<i>Opuntia polyacantha</i> var. <i>erinacea</i>	50	0.7	0.1	0.2	0.2				x
	<i>Eriogonum fasciculatum</i>	50	0.3	0.1	0.01	0.2				x
	<i>Garrya flavescens</i>	25	8.8	10	40	40				
	<i>Frangula californica</i> ssp. <i>ursina</i>	25	2.2	2.5	10	10				
	<i>Rhamnus ilicifolia</i>	25	2.2	2.5	10	10				
	<i>Artemisia tridentata</i>	25	9.3	1.3	5	5				
	<i>Viguiera reticulata</i>	25	5	1	4	4				
	<i>Salazaria mexicana</i>	25	2.5	0.5	2	2				
	<i>Acacia greggii</i>	25	0	0.1	0.2	0.2				
	<i>Agave deserti</i>	25	0	0.1	0.2	0.2				
	<i>Artemisia dracunculus</i>	25	0.4	0.1	0.2	0.2				
	<i>Encelia actonii</i>	25	0.2	0.1	0.2	0.2				
	<i>Ephedra viridis</i>	25	0.2	0.1	0.2	0.2				
	<i>Ericameria cuneata</i>	25	0.2	0.1	0.2	0.2				
	<i>Eriogonum wrightii</i>	25	0.3	0.1	0.2	0.2				
	<i>Hymenoclea salsola</i>	25	0.3	0.1	0.2	0.2				
	<i>Krascheninnikovia lanata</i>	25	0.4	0.1	0.2	0.2				
	<i>Lotus rigidus</i>	25	0	0.1	0.2	0.2				
	<i>Penstemon fruticiformis</i>	25	0.2	0.1	0.2	0.2				
	<i>Psoralea argophylla</i>	25	0.2	0.1	0.2	0.2				
	<i>Thamnosma montana</i>	25	0.2	0.1	0.2	0.2				
	<i>Yucca baccata</i>	25	0	0.1	0.2	0.2				
	<i>Ericameria nauseosa</i>	25	0	0	0.01	0.01				

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Herb										
	<i>Bromus rubens</i>	100	24	1.8	0.2	4	x			
	<i>Sphaeralcea ambigua</i>	100	6	0.2	0.2	0.2	x			
	<i>Bromus tectorum</i>	75	5.1	0.4	0.2	1	x			
	<i>Elymus elymoides</i>	75	3.9	0.2	0.2	0.2	x			
	<i>Muhlenbergia porteri</i>	50	3.3	0.4	0.5	1				x
	<i>Cryptantha</i>	50	2.4	0.3	0.6	0.6				x
	<i>Bouteloua eriopoda</i>	50	2.9	0.3	0.2	1				x
	<i>Achnatherum speciosum</i>	50	5.2	0.1	0.2	0.2				x
	<i>Amsinckia</i>	50	0.8	0.1	0.2	0.2				x
	<i>Artemisia ludoviciana</i>	50	0.8	0.1	0.2	0.2				x
	<i>Aristida purpurea</i>	50	0.8	0.1	0.2	0.2				x
	<i>Dasyochloa pulchella</i>	50	0.8	0.1	0.2	0.2				x
	<i>Eriastrum</i>	50	0.8	0.1	0.2	0.2				x
	<i>Eriogonum inflatum</i>	50	3.6	0.1	0.2	0.2				x
	<i>Eriogonum palmerianum</i>	50	0.8	0.1	0.2	0.2				x
	<i>Machaeranthera canescens</i>	50	0.8	0.1	0.2	0.2				x
	<i>Plantago patagonica</i>	50	0.8	0.1	0.2	0.2				x
	<i>Erodium cicutarium</i>	25	9.9	1.8	7	7				
	<i>Sporobolus cryptandrus</i>	25	1.4	0.3	1	1				
	<i>Achnatherum hymenoides</i>	25	1.3	0.1	0.5	0.5				
	<i>Descurainia</i>	25	1.3	0.1	0.5	0.5				
	<i>Sporobolus contractus</i>	25	1.3	0.1	0.5	0.5				
	<i>Chaenactis</i>	25	0.6	0.1	0.4	0.4				
	<i>Linanthus</i>	25	0.6	0.1	0.4	0.4				
	<i>Adenophyllum cooperi</i>	25	0.5	0.1	0.2	0.2				
	<i>Asclepias erosa</i>	25	0.5	0.1	0.2	0.2				
	<i>Baileya multiradiata</i>	25	0.5	0.1	0.2	0.2				
	<i>Bouteloua</i>	25	3.1	0.1	0.2	0.2				
	<i>Cryptantha circumscissa</i>	25	0.3	0.1	0.2	0.2				
	<i>Eriastrum diffusum</i>	25	0.5	0.1	0.2	0.2				
	<i>Eriogonum pusillum</i>	25	0.5	0.1	0.2	0.2				
	<i>Eucrypta micrantha</i>	25	2.1	0.1	0.2	0.2				
	<i>Euphorbia</i>	25	2.1	0.1	0.2	0.2				
	<i>Galium</i>	25	2.1	0.1	0.2	0.2				
	<i>Lepidium lasiocarpum</i>	25	0.3	0.1	0.2	0.2				
	<i>Linanthus pungens</i>	25	3.1	0.1	0.2	0.2				
	<i>Mirabilis multiflora</i>	25	0.5	0.1	0.2	0.2				
	<i>Oenothera</i>	25	0.5	0.1	0.2	0.2				
	<i>Pellaea mucronata</i>	25	2.1	0.1	0.2	0.2				
	<i>Salvia columbariae</i>	25	0.3	0.1	0.2	0.2				
	<i>Schismus</i>	25	0.3	0.1	0.2	0.2				
	<i>Tridens muticus</i>	25	2.1	0.1	0.2	0.2				
Non-vascular										
	Unknown Lichen	50	29	0.2	0.4	0.4				x
	Unknown Moss	50	15	0.1	0.2	0.2				x
	Cryptogamic crust	25	6.3	0.1	0.2	0.2				

***Hymenoclea salsola* - *Bebbia juncea* Mojave-Sonoran Desert Wash Alliance**

Common Name: Mojave-Sonoran Burrobrush - Sweetbush Desert Wash

Group Assignment: G541; **Alliance Code:** A4188

Alliance Concept

The Mojave-Sonoran Burrobrush - Sweetbush Desert Wash Alliance forms an open to intermittent shrub layer. The emergent tree layer, when present, is typically sparse, and the herbaceous layer is sparse to open. The alliance is often found in dry washes or alluvial deposits, but soils may be derived from a variety of substrates. Soils tend to be sandy, but sometimes have high clay content. Elevations range from approximately 75 to 1900 meters. *Hymenoclea salsola* is often dominant or co-dominant in the shrub layer, though sometimes *Bebbia juncea* or *Senna armata* is dominant or co-dominant in the shrub layer. Other characteristic shrubs include *Larrea tridentata*. *Ambrosia dumosa* is often present in the shrub layer while *Bromus rubens* and *Erodium cicutarium* are often present in the herbaceous layer.

Diagnostic Criteria: This alliance is characterized by an open to intermittent shrub layer with *Hymenoclea salsola*, *Bebbia juncea*, or *Senna armata* dominant or co-dominant with each other or with other shrubs such as *Larrea tridentata*. The overall shrub cover ranges from 2 to 60 percent.

Alliance Distribution

The alliance is well-defined in sampling at all three Parks. It is scattered throughout DEVA, MOJA, and LAKE at all elevations.

States: AZ, CA, NV

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (150): 322Ab, 322Ac, 322Ad, 322Af, 322Ai, 322Aj, 322Ak, 322Al, 322Am, 322At, 322Av, 322Ay, 322Az; Southeastern Great Basin (12): 341Fa, 341Fc, 341Fd, 341Ff

Park Sampling Zones: **DEVA** Black Mtns, CottonWood Mtns, Death Valley, Funeral Mtns, Grapevine Mtns, Green Water Rng/Vlly, Joshua Flat, Last Chance Range, Last Chance Vlly, Owshead Mtns, Panamint Mtns; **LAKE:** Boulder City, Bridge Canyon, Callville, Cottonwood Cove, Echo Bay, Gold Butte, Juniper Mine, Katherine, Lakeshore, Searchlight SE, Temple Bar, Willow Beach; **MOJA:** Baker-Halloran, Budweiser Wash, Cima Dome NW, Cima Dome SE, Cinder Cones, Clark Mtn West, Clipper Vlly, Devil's Playground, Halloran Spring, Ivanpah Mtns, Ivanpah Vlly, Kelso Mtns, Kelso-Cima, Lanfair Vlly, Marl Mtns, Mid Hills, Old Dad Mtns, Piute Range, Providence Mtns, Turquoise Mountain, Van Winkle Mtn, Vulcan Mine, Woods Mtns

Associations

Association Scientific Name [NVC Code]	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Bebbia juncea</i> –(<i>Hymenoclea salsola</i>) [CEGL005391]	31	x	x	x	
<i>Hymenoclea salsola</i> [CEGL005398]	75	x	x	x	x
<i>Hymenoclea salsola</i> (alliance)	1		x		
<i>Hymenoclea salsola</i> –(<i>Ambrosia eriocentra</i> – <i>Brickellia incana</i>) [CEGL002702]	17			x	x
<i>Hymenoclea salsola</i> – <i>Eriogonum fasciculatum</i>	6			x	x
<i>Hymenoclea salsola</i> – <i>Larrea tridentata</i>	57	x	x	x	x
<i>Senna armata</i> –(<i>Hymenoclea salsola</i>) Wash	28	x	x	x	x

Association Notes: None.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 890.2 m, Range 79 – 1867 m

Aspect: N (15), NE (16), E (32), NW (32), SE (28), Flat, Variable (2), W (13), SW (44), S (29)

Slope: Mean 4.0 degrees, Range 0 – 33 degrees

Macro Topography: Basin floor/wetland (1), Channel bed (37), Channel wall (1), Entire slope (1), High level/summit (1), High slope (6), Low level/bottom (11), Lowslope (11), Midslope (38), Toeslope (alluvial fan/bajada) (1)

Tree Cover: Mean 0.1%, Range 0 – 1.5%

Shrub Cover: Mean 14.1%, Range 2.2 – 60.2%

Herb Cover: Mean 3.4%, Range 0 – 22%

Large Rock: Mean 3.7%, Range 0 – 50%

Small Rock: Mean 77.4%, Range 7 – 99%

Fines Cover: Mean 16.3%, Range 0 – 91%

Litter Cover: Mean 2.2%, Range 0 – 12%

Geology: alkali-granite (alaskite) (3), alluvium (80), andesite (1), basalt (3), conglomerate (6), dacite (2), diorite (1), dune sand (1), dolostone (dolomite) (1), gneiss (9), granite (2), granodiorite (9), gravel (3), limestone (1), plutonic rock (phaneritic) (1), rhyolite (13), sand (1), sandstone (20), schist (1), shale (2), tephrite (basanite) (2)

Soil Texture: Clay (1), Clay loam (4), Coarse loamy sand (2), Coarse sand (21), Loam (4), Loamy sand (33), Medium sand (22), Medium to very fine sandy loam (1), Sand (29), Sandy loam (11)

Environment: The Cheesbush Shrubland Alliance occurs at low to high elevations and all aspects in our sample area. The alliance generally occurs in dry washes and bajadas. The soils

are generally alluvial, but may be derived from a variety of parent materials. The soil texture is most often sand, but ranges from coarse sand to clay loam.

Vegetation Description

Vegetation Structure: The alliance forms an open to intermittent shrub layer and the overall shrub cover ranges from 2 to 60 percent. The tree layer, when present, is typically sparse, and the herb layer is sparse to open. Non-vascular plants are typically sparse.

Vegetation Floristics: *Hymenoclea salsola*, *Bebbia juncea*, or *Senna armata* is dominant or co-dominant with shrubs such as *Larrea tridentata*. Those often present include *Ambrosia dumosa*. *Bromus rubens* and *Erodium cicutarium* are often present in the herbaceous layer.

Dynamics: *Hymenoclea salsola*, *Bebbia juncea*, and *Senna armata* are widespread native shrubs associated commonly with semi-desert washes, but they also occur in other disturbed areas including in burned areas, heavily grazed areas, abandoned town and old farming sites, and roadsides. *Senna armata*, while not as wide-ranging, also occurs in washes, other disturbed areas, and areas with sheetflow such as pediment at the base of mountains.

Classification Comments

Stands of this alliance include those where *Larrea tridentata* is co-dominant with *Hymenoclea salsola* on less active portions of washes and wash terraces. Stands also include those with *Bebbia juncea* or *Senna armata* dominant to co-codominant with *Hymenoclea salsola*.

Classification Confidence of Alliance: High

Conservation Status Rank

Global: G5

State (California): S4

References

Buck-Diaz et al. 2012, Evens 2000, Evens and Hartman 2007, Evens et al. 2012, Hart et al. 1979, Keeler-Wolf and Thomas 2000, Keeler-Wolf et al. 1998b, Root 1978, NatureServe 2012, Sawyer et al. 2009, Thomas et al. 2004, VegCAMP and AIS 2013

Surveys (with Sample Sizes) Used in Description

MOJN: N=215

LAKE (n=35): LAKE0127, LAKE0130, LAKE0133, LAKE0141, LAKE0150, LAKE0209, LAKE0213, LAKE0240, LAKE0289, LAKE0334, LAKE0340, LAKE0341, LAKE0379, LAKE0401, LAKE0418, LAKE0419, LAKE0536, LAKE0607, LAKE9144, LAKE9152, LAKE9168, LAKE9195, LAKE9228, LAKE9231, LAKE9242, LAKE9243, LAKE9283, LAKE9319, LAKE9350, LAKE9359, LAKE9622, LAMEN046, LAMEN047, LAMEN019, LAMEN109

DEVA (n=56): DEVA0319, DEVA0333, DEVA0387, DEVA0503, DEVA0534, DEVA0628, DEVA0918, DEVA9214, DEVA9222, DEVA9286, DEVA9294, DEVA9337, DEVA9362, DEVA9365, DEVA9375, DEVA9406, DEVA9408, DEVA9432, DEVA9505, DEVA9513, DEVA9525, DEVA9533, DEVA9535, DEVA9605, DEVA9652, DEVA9807, DEVA9917, DEVAD003, DEVAD007, DEVAD015, DEVAD016, DEVAD020, DEVAD021, DEVAD029, DEVAD034, DEVAD036, DEVAD040, DEVAD075, DEVAD159, DEVAD206, DEVAD212, DEVAR060, DEVAS096, DEVAS190, DEVAS194, MOJC0455, MOJC0536, MOJC0574, MOJC0674, MOJC0739, MOJC0910, MOJC0962, MOJC1032, MOJC1033, MOJC1034, MOJC1052

MOJA (n=71): MOJA0147, MOJA0204, MOJA0365, MOJA0383, MOJA0506, MOJA0514, MOJA9201, MOJA9205, MOJA9207, MOJA9282, MOJA9285, MOJA9312, MOJA9316, MOJA9334, MOJA9366, MOJA9368, MOJA9385, MOJA9518, MOJA9526, MOJA9542, MOJA9593, MOJA9560, MOJA9594, MOJA9600, MOJA9611, MOJA9655, MOJA9666, MOJA9667, MOJA9669, MOJA9673, MOJA9683, MOJA9800, MOJA9802, MOJAE013, MOJAE014, MOJAE015, MOJAE016, MOJAE018, MOJAE021, MOJAE160, MOJAE161, MOJAE162, MOJAE163, MOJAE182, MOJAE190, MOJAE224, MOJAE225, MOJAE226, MOJAE248, MOJAE251, MOJAE252, MOJAE253, MOJAE254, MOJAE255, MOJAE256, MOJAE257, MOJAE258, MOJAE259, MOJAE260, MOJAE261, MOJAE262, MOJAE263, MOJAE264, MOJC0005, MOJC0023, MOJC0193, MOJC0250, MOJC0735, MOJC0799, MOJC1049, MOJC1230

MOJN-Johnson (n=53): MOJJE001, MOJJE006, MOJJE014, MOJJE040, MOJJE080, MOJJE092, MOJJE094, MOJJE102, MOJJE121, MOJJE134, MOJJE149, MOJJE165, MOJJE182, MOJJE191, MOJJE196, MOJJE199, MOJJE277, MOJJE290, MOJJE325, MOJJE338, MOJJE390, MOJJE519, MOJJE529, MOJJE539, MOJJE544, MOJJE546, MOJJE562, MOJJE563, MOJJE586, MOJJE600, MOJJE624, MOJJE636, MOJJE642, MOJJE671, MOJJE674, MOJJE680, MOJJE691, MOJJE704, MOJJE722, MOJJE724, MOJJE749, MOJJE760, MOJJE768, MOJJE807, MOJJE826, MOJJE829, MOJJE907, MOJJE912, MOJJE919, MOJJE920, MOJJE921, MOJJE922, MOJJE924

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Shrub	<i>Hymenoclea salsola</i>	97.5	40	5.3	0.2	28	x		x	
	<i>Larrea tridentata</i>	82.1	12	1.8	0.01	15	x			
	<i>Ambrosia dumosa</i>	59.9	5.6	0.8	0.1	10				x
	<i>Acacia greggii</i>	41.4	2.9	0.4	0.01	4				
	<i>Bebbia juncea</i>	38.3	8.8	1.2	0.1	30				
	<i>Eriogonum fasciculatum</i>	35.2	1.4	0.2	0.1	3				
	<i>Stephanomeria pauciflora</i>	30.2	0.7	0.1	0.1	1				
	<i>Opuntia basilaris</i>	26.5	0.5	0.1	0.1	0.5				
Herb	<i>Erodium cicutarium</i>	58	11	0.6	0.2	8				x
	<i>Bromus rubens</i>	53.1	8.4	0.5	0.1	7				x
	<i>Schismus</i>	45.7	8.7	0.4	0.2	6				
	<i>Eriogonum inflatum</i>	45.1	6.1	0.1	0.06	2				
	<i>Amsinckia</i>	38.9	2.8	0.2	0.2	5				
	<i>Cryptantha</i>	36.4	6.1	0.4	0.3	3.6				
	<i>Chaenactis</i>	26.5	3.7	0.3	0.2	16.4				
	<i>Salvia columbariae</i>	25.9	1.5	0.1	0.1	1				

***Prunus fasciculata* - *Salazaria mexicana* Northern Mojave Desert Wash**

Common Name: Desert Almond–Bladder Sage Scrub

Group Assignment: G541; **Alliance Code:** A4185, A1129

Alliance Concept

The Desert Almond–Bladder Sage Scrub Alliance forms an open to intermittent shrub layer. The emergent tree layer, when present, is typically sparse to open, and the herbaceous layer is sparse to open. The alliance is found primarily in washes and in canyon channel bottoms along hillsides at a variety of aspects. Soils are derived from a variety of substrates including alluvium, granodiorite, limestone and sandstone, and soil textures are often sand or sandy loam. Elevations range from approximately 750 to 1900 meters. *Prunus fasciculata*, *Prunus eremophila*, or *Salazaria mexicana* is dominant or co-dominant in the shrub canopy, and those shrubs often present include *Eriogonum fasciculatum*. Sometimes, *Salvia dorrii* may be dominant or co-dominant with *Prunus fasciculata* and other shrubs. Characteristic herbs include *Bromus rubens*, and those often present include *Achnatherum speciosum*, *Erodium cicutarium* and *Sphaeralcea ambigua*.

Diagnostic Criteria: This alliance is characterized by an open to intermittent shrub layer with *Prunus fasciculata*, *Prunus eremophila*, and/or *Salazaria mexicana* dominant or co-dominant. Sometimes, *Salvia dorrii* may be dominant or co-dominant with *Prunus fasciculata* and other shrubs. Rarely, *Keckiella antirrhinoides* is the dominant shrub, and *Prunus fasciculata* characteristically present. The overall shrub cover ranges from 5 to 48 percent.

Alliance Distribution

The alliance is well-defined in sampling in MOJA, including in the Clark, New York, and Providence mountains, and in DEVA in various mountain ranges. Samples of this alliance are less frequent in LAKE. The alliance is found at mid to high elevations.

States: AZ, CA

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (65): 322Ad, 322Af, 322Aj, 322Ak, 322Al, 322Av; Southeastern Great Basin (13): 341Fc, 341Fd, 341Ff

Park Sampling Zones: **DEVA:** CottonWood Mtns, Grapevine Mtns, Green Water Rng/Vlly, Last Chance Range, Panamint Dunes, Panamint Mtns; **LAKE:** Pearce Ferry, Temple Bar; **MOJA:** Baker-Halloran, Clark Mtn, Clark Mtn West, Granite Mtns, HackberryVontraigger, Hart Peak, Ivanpah Mtns, Lanfair Vlly, Marl Mtns, Mid Hills, New York Mtns, Piute Range, Providence Mtns, Signal Hill, Solomons Knob, Vulcan Mine, Woods Mtns

Associations

Association Scientific Name [NVC Code]	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Keckiella anthirrhinoides</i> – <i>Prunus fasciculata</i> (provisional)	2	x		x	
<i>Prunus eremophila</i> (provisional)	1			x	
<i>Prunus fasciculata</i> [CEGL002704]	11			x	
<i>Prunus fasciculata</i> (alliance)	1	x			
<i>Prunus fasciculata</i> –(<i>Purshia stansburiana</i> – <i>Viguiera reticulata</i>) [cf. CEGL002704]	10		x	x	
<i>Prunus fasciculata</i> – <i>Ambrosia eriocentra</i>	13			x	
<i>Prunus fasciculata</i> – <i>Rhus trilobata</i>	4	x		x	
<i>Salazaria mexicana</i> [CEGL005293]	24		x	x	x
<i>Salazaria mexicana</i> – <i>Hymenoclea salsola</i>	8		x	x	x
<i>Salazaria mexicana</i> – <i>Viguiera reticulata</i> – <i>Atriplex (confertifolia)</i>	3		x		
<i>Salvia dorrii</i> Wash [CEGL002965]	10			x	x

Association Notes: One sample was classified to alliance level only in which *Prunus fasciculata* was co-dominant with *Ericameria laricifolia*, and *Brickellia desertorum*.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 1367.5 m, Range 768 – 1883 m

Aspect: N (12), NE (7), E (10), NW (13), SE (10), SW (20), W (7), S (7)

Slope: Mean 9.3 degrees, Range 1 – 40 degrees

Macro Topography: Channel bed (7), High slope (7), Lowslope (7), Midslope (23), Toeslope (alluvial fan/bajada) (1)

Tree Cover: Mean 0.2%, Range 0 – 6%

Shrub Cover: Mean 19.0%, Range 5.4 – 47.9%

Herb Cover: Mean 7.7%, Range 0 – 39%

Large Rock: Mean 16.9%, Range 0 – 93%

Small Rock: Mean 64.3%, Range 4 – 96%

Fines Cover: Mean 13.8%, Range 0 – 90%

Litter Cover: Mean 3.8%, Range 0 – 40%

Geology: alluvium (13), conglomerate (1), dolostone (dolomite) (5), gneiss (7), granodiorite (23), limestone (6), plutonic rock (phaneritic) (1), rhyolite (7), sand (1), sandstone (14)

Soil Texture: Clay (1), Clay loam (7), Coarse loamy sand (2), Coarse sand (11), Fine Sand (1), Loam (2), Loamy sand (12), Medium sand (13), Medium silt (1), Medium to very fine sandy loam (1), Moderately fine sandy clay loam (1), Sand (11), Sandy loam (11), Silty clay (1)

Environment: The alliance is found at mid to high elevations at various aspects. The alliance primarily occurs on the sandy soils of washes and mountain canyons, which are derived from various materials including calcareous substrates.

Vegetation Description

Vegetation Structure: The alliance forms an open to intermittent shrub layer and the overall shrub cover ranges from 5 to 48 percent. The tree layer is typically sparse to open, and the herb layer is sparse to open. Non-vascular plants are typically sparse to open.

Vegetation Floristics: *Prunus fasciculata*, *Prunus eremophila* or *Salazaria mexicana* is dominant or co-dominant in the shrub layer. Sometimes, *Salvia dorrii* may be dominant or co-dominant with *Prunus fasciculata* and other shrubs. Rarely, *Keckiella anthirrinoides* is dominant instead, and *P. fasciculata* is characteristically present. Those shrubs that are often present include *Eriogonum fasciculatum*. Characteristic herbs include *Bromus rubens*, and those often present include *Achnatherum speciosum*, *Erodium cicutarium* and *Sphaeralcea ambigua*.

Dynamics: *Prunus fasciculata*, *Salazaria mexicana*, and *Salvia dorrii* commonly occur in gravelly and rocky washes on upper bajadas into the mountains, occurring with related alliances of *Acacia greggii* and *Baccharis sergiloides*. Both *Prunus fasciculata* and *Salazaria mexicana* vigorously resprout after fire, and these shrubs can expand in extent within a few years after a fire at the expense of other fire-sensitive plants, including *Juniperus osteosperma*, *Coleogyne ramosissima* and other related mid-elevation desert scrub species. Post-burn stands that occur along rocky montane slopes in the Mojave Desert ecoregion include those at the Mid Hills after the Hackberry Complex Fire.

Classification Comments

The *Prunus fasciculata*, *Salazaria mexicana* and *Salvia dorrii* alliances previously defined by Sawyer et al. (2009) and Thomas et al. (2004) have been merged into this broader *Prunus fasciculata*–*Salazaria mexicana* defined in this report, which is based on similarity in their floristics and ecology (and their proximate grouping in the ordination analyses).

Classification Confidence of Alliance: High

Conservation Status Rank

Global: G4

State (California): S4

References

Evens 2000, Evens et al. 2012, Keeler-Wolf and Thomas 2000, NatureServe 2012, Sawyer et al. 2009, VegCamp and AIS 2013

Surveys (with Sample Sizes) Used in Description

MOJN: N=87

DEVA (n=17): DEVA9125, DEVA9455, DEVA9671, DEVA9802, DEVA9803, DEVA9804, DEVA9805, DEVAS418, DEVAS201, MOJC0058, MOJC0361, MOJC0466, MOJC0526, MOJC0593, MOJC0955, MOJC0990, MOJC1102

MOJN-Johnson (n=9): MOJJE093, MOJJE272, MOJJE273, MOJJE560, MOJJE601, MOJJE643, MOJJE655, MOJJE886, MOJJE894

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Shrub	<i>Prunus fasciculata</i>	76.9	19	3.9	0.2	25	x			
	<i>Salazaria mexicana</i>	61.5	13	2.1	0.2	12.5				x
	<i>Eriogonum fasciculatum</i>	60.3	4.5	0.6	0.2	5				x
	<i>Salvia dorrii</i>	51.3	5.5	1	0.11	9				x
	<i>Hymenoclea salsola</i>	48.7	3.7	0.6	0.11	7				
	<i>Acacia greggii</i>	46.2	3.6	0.7	0.2	6				
	<i>Thamnosma montana</i>	44.9	1.1	0.2	0.2	2				
	<i>Cylindropuntia acanthocarpa</i>	43.6	0.9	0.2	0.2	2				
	<i>Yucca baccata</i>	42.3	1.8	0.3	0.2	5				
	<i>Stephanomeria pauciflora</i>	42.3	0.7	0.1	0.2	0.5				
	<i>Gutierrezia sarothrae</i>	41	2.7	0.4	0.2	5				
	<i>Ephedra nevadensis</i>	39.7	1.9	0.4	0.2	4				
	<i>Gutierrezia microcephala</i>	37.2	2.3	0.4	0.2	8				
	<i>Echinocereus engelmannii</i>	37.2	0.5	0.1	0.11	0.5				
	<i>Ephedra viridis</i>	30.8	1.6	0.4	0.2	8				
	<i>Ambrosia eriocentra</i>	26.9	5.4	1	0.2	13.1				
	<i>Ericameria linearifolia</i>	26.9	1	0.2	0.2	3				
	<i>Artemisia ludoviciana</i>	26.9	0.9	0.2	0.2	3.5				
	<i>Rhus trilobata</i>	25.6	1.5	0.3	0.2	5				
Herb	<i>Bromus rubens</i>	88.5	25	2.7	0.2	25	x			
	<i>Erodium cicutarium</i>	65.4	12	1.8	0.11	30				x
	<i>Sphaeralcea ambigua</i>	61.5	4.4	0.4	0.1	4				x
	<i>Achnatherum speciosum</i>	61.5	6.7	0.3	0.1	3				x
	<i>Amsinckia</i>	37.2	1.2	0.1	0.11	1				
	<i>Eriogonum inflatum</i>	35.9	2.6	0.1	0.2	1				
	<i>Cryptantha</i>	29.5	4	0.3	0.6	6				
	<i>Penstemon palmeri</i>	28.2	2.3	0.1	0.2	1				
	<i>Mirabilis laevis</i>	25.6	1.6	0.1	0.2	0.5				
	<i>Elymus elymoides</i>	25.6	0.8	0.1	0.01	0.5				
	<i>Mirabilis laevis</i>	28.6	1.4	0.1	0.2	0.5				
	<i>Elymus elymoides</i>	26.2	1	0.1	0.2	0.5				

***Psorothamnus fremontii* - *Psorothamnus polydenius* Wash Alliance**

Common Name: Smokebush Wash Scrub

Group Assignment: G541, G559; **Alliance Code:** A4186

Alliance Concept

The Smokebush Wash Scrub Alliance forms an open shrub layer. The emergent tree layer is sparse if present, and the herbaceous layer is sparse to open. The alliance is found primarily in alluvial fans, dry washes, lower slopes, and sand dunes, and often occurs in sites that experience disturbance from flooding to shifting substrates. Soils are derived from a variety of substrates including alluvium, dune sand, and sedimentary rock, and soil textures are sand to sandy loam. Elevations range from approximately 390 to 1610 meters. Dominant and characteristic shrubs include *Psorothamnus fremontii* or *P. polydenius* in the study area, and those that are often present include *Ambrosia dumosa*, *Larrea tridentata*. Herbs that are often present include *Sphaeralcea ambigua*, and commonly associated non-vascular plants include cryptogamic crust.

Diagnostic Criteria: This alliance is characterized by an open shrub layer with *Psorothamnus arborescens*, *Psorothamnus fremontii* or *Psorothamnus polydenius*, which can be dominant or co-dominant in the shrub layer. The overall shrub cover ranges from 2 to 28 percent cover.

Alliance Distribution

The alliance has been sampled in both LAKE and DEVA in various sites.

States: AZ, CA, NV

Ecoregion Sections and Subsection Codes: Mojave Desert (11), 322Av, 322Ay, 322Az, Southeastern Great Basin (9): 341Fc

Park Sampling Zones: **DEVA:** Eureka Valley, Joshua Flat, Last Chance Range; **LAKE:** Boulder City, Callville, Echo Bay, Pearce Ferry

Associations

Association Scientific Name	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Psorothamnus</i> (<i>arborescens</i> , <i>fremontii</i> , <i>polydenius</i>) (alliance)	1		x		
<i>Psorothamnus fremontii</i> sand dunes/flats [CEGL005154]	2	x			
<i>Psorothamnus fremontii</i> -(<i>Hymenoclea salsola</i>) [CEGL005154]	5	x			
<i>Psorothamnus fremontii</i> - <i>Ambrosia dumosa</i>	4	x			
<i>Psorothamnus polydenius</i> (provisional) [CEGL001353]	8		x		

Association Notes: None.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 799.4 m, Range 389 – 1612 m
Aspect: N (6), NE (3), E (1), NW (2), SE (4), SW (3)
Slope: Mean 10.1 degrees, Range 1 – 34 degrees
Macro Topography: Channel bed (2), High level/summit (2), High slope (2), Low level/bottom (3), Lowslope (6), Midslope (4)

Tree Cover: Mean 0.1%, Range 0 – 1%
Shrub Cover: Mean 9.3%, Range 2.1 – 28.1%
Herb Cover: Mean 3.5%, Range 0 – 12%

Large Rock: Mean 8.8%, Range 0 – 90%
Small Rock: Mean 48.6%, Range 0 – 98%
Fines Cover: Mean 37.7%, Range 0 – 95.5%
Litter Cover: Mean 0.8%, Range 0 – 5.2%

Geology: alluvium (4), basalt (2), conglomerate (3), dolostone (dolomite) (1), dune sand (3), gneiss (2), sandstone (3), sedimentary (gypsum) (1), water (1)
Soil Texture: Loamy sand (1), Sand (6), Sandy loam (4)

Environment: Stands occur in various settings including alluvial fans, dry washes, lower mountain slopes, and sand dunes at lower elevations. Stands in DEVA included *Psorothamnus polydenius* as the dominant, often found on sandy dunes in Eureka Valley and the Saline Range, or on steep eroding slopes of the Last Chance Range and Saline Range. Stands in LAKE occur along sand dunes, in washes, and along alluvial fans and slopes with intermittent drainages in a variety of locations.

Vegetation Description

Vegetation Structure: The Alliance forms an open shrub layer, and shrub cover ranges from 2 to 28 percent cover. The tree layer is sparse if present, and the herb layer is sparse to open. Non-vascular plants are typically sparse to open.

Vegetation Floristics: Characteristic shrubs include *Psorothamnus* spp., including *Psorothamnus fremontii* or *Psorothamnus polydenius*, which are either dominant or co-dominant in the shrub layer. Those shrubs often present include *Ambrosia dumosa* and *Larrea tridentata*, and sometimes present is *Hymenoclea salsola*. The tree layer is typically absent or sparse in cover. The herbaceous layer typically or often includes *Sphaeralcea ambigua*, and sometimes includes *Cryptantha* spp., *Bromus rubens*, and *Eriogonum inflatum*. Commonly associated non-vascular plants include cyptogamic crust.

Dynamics: *Psorothamnus* spp. appear adapted to disturbance, including alluvial, colluvial and aeolian (shifting-sand) movement.

Classification Comments

Psoralea spp. associations are placed within the Warm Semi-Desert Shrub & Herb Dry Wash & Colluvial Slope Group (G541) and Cool Semi-Desert Shrub & Herb Wash-Arroyo Group (G559) in the NVC hierarchy. For the Mojave Network classification, we have combined the associations into one alliance in the G541 group. However, further review and analysis is needed since Intermountain Semi-Desert Shrubland & Steppe (G310) and Mojave-Sonoran Bajada & Valley Desert Scrub (G295) are other groups with similar floristic and environmental characteristics.

Classification Confidence of Alliance: Low

Conservation Status Rank

Global: G4?

State (California): S2

References

cf. NatureServe 2012

Surveys (with Sample Sizes) Used for Description

MOJN: N=20

LAKE (n=11): ASGES1av, LAKE0308, LAKE0331, LAKE0513, LAKE9180, LAKE9262, LAKE9267, LAKE9332, LAKE9392, LAKE9603, LAKE9706

DEVA (n=9): DEVA0114, DEVA0449, DEVA0560, DEVA0561, DEVA0635, DEVA9904, DEVAD026, DEVAS064, DEVAS065

MOJA (n=0)

MOJN-Johnson (n=0)

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Shrub	<i>Larrea tridentata</i>	60	9.9	0.8	0.2	6				x
	<i>Psorothamnus fremontii</i>	55	28	2.3	2	8				x
	<i>Ambrosia dumosa</i>	55	5	0.5	0.06	3				x
	<i>Psorothamnus polydenius</i>	40	27	2.7	2	28				
	<i>Hymenoclea salsola</i>	40	5.1	0.6	0.2	4				
	<i>Acacia greggii</i>	30	0.9	0.1	0.2	1				
	<i>Opuntia basilaris</i>	30	0.7	0.1	0.2	0.2				
	<i>Stephanomeria pauciflora</i>	30	0.7	0.1	0.2	0.2				
	<i>Bebbia juncea</i>	25	2	0.2	0.2	4				
	<i>Krameria erecta</i>	25	1.2	0.1	0.2	2				
	<i>Encelia farinosa</i>	25	1.3	0.1	0.2	1				
Herb	<i>Sphaeralcea ambigua</i>	65	5.2	0.2	0.06	1				x
	<i>Cryptantha</i>	40	8.5	0.7	0.6	7.2				
	<i>Salsola</i>	40	8.1	0.4	0.11	5				
	<i>Bromus rubens</i>	40	3.3	0.2	0.2	1				
	<i>Eriogonum inflatum</i>	35	0.9	0.1	0.2	0.2				
	<i>Achnatherum hymenoides</i>	30	4.5	0.1	0.11	1				
	<i>Mentzelia</i>	30	3	0.1	0.4	0.4				
	<i>Plantago ovata</i>	25	1.5	0.1	0.2	1				
	<i>Dicoria canescens</i>	25	4.1	0.1	0.1	1.11				
	<i>Chaenactis fremontii</i>	25	1.6	0.1	0.2	1				
	<i>Antheropeas</i>	25	1.1	0.1	0.2	0.2				
	<i>Camissonia refracta</i>	25	0.8	0.1	0.2	0.2				
	<i>Cryptantha pterocarya</i>	25	0.9	0.1	0.2	0.2				
	<i>Schismus</i>	25	1	0.1	0.2	0.2				
Non-vasc										
	<i>Cryptogamic crust</i>	50	50	0.2	0.2	2				x

3. Desert & Semi-Desert Class

3.A.2. Warm Desert & Semi-Desert Scrub & Grassland Formation

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

M117. North American Warm Semi-Desert Cliff, Scree & Rock Vegetation Macrogroup

G569. North American Warm Semi-Desert Cliff, Scree & Pavement Sparse Vegetation Group

***Aloysia wrightii* - *Pericome caudata* - *Ephedra nevadensis* Sparsely Vegetated Bedrock Cliff & Lava Field Alliance**

Common Name: Sparsely Vegetated Bedrock Cliff & Lava Field

Group Assignment: G569; **Alliance Code:** A4025

Alliance Concept

Other stands in the North American Warm Semi-Desert Cliff, Scree & Pavement Sparse Vegetation Group occur as Sparsely Vegetated Rock Outcrops that contain sparse vegetation cover. The herbaceous, shrub layer and tree layers, if present, are sparse. Commonly associated are non-vascular plants including cryptogamic crust. The type is found primarily on midslopes to summits at all aspects. Elevations range from approximately 100 to 1100 meters. Soils are rocky, and derived from a variety of substrates including basalt, conglomerate, gneiss, and sedimentary (gypsum), and textures include sand and silty clay.

Diagnostic Criteria: This type is characterized by non-vascular plants of cryptogamic crust and lichen, and the steep rocky substrate particularly defines the type. The herbaceous cover ranges from 0 to 6 percent cover, and shrub cover ranges from 0 to 4 percent cover.

Alliance Distribution

The alliance occurs in all three park areas and was sampled in DEVA and LAKE at low to mid elevations.

States: CA, NV

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (5): 322Ab, 322Ad, 322At, 322Az

Park Sampling Zones: **DEVA:** Black Mtns, Green Water Rng/Vlly; **LAKE:** Boulder City, Gold Butte

Associations

Association Scientific Name	Sample Size	LAKE	DEVA	MOJA	Johnson
Sparsely vegetated rock outcrop	6	x	x		

Association Notes: None.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 608 m, Range 135 – 1102 m

Aspect: NE (1), NW (1), Flat, Variable (1), SW (1), W (2)

Slope: Mean 47 degrees, Range 27 – 62 degrees

Macro Topography: High level/summit (1), High slope (2), Midslope (2)

Tree Cover: Mean 0%, Range 0 – 0%

Shrub Cover: Mean 1.2%, Range 0 – 4%

Herb Cover: Mean 1.5%, Range 0 – 6%

Large Rock: Mean 73%, Range 0 – 96%

Small Rock: Mean 5.6%, Range 1 – 13%

Fines Cover: Mean 20.6%, Range 0 – 99%

Litter Cover: Mean 0.2%, Range 0 – 1%

Geology: basalt (1), conglomerate (2), gneiss (2), sedimentary (gypsum) (1)

Soil Texture: Sand (1), Silty clay (1)

Environment: The alliance occurs at low to mid elevations on midslopes to summits at all aspects. Soils are rocky, and derived from basalt, conglomerate, gneiss, and sedimentary (gypsum), and textures include sand and silty clay.

Vegetation Description

Vegetation Structure: The alliance forms a sparse to open herbaceous layer, and the overall herbaceous cover ranges from 0 to 6 percent cover. The tree layer, if present, is sparse, and the shrub layer is sparse to open. Non-vascular plants are variable and often sparse to open.

Vegetation Floristics: Commonly associated plants are non-vascular including cryptogamic crust and lichen.

Dynamics: The steep, rocky substrate defines the type with little to no vascular vegetation cover, and instead non-vascular plants are present and variable in cover.

Classification Comments

None.

Classification Confidence of Alliance: Low

Conservation Status Rank

Global: GNR

State (California): GNR

References

NatureServe 2015, VegCAMP and AIS 2013

Surveys (with Sample Sizes) Used in Description

MOJN: N=6

LAKE (n=3): LAKE9212, LAKE9285, LAKE9286

DEVA (n=3): DEVA0393, DEVA9385, MOJC0902

MOJA (n=0)

MOJN-Johnson (n=0)

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Shrub	<i>Agave utahensis</i>	33.3	2.46	0.1	0.2	0.2				
	<i>Ephedra nevadensis</i>	33.3	2.46	0.1	0.2	0.2				
	<i>Galium stellatum</i>	33.3	2.46	0.1	0.2	0.2				
	<i>Salvia mohavensis</i>	33.3	2.46	0.1	0.2	0.2				
Herb	<i>Bromus rubens</i>	33.3	12.5	0.7	1	3				
	<i>Erodium cicutarium</i>	33.3	5.741	0.4	0.2	2				
	<i>Achnatherum speciosum</i>	33.3	1.574	0.1	0.2	0.2				
	<i>Cirsium neomexicanum</i>	33.3	1.574	0.1	0.2	0.2				
	<i>Nicotiana obtusifolia</i>	33.3	1.574	0.1	0.2	0.2				
	<i>Sphaeralcea ambigua</i>	33.3	2.963	0.1	0.2	0.2				
Non-vasc										
	<i>Cryptogamic crust</i>	66.7	66.67	0.6	0.2	2				x

***Atriplex hymenelytra* Shrubland Alliance**

Common Name: Desert Holly Scrub

Group Assignment: G569, G300; **Alliance Code:** A0872

Alliance Concept

The Desert Holly Scrub Alliance forms a sparse to open shrub layer. The emergent tree layer, when present, is typically sparse and the herbaceous layer is sparse to open. The alliance is found on variety of landforms and aspects, including alkaline basins and mudhills, low-slope position desert pavement and washes, and skeletal volcanic and limestone slopes. Soils are derived from a variety of substrates including alluvium, rhyolite, sandstone, and limestone, and the soil texture is highly variable. Elevations range from approximately -77 to 1300 meters. *Atriplex hymenelytra* is dominant or co-dominant in the shrub layer, and those shrubs often present include *Ambrosia dumosa*, *Larrea tridentata* or *Tidestromia* sp. The herbaceous layer is variable, but *Eriogonum inflatum*, *Chorizanthe rigida*, *Cryptantha* spp., and *Plantago ovata* are sometimes present.

Diagnostic Criteria: This alliance is characterized by a sparse to open shrub layer with *Atriplex hymenelytra* dominant or co-dominant with shrubs such as *Ambrosia dumosa*, *Larrea tridentata* or *Tidestromia oblongifolia*. The overall shrub cover ranges from 0.5 to 30 percent.

Alliance Distribution

The alliance is well-defined in sampling at DEVA and the northern portion of LAKE, and represented by three plots in MOJA localized to the Seventeen Mile Point area near Devil's Playground. The alliance is typically found at low to mid elevations.

States: AZ, CA, NV

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (106): 322Ab, 322Ac, 322Ad, 322Ae, 322Af, 322Ai, 322Aj, 322Am, 322Ar, 322Av, 322Ay, 322Az; Southeastern Great Basin (18): 341Fc, 341Ff

Park Sampling Zones: **DEVA:** Black Mtns, CottonWood Mtns, Death Valley, Devil's Hole, East of Deadman Pass, Eureka Valley, Funeral Mtns, Grapevine Mtns, Green Water Rng/Vlly, Joshua Flat, Last Chance Range, Owlshead Mtns, Panamint Dunes, Panamint Mtns, Saline Valley; **LAKE:** Callville, Government Wash, Lakeshore, Temple Bar; **MOJA:** Cinder Cones, Cow Hole Mtns, Old Dad Mtns

Associations

Association Scientific Name [NVC Code]	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Atriplex hymenelytra</i> [CEGL001317]	31	x	x	x	
<i>Atriplex hymenelytra</i> (alliance)	2		x		
<i>Atriplex hymenelytra</i> Sparse	24	x	x		
<i>Atriplex hymenelytra</i> – <i>Ambrosia dumosa</i>	21	x	x		
<i>Atriplex hymenelytra</i> – <i>Tidestromia oblongifolia</i>	24		x		
<i>Atriplex hymenelytra</i> – <i>Larrea tridentata</i> [cf. CEGl001264]	24	x	x	x	

Association Notes: Four stands are classified at the alliance level, in which *Atriplex hymenelytra* occurs at low cover with various shrubs and herbs.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 440.3 m, Range -77 – 1274 m

Aspect: Flat, Variable (2), N (9), NE (11), E (11), NW (10), SE (10), SW (33), W (16), S (7), Flat (1)

Slope: Mean 11.5 degrees, Range 0 – 49 degrees

Macro Topography: Channel bed (1), Entire slope (4), High level/summit (6), High slope (4), Low level/bottom (7), Lowslope (15), Midslope (16), Toeslope (alluvial fan/bajada) (6)

Tree Cover: Mean 0%, Range 0 – 0.1%

Shrub Cover: Mean 5.8%, Range 0.5 – 30.3%

Herb Cover: Mean 2.9%, Range 0 – 20%

Large Rock: Mean 13.0%, Range 0 – 80%

Small Rock: Mean 66.0%, Range 2.5 – 100%

Fines Cover: Mean 16.3%, Range 0 – 96.6%

Litter Cover: Mean 1.1%, Range 0 – 11%

Geology: alluvium (43), basalt (2), conglomerate (6), granodiorite (1), gravel (1), limestone (5), rhyolite (15), sandstone (42), schist (1), sedimentary (gypsum) (6), tephrite (basanite) (2)

Soil Texture: Clay loam (5), Coarse loamy sand (5), Coarse sand (2), Fine silty clay (1), Loam (4), Loamy sand (6), Medium sand (8), Medium silt loam (1), Medium to very fine sandy loam (23), Moderately coarse sandy loam (1), Moderately fine clay loam (2), Moderately fine silty clay loam (3), Sand (6), Sandy clay (1), Sandy loam (11), Silt (1), Silty clay (4)

Environment: The alliance is found on variety of landforms and aspects, including alkaline basins and mudhills, low-slope position desert pavement and washes, and skeletal volcanic and

limestone slopes. Soils are derived from a variety of substrates including alluvium, rhyolite, sandstone, and limestone, and the soil texture is highly variable.

Vegetation Description

Vegetation Structure: The alliance forms a sparse to open shrub layer and the overall shrub cover ranges from 0.5 to 30 percent. The tree layer is typically sparse, if present, and the herb layer is sparse to open. Non-vascular plants are typically sparse to open.

Vegetation Floristics: *Atriplex hymenelytra* is dominant or co-dominant in the shrub layer, and those shrubs often present include *Ambrosia dumosa*, *Larrea tridentata* or *Tridestromia* sp. The herbaceous layer is variable, but *Eriogonum inflatum*, *Chorizanthe rigida*, *Cryptantha* spp., and *Plantago ovata* are sometimes present. The composition of other strata is variable.

Dynamics: *Atriplex hymenelytra* stands often occur on harsh upland sites and are floristically simple. Stands may fluctuate in shrub cover depending on moisture availability in successive years, with shrub die-off in series of drier years. Severe degradation of upland stands can result in sparse stands of *Atriplex hymenelytra* and/or *Tidestromia oblongifolia*, or a lack of shrub cover and ephemeral annual herb cover.

Classification Comments

Stands can vary spatially and temporally in shrub cover from trace (0.5%) to higher in cover (20%), depending on site-dependent moisture availability, natural disturbances, and annual rainfall fluctuations. They also can vary in having *Tidestromia oblongifolia* dominant with trace cover of *Atriplex hymenelytra*, or vice versa. The association-level classification takes this variation into consideration (instead of describing two or more different alliances). However, *Atriplex hymenelytra* associations have been placed within the Intermountain Shadscale - Saltbush Scrub (G300) and the North American Warm Semi-Desert Cliff, Scree & Pavement Sparse Vegetation (G569) groups in the revised NVC hierarchy. With further introspection of the NVC hierarchy, stands with low to trace cover are best placed in North American Warm Semi-Desert Cliff, Scree & Pavement Sparse Vegetation (G569) while stands with higher cover may better placed in Mojave-Sonoran Bajada & Valley Desert Scrub (G295), as compared to the cool semi-desert group (G300) that it has additionally been placed in the NVC. With G569 being nested now in the same division as G295, we have placed all stands in one group, G569.

Classification Confidence of Alliance: High

Conservation Status Rank

Global: G5

State (California): S4

References

Annable 1985, Evens and Hartman 2007, Evens et al. 2012, Keeler-Wolf and Thomas 2000, Root 1978, Sawyer et al. 2009, VegCAMP and AIS 2013

Surveys (with Sample Sizes) Used in Description

MOJN: N=124

LAKE (n=13): LAKE0183, LAKE0397, LAKE0628, LAKE0702, LAKE9125, LAKE9149, LAKE9352, LAKE9353, LAKE9357, LAKE9364, LAKE9388, LAKE9420, LAKE9629

DEVA (n=107): DEVA0128, DEVA0368, DEVA0395, DEVA0429, DEVA0501, DEVA0627, DEVA9183, DEVA9194, DEVA9284, DEVA9289, DEVA9332, DEVA9369, DEVA9383, DEVA9390, DEVA9391, DEVA9392, DEVA9394, DEVA9407, DEVA9428, DEVA9431, DEVA9460, DEVA9500, DEVA9517, DEVA9537, DEVA9602, DEVA9618, DEVA9965, DEVAD084, DEVAD094, DEVAD195, DEVAD196, DEVAD197, DEVAD202, DEVAD226, DEVAR003, DEVAR004, DEVAR030, DEVAR045, DEVAR049, DEVAR050, DEVAR053, DEVAR065, DEVAR079, DEVAR094, DEVAR109, DEVAS006, DEVAS007, DEVAS009, DEVAS010, DEVAS013, DEVAS016, DEVAS019, DEVAS037, DEVAS103, DEVAS115, DEVAS153, MOJC0374, MOJC0420, MOJC0499, MOJC0540, MOJC0541, MOJC0542, MOJC0543, MOJC0559, MOJC0560, MOJC0562, MOJC0564, MOJC0584, MOJC0585, MOJC0586, MOJC0588, MOJC0590, MOJC0591, MOJC0592, MOJC0662, MOJC0663, MOJC0665, MOJC0677, MOJC0689, MOJC0711, MOJC0712, MOJC0713, MOJC0740, MOJC0741, MOJC0742, MOJC0743, MOJC0744, MOJC0745, MOJC0746, MOJC0867, MOJC0868, MOJC0869, MOJC0875, MOJC0895, MOJC0896, MOJC0897, MOJC0898, MOJC0899, MOJC0900, MOJC0901, MOJC1086, MOJC1087, MOJC1088, MOJC1182, MOJC1183, MOJC1184, MOJC1185

MOJA (n=4): MOJA9183, MOJC0153, MOJC0154, MOJC0253

MOJN-Johnson (n=0)

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Shrub	<i>Atriplex hymenelytra</i>	100	54	2.6	0.11	20	x	x		
	<i>Larrea tridentata</i>	49.2	11	0.7	0.1	10				
	<i>Ambrosia dumosa</i>	47.6	9.9	0.7	0.11	10				
	<i>Tidestromia</i>	29.8	9.1	0.2	0.1	3				
Herb	<i>Eriogonum inflatum</i>	37.1	11	0.2	0.1	3				
	<i>Chorizanthe rigida</i>	31.5	5.4	0.1	0.1	2				
	<i>Cryptantha</i>	29.8	6.3	0.3	0.3	6.6				
	<i>Plantago ovata</i>	25.8	5.4	0.4	0.1	15				

***Chorizanthe rigida* – *Geraea canescens* Desert Pavement Sparsely Vegetated Alliance**

Common Name: Warm Semi-Desert Ephemeral Vegetated Pavement

Group Assignment: G569; **Alliance Code:** A4024

Alliance Concept

The Rigid Spineflower–Desert Gold Sunflower Desert Pavement Sparsely Vegetated Alliance forms a sparse to intermittent herbaceous layer. The shrub and tree layers are sparse. The alliance is found from basin floors to upper bajadas at all aspects, and they are often found on desert pavement and skeletal bajadas. Soils are derived from a variety of substrates and textures range from sand to sandy clay and silty clay. Elevations range from approximately -62 to 900 meters. Herbs are variable in presence and cover annually depending on rainfall and often include *Chorizanthe rigida*, *Cryptantha* spp. and *Geraea canescens*. Commonly associated emergent shrubs at sparse cover include *Larrea tridentata*.

Diagnostic Criteria: This alliance is characterized by a sparse to intermittent herbaceous layer with various herbs, including *Chorizanthe rigida*, *Geraea canescens*, and/or *Cryptantha* species, having variable cover. The overall herbaceous cover ranges from 0 to 52 percent cover.

Alliance Distribution

The alliance is well-defined in sampling at all three Parks. It is scattered throughout the valleys and bajadas in DEVA, MOJA and LAKE at low to mid elevations.

States: CA, NV

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (13): 322Ab, 322Ad, 322Af, 322Ai, 322Ay; Southeastern Great Basin (1): 341Fc

Park Sampling Zones: **DEVA:** Black Mtns, Death Valley, Eureka Valley, Owlshead Mtns;

LAKE: Government Wash; **MOJA:** Cow Hole Mtns

Associations

Association Scientific Name [NVC Code]	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Chorizanthe rigida</i> – <i>Geraea canescens</i> Desert Pavement [cf. CEPS009686]	14	x	x	x	

Association Notes: None.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 214.6 m, Range -62 – 900 m

Aspect: Flat, Variable (1), Flat, Variable (2), NE (1), NW (2), SW (2), W (1), SW (2), S (2)

Slope: Mean 5.3 degrees, Range 0 – 23 degrees

Macro Topography: Basin floor/wetland (2), Bottom to midslope (1), High level/summit (1), Low level/bottom (4), Lowslope (2), Midslope (1), Toeslope (alluvial fan/bajada) (3)

Tree Cover: Mean 0%, Range 0 – 0%

Shrub Cover: Mean 0.7%, Range 0 – 1.8%

Herb Cover: Mean 7.8%, Range 0 – 51.6%

Large Rock: Mean 12.8%, Range 0 – 98%

Small Rock: Mean 50.7%, Range 1 – 90.8%

Fines Cover: Mean 35.7%, Range 1 – 89.8%

Litter Cover: Mean 0.8%, Range 0 – 4%

Geology: alluvium (8), conglomerate (3), dune sand (1), rhyolite (1), sandstone (1)

Soil Texture: Loamy sand (3), Sand (5), Sandy clay (1), Sandy loam (1), Silty clay (1)

Environment: The alliance occurs primarily on valley floors and bottoms but can also be found on low and mid slopes at low to mid elevations and all aspects. It is often found on desert pavements and bajadas with skeletal soil. Soils range from sand to sandy clay and silty clay and are derived from a variety of substrates.

Vegetation Description

Vegetation Structure: The alliance forms a sparse to intermittent herbaceous layer, and the overall herbaceous cover ranges from 0 to 51.6 percent cover. The tree and shrub layers and non-vascular plants, if present, are sparse.

Vegetation Floristics: Herbs are variable in presence and cover annually and often include *Chorizanthe rigida*, *Cryptantha* spp. and *Geraea canescens*. The shrub layer is emergent, sparse, and often or sometimes includes *Larrea tridentata* or *Atriplex hymenelytra*.

Dynamics: The germination and abundance of *Chorizanthe rigida*, *Geraea canescens*, and related annual herbs vary among years depending on annual precipitation and temperature patterns. Their seeds can persist in seed banks for decades awaiting optimum fall and winter climate conditions. In El Niño years, their abundance can be substantial, covering desert pavement, bajadas, and hills in vibrant green and gold hues.

Classification Comments

None.

Classification Confidence of Alliance: Moderate

Conservation Status Rank

Global: G4?

State (California): S4?

References

Evens et al. 2012, Thomas et al. 2004, VegCAMP and AIS 2013

Surveys (with Sample Sizes) Used in Description

MOJN: N=14

LAKE (n=1): LAKE0188

DEVA (n=12): DEVA0178, DEVA0184, DEVA0381, DEVA9182, DEVA9291, DEVA9298, DEVA9447, DEVAD229, DEVAD230, DEVAS004, DEVAS008, DEVAS011

MOJA (n=1): MOJA9182

MOJN-Johnson (n=0)

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Shrub	<i>Larrea tridentata</i>	64	50	0.4	0.2	1				x
	<i>Atriplex hymenelytra</i>	29	18	0.1	0.1	1				
	<i>Tidestromia</i>	29	15	0.1	0.1	0.3				
Herb	<i>Chorizanthe rigida</i>	86	7	0.4	0.1	2	x			
	<i>Geraea canescens</i>	71	7.5	0.8	0.1	5				x
	<i>Cryptantha</i>	50	7.1	0.5	0.6	3				x
	<i>Schismus</i>	36	3.8	0.2	0.2	1				
	<i>Chaenactis</i>	29	8.5	3.3	0.4	40				
	<i>Camissonia</i>	29	3.8	0.2	0.4	2				

***Peucephyllum schottii* Shrubland Alliance**

Common Name: Schott's Pygmycedar Scrub

Group Assignment: G569; **Alliance Code:** A3143

Alliance Concept

The Schott's Pygmycedar Scrub Alliance forms a sparse to open shrub layer. The emergent tree layer is typically not present, and the herbaceous layer is sparse to open. The alliance is found primarily on steep slopes with exposed bedrock and drainage channel walls at various aspects. Soils are derived most commonly from basalt, limestone, sandstone, and calcareous gravel. Soil texture was highly variable ranging from sand to silt to clay loam. Elevations range from approximately 150 to 1300 meters. Dominant and characteristic shrubs include *Peucephyllum schottii*, and those that are often present include *Eriogonum fasciculatum*, *Eucnide urens*, *Pleurocoronis pluriseta*, and *Larrea tridentata*. Herbs that are sometimes present include *Bromus rubens*, *Cryptantha* spp., *Eriogonum inflatum*, *Sphaeralcea ambigua*, and *Nicotiana obtusifolia*.

Diagnostic Criteria: This alliance is characterized by a sparse to intermittent shrub layer of *Peucephyllum schottii* dominant or co-dominant, or sometimes with *Eucnide urens* and/or *Pleurocoronis pluriseta* (co-)dominant. The overall shrub cover ranges from 0.3 to 12 percent.

Alliance Distribution

The alliance is well-defined in sampling at MOJA and LAKE. It is scattered throughout MOJA and LAKE at low to mid elevations with one sample occurring at high elevation.

States: AZ, CA, NV

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (18): 322Ab, 322Ad, 322Am, 322Av, 322Ay, 322Az; Southeastern Great Basin (8): 341Fc, 341Fd, 341Ff

Park Sampling Zones: **DEVA:** Black Mtns, CottonWood Mtns, Grapevine Mtns, Green Water Rng/Vlly, Last Chance Range, Panamint Mtns; **LAKE:** Boulder City, Callville, Cottonwood Cove, Echo Bay, Government Wash, Katherine, Parashant, Temple Bar, Willow Beach

Associations

Association Scientific Name [NVC Code]	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Peucephyllum schottii</i> [CEPS009525]	8	x	x		
<i>Peucephyllum schottii</i> – <i>Eucnide urens</i> – <i>Pleurocoronis pluriseta</i>	18	x	x		

Association Notes: None.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 598 m, Range 168 – 1274 m

Aspect: N (7), NE (2), E (1), NW (5), SE (3), SW (2), S (4)

Slope: Mean 42.8 degrees, Range 3 – 90 degrees

Macro Topography: Backslope (3), Channel bed (4), Channel wall (5), High level/summit (1), High slope (3), Low level/bottom (1), Lowslope (1), Midslope (6), Toeslope (alluvial fan/bajada) (1)

Tree Cover: Mean 0%, Range 0 – 0%

Shrub Cover: Mean 5.5%, Range 0.3 – 12.2%

Herb Cover: Mean 2.3%, Range 0 – 10%

Large Rock: Mean 69.3%, Range 0 – 100%

Small Rock: Mean 26.2%, Range 0 – 92%

Fines Cover: Mean 3.2%, Range 0 – 20%

Litter Cover: Mean 0.9%, Range 0 – 6%

Geology: alkali-granite (alaskite) (1), alluvium (3), basalt (4), conglomerate (1), dolostone (dolomite) (2), gravel (3), limestone (2), rhyolite (1), sandstone (9)

Soil Texture: Clay loam (3), Loam (1), Loamy sand (1), Medium silt loam (1), Sand (2), Silt (1)

Environment: The alliance is found primarily on steep slopes with exposed bedrock and drainage channel walls at various aspects. Soils are derived most commonly from sandstone, but also a variety of other substrates including basalt, limestone, and gravel. Soil texture was highly variable ranging from sand to silt to clay loam. Elevations were typically low to mid, but there was one sample at high elevation.

Vegetation Description

Vegetation Structure: The Alliance forms a sparse to intermittent shrub layer and the overall shrub cover ranges from 0.3 to 12.2 percent. The tree layer is typically not present, and the herb layer is sparse to open. Non-vascular plants are typically sparse to open.

Vegetation Floristics: Dominant and characteristic shrubs include *Peucephyllum schottii*, and those that are often present include *Eriogonum fasciculatum*, *Eucnide urens*, *Pleurocoronis pluriseta*, and *Larrea tridentata*. Herbs that are sometimes present include *Bromus rubens*, *Cryptantha* spp., *Eriogonum inflatum*, *Sphaeralcea ambigua*, and *Nicotiana obtusifolia*.

Dynamics: Stands of *Peucephyllum schottii* and *Pleurocoronis pluriseta* prefer steep slopes with intermittent colluvial disturbance, washes with intermittent alluvial disturbance, and canyon walls above arroyo channels. The *Peucephyllum schottii*–*Eucnide urens*–*Pleurocoronis pluriseta* Association is often found on steep slopes and cliffs with calcareous parent material, while the

Peucephyllum schottii Association is often found on steep slopes, cliffs, and channel walls with basalt and sandstone parent material.

Classification Comments

This alliance is usually a fine-scale matrix type adjacent to stands of *Larrea tridentata*–*Ambrosia dumosa*, *Larrea tridentata*–*Encelia farinosa*, *Acacia greggii*, and *Hymenoclea salsola* Alliances and other related sparsely vegetated stands on cliffs and rockwalls. Stands are not clearly aligned with one NVC group and could be considered in lower elevation G295 Mojave-Sonoran Bajada & Valley Desert Scrub, G541 Warm Semi-Desert Shrub & Herb Dry Wash & Colluvial Slope, and G569 North American Warm Semi-Desert Cliff, Scree & Pavement Sparse Vegetation groups. Currently, we have placed associations of this alliance in G569 since most stands occur on steep rockwalls with sparse cover.

Classification Confidence of Alliance: High

Conservation Status Rank

Global: G3?

State (California): S3?

References

Evens et al. 2012, NatureServe 2010, NatureServe 2012, VegCAMP and AIS 2013

Surveys (with Sample Sizes) Used in Description

MOJN: N=26

LAKE (n=15): LAKE0703, LAKE9106, LAKE9116, LAKE9123, LAKE9139, LAKE9192, LAKE9215, LAKE9220, LAKE9223, LAKE9358, LAKE9409, LAKE9437, LAKE9438, LAKE9527, LAKE9627

DEVA (n=11): DEVA0386, DEVA9287, DEVA9472, DEVA9491, DEVA9823, DEVA9926, DEVAD061, DEVAD105, DEVAD227, DEVAS116, MOJC0925

MOJA (n=0)

MOJN-Johnson (n=0)

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Shrub	<i>Peucephyllum schottii</i>	92	27	1.6	0.1	5	x			
	<i>Larrea tridentata</i>	62	6.6	0.4	0.1	3				x
	<i>Eucnide urens</i>	62	11	0.3	0.1	2				x
	<i>Pleurocoronis pluriseta</i>	50	7.8	0.4	0.2	3				x
	<i>Eriogonum fasciculatum</i>	50	3.1	0.1	0.1	0.3				x
	<i>Encelia farinosa</i>	46	6.4	0.3	0.1	3				
	<i>Ambrosia dumosa</i>	42	3.5	0.2	0.1	2				
	<i>Hymenoclea salsola</i>	27	2.5	0.2	0.2	5				
	<i>Lepidium fremontii</i>	27	2.7	0.2	0.2	2				
Herb	<i>Bromus rubens</i>	42	8.4	0.5	0.2	8				
	<i>Cryptantha</i>	35	14	0.5	0.6	6				
	<i>Eriogonum inflatum</i>	35	6.7	0.1	0.11	0.2				
	<i>Sphaeralcea ambigua</i>	31	4.8	0.1	0.2	0.5				
	<i>Nicotiana obtusifolia</i>	31	4.8	0.1	0.2	0.5				

3. Desert & Semi-Desert Class

3.A.2. Warm Desert & Semi-Desert Scrub & Grassland Formation

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

M512. North American Warm Desert Ruderal Scrub & Grassland Macrogroup

G677. North American Warm Desert Ruderal Scrub & Grassland Group

***Brassica tournefortii* and Other Mustards Ruderal Herbaceous Alliance**

Common Name: Tournefort's Mustard and Other Ruderal Desert Forbs

Group Assignment: G677; **Alliance Code:** cf. A4166

Alliance Concept

The Tournefort's Mustard and Other Ruderal Desert Forbs Alliance form an open to intermittent herbaceous layer. The shrub layer is open and the tree layer, when present, is sparse. The alliance is found on low level bottoms, roadsides, sand dunes, lake shorelines, and washes at flat or variable aspects, typically in disturbed areas. Soils are sandy to clay loam derived from conglomerate. Elevation is from lake level (197 to) 895 meters. Dominant herbs include *Brassica tournefortii* or *Malcolmia africana*. Associated herbs in one stand sampled include *Antheropeas* spp., *Cryptantha* spp., *Erodium cicutarium*, *Gilia* spp., *Ipomopsis polycladon*, *Plantago ovata*, and *Schismus* spp., and associated emergent shrubs include *Gutierrezia sarothrae*.

Diagnostic Criteria: This alliance is characterized by an open herbaceous layer dominated by *Brassica tournefortii* or *Malcolmia africana*. In the stand sampled at LAKE, *M. africana* is dominant. The overall herbaceous cover is 22 percent cover.

Alliance Distribution

The alliance is localized in LAKE at mid elevation at the air strip near North Pierce Ferry Rd where it was sampled once in the study area. It also occurs at lower elevations along the lake shorelines, sand dunes, and washes in LAKE. It also has been observed in MOJA adjacent to roads in the southern portion of the park, including near Interstate 40 and Kelbaker Road.

States: AZ, (CA, NV)

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (1): 322Av

Park Sampling Zones: **LAKE:** (Callville, Echo Bay, Katherine) Pearce Ferry; **MOJA:** (Granite Mtns)

Associations

Association Scientific Name	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Malcolmia africana</i> Ruderal Herbaceous	1	x			

Association Notes: Stands with *Brassica tournefortii* also appear to occur in the warm deserts of California, Arizona and Nevada, especially adjacent to roads.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: 895 m

Aspect: Flat, Variable (1)

Slope: 0 degrees

Macro Topography: Low level/bottom (1)

Tree Cover: 0%

Shrub Cover: 2%

Herb Cover: 22%

Large Rock: 0%

Small Rock: 4%

Fines Cover: 96%

Litter Cover: 0%

Geology: conglomerate (1)

Soil Texture: Clay loam (1)

Environment: The alliance was sampled once at mid elevation in LAKE. A stand of *Malcolmia africana* occurs at the air strip near North Pierce Ferry Rd on the bottomland with a flat aspect. Soil is clay loam derived from conglomerate. *Brassica tournefortii* has established as a highly invasive plant at LAKE; occurring abundantly on sand dunes, shoreline beaches, and washes with sandy to gravelly soils (Newton 2012). Stands have been observed in MOJA with *Brassica tournefortii* dominant especially along roadsides and washes (J. Evens per. obs. 2009), and invasion of *Malcolmia africana* has recently been observed in DEVA along roadsides and road construction areas (J. Cipra, pers. com. 2013).

Stands of this alliance in the Mojave, Colorado, and Sonoran deserts are found in areas disturbed by fire, clearing, and roads. Recurrent disturbance magnifies the abundance of non-native mustards and other non-native annuals.

Vegetation Description

Vegetation Structure: The alliance forms an open herbaceous layer, and the overall herbaceous cover is 22 percent cover. The shrub layer is sparse to open. The tree layer and non-vascular plants, when present, are sparse.

Vegetation Floristics: Dominant herbs include *Brassica tournefortii* or *Malcolmia africana*, and characteristic herbs include *Antheropeas* spp., *Cryptantha* spp., *Erodium cicutarium*, *Gilia* spp., *Ipomopsis polycladon*, *Plantago ovata*, and *Schismus* spp. The shrub layer is emergent and typically or often includes *Gutierrezia sarothrae*.

Dynamics: *Malcolmia africana* dominates the herbaceous layer particularly in disturbed areas, and emergent shrubs and trees may be present at low cover. Highly localized stands occurs in LAKE, and individuals have been observed in DEVA. Stands with *Brassica tournefortii* are beginning to expand in desert areas of the southwest United States, including at MOJA and JOTR. Efforts to control and eradicate current extent are important for limiting the spread and impact of these non-native mustards in these desert parks. Some weed management treatments, including hand-pulling and herbicides, have been explored (Barrows et al. 2009, Newton 2012, Marushia 2009).

Classification Comments

Stands of non-native mustards have been observed both in the warm deserts of Arizona and California and in Mediterranean California. Stands of *Brassica nigra* and *Hirshfeldia incana* have particularly spread in Mediterranean California (Buck Diaz et al. 2012, Keeler-Wolf and Evens 2006), while *Brassica tournefortii* has begun to spread from the Coachella Valley and east of the San Bernarindo Mountains in California (Marushia 2009), and it has become locally abundant in the U.S. desert southwest (Minnich and Sanders 2000). More localized occurrences of *Malcomnia africana* have been observed, including the Mojave Desert. Further review of NVC groups may be necessary to determine the best placement of these stands since three groups of ruderal (semi-natural) herbaceous stands exist with related concepts: California Ruderal Grassland & Forb Meadow Group (G497), North American Warm Desert Ruderal Scrub & Grassland Group (G677), and Great Basin & Intermountain Ruderal Dry Shrubland & Grassland Group (G600).

Classification Confidence of Alliance: Low

Conservation Status Rank

Global: GNR

State (California): GNR

References

Buck-Diaz et al. 2012, Marushia 2009, Newton 2012, Sawyer et al. 2009, VegCAMP and AIS 2013

Surveys (with Sample Sizes) Used in Description

MOJN: N=1

LAKE (n=1): LAKE9424

DEVA (n=0)

MOJA (n=0)

MOJN-Johnson (n=0)

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Shrub										
	<i>Gutierrezia sarothrae</i>	100	100	2	2	2	x	x		
Herb										
	<i>Malcolmia africana</i>	100	87	20	20	20	x	x		
	<i>Schismus</i>	100	4.3	1	1	1	x			
	<i>Cryptantha</i>	100	2.6	0.6	0.6	0.6	x			
	<i>Gilia</i>	100	2.6	0.6	0.6	0.6	x			
	<i>Antheropeas</i>	100	0.9	0.2	0.2	0.2	x			
	<i>Erodium cicutarium</i>	100	0.9	0.2	0.2	0.2	x			
	<i>Ipomopsis polycladon</i>	100	0.9	0.2	0.2	0.2	x			
	<i>Plantago ovata</i>	100	0.9	0.2	0.2	0.2	x			

***Bromus rubens* - *Schismus arabicus* - *Schismus barbatus* Ruderal Herbaceous Alliance**

Common Name: Red Brome - Arabian Schismus - Common Mediterranean Grass Ruderal Grassland

Group Assignment: G677; **Alliance Code:** A4121

Alliance Concept

The Red Brome - Arabian Schismus - Common Mediterranean Grass Ruderal Grassland forms an open herbaceous layer. The shrub layer is open and the tree layer, when present, is sparse. The alliance is found primarily on low and midslopes at east to southwest aspects. Soils are derived from a variety of substrates and textures range from sand to clay loam. Elevations range from approximately 350 to 1400 meters. *Bromus rubens*, *Schismus arabicus*, *Schismus barbatus* and/or *Erodium cicutarium* are dominant in the herbaceous layer, and sometimes natives such as *Eriogonum deflexum* can be co-dominant. Herbs often present at low cover are *Chaenactis* spp., and *Cryptantha* spp. Commonly associated shrubs at sparse cover include *Larrea tridentata* and *Ambrosia dumosa*.

Diagnostic Criteria: This alliance is characterized by an open herbaceous layer with *Bromus rubens*, *Erodium cicutarium*, *Schismus arabicus*, and/or *Schismus barbatus* dominant. Sometimes *Eriogonum deflexum* can be co-dominant with one or more of these non-native erbs. The overall herbaceous cover ranges from 4 to 31 percent cover.

Alliance Distribution

The alliance occurs at all three Parks at low to upper elevations. The alliance was sampled in DEVA at mid elevations in the Greenwater Valley and east of the Grapevine Mountains at high elevations. It was sampled in MOJA at Henry's Spring at mid elevations. It was sampled in LAKE at low elevations on a road cut on Northshore Road and near the lake north of Echo Bay.

States: CA, NV

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (7): 322Ac, 322Ad, 322Aj, 322Ay, 322Az

Park Sampling Zones: **DEVA:** Green Water Rng/Vlly, Nevada Triangle; **LAKE:** Echo Bay, Gold Butte, Lakeshore; **MOJA:** Baker-Halloran

Associations

Association Scientific Name	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Bromus rubens</i> – <i>Erodium cicutarium</i> – <i>Chaenactis</i> spp.	3		x		
<i>Bromus rubens</i> – <i>Schismus (arabicus, barbatus)</i> (alliance) [cf. CEPS009691]	1			x	
<i>Schismus (arabicus, barbatus)</i> – <i>Eriogonum (deflexum)</i> Semi-natural	3	x			

Association Notes: One sample was classified to alliance level only in which *Bromus rubens* was co-dominant with *Schismus* spp.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 740 m, Range 367 – 1337 m
Aspect: E (1), SE (1), SW (2), S (1)
Slope: Mean 9.4 degrees, Range 2 – 21 degrees
Macro Topography: Lowslope (1), Midslope (4)

Tree Cover: Mean 0%, Range 0 – 0%
Shrub Cover: Mean 0.9%, Range 0 – 2.1%
Herb Cover: Mean 16.6%, Range 4 – 31%

Large Rock: Mean 1%, Range 0 – 3%
Small Rock: Mean 69.6%, Range 43 – 92%
Fines Cover: Mean 22.6%, Range 5– 40%
Litter Cover: Mean 6.8%, Range 0 – 25%

Geology: alluvium (3), rhyolite (1), sandstone (1), water (2)
Soil Texture: Clay loam (1), Loamy sand (1), Sand (1), Sandy loam (1)

Environment: The alliance was sampled at all three Parks. It occurs at most elevations, on low to midslopes with east to southwest aspects. It is found primarily in disturbed areas. Soils range from sand to clay loam and substrates are variable.

Vegetation Description

Vegetation Structure: The alliance forms an open herbaceous layer and the overall herbaceous cover ranges from 4 to 31 percent cover. The shrub layer is sparse to open. The tree layer and non-vascular plants, when present are sparse.

Vegetation Floristics: *Bromus rubens*, *Schismus arabicus*, *Schismus barbatus* and/or *Erodium cicutarium* are strongly dominant in the herbaceous layer, and sometimes natives such as *Eriogonum deflexum* can be co-dominant. Herbs often present at low cover are *Chaenactis* spp., and *Cryptantha* spp. Commonly associated shrubs at sparse cover include *Larrea tridentata* and *Ambrosia dumosa*.

Dynamics: Depending on the site history, *Bromus rubens*, *Erodium cicutarium*, and/or *Schismus* spp. can strongly dominate desert locales. The abundance of these species may be precipitation and temperature driven, and also disturbance driven. These species have Cal-IPC ratings of high, limited, and limited, respectively. When they invade desert and semi-desert stands, they can convert them to semi-natural grasslands especially in sites experiencing frequent and/or high intensity fires or in cleared and/or grazed areas.

Classification Comments

Stands with *Bromus rubens*, *Erodium cicutarium*, and *Schismus* spp. occur in the warm and cool deserts of California and Nevada and in Mediterranean California. Further review of the NVC groups may be necessary to determine the best placement for these stands since three groups of ruderal (semi-natural) herbaceous stands exist with related concepts: California Ruderal Grassland & Forb Meadow Group (G497), North American Warm Desert Ruderal Scrub & Grassland Group (G677), and Great Basin & Intermountain Ruderal Dry Shrubland & Grassland Group (G600).

Classification Confidence of Alliance: Moderate

Conservation Status Rank

Global: GNR

State (California): GNR

References

Buck-Diaz et al. 2012, cf. Evens and San 2006, Evens et al. 2012, cf. Klein and Evens 2005, Sawyer et al. 2009, VegCAMP and AIS 2013

Surveys (with Sample Sizes) Used in Description

MOJN: N=7

LAKE (n=3): ERVILCav, LAKE9701, LMJOA047

DEVA (n=3): DEVA0603, DEVA0604, DEVAS145

MOJA (n=1): MOJA9177

MOJN-Johnson (n=0)

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Shrub	<i>Larrea tridentata</i>	57.1	20	0.2	0.11	0.5				x
	<i>Ambrosia dumosa</i>	57.1	13	0.1	0.08	0.2				x
	<i>Tamarix ramosissima</i>	28.6	19	0.3	0.3	1.72				
	<i>Hymenoclea salsola</i>	28.6	7.9	0.1	0.2	0.2				
	<i>Stephanomeria pauciflora</i>	28.6	5.1	0	0.05	0.2				
Herb	<i>Bromus rubens</i>	71.4	24	6.8	0.2	20				x
	<i>Erodium cicutarium</i>	71.4	6.8	2.1	0.01	10				x
	<i>Schismus</i>	57.1	14	2.6	0.2	13				x
	<i>Chaenactis</i>	57.1	7	1.8	0.4	10				x
	<i>Cryptantha</i>	57.1	2.8	0.5	0.33	2.2				x
	<i>Eriogonum deflexum</i>	42.9	16	0.7	0.44	3.7				
	<i>Amsinckia</i>	42.9	1.9	0.5	0.2	2				
	<i>Sphaeralcea ambigua</i>	42.9	0.2	0	0.02	0.2				
	<i>Salsola</i>	28.6	3.3	0.3	0.92	1				
	<i>Eriogonum</i>	28.6	0.4	0.1	0.4	0.4				
	<i>Langloisia setosissima</i>	28.6	0.8	0.1	0.2	0.49				
	<i>Mentzelia</i>	28.6	0.3	0.1	0.22	0.4				
	<i>Dalea</i>	28.6	0.2	0.1	0.2	0.2				
	<i>Eschscholzia</i>	28.6	0.2	0.1	0.2	0.2				
	<i>Phacelia fremontii</i>	28.6	0.2	0.1	0.2	0.2				
	<i>Plantago ovata</i>	28.6	0.6	0	0.12	0.2				
	<i>Salvia columbariae</i>	28.6	0.2	0	0.11	0.2				
	<i>Camissonia brevipes</i>	28.6	0.6	0	0.1	0.2				
	<i>Cryptantha micrantha</i>	28.6	0.6	0	0.08	0.2				
	<i>Rafinesquia neomexicana</i>	28.6	0.1	0	0.06	0.2				
	<i>Chorizanthe brevicornu</i>	28.6	0.6	0	0.03	0.2				
	<i>Malacothrix glabrata</i>	28.6	0.6	0	0.01	0.2				

3. Desert & Semi-Desert Class

3.B.1. Cool Semi-Desert Scrub & Grassland Formation

3.B.1.Ne. Western North American Cool Semi-Desert Scrub & Grassland Division

M093. Great Basin Saltbush Scrub Macrogroup

G300. Intermountain Shadscale - Saltbush Scrub Group

***Atriplex canescens* Shrubland Alliance**

Common Name: Fourwing Saltbush Scrub

Group Assignment: G300, G559; **Alliance Code:** A0869, A3266

Alliance Concept

The Fourwing Saltbush Scrub Alliance forms an open to intermittent shrub layer. The emergent tree layer, when present, is typically sparse, when present, and the herbaceous layer is sparse to open. The alliance is found primarily on valley floors and dry washes at various aspects. Soils are derived from a variety of substrates including alluvium and sandstone, and textures include clay loam, sand and silt. Elevations range from approximately 0 to 2250 meters. *Atriplex canescens* is the dominant or co-dominant in the shrub canopy, and *Krascheninnikovia lanata* is often present. *Mentzelia albicaulis* and *Salsola spp.* are often present in the herbaceous layer.

Diagnostic Criteria: This alliance is characterized by an open to intermittent shrub layer with *Atriplex canescens* dominant or co-dominant with shrubs such as *Krascheninnikovia lanata*. The overall shrub cover ranges from 6 to 60 percent.

Alliance Distribution

The alliance is well-defined in sampling at DEVA and represented by two plots each in MOJA and LAKE. It is scattered throughout DEVA and is found in the northeast portion of MOJA and the northern portion of LAKE. The alliance occurs at low to high elevations.

States: CA, NV

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (5): 322Ab, 322Ai, 322Aj, 322Az, Southeastern Great Basin (13): 341Fb, 341Fc, 341Fe, 341Ff

Park Sampling Zones: **DEVA:** CottonWood Mtns, Death Valley, Joshua Flat, Last Chance Range, Nelson Range, Panamint Mtns; **LAKE:** Callville, Overton; **MOJA:** Baker-Halloran, Clark Mountain

Associations

Association Scientific Name [NVC Code]	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Atriplex canescens</i> [CEGL001281]	9		x	x	x
<i>Atriplex canescens</i> Desert Wash [CEGL003470]	3	x	x		
<i>Atriplex canescens</i> – <i>Krascheninnikovia lanata</i> [CEGL001285]	7		x		

Association Notes: None.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 1294 m, Range 33 – 2222 m

Aspect: Flat, Variable (7), N (2), E (1), SE (1), W (1), SW (1), S (4)

Slope: Mean 1.3 degrees, Range 0 – 5 degrees

Macro Topography: Basin floor/wetland (1), Channel bed (2), Low level/bottom (11),

Lowslope (2), Midslope (1), Toeslope (alluvial fan/bajada) (1)

Tree Cover: Mean 0%, Range 0 – 0.2%

Shrub Cover: Mean 14.0%, Range 6.2 – 60.2%

Herb Cover: Mean 5.0%, Range 0 – 23%

Large Rock: Mean 0.01%, Range 0 – 0.2%

Small Rock: Mean 19%, Range 0 – 69%

Fines Cover: Mean 74.1%, Range 25 – 98%

Litter Cover: Mean 6.6%, Range 1 – 31%

Geology: alluvium (9), conglomerate (1), landslide (2), rhyolite (1), sandstone (4),
sedimentary (gypsum) (1)

Soil Texture: Clay loam (1), Loamy sand (1), Sand (6), Sandy loam (3), Silt (1), Silt loam (1),
Silty clay (3)

Environment: The Four wing Saltbush Scrub Alliance occurs in dry washes and valley floors at low to high elevation. The alliance occurs at all aspects, in most soil textures, and in a variety of geologic conditions.

Vegetation Description

Vegetation Structure: The alliance forms an open to intermittent shrub layer and the overall shrub cover ranges from 6 to 60 percent. The tree layer, when present, is typically sparse, and the herb layer is sparse to open. Non-vascular plants are typically sparse.

Vegetation Floristics: *Atriplex canescens* is the dominant and characteristic shrub of this alliance, and *Kraschennikovia lanata* is often present. *Mentzelia albicaulis* and *Salsola spp.* are often present in the herbaceous layer.

Dynamics: *Atriplex canescens* is tolerant of alkaline, saline, and gypsum soils, often occurring around alkaline dry lake beds, adjacent sand dunes and low hills, and near alkaline springs. It is the most rapidly evolving shrub in North America with different ploidy levels, regional ecotypes, and infraspecific variation. Some varieties appear similar to other saltbush species and some are introgressing with other species.

Classification Comments

Atriplex canescens associations are placed within the Intermountain Shadscale - Saltbush Scrub (G300) and the Cool Semi-Desert Shrub & Herb Wash-Arroyo (G559) groups in the revised NVC hierarchy. For the Mojave Network classification we have combined the *Atriplex canescens* shrubland associations into one alliance in the G300 group.

Classification Confidence of Alliance: High

Conservation Status Rank

Global: G5

State (California): S4

References

Evens and Hartman 2007, Evens et al. 2012, Keeler-Wolf and Thomas 2000, Keeler-Wolf et al. 1998b, NatureServe 2012, Peterson 1984a, Sawyer et al. 2009, VegCAMP and AIS 2013

Surveys (with Sample Sizes) Used in Description

MOJN: N=19

LAKE (n=2): LAKE0124, LAKE9413

DEVA (n=14): DEVA0136, DEVA0228, DEVA9122, DEVA9153, DEVA9162, DEVA9231, DEVA9321, DEVA9322, DEVA9325, DEVA9331, DEVA9356, DEVA9906, DEVAD109, DEVAS014

MOJA (n=2): MOJA9139, MOJA9651

MOJN-Johnson (n=1): MOJJE509

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Shrub	<i>Atriplex canescens</i>	100	65	9.8	2	45	x	x		
	<i>Krascheninnikovia lanata</i>	61.1	8.7	1.3	0.2	10				x
	<i>Picrothamnus desertorum</i>	33.3	2.2	0.3	0.1	3				
Herb	<i>Mentzelia albicaulis</i>	55.6	3.6	0.2	0.1	2				x
	<i>Salsola</i>	50	8.1	0.2	0.2	2				x
	<i>Eriogonum deflexum</i>	44.4	8.6	0.3	0.2	3				
	<i>Achnatherum hymenoides</i>	44.4	2.9	0.2	0.2	1				
	<i>Chaenactis fremontii</i>	27.8	6	0.5	0.2	5				
	<i>Bromus rubens</i>	27.8	2.9	0.1	0.2	1				
	<i>Eriogonum nidularium</i>	27.8	1.2	0.1	0.1	0.2				
	<i>Sphaeralcea ambigua</i>	27.8	1.2	0.1	0.1	0.2				
Non-vascular										
	Cryptogamic crust	27.8	28	0.1	0.2	1				

***Atriplex confertifolia* Shrubland Alliance**

Common Name: Shadscale Scrub

Group Assignment: G300; **Alliance Code:** A0870

Alliance Concept

The Shadscale Scrub Alliance forms a sparse to intermittent shrub layer. The emergent tree layer, when present is typically sparse, and the herbaceous layer is sparse to open. The alliance is found everywhere from high slopes to canyon bottoms at all aspects. Soils are derived from a variety of substrates and include almost all soil textures. Elevations range from approximately 400 to 2200 meters. *Atriplex confertifolia* is dominant or co-dominant in the shrub layer, and *Lycium andersonii* is frequently present. *Eriogonum inflatum*, *Bromus rubens*, *Sphaeralcea ambigua* and *Xylorhiza tortifolia* are frequently present in the herbaceous layer.

Diagnostic Criteria: This alliance is characterized by a sparse to intermittent shrub layer with *Atriplex confertifolia* dominant or co-dominant. The overall shrub cover ranges from 0.25 to 48 percent.

Alliance Distribution

The alliance is extremely well-defined in sampling at DEVA, poorly defined at LAKE, and not documented in MOJA. It is distributed throughout DEVA at mid to high elevations, and is represented by three plots in the northern portion of LAKE at low elevation.

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (20): 322Ab, 322Ad, 322Ae, 322Az; Southeastern Great Basin (78): 341Fa, 341Fb, 341Fc, 341Fd, 341Fe, 341Ff, 341Fg

Park Sampling Zones: **DEVA:** Black Mtns, CottonWood Mtns, Funeral Mtns, Grapevine Mtns, Joshua Flat, Last Chance Range, Last Chance Vlly, Nelson Range, Nevada Triangle, Panamint Mtns; **LAKE:** Echo Bay

Associations

Association Scientific Name [NVC Code]	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Atriplex confertifolia</i> (alliance)	11		x		
<i>Atriplex confertifolia</i> Great Basin [CEGL001294]	5		x		
<i>Atriplex confertifolia</i> – <i>Ambrosia dumosa</i>	15		x		x
<i>Atriplex confertifolia</i> – <i>Atriplex canescens</i>	1		x		
<i>Atriplex confertifolia</i> – <i>Ephedra nevadensis</i> [CEGL001303]	14		x		
<i>Atriplex confertifolia</i> – <i>Krascheninnikovia lanata</i> [CEGL001301]	11		x		
<i>Atriplex confertifolia</i> – <i>Lepidium fremontii</i>	15		x		
<i>Atriplex confertifolia</i> – <i>Lycium andersonii</i> [CEGL001308]	25		x		
<i>Atriplex confertifolia</i> – <i>Picrothamnus desertorum</i> [CEGL001295]	1		x		
<i>Atriplex confertifolia</i> – <i>Suaeda moquinii</i>	3	x			

Association Notes: Eleven samples were classified to the alliance level only. Some of these samples had another shrub such as *Grayia spinosa* or *Larrea tridentata* co-dominating, suggesting further variation, but this variation is not adequately documented to denote additional associations.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 1413.3 m, Range 405 – 2162 m

Aspect: Flat, Variable (1), N (11), NE (9), E (9), NW (10), SE (17), Flat, Variable (1), W (8), SW (13), S (9)

Slope: Mean 16.5 degrees, Range 0 – 36 degrees

Macro Topography: Basin floor/wetland (1), Entire slope (1), High level/summit (2), High slope (15), Low level/bottom (4), Lowslope (3), Midslope (18), Toeslope (alluvial fan/bajada) (1)

Tree Cover: Mean 0.1%, Range 0 – 2%

Shrub Cover: Mean 12.2%, Range 0.4 – 47.6%

Herb Cover: Mean 6.0%, Range 0 – 17%

Large Rock: Mean 15.9%, Range 0 – 92%

Small Rock: Mean 63.8%, Range 0 – 100%

Fines Cover: Mean 13.3%, Range 0 – 98%

Litter Cover: Mean 1.6%, Range 0 – 9%

Geology: alluvium (15), dolostone (dolomite) (7), granodiorite (2), limestone (2), peraluminous granite (1), rhyolite (25), sandstone (40), shale (6)

Soil Texture: Clay (1), Clay loam (5), Fine sand (1), Loam (9), Loamy sand (7), Medium sand (2), Medium silt loam (6), Medium to very fine sandy loam (3), Moderately coarse sandy loam (1), Moderately fine clay loam (1), Moderately fine sandy clay loam (13), Moderately fine silty clay loam (5), Sand (3), Sandy loam (14), Silt loam (2), Silty clay (3)

Environment: The Shadscale Scrub Alliance occurs at low to high elevations at all aspects and landforms. The soils are variously derived, though often calcareous or volcanic, and encompass the majority of soil textures.

Vegetation Description

Vegetation Structure: The alliance forms an open to intermittent shrub layer and the overall shrub cover ranges from 0.25 to 48 percent. The tree layer is typically sparse, and the herb layer is sparse to open. Non-vascular plants are typically sparse to open.

Vegetation Floristics: *Atriplex confertifolia* is the dominant and characteristic shrub of this alliance and is often accompanied by *Lycium andersonii*. *Eriogonum inflatum*, *Bromus rubens*, *Sphaeralcea ambigua* *Xylorhiza tortifolia* are frequently present in the herbaceous layer.

Dynamics: *Atriplex confertifolia* exist in various settings including alkaline basins, across intermountain flats, and on rocky uplands. *A. confertifolia* has infraspecific variation, including different ploidy levels, which appears to enable plants to occupy a variety of ecological settings. Plants often prefer well-drained, moderately saline soils where groundwater is below the rooting zone, and they can occur in drier and colder sites than both *A. canescens* and *A. polycarpa*.

Classification Comments

None.

Classification Confidence of Alliance: High

Conservation Status Rank

Global: G5

State (California): S4

References

Annable 1985, Keeler-Wolf and Thomas 2000, MacMahon and Wagner 1985, McHargue 1973, NatureServe 2010, NatureServe 2012, Paysen et al. 1980, Peterson 1984a, Root 1978, Sawyer et al. 2009, VegCAMP and AIS 2013

Surveys (with Sample Sizes) Used in Description

MOJN: N=101

LAKE (n=3): LAKE9299, LMJOA038, LMJOA039

DEVA (n=97): DEVA0104, DEVA0200, DEVA0648, DEVA9117, DEVA9139, DEVA9143, DEVA9152, DEVA9171, DEVA9208, DEVA9225, DEVA9230, DEVA9240, DEVA9243, DEVA9256, DEVA9274, DEVA9315, DEVA9329, DEVA9330, DEVA9336, DEVA9355, DEVA9424, DEVA9439, DEVA9440, DEVA9488, DEVA9509, DEVA9520, DEVA9530, DEVA9547, DEVA9573, DEVA9608, DEVA9653, DEVA9657, DEVA9913, DEVAD076, DEVAD169, DEVAD187, DEVAR017, DEVAR028, DEVAR034, DEVAR071, DEVAR078, DEVAR091, DEVAR132, DEVAR135, DEVAS074, DEVAS081, DEVAS131, DEVAS169, DEVAS188, DEVAS204, DEVAS205, DEVAS229, MOJC0059, MOJC0060, MOJC0064, MOJC0171, MOJC0175, MOJC0177, MOJC0178, MOJC0180, MOJC0181, MOJC0257, MOJC0258, MOJC0259, MOJC0261, MOJC0334, MOJC0336, MOJC0360, MOJC0419, MOJC0447, MOJC0450, MOJC0451, MOJC0459, MOJC0460, MOJC0485, MOJC0486, MOJC0487, MOJC0492, MOJC0495, MOJC0496, MOJC0571, MOJC0595, MOJC0608, MOJC0609, MOJC0611, MOJC0618, MOJC0655, MOJC0690, MOJC0703, MOJC0704, MOJC0705, MOJC0706, MOJC0837, MOJC0838, MOJC0839, MOJC0972, MOJC0973

MOJA (n=0)

MOJN-Johnson (n=1): MOJJE615

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Shrub										
	<i>Atriplex confertifolia</i>	100	32	3.7	0.2	25	x		x	
	<i>Lycium andersonii</i>	55	6.1	0.7	0.2	5				x
	<i>Ambrosia dumosa</i>	47	7.1	0.9	0.11	20				
	<i>Ephedra nevadensis</i>	47	5.6	0.6	0.2	4				
	<i>Lepidium fremontii</i>	36	3.4	0.3	0.11	3				
	<i>Opuntia basilaris</i>	32	1.9	0.3	0.2	15				
	<i>Krascheninnikovia lanata</i>	31	3.4	0.4	0.2	4.5				
	<i>Echinocactus polycephalus</i>	31	1.5	0.2	0.1	3				
	<i>Larrea tridentata</i>	29	3.4	0.4	0.1	7				
	<i>Picrothamnus desertorum</i>	27	2.2	0.3	0.2	10				
	<i>Eriogonum fasciculatum</i>	27	2.1	0.3	0.11	5				
	<i>Acamptopappus shockleyi</i>	27	1.9	0.2	0.2	5				
	<i>Hymenoclea salsola</i>	26	2.1	0.3	0.1	6.5				
	<i>Psoralea arborescens</i>	25	1.8	0.2	0.11	3				
Herb										
	<i>Eriogonum inflatum</i>	71	12	0.4	0.1	3				x
	<i>Xylorhiza tortifolia</i>	53	7.7	0.3	0.11	3				x
	<i>Bromus rubens</i>	52	7.3	0.3	0.11	6				x
	<i>Sphaeralcea ambigua</i>	51	7.2	0.3	0.11	4				x
	<i>Achnatherum speciosum</i>	35	6	0.3	0.11	3				
	<i>Achnatherum hymenoides</i>	32	3.5	0.2	0.11	3				
Non-vasc										
	Cryptogamic crust	25	19	0.2	0.2	5				

***Atriplex polycarpa* Shrubland Alliance**

Common Name: Cattle Saltbush Shrubland

Group Assignment: G300; **Alliance Code:** A3174

Alliance Concept

The Cattle Saltbush Shrubland Alliance forms a sparse to intermittent shrub layer. The emergent tree layer, when present, is typically sparse, and the herbaceous layer is sparse to open. The alliance is found primarily in drainages, valley bottoms, alluvial fans, and slopes at all aspects. Soils are derived from a variety of substrates including alluvium and sandstone. Soil texture is highly variable. Elevations range from approximately -69 to 1500 meters. The dominant and characteristic shrub is *Atriplex polycarpa* in relatively simple shrubland stands, and those shrubs often present include *Larrea tridentata*. *Schismus* spp. is often present in the herbaceous layer.

Diagnostic Criteria: This alliance is characterized by a sparse to intermittent shrub layer with *Atriplex polycarpa* dominant. The overall shrub cover ranges from 2 to 42 percent.

Alliance Distribution

The alliance is well-defined in sampling at DEVA and the northern portion of MOJA. The alliance is represented by one sample at LAKE at low elevation. The plots are scattered throughout DEVA and northern MOJA at low to high elevation.

States: CA, NV

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (34); 322Ab, 322Ac, 322Ad, 322Ae, 322Af, 322Ai, 322Aj, 322Ak, 322At; Southeastern Great Basin (6): 341Fc

Park Sampling Zones: **DEVA:** Black Mtns, Death Valley, Eureka Valley, Funeral Mtns, Jail Canyon, Last Chance Vly, Owlshead Mtns, Saline Valley; **LAKE:** Gold Butte; **MOJA:** Baker, Baker-Halloran, Cima Dome NW, Cinder Cones, Clark Mtn West, Cow Hole Mtns, Crucero Hill, Ivanpah Vly

Associations

Association Scientific Name [NVC Code]	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Atriplex polycarpa</i> [CEGL001318]	41	x	x	x	x
<i>Atriplex polycarpa</i> (alliance)	2		x		

Association Notes: Two stands are classified at the alliance level include *Atriplex polycarpa* at trace cover along with *Larrea tridentata* and *Suaeda moquinii*.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 625.5 m, Range -69 – 1491 m
Aspect: Flat, Variable (5), Flat (2), N (4), NE (3), E (3), NW (4), SE (4), SW (11), S (4)
Slope: Mean 2.0 degrees, Range 0 – 12 degrees
Macro Topography: Channel bed (2), High level/summit (1), High slope (2), Low level/bottom (14), Lowslope (5), Midslope (8)

Tree Cover: Mean 0%, Range 0 – 1%
Shrub Cover: Mean 12.1%, Range 1.6 – 42.1%
Herb Cover: Mean 3.3%, Range 0 – 11%

Large Rock: Mean 0.5%, Range 0 – 9%
Small Rock: Mean 43.0%, Range 0 – 97%
Fines Cover: Mean 48%, Range 0 – 99%
Litter Cover: Mean 3.5%, Range 0 – 23%

Geology: alluvium (26), diorite (1), dune sand (3), felsic volcanic rock (1), granodiorite (1), rhyolite (1), sandstone (4), tephrite (basanite) (3)
Soil Texture: Clay (1), Clay loam (1), Coarse sand (1), Fine silty clay (1), Loam (4), Loamy sand (7), Medium silt (1), Medium to very fine sandy loam (1), Sand (9), Sandy clay (2), Sandy loam (2), Silt loam (3), Silty clay (1)

Environment: The alliance is found primarily in drainages, valley bottoms, alluvial fans, and slopes at all aspects. Soils are derived from a variety of substrates including alluvium and sandstone. The alliance occurs at low to high elevations.

Vegetation Description

Vegetation Structure: The alliance forms a sparse to intermittent shrub layer and the overall shrub cover ranges from 1.6 to 42 percent. The tree layer, when present, is typically sparse, and the herb layer is sparse to open. Non-vascular plants are typically sparse to open.

Vegetation Floristics: The dominant and characteristic shrub is *Atriplex polycarpa* in relatively simple shrubland stands, and those shrubs often present include *Larrea tridentata*. *Schismus* spp. is often present in the herbaceous layer.

Dynamics: Similar to other saltbush species, *Atriplex polycarpa* occurs in a variety of environmental settings from alkaline basins, wash terraces, and mudhills, to lava beds and lower foothill slopes. Sites are typically above the seasonal inundation zone of playas, where alliances with *Allenrolfea occidentalis* and *Suaeda moquinii* occur, and occur in drier areas with intermittent flooding or lower water tables.

Classification Comments

Stands of *Atriplex polycarpa* co-dominant with *Larrea tridentata* are classified in the *L. tridentata* alliance. Stands of this alliance typically have *A. polycarpa* dominant.

Classification Confidence of Alliance: High

Conservation Status Rank

Global: G5

State (California): S4

References

Keeler-Wolf and Thomas 2000, Peterson 1984a, Root 1978, Sawyer et al. 2009, VegCAMP and AIS 2013

Surveys (with Sample Sizes) Used in Description

MOJN: N=43

LAKE (n=1): LAKE0276

DEVA (n=22): DEVA0413, DEVA0515, DEVA0801, DEVA9180, DEVA9290, DEVA9316, DEVA9317, DEVA9374, DEVA9414, DEVA9415, DEVA9446, DEVA9502, DEVA9546, DEVA9626, DEVA9962, DEVAD022, DEVAD023, DEVAR027, DEVAR055, MOJC0038, MOJC0046, MOJC0055

MOJA (n=17): MOJA0106, MOJA0306, MOJA0603, MOJA9163, MOJA9181, MOJA9307, MOJA9345, MOJA9516, MOJA9528, MOJA9602, MOJA9605, MOJA9607, MOJA9645, MOJA9653, MOJC0022, MOJC0026, MOJC0864

MOJN-Johnson (n=3): MOJJE505, MOJJE506, MOJJE507

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Shrub	<i>Atriplex polycarpa</i>	100	72	9	0.5	40	x	x		
	<i>Larrea tridentata</i>	65	10	0.8	0.01	5				x
	<i>Ambrosia dumosa</i>	27.5	2.5	0.3	0.2	4				
	<i>Suaeda moquinii</i>	27.5	4.4	0.3	0.1	3.5				
Herb	<i>Schismus</i>	55	13	0.7	0.2	6				x
	<i>Cryptantha</i>	35	8.1	0.2	0.6	1.5				
	<i>Amsinckia</i>	35	2.7	0.1	0.2	1				
	<i>Camissonia</i>	32.5	4.8	0.2	0.4	1				
	<i>Bromus rubens</i>	30	4.2	0.3	0.2	3				
	<i>Chorizanthe rigida</i>	27.5	1.9	0.1	0.2	0.2				
	<i>Chaenactis</i>	25	2	0.1	0.4	0.4				

3. Desert & Semi-Desert Class

3.B.1. Cool Semi-Desert Scrub & Grassland Formation

3.B.1.Ne. Western North American Cool Semi-Desert Scrub & Grassland Division

M118. Intermountain Basins Cliff, Scree & Badland Sparse Vegetation Macrogroup

G570. Intermountain Basins Cliff, Scree & Badland Sparse Vegetation Group

***Ephedra* spp. - *Leymus salinus* - *Eriogonum corymbosum* Badlands Cold Desert Sparse Vegetation Alliance**

Common Name: Intermountain Shale Badlands Cold Desert

Group Assignment: G570, cf. G312; **Alliance Code:** A4052, cf. A2572

Alliance Concept

The Intermountain Shale Badlands Cold Desert Alliance forms a sparse to open shrub layer. The emergent tree layer, when present, is typically sparse, and the herbaceous layer is sparse to open. The alliance is found on rare gypsum rock outcrops. Stands are often small and occur at various aspects. The alliance generally grows on gypsum-derived soils that are sandy or loamy. Elevations range from approximately 400 to 900 meters. *Ephedra torreyana*, *Ephedra trifurca*, and/or *Psoralea fremontii* are characteristically present at sparse cover, and those shrubs often present include *Acacia greggii*, *Ambrosia dumosa*, *Atriplex confertifolia*, *Larrea tridentata*, *Lepidium fremontii*, and *Stephanomeria pauciflora*. Often present herbs include *Arctostaphylos californica*, *Enceliopsis argophylla*, *Eriogonum inflatum*, *Phacelia pulchella*, and *Schismus* spp. Cryptogamic crust is often the dominant or characteristic layer of non-vascular vegetation.

Diagnostic Criteria: This alliance is characterized by a sparse to open shrub layer typically with *Psoralea fremontii*, *Ephedra torreyana*, and/or *Ephedra trifurca* at sparse cover, and there is a sparse to continuous cover of cryptogamic crust. The overall shrub cover ranges from less than one to 8 percent.

Alliance Distribution

The alliance is well-defined in sampling at LAKE. It was not found at the other parks. It occurs at low to mid elevations.

States: AZ, NV

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (24): 322Am, 322At, 322Av, 322Az

Park Sampling Zones: LAKE: Callville, Callville Bay, Echo Bay, Frenchman Mountain, Overton, Overton Beach, Temple Bar, Willow Beach

Associations

Association Scientific Name [NVC Code]	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Ephedra torreyana</i> –(<i>Atriplex</i> spp.) / Non-vascular Gypsum Sparse [CEGL002349]	9	x			
<i>Psoralea fremontii</i> / Cryptogamic Crust (Gypsum)	15	x			

Association Notes: *Ephedra trifurca* Badlands Shrubland Association was mapped but not sampled in the area along the border area of Grand Canyon-Parashant National Monument and LAKE.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 535.8 m, Range 435 – 881 m

Aspect: Flat, Variable (1), N (1), NE (2), E (4), NW (1), SE (1), W (2), S (2)

Slope: Mean 9.1 degrees, Range 0 – 45 degrees

Macro Topography: High level/summit (5), High slope (2), Low level/bottom (5), Lowslope (4)

Tree Cover: Mean 0.1%, Range 0 – 1.1%

Shrub Cover: Mean 3.9%, Range 0.4 – 8.3%

Herb Cover: Mean 1.9%, Range 1 – 3.7%

Large Rock: Mean 7.9%, Range 0 – 50%

Small Rock: Mean 29.3%, Range 0 – 98%

Fines Cover: Mean 61.5%, Range 2 – 96%

Litter Cover: Mean 0.4%, Range 0 – 2%

Geology: gravel (1), sedimentary (gypsum) (23)

Soil Texture: Clay loam (1), Loamy sand (1), Sand (3), Sandy loam (1)

Environment: The alliance is found on gypsum rock outcrops at low to mid elevations. Sites include bottoms, lowslopes to hill summits with variable aspect. Soil textures vary from sand to clay loam.

Vegetation Description

Vegetation Structure: The alliance forms a sparse to open shrub layer and the overall shrub cover ranges from >1 to 8 percent. The tree layer is typically sparse, and the herb layer is sparse to open. Non-vascular plants are sparse to continuous.

Vegetation Floristics: *Psoralea fremontii*, *Ephedra torreyana*, and/or *Ephedra trifurca* are characteristically present at sparse cover, and those shrubs often present at sparse cover

include *Acacia greggii*, *Ambrosia dumosa*, *Atriplex confertifolia*, *Larrea tridentata*, *Lepidium fremontii*, and *Stephanomeria pauciflora*. Herbs often present include *Arctomecon californica*, *Enceliopsis argophylla*, *Eriogonum inflatum*, *Phacelia pulchella*, and *Schismus* spp. Cryptogamic crust is often the dominant or characteristic layer of non-vascular vegetation.

Dynamics: Stands occur on rare gypsum outcrops in LAKE that include uncommon and rare plants such as *Arctomecon californica* and *Enceliopsis argophylla*.

Classification Comments

This type is placed in a cool semi-desert formation and division within the NVC hierarchy because stands often occur outside of the Mojave Desert into the eastern and northern Colorado Plateau in Utah. The classification of the alliance level in the NVC is still under review, so the alliance name may change though the concept will stay the same. However, one association with *Ephedra torreyana* (e.g., *Ephedra torreyana* - (*Atriplex canescens*, *Atriplex confertifolia*) Sparse Vegetation Association) is currently placed in *Ephedra torreyana* Shrubland Alliance within Colorado Plateau Blackbrush - Mormon-tea Shrubland (G312) in the NVC hierarchy. This association is similar to the associations noted here for LAKE on sparsely vegetated gypsum sites, and review of this association's placement in the NVC is needed.

Classification Confidence of Alliance: Moderate

Conservation Status Rank

Global: G4?

State (California): G3?

References

cf. NatureServe 2012

Surveys (with Sample Sizes) Used in Description

MOJN: N=24

LAKE (n=24): ANLEV Fav, ARCAB Pav, ARCAG Bav, ARCAG Hav, ARCARDav, ARCASHav, ARCAV Fav, LAKE0109, LAKE0132, LAKE0196, LAKE0197, LAKE0294, LAKE0608, LAKE9185, LAKE9248, LAKE9253, LAKE9295, LAKE9313, LAKE9403, LAKE9511, LAKE9512, LAKE9515, LAKE9609, LAKE9610

DEVA (n=0)

MOJA (n=0)

MOJN-Johnson (n=0)

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Shrub	<i>Ephedra torreyana</i>	79.2	11	0.4	0.04	1	x			
	<i>Psoralea fremontii</i>	75	18	0.8	0.12	3	x			
	<i>Atriplex confertifolia</i>	58.3	8.6	0.4	0.06	1.26				x
	<i>Ambrosia dumosa</i>	58.3	8.2	0.3	0.2	1.18				x
	<i>Larrea tridentata</i>	54.2	8.8	0.3	0.1	4				x
	<i>Lepidium fremontii</i>	54.2	5.1	0.2	0.02	1				x
	<i>Acacia greggii</i>	50	4	0.2	0.08	1.68				x
	<i>Stephanomeria pauciflora</i>	50	2.2	0.1	0.04	0.46				x
	<i>Atriplex hymenelytra</i>	37.5	4.2	0.1	0.02	1				
	<i>Suaeda moquinii</i>	25	3.6	0.2	0.12	2				
	<i>Isocoma acradenia</i>	25	3	0.2	0.04	3				
	<i>Peucephyllum schottii</i>	25	5.2	0.1	0.04	1.84				
	<i>Petalonyx parryi</i>	25	1.4	0.1	0.2	0.38				
Herb	<i>Eriogonum inflatum</i>	70.8	7.6	0.2	0.2	0.52				x
	<i>Phacelia pulchella</i>	66.7	4.6	0.1	0.02	0.48				x
	<i>Schismus</i>	62.5	3.8	0.1	0.02	0.44				x
	<i>Arctomecon californica</i>	58.3	10	0.2	0.2	1.16				x
	<i>Enceliopsis argophylla</i>	58.3	12	0.2	0.04	1				x
	<i>Anulocaulis leiosolenus</i>	41.7	5	0.1	0.04	1.26				
	<i>Plantago ovata</i>	41.7	2.7	0.1	0.1	0.21				
	<i>Pleuraphis rigida</i>	41.7	2.7	0.1	0.02	0.44				
	<i>Bromus rubens</i>	41.7	2.2	0.1	0.02	0.25				
	<i>Eriogonum deflexum</i>	37.5	3.9	0.1	0.04	1				
	<i>Sphaeralcea ambigua</i>	37.5	2.7	0.1	0.1	0.26				
	<i>Cryptantha</i>	33.3	6.2	0.2	0.06	0.6				
	<i>Camissonia multijuga</i>	33.3	1.4	0	0.02	0.2				
	<i>Chorizanthe rigida</i>	29.2	1.9	0.1	0.02	0.2				
	<i>Camissonia brevipes</i>	29.2	0.6	0	0.02	0.2				
	<i>Camissonia</i>	25	2.3	0.1	0.04	0.4				
Non-vasc	Cryptogamic crust	70.8	70	17	0.2	70				x

3. Desert & Semi-Desert Class

3.B.1. Cool Semi-Desert Scrub & Grassland Formation

3.B.1.Ne. Western North American Cool Semi-Desert Scrub & Grassland Division

M171. Great Basin & Intermountain Dry Shrubland & Grassland Macrogroup

G296. Mojave Mid-Elevation Mixed Desert Scrub Group

***Coleogyne ramosissima* Mojave Desert Shrubland Alliance**

Common Name: Blackbrush Mojave Desert Shrubland

Group Assignment: G296, G312; **Alliance Code:** A3144, A3220

Alliance Concept

The Blackbrush Mojave Desert Shrubland Alliance forms an open to intermittent shrub layer. The emergent tree layer is typically sparse, and the herbaceous layer is sparse to intermittent. The alliance is found from toeslopes to summits at all aspects. Soils are derived from a variety of and textures are variable. Elevations range from approximately 750 to 2150 meters.

Coleogyne ramosissima is dominant or co-dominant in stands. Shrubs that are often present include *Ephedra nevadensis*, *Eriogonum fasciculatum*, *Lycium andersonii*, and *Thamnosma montana*. *Bromus rubens* is a characteristic herb and those often present are *Achnatherum speciosum* and *Sphaeralcea ambigua*.

Diagnostic Criteria: This alliance is characterized by an open to intermittent shrub layer with *Coleogyne ramosissima* dominant or co-dominant. The overall shrub cover ranges from 6 to 43 percent.

Alliance Distribution

The alliance is well-defined in sampling at all three Parks. It is scattered throughout the parks in mid to upper elevations.

States: AZ, CA, NV

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (69): 322Ad, 322Af, 322Ai, 322Aj, 322Ak, 322Al, 322Am, 322At, 322Av; Southeastern Great Basin (42): 341Fb, 341Fc, 341Ff

Park Sampling Zones: **DEVA:** Black Mtns, CottonWood Mtns, Funeral Mtns, Green Water Rng/Vlly, Joshua Flat, Last Chance Range, Nelson Range, Owlshead Mtns, Panamint Mtns; **LAKE:** Gold Butte, Juniper Mine, Pearce Ferry, Searchlight SE, Temple Bar, Willow Beach; **MOJA:** Cima Dome NW, Cima Dome SE, Clark Mountain, Clark Mtn, Clark Mtn West, Granite Mtns, Hackberry/Vontrigger, Ivanpah Mtns, Ivanpah Vly, Kelso Mtns, Mescal Range, Mid Hills, Mineral Hill, Providence Mtns, Vulcan Mine, Woods Mtns

Associations

Association Scientific Name [NVC Code]	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Coleogyne ramosissima</i> [CEGL001332]	46		x	x	x
<i>Coleogyne ramosissima</i> (alliance)	11		x	x	
<i>Coleogyne ramosissima</i> – <i>Ephedra</i> spp. Warm Desert [CEGL005297]	61		x	x	x
<i>Coleogyne ramosissima</i> – <i>Eriogonum fasciculatum</i> [CEGL001333]	38	x	x	x	x
<i>Coleogyne ramosissima</i> – <i>Larrea tridentata</i> [CEGL002717]	15	x	x	x	x
<i>Coleogyne ramosissima</i> – <i>Lycium andersonii</i>	16		x		x

Association Notes: None.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 1396.2 m, Range 772 – 2140 m

Aspect: Flat, Variable (2), N (25), NE (35), E (28), NW (15), WNW (1), SE (20), SW (25), W (9), S (13)

Slope: Mean 10.8 degrees, Range 0 – 90 degrees

Macro Topography: High level/summit (9), High slope (16), Lowslope (6), Midslope (29), Step in slope (1), Toeslope (alluvial fan/bajada) (3)

Tree Cover: Mean 0.1%, Range 0 – 1.5%

Shrub Cover: Mean 20.5%, Range 5.7 – 42.9%

Herb Cover: Mean 7.5%, Range 0 – 41.4%

Large Rock: Mean 10.1%, Range 0 – 85%

Small Rock: Mean 68%, Range 0 – 97.5%

Fines Cover: Mean 12.6%, Range 0 – 60%

Litter Cover: Mean 3.4%, Range 0 – 25%

Geology: alkali-granite (alaskite) (2), alluvium (25), conglomerate (1), dolostone (dolomite) (5), gneiss (4), granite (2), granodiorite (20), limestone (2), peraluminous granite (1), plutonic rock (phaneritic) (1), quartz monzonite (3), rhyolite (12), sand (1), sandstone (31), shale (1)

Soil Texture: Clay loam (11), Coarse loamy sand (7), Coarse sand (1), Fine silty clay (2), Loam (3), Loamy sand (3), Medium loam (2), Medium silt loam (4), Medium to very fine sandy loam (5), Moderately coarse loamy sand (1), Moderately fine clay loam (1), Moderately fine sandy clay loam (4), Moderately fine silty clay loam (2), Sand (2), Sandy clay (5), Sandy loam (25), Silt loam (1), Silty clay (3)

Environment: The alliance occurs at mid to high elevations from toeslopes to summits and at all aspects. It primarily occurs on areas with shallow soils and abundant exposed bedrock. Soil textures are variable and are derived from a variety of substrates.

Vegetation Description

Vegetation Structure: The Alliance forms an open to intermittent shrub layer and the overall shrub cover ranges from 5.7 to 42.9 percent. The tree layer is typically sparse, and the herb layer is sparse to intermittent. Non-vascular plants are typically sparse to open.

Vegetation Floristics: *Coleogyne ramosissima* is dominant or co-dominant in the shrub layer. Shrubs that are often present include *Ephedra nevadensis*, *Eriogonum fasciculatum*, *Lycium andersonii*, and *Thamnosma montana*. *Bromus rubens* is a characteristic herb and those often present are *Achnatherum speciosum* and *Sphaeralcea ambigua*.

Dynamics: *Coleogyne ramosissima* is sensitive to fire and slowly returns as a dominant to shrublands once burned. Fire spreads quickly and easily in closely spaced stands, and fire in stands with cover of non-native annual grasses are of significant threat to this alliance.

Classification Comments

Associations with *Coleogyne ramosissima* dominant or codominant are currently placed in two Groups in the NVC hierarchy: Mojave Mid-Elevation Mixed Desert Scrub Group (G296) and Colorado Plateau Blackbrush - Mormon-tea Shrubland Group (G312). Similarities between these two groups and related alliances/associations need further review by the NVC hierarchy working group. For the Mojave Network classification we have combined these associations into one alliance description in the G296 group.

Classification Confidence of Alliance: High

Conservation Status Rank

Global: G5

State (California): S4

References

Annable 1985, Evens et al. 2012, Keeler-Wolf and Thomas 2000, NatureServe 2010, NatureServe 2012, Peterson 1984a, Root 1978, Sawyer et al. 2009, Shiflet 1994, Spolsky 1979, VegCAMP and AIS 2013

Surveys (with Sample Sizes) Used in Description

MOJN: N=187

LAKE (n=11): LAKE0271, LAKE0284, LAKE9112, LAKE9153, LAKE9176, LAKE9710, LAMEN040, LAMEN085, LAMEN087, LAMEN088, LAMEN110

DEVA (n=69): DEVA0113, DEVA9101, DEVA9148, DEVA9174, DEVA9176, DEVA9195, DEVA9197, DEVA9207, DEVA9261, DEVA9351, DEVA9354, DEVA9361, DEVA9370, DEVA9371, DEVA9376, DEVA9377, DEVA9378, DEVA9398, DEVA9400, DEVA9402, DEVA9403, DEVA9458, DEVA9504, DEVA9506, DEVA9609, DEVA9612, DEVAD118, DEVAD123, DEVAR036, DEVAR062, DEVAR082, DEVAR107, DEVAR117, DEVAR125, DEVAR126, DEVAR140, DEVAR148, DEVAS055, DEVAS119, DEVAS127, DEVAS141, DEVAS203, DEVAS213, DEVAS228, MOJC0330, MOJC0331, MOJC0332, MOJC0333, MOJC0338, MOJC0339, MOJC0340, MOJC0341, MOJC0359, MOJC0448, MOJC0449, MOJC0453, MOJC0454, MOJC0465, MOJC0472, MOJC0473, MOJC0474, MOJC0610, MOJC0612, MOJC0635, MOJC0963, MOJC0964, MOJC0965, MOJC0992, MOJC0994

MOJA (n=33): MOJA0102, MOJA0257, MOJA0323, MOJA0444, MOJA0454, MOJA0503, MOJA0505, MOJA9137, MOJA9218, MOJA9236, MOJA9288, MOJA9342, MOJA9344, MOJA9347, MOJA9381, MOJA9389, MOJA9417, MOJA9447, MOJA9448, MOJA9519, MOJA9597, MOJA9609, MOJA9674, MOJA9689, MOJAJC03, MOJAJC04, MOJC0268, MOJC0948, MOJC0980, MOJC1075, MOJC1109, MOJC1147, MOJC1149

MOJN-Johnson (n=74): MOJJE002, MOJJE004, MOJJE008, MOJJE010, MOJJE011, MOJJE018, MOJJE023, MOJJE025, MOJJE026, MOJJE061, MOJJE082, MOJJE084, MOJJE088, MOJJE126, MOJJE133, MOJJE135, MOJJE136, MOJJE146, MOJJE152, MOJJE156, MOJJE164, MOJJE194, MOJJE195, MOJJE207, MOJJE372, MOJJE407, MOJJE421, MOJJE422, MOJJE444, MOJJE455, MOJJE510, MOJJE512, MOJJE527, MOJJE618, MOJJE619, MOJJE620, MOJJE621, MOJJE622, MOJJE623, MOJJE638, MOJJE639, MOJJE647, MOJJE653, MOJJE654, MOJJE656, MOJJE705, MOJJE738, MOJJE739, MOJJE753, MOJJE757, MOJJE758, MOJJE772, MOJJE820, MOJJE822, MOJJE823, MOJJE824, MOJJE825, MOJJE835, MOJJE836, MOJJE837, MOJJE838, MOJJE842, MOJJE850, MOJJE851, MOJJE855, MOJJE861, MOJJE885, MOJJE898, MOJJE902, MOJJE904, MOJJE905, MOJJE906, MOJJE929, MOJJE930

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Shrub	<i>Coleogyne ramosissima</i>	100	41	8.6	0.5	35.3	x		x	
	<i>Ephedra nevadensis</i>	70.8	5.3	1	0.2	4				x
	<i>Eriogonum fasciculatum</i>	65.5	3.4	0.6	0.11	3				x
	<i>Thamnosma montana</i>	55.8	1.7	0.3	0.05	8				x
	<i>Lycium andersonii</i>	53.1	3.5	0.6	0.11	5.5				x
	<i>Hymenoclea salsola</i>	44.2	2.2	0.5	0.2	10				
	<i>Larrea tridentata</i>	37.2	3.6	0.6	0.2	6				
	<i>Grayia spinosa</i>	33.6	2.7	0.5	0.2	5				
	<i>Krascheninnikovia lanata</i>	31	1.2	0.2	0.1	4				
	<i>Ephedra viridis</i>	28.3	1.8	0.3	0.2	3				
	<i>Yucca schidigera</i>	27.4	2.1	0.4	0.2	3				
	<i>Salazaria mexicana</i>	27.4	1.5	0.3	0.13	4.5				
	<i>Ambrosia dumosa</i>	27.4	1.7	0.3	0.04	4				
	<i>Echinocereus engelmannii</i>	26.5	0.5	0.1	0.1	1				
	<i>Stephanomeria pauciflora</i>	25.7	0.4	0.1	0.05	0.5				
Herb	<i>Bromus rubens</i>	76.1	22	1.7	0.11	35	x			
	<i>Achnatherum speciosum</i>	62.8	10	0.4	0.02	5				x
	<i>Sphaeralcea ambigua</i>	50.4	3.9	0.2	0.04	3				x
	<i>Erodium cicutarium</i>	38.9	5.7	0.4	0.11	8				
	<i>Amsinckia</i>	35.4	3	0.2	0.11	2				
	<i>Xylorhiza tortifolia</i>	31	4.3	0.1	0.06	3				
	<i>Eriogonum inflatum</i>	25.7	2.3	0.1	0.13	3				
Non-vasc	Cryptogamic crust	31	22	0.3	0.2	8				

***Eriogonum fasciculatum* - *Viguiera parishii* Shrubland Alliance**

Common Name: Eastern Mojave Buckwheat–Parish's Goldeneye Scrub

Group Assignment: G296; **Alliance Code:** A3150, cf. A3144

Alliance Concept

The Eastern Mojave Buckwheat–Parish's Goldeneye Scrub Alliance forms an open to intermittent shrub layer. The emergent tree layer is typically sparse to open, and the herbaceous layer is sparse to continuous. The alliance is found on a variety of landforms from drainage channels to mid-elevation slopes to ridges at various aspects. Soils are derived from a variety of substrates including alkali-granite (alaskite), granodiorite, and rhyolite and textures vary greatly and include clay loam, sand, and silt loam. Elevations range from approximately 450 to 1900 meters. Dominant and characteristic shrubs include *Eriogonum fasciculatum* and/or *Viguiera parishii*, and those that are often present include *Ephedra nevadensis* and *Stephanomeria pauciflora*. *Achnatherum speciosum*, *Bromus rubens*, and *Sphaeralcea ambigua* are often present in the herbaceous layer.

Diagnostic Criteria: This alliance is characterized by an open to intermittent shrub layer with *Eriogonum fasciculatum* and/or *Viguiera parishii* dominant or co-dominant. If *Yucca schidigera* is present, then its cover is less than two times (2x) the (combined) cover of the diagnostic shrub(s) of this alliance. The overall shrub cover ranges from 4 to 55 percent.

Alliance Distribution

The alliance is well-defined in sampling at all three Parks. It is scattered throughout the parks in low to high elevations.

States: AZ, CA, NV

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (95): 322Ac, 322Ad, 322Ae, 322Af, 322Aj, 322Ak, 322Al, 322Am, 322At, 322Av, 322Ay, 322Az; Southeastern Great Basin (19): 341Fa, 341Fb, 341Fc, 341Fd, 341Ff

Park Sampling Zones: **DEVA:** Black Mtns, CottonWood Mtns, Funeral Mtns, Grapevine Mtns, Green Water Rng/Vlly, Joshua Flat, Last Chance Range, Nelson Range, Owlshead Mtns, Panamint Mtns, Saline Valley; **LAKE:** Boulder City, Bridge Canyon, Cottonwood Cove, Gold Butte, Juniper Mine, Katherine, Pearce Ferry, Temple Bar, Willow Beach; **MOJA:** Cinder Cones, Clipper Vly, Fenner Vly, Granite Mtns, HackberryVotrigger, Ivanpah Mtns, Kelso-Cima, Lanfair Vly, Marl Mtns, Mid Hills, New York Mtns, Piute Range, Providence Mtns, Signal Hill, Van Winkle Mtn, West of Juniper Mine, Woods Mtns

Associations

Association Scientific Name [NVC Code]	Sample Size	LAKE	DEVA	MOJA	Johnson
Eriogonum fasciculatum (wash)	8		x	x	x
Eriogonum fasciculatum rock outcrop [CEGL001260]	34	x	x	x	x
Eriogonum fasciculatum–Ericameria (laricifolia, linearifolia)	38		x	x	x
Viguiera parishii [CEGL002721]	15	x		x	x
Viguiera parishii–Eriogonum fasciculatum	42	x		x	x

Association Notes: None.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 1157.9 m, Range 498 – 1889 m

Aspect: N (24), NE (13), E (20), NW (13), SE (16), SW (22), W (8), S (12)

Slope: Mean 17.6 degrees, Range 0 – 40 degrees

Macro Topography: Channel bed (3), High level/summit (6), High slope (21), Low level/bottom (1), Lowslope (9), Midslope (31), Toeslope (alluvial fan/bajada) (3)

Tree Cover: Mean 0.1%, Range 0 – 3.4%

Shrub Cover: Mean 17.1%, Range 4.3 – 55.4%

Herb Cover: Mean 8.9%, Range 0 – 89.8%

Large Rock: Mean 25.5%, Range 0 – 90%

Small Rock: Mean 61.6%, Range 0 – 97.5%

Fines Cover: Mean 7.3%, Range 0 – 50%

Litter Cover: Mean 2.3%, Range 0 – 11%

Geology: alkali-granite (alaskite) (22), alluvium (13), basalt (4), conglomerate (1) dacite (1), gneiss (11), granite (5), granodiorite (16), rhyolite (25), sandstone (14), schist (1), shale (1)

Soil Texture: Clay (1), Clay loam (13), Coarse loamy sand (1), Coarse sand (1), Fine sand (1), Fine silty clay (1), Loam (1), Loamy sand (13), Medium sand (7), Medium to very fine sandy loam (2), Moderately coarse loamy sand (2), Moderately fine sandy clay loam (1), Moderately fine silty clay loam (4), Sand (4), Sandy clay (5), Sandy loam (19), Silt loam (1), Silty clay (1)

Environment: The alliance is found on a variety of landforms from drainage channels to mid-elevation slopes to ridges at various aspects. Soils are derived from a variety of substrates including alkali-granite (alaskite), granodiorite, and rhyolite and textures vary greatly and include clay loam, sand, and silt loam. Elevations range from low to high.

Vegetation Description

Vegetation Structure: The Alliance forms an open to intermittent shrub layer and the overall shrub cover ranges from 4 to 55 percent. The tree layer is typically sparse to open, and the herb layer is sparse to continuous. Non-vascular plants are typically sparse to open.

Vegetation Floristics: *Eriogonum fasciculatum* and/or *Viguiera parishii* is dominant or co-dominant in the shrub layer, and those shrubs often present include *Ephedra nevadensis* and *Stephanomeria pauciflora*. *Achnatherum speciosum*, *Bromus rubens*, and *Sphaeralcea ambigua* are often present in the herbaceous layer.

Dynamics: *Eriogonum fasciculatum* occurs commonly in mid-elevations of the Mojave Desert and in the Colorado and Sonoran deserts with a suite of desert species, including *Ambrosia dumosa*, *Ericameria* spp., *Viguiera parishii*, and *Yucca schidigera*. *Eriogonum fasciculatum* has broad ecological tolerances as a species with multiple subspecies recognized that occur in different ecoregions from the Central and South Coast of California to the Colorado, Sonoran, and Mojave deserts.

Classification Comments

This alliance was previously named as *Viguiera parishii* Shrubland Alliance (cf. Thomas et al. 2004, Keeler-Wolf et al. 2005). With further data collection and analysis in the region, we have redefined the alliance to include stands that have *Eriogonum fasciculatum* and/or *Viguiera parishii* dominant or co-dominant. *E. fasciculatum* also occurs with a variety of drought-deciduous shrubs in coastal scrub in southwestern to central California, in which a different alliance is defined based on its varied floristics and environmental settings. Stand of this alliance are often found intermixed with other semi-desert alliances in the Mojave Mid-elevation Mixed Desert Scrub Group (G296).

Additionally, the revised NVC hierarchy has placed desert stands with *Eriogonum fasciculatum* and/or *Viguiera parishii* dominant within two groups: Sonoran Paloverde - Mixed Cacti Desert Scrub (G293) and Mojave Mid-Elevation Mixed Desert Scrub (G296). For this Mojave Desert Network classification, we have placed all of their related associations within one group (G296) and one alliance, since they are typically found at mid to upper elevations with other alliances.

Classification Confidence of Alliance: High

Conservation Status Rank

Global: G4

State (California): S4

References

Evens and San 2005, Evens et al. 2012, Keeler-Wolf and Thomas 2000, Keeler-Wolf et al. 1998b, NatureServe 2012, cf. Sawyer et al. 2009, Thomas et al. 2004, cf. VegCAMP and AIS 2013

Surveys (with Sample Sizes) Used in Description

MOJN: N=137

LAKE (n=40): LAKE0115, LAKE0121, LAKE0229, LAKE0272, LAKE0398, LAKE0432, LAKE0521, LAKE0529, LAKE9246, LAKE9259, LAKE9282, LAKE9327, LAKE9343, LAKE9345, LAKE9374, LAKE9517, LAKE9519, LAKE9523, LAKE9532, LAMEN042, LAMEN043, LAMEN044, LAMEN045, LAMEN049, LAMEN050, LAMEN062, LAMEN064, LAMEN077, LAMEN078, LAMEN091, LAMEN092, LAMEN093, LAMEN101, LAMEN105, LAMEN106, LAMEN107, LMJOA049, LMJOA050, LMJOA051, LMJOA055

DEVA (n=30): DEVA0102, DEVA0306, DEVA0342, DEVA0474, DEVA9107, DEVA9198, DEVA9218, DEVA9268, DEVA9296, DEVA9302, DEVA9305, DEVA9363, DEVA9404, DEVA9464, DEVA9475, DEVA9476, DEVA9482, DEVA9487, DEVA9489, DEVA9490, DEVA9523, DEVA9555, DEVA9638, DEVA9911, DEVA9923, DEVA9924, DEVAS042, DEVAS094, DEVAS134, MOJC0634

MOJA (n=45): MOJA0311, MOJA0571, MOJA0696, MOJA9180, MOJA9210, MOJA9211, MOJA9212, MOJA9283, MOJA9290, MOJA9319, MOJA9320, MOJA9367, MOJA9380, MOJA9391, MOJA9404, MOJA9427, MOJA9451, MOJA9535, MOJA9635, MOJA9637, MOJA9675, MOJA9687, MOJA9688, MOJA9902, MOJA9913, MOJAE081, MOJAE084, MOJAE085, MOJAE086, MOJAE087, MOJAE088, MOJAE093, MOJAE205, MOJAN002, MOJC0095, MOJC0190, MOJC0206, MOJC0208, MOJC0214, MOJC0215, MOJC0242, MOJC0252, MOJC0267, MOJC1175, MOJC1221

MOJN-Johnson (n=22): MOJJE030, MOJJE042, MOJJE048, MOJJE056, MOJJE096, MOJJE106, MOJJE109, MOJJE113, MOJJE117, MOJJE120, MOJJE140, MOJJE176, MOJJE249, MOJJE297, MOJJE414, MOJJE423, MOJJE533, MOJJE568, MOJJE603, MOJJE736, MOJJE882, MOJJE895

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Shrub										
	<i>Eriogonum fasciculatum</i>	99.1	26	3.4	0.2	10	x			
	<i>Viguiera parishii</i>	59.1	11	1.6	0.12	10				x
	<i>Ephedra nevadensis</i>	56.5	4.3	0.6	0.04	5				x
	<i>Stephanomeria pauciflora</i>	52.2	1.4	0.2	0.04	1.1				x
	<i>Larrea tridentata</i>	48.7	4	0.5	0.2	4				
	<i>Yucca schidigera</i>	46.1	2.7	0.4	0.1	4.2				
	<i>Ambrosia dumosa</i>	44.3	4.5	0.6	0.2	5				
	<i>Acacia greggii</i>	44.3	3	0.5	0.2	4.6				
	<i>Cylindropuntia acanthocarpa</i>	40.9	2.5	0.4	0.01	4.5				
	<i>Krameria erecta</i>	38.3	1.2	0.2	0.07	2				
	<i>Ferocactus cylindraceus</i>	36.5	1.4	0.2	0.01	3				
	<i>Ephedra viridis</i>	31.3	2.6	0.3	0.11	3				
	<i>Opuntia basilaris</i>	31.3	0.5	0.1	0.01	0.5				
	<i>Salazaria mexicana</i>	30.4	1.8	0.3	0.08	13				
	<i>Echinocereus engelmannii</i>	29.6	0.5	0.1	0.12	0.5				
	<i>Ericameria laricifolia</i>	27	5.1	0.6	0.02	5				
	<i>Thamnosma montana</i>	25.2	0.6	0.1	0.11	1				
Herb										
	<i>Bromus rubens</i>	60	18	1.6	0.11	15				x
	<i>Sphaeralcea ambigua</i>	58.3	3.6	0.2	0.02	2				x
	<i>Achnatherum speciosum</i>	54.8	8.4	0.4	0.01	6				x
	<i>Erodium cicutarium</i>	48.7	4.3	0.3	0.2	4				
	<i>Amsinckia</i>	41.7	4.7	0.6	0.11	20				
	<i>Mirabilis laevis</i>	34.8	3.6	0.1	0.02	1				
	<i>Xylorhiza tortifolia</i>	33.9	2.6	0.1	0.03	2				
	<i>Eriogonum inflatum</i>	31.3	1.6	0.1	0.03	1				
	<i>Pleuraphis rigida</i>	27.8	4.8	0.5	0.04	12				
	<i>Cryptantha</i>	27	3.3	0.2	0.33	3				
	<i>Gilia</i>	26.1	3.1	0.2	0.33	3				
	<i>Porophyllum gracile</i>	26.1	6.2	0	0.01	0.5				
Non-vasc										
	Unknown Lichen	40.9	33	0.4	0.4	6				
	Cryptogamic crust	25.2	16	0.2	0.2	5				

***Eriogonum wrightii* - *Eriogonum heermannii* - *Buddleja utahensis* Shrubland Shrubland Alliance**

Common Name: Wright's Buckwheat - Heermann's Buckwheat - Utah Butterfly-bush Scrub

Group Assignment: G296; **Alliance Code:** A4167

Alliance Concept

The Wright's Buckwheat - Heermann's Buckwheat - Utah Butterfly-bush Scrub Shrubland Alliance forms an open shrub layer. The emergent tree layer is typically sparse, and the herbaceous layer is sparse to open. The alliance is found primarily on slopes at a variety of aspects. Soils are derived from a variety of substrates including alluvium, conglomerate, granodiorite, limestone, sandstone, rhyolite, and shale and textures include clay loam, loamy sand, sandy loam, and silty clay. Elevations range from approximately 968 to 1896 meters. One or more shrub species is dominant or characteristic including *Buddleja utahensis*, *Eriogonum heermannii*, *Eriogonum wrightii* or *Hecastocleis shockleyi*. Other characteristic shrubs include *Eriogonum fasciculatum*. Herbs that are often present include *Achnatherum speciosum* and *Bromus rubens*, and those sometimes present include *Achnatherum hymenoides*, *Aristida purpurea*, *Castilleja* spp., *Cryptantha* spp., *Gilia* spp., and *Sphaeralcea ambigua*. Commonly associated non-vascular plants are cryptogamic crust and unknown moss.

Diagnostic Criteria: This alliance has an open shrub layer characterized by a variable component of shrubs including *Buddleja utahensis*, *Eriogonum heermannii*, *Eriogonum wrightii*, *Hecastocleis shockleyi*, and *Eriogonum fasciculatum*. The overall shrub cover ranges from 3 to 16 percent cover.

Alliance Distribution

The alliance is well-defined in sampling at DEVA, and rarely sampled at LAKE and MOJA. It is found scattered throughout the parks in mid to upper elevations.

States: AZ, CA

Ecoregion Sections and Subsection Codes: Mojave Desert (2), Southeastern Great Basin (18): 322Al, 322Av, 341Fc, 341Fd, 341Ff

Park Sampling Zones: **DEVA:** CottonWood Mtns, Grapevine Mtns, Joshua Flat, Last Chance Range, Panamint Mtns; **LAKE:** Willow Beach; **MOJA:** New York Mtns

Associations

Association Scientific Name	Sample Size	LAKE	DEVA	MOJA	Johnson
(<i>Buddleja utahensis</i> – <i>Eriogonum heermannii</i>)– <i>Gutierrezia</i> spp. limestone	11		x		
<i>Eriogonum heermannii</i> (provisional)	1	x			
<i>Eriogonum wrightii</i> ssp. <i>wrightii</i> (provisional)	2			x	x
<i>Hecastocleis shockleyi</i>	6		x		

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 1429.3 m, Range 968 – 1896 m

Aspect: N (2), NE (4), NE (1), E (4), NW (5), SE (2), SW (1), W (1)

Slope: Mean 32.7 degrees, Range 11 – 65 degrees

Macro Topography: Channel wall (1), High level/summit (2), High slope (4), Lowslope (3), Midslope (9)

Tree Cover: Mean 0.1%, Range 0 – 0.1%

Shrub Cover: Mean 10.7%, Range 3 – 16.4%

Herb Cover: Mean 3.0%, Range 0 – 15%

Large Rock: Mean 58.5%, Range 6 – 98%

Small Rock: Mean 35.3%, Range 0.2 – 89%

Fines Cover: Mean 2.9%, Range 0.2 – 9%

Litter Cover: Mean 2.7%, Range 0.2 – 8%

Geology: alluvium (3), conglomerate (1), granodiorite (2), limestone (3), rhyolite (1), sandstone (7), shale (2)

Soil Texture: Clay loam (3), Loamy sand (4), Sandy clay (1), Sandy loam (5), Silty clay (2)

Environment: None.

Vegetation Description

Vegetation Structure: The Alliance forms an open shrub layer, and the overall shrub cover ranges from 3 to 13 percent cover. The tree layer is typically sparse, and the herb layer is sparse to open. Non-vascular plants are typically sparse to open.

Vegetation Floristics: One or more shrub species is dominant or characteristic including *Buddleja utahensis*, *Eriogonum heermannii*, *Eriogonum wrightii* or *Hecastocleis shockleyi*. Other characteristic shrubs include *Eriogonum fasciculatum*. Herbs that are often present include *Achnatherum speciosum* and *Bromus rubens*, and those sometimes present include *Achnatherum hymenoides*, *Aristida purpurea*, *Castilleja* spp., *Cryptantha* spp., *Gilia* spp., and *Sphaeralcea ambigua*. Commonly associated non-vascular plants are cryptogamic crust and unknown moss.

Dynamics: Stands are localized in the three parks, typically on nutrient-poor soils such as dolostone and limestone, and they are often along steep slopes and ridges with colluvial disturbance.

Classification Comments

Stands with *Hecastocleis shockleyi* dominant or characteristically present are rare in DEVA, and they are related floristically and environmentally to those with *Eriogonum heermannii* and *Buddleja utahensis*. Other stands with *Eriogonum wrightii* dominant also are rare in MOJA, and often include rare plant species.

Classification Confidence: Moderate

Conservation Status Rank

Global: G3

State (California): S3

References

Buck-Diaz et al. 2012, Sawyer et al. 2009, Thomas et al. 2004, VegCAMP and AIS 2013

Surveys (with Sample Sizes) Used for Description

MOJN: N=20

LAKE (n=1): LAKE9443

DEVA (n=17): DEVA0442, DEVA0157, DEVA9131, DEVA9437, DEVA9438, DEVA9454, DEVA9468, DEVA9481, DEVA9554, DEVA9587, DEVA9588, DEVA9651, DEVA9670, DEVA9903, DEVAS196, DEVAS232, DEVAS234

MOJA (n=1): MOJA9424

MOJN-Johnson (n=1): MOJJE442

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Shrub										
	<i>Eriogonum fasciculatum</i>	78.9	6.1	0.6	0.11	3	X			
	<i>Hecastocleis shockleyi</i>	47.4	9.9	1.2	0.11	6				
	<i>Gutierrezia sarothrae</i>	47.4	9.7	1	0.2	4				
	<i>Buddleja utahensis</i>	47.4	8.8	0.8	0.11	4				
	<i>Eriogonum heermannii</i>	47.4	5.6	0.5	0.11	5				
	<i>Prunus fasciculata</i>	47.4	2.3	0.1	0.11	1				
	<i>Atriplex confertifolia</i>	47.4	1.3	0.1	0.11	1				
	<i>Scopulophila rixfordii</i>	42.1	1	0.1	0.11	0.2				
	<i>Gutierrezia microcephala</i>	36.8	7	0.6	0.11	3				
	<i>Ephedra nevadensis</i>	36.8	3.7	0.4	0.2	2				
	<i>Ephedra viridis</i>	36.8	2.7	0.3	0.11	2				
	<i>Lepidium fremontii</i>	36.8	0.8	0.1	0.11	0.2				
	<i>Tetradymia axillaris</i>	31.6	5.8	0.7	0.11	7				
	<i>Krascheninnikovia lanata</i>	31.6	2.2	0.2	0.2	2				
	<i>Echinocactus polycephalus</i>	31.6	1.7	0.1	0.11	1				
	<i>Brickellia microphylla</i>	31.6	1.2	0.1	0.2	0.5				
	<i>Galium stellatum</i>	26.3	0.7	0.1	0.2	0.5				
	<i>Echinocereus engelmannii</i>	26.3	0.5	0	0.11	0.2				
Herb										
	<i>Bromus rubens</i>	68.4	20	1.4	0.11	10				X
	<i>Achnatherum speciosum</i>	68.4	9.7	0.3	0.11	2				X
	<i>Aristida purpurea</i>	42.1	6.8	0.2	0.11	1				
	<i>Sphaeralcea ambigua</i>	42.1	2.1	0.1	0.11	0.2				
	<i>Castilleja</i>	36.8	2.3	0.1	0.11	0.2				
	<i>Gilia</i>	31.6	4.2	0.2	0.33	1.2				
	<i>Achnatherum hymenoides</i>	31.6	3.7	0.1	0.11	0.2				
	<i>Cryptantha</i>	26.3	6.3	0.2	0.33	1.5				
Non-vasc										
	Cryptogamic crust	57.9	31	0.6	0.2	4				X
	Unknown Moss	57.9	18	0.4	0.2	2				X
	Unknown Lichen	47.4	30	0.6	0.4	4				

***Juniperus californica* Wooded Shrubland Alliance**

Common Name: California Juniper Wooded Shrubland

Group Assignment: G296; **Alliance Code:** A0502

Alliance Concept

The California Juniper Woodland Alliance forms a sparse to open tree canopy with an open shrub understory. It is found from bottoms to summits and at all aspects. Soils are derived from a variety of substrates and textures range from sand to sandy loam and are often very shallow. Elevations range from approximately 900 to 1600 meters. The dominant tree is *Juniperus californica*. Commonly associated shrubs include *Cylindropuntia acanthocarpa*, *Echinocereus engelmannii*, *Ephedra nevadensis*, *Eriogonum fasciculatum*, *Yucca schidigera*, *Coleogyne ramosissima*, *Ferocactus cylindraceus*, and *Krameria erecta*. Commonly associated herbs include *Achnatherum speciosum* and *Porophyllum gracile*.

Diagnostic Criteria: This alliance is characterized by sparse to open tree canopy dominated by *Juniperus californica*, which ranges from 1.9 to 8.3 percent cover. The overall tree cover ranges from 1.9 to 8.3 percent cover.

Alliance Distribution

The alliance is found at mid to upper elevations in MOJA in the Granite, New York and Castle Mountains and in LAKE in the Newberry Mountains.

States: CA, NV

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (10): 322Al, 322Am

Park Sampling Zones: **LAKE:** Juniper Mine, Katherine, Spirit Mountain; **MOJA:** New York Mtns, Van Winkle Mtn

Associations

Association Scientific Name	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Juniperus californica</i> / <i>Coleogyne ramosissima</i>	4	x		x	
<i>Juniperus californica</i> / <i>Nolina bigelovii</i> (provisional)	3	x			
<i>Juniperus californica</i> / <i>Yucca schidigera</i> / <i>Pleuraphis rigida</i>	3	x		x	

Association notes: None.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 1241.9 m, Range 894 – 1575 m
Aspect: N (2), NE (2), E (2), NW (1), SE (2), W (1)
Slope: Mean 15.4 degrees, Range 3 – 30 degrees
Macro Topography: High level/summit (1), Low level/bottom (1), Midslope (1)

Tree Cover: Mean 4.7%, Range 1.85 – 8.3%
Shrub Cover: Mean 19%, Range 12.5 – 28.4%
Herb Cover: Mean 6.9%, Range 3 – 13%

Large Rock: Mean 18.3%, Range 0 – 75%
Small Rock: Mean 71.5%, Range 40 – 90%
Fines Cover: Mean 3.2%, Range 0 – 10%
Litter Cover: Mean 3.6%, Range 0.2 – 6.2%

Geology: alkali-granite (alaskite) (7), alluvium (1), gneiss (1), rhyolite (1)
Soil Texture: Coarse loamy sand (2), Sand (1), Sandy loam (2)

Environment: The alliance is found at mid to upper elevations often in washes with shallow soils with exposed bedrock. It is found on bottoms, midslopes, and summits at most aspects. Soils range from sand to sandy loam typically derived from alkali-granite but also alluvium, gneiss and rhyolite.

Vegetation Description

Vegetation Structure: The Alliance forms a sparse to open tree layer with a sparse to open shrub layer and sparse or open herbaceous understory.

Vegetation Floristics: The dominant tree is *Juniperus californica* in the overstory. Shrubs that are characteristic or often present include *Cylindropuntia acanthocarpa*, *Echinocereus engelmannii*, *Ephedra nevadensis*, *Eriogonum fasciculatum*, *Yucca schidigera*, *Coleogyne ramosissima*, *Ferocactus cylindraceus*, and *Krameria erecta*. Herbs that are characteristic or often present include *Achnatherum speciosum* and *Porophyllum gracile*.

Dynamics: *Juniperus californica* is dominate or co-dominate with *Pinus monophylla*. Stands may be open-grown trees with grassy understories or form a mixed canopy with other trees and shrubs.

J. californica stands were once extensive in Antelope Valley and the San Gabriel Mountains but have been lost or degraded due to increased fire and clearing for agriculture and urban development. *Juniperus osteosperma* woodland alliance occupies areas east of the distribution of *J. californica*. Overlap of the two alliances does occur and the identification of the two species can be difficult. Many stands of *Juniperus californica* are at risk of stand replacing fires due to the increased build-up of fine fuels from non-native annual grasses.

Classification Comments

Some stands in California with *Juniperus californica* dominant in the overstory have been placed in G198 California Conifer Forest & Woodland of the NVC hierarchy, while other stands have been placed in G296 Mojave Mid-Elevation Mixed Desert Scrub Group. Further review is needed to determine if these stands should be combined in one group, and we currently have placed the associations sampled in the Mojave Desert within the G296 group.

Classification Confidence of Alliance: Moderate

Conservation Status Rank

Global: G4

State (California): S4

References

Evens et al. 2012, Keeler-Wolf and Thomas 2000, Keeler-Wolf et al. 1998b, Keeler-Wolf et al. 2005, Sawyer et al. 2009, VegCAMP and AIS 2013

Surveys (with Sample Sizes) Used in Description

MOJN: N=10

LAKE (n=7): LAKE0516, LAKE0613, LAMEN074, LAMEN079, LAMEN089, LAMEN097, LAMEN098

DEVA (n=0)

MOJA (n=3): MOJA9909, MOJC1095, MOJC1150

MOJN-Johnson (n=0)

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Tree	<i>Juniperus californica</i>	100	92	4.3	1.9	7.6	x	x		
	<i>Pinus monophylla</i>	30	4.1	0.2	0.5	1				
Shrub	<i>Eriogonum fasciculatum</i>	100	18	2.7	0.5	6.3	x			
	<i>Yucca schidigera</i>	80	7.5	1.4	0.2	3.1	x			
	<i>Cylindropuntia acanthocarpa</i>	80	4.1	0.9	0.03	5	x			
	<i>Ephedra nevadensis</i>	80	4	0.6	0.07	2.4	x			
	<i>Echinocereus engelmannii</i>	80	1.3	0.2	0.03	0.5	x			
	<i>Coleogyne ramosissima</i>	60	18	2.9	0.1	8.2				x
	<i>Krameria erecta</i>	50	2	0.3	0.2	1.2				x
	<i>Ferocactus cylindraceus</i>	50	0.9	0.2	0.1	0.6				x
	<i>Nolina bigelovii</i>	40	5.6	0.8	0.6	2.8				
	<i>Larrea tridentata</i>	40	3.2	0.7	0.1	5				
	<i>Acacia greggii</i>	40	1.1	0.2	0.2	1				
	<i>Opuntia polyacantha</i> var. <i>erinacea</i>	40	1.5	0.2	0.4	0.7				
	<i>Gutierrezia sarothrae</i>	40	1.3	0.2	0.03	1				
	<i>Thamnosma montana</i>	40	0.7	0.1	0.2	0.6				
	<i>Stephanomeria pauciflora</i>	40	0.7	0.1	0.01	0.5				
	<i>Lotus rigidus</i>	40	0.2	0	0.01	0.2				
	<i>Quercus turbinella</i>	30	4	0.7	0.9	4.9				
	<i>Ericameria linearifolia</i>	30	2.4	0.4	0.5	2.01				
	<i>Viguiera parishii</i>	30	2	0.3	1	1.3				
	<i>Opuntia basilaris</i>	30	0.3	0.1	0.2	0.2				
Herb	<i>Achnatherum speciosum</i>	80	27	0.3	0.2	0.5	x			
	<i>Porophyllum gracile</i>	50	12	0.1	0.03	0.5				x
	<i>Bromus rubens</i>	40	5.1	0.4	0.2	3				
	<i>Pleuraphis rigida</i>	40	5.3	0.4	0.03	3				
	<i>Amsinckia</i>	30	1.8	0.1	0.2	1				
	<i>Pectocarya recurvata</i>	30	1.8	0.1	0.2	1				
	<i>Sphaeralcea ambigua</i>	30	1.2	0.1	0.2	0.5				
	<i>Chorizanthe brevicornu</i>	30	0.8	0.1	0.2	0.2				
	<i>Erodium cicutarium</i>	30	0.8	0.1	0.2	0.2				
	<i>Mirabilis laevis</i>	30	1	0	0.04	0.2				
Non-vascular	Standing snag	50	50	0.3	0.3	0.9				x
	Cryptogamic crust	30	23	0.1	0.2	0.2				

***Lycium andersonii* - *Lycium cooperi* Shrubland Alliance**

Common Name: Desert-Thorn Scrub

Group Assignment: G296; **Alliance Code:** A3142

Alliance Concept

The Desert-Thorn Scrub Shrubland Alliance forms an open shrub layer. The emergent tree layer, when present, is typically sparse, and the herbaceous layer is open. The alliance is found primarily on alluvial fans, bajadas, and slopes at all aspects. Soils are derived from a variety of substrates including alluvium, granodiorite, and rhyolite and textures include loam, silt loam, sandy clay loam. Elevations range from approximately 800 to 1550 meters. Dominant and characteristic shrubs include *Lycium andersonii* and/or *Lycium cooperi*, and those that are often present include *Ambrosia dumosa*, *Atriplex confertifolia*, *Eriogonum fasciculatum*, *Hymenoclea salsola*, and *Larrea tridentata*. Commonly associated emergent trees at sparse cover include *Yucca brevifolia*. Dominant and characteristic herbs include *Bromus rubens*, and those often present are *Eriogonum inflatum* and *Sphaeralcea ambigua*.

Diagnostic Criteria: This alliance is characterized by an open shrub layer of with *Lycium andersonii* and/or *Lycium cooperi* dominant. The overall shrub cover ranges from 7 to 26 percent.

Alliance Distribution

The alliance is poorly defined in sampling in MOJA and DEVA **Most of the points are Johnson and have no location information.** The alliance is found at mid to high elevation.

States: AZ, CA

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (6): 322Ad, 322Af, 322Aj, 322Al, 322Av; Southeastern Great Basin (3): 341Fd, 341Fe

Park Sampling Zones: **DEVA:** Grapevine Mtns, Green Water Range and Valley, Nelson Range, Panamint Mtns; **LAKE:** Willow Beach; **MOJA:** Cinder Cones, Mid Hills

Associations

Association Scientific Name [NVC Code]	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Lycium andersonii</i> [cf. CEGLO05150]	11		x	x	x
<i>Lycium</i> (<i>andersonii</i> , <i>cooperi</i>) (alliance)	4		x		
<i>Lycium cooperi</i> (provisional)	2	x		x	

Association Notes: None.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 1233 m, Range 816 – 1537 m

Aspect: NE (1), E (2), NW (2), SE (3), W (4), SW (1)
Slope: Mean 7.2 degrees, Range 1 – 20 degrees
Macro Topography: Channel bed (1), Midslope (2)

Tree Cover: Mean 0.1%, Range 0 – 0.5%
Shrub Cover: Mean 13.6%, Range 7 – 26.7%
Herb Cover: Mean 9.5%, Range 3 – 32%

Large Rock: Mean 2.7%, Range 0 – 15%
Small Rock: Mean 81.5%, Range 62.7 – 97.5%
Fines Cover: Mean 14.4%, Range 4 – 37.5%
Litter Cover: Mean 3.0%, Range 0.2 – 13%

Geology: alluvium (3), granodiorite (1), limestone (1), rhyolite (2), sandstone (1), tephrite (basanite) (1)
Soil Texture: Loam (1), Loamy sand (1), Medium silt loam (1), Moderately fine sandy clay loam (2)

Environment: The alliance is found primarily on alluvial fans, bajadas, and slopes at all aspects. Soils are derived from a variety of substrates including alluvium, granodiorite, and rhyolite and textures include loam, silt loam, sandy clay loam. The alliance occurred at mid to high elevations.

Vegetation Description

Vegetation Structure: The Alliance forms an open shrub layer and the overall shrub cover ranges from 7 to 27 percent cover. The tree layer, when present, is typically sparse, and the herb layer is sparse to 32. Non-vascular plants are typically not present.

Vegetation Floristics: Dominant and characteristic shrubs include *Lycium andersonii*, and those that are often present include *Ambrosia dumosa*, *Atriplex confertifolia*, *Eriogonum fasciculatum*, *Hymenoclea salsola*, and *Larrea tridentata*. Commonly associated emergent trees at sparse cover include *Yucca brevifolia*. Dominant and characteristic herbs include *Bromus rubens*, and those often present are *Eriogonum inflatum* and *Sphaeralcea ambigua*.

Dynamics: Stands with *Lycium andersonii* and related *Lycium* spp. occur in a mosaic with other mid-elevation mixed desert scrub alliances of the Mojave Desert and southeastern Great Basin including *Ephedra nevadensis*, *Grayia spinosa*, and *Menodora spinescens* alliances. Stands with *Lycium* appear to have more disturbance and/or moisture from intermittent drainage flooding.

Classification Comments

None.

Classification Confidence of Alliance: Moderate

Conservation Status Rank

Global: G4

State (California): S3

References

Evens et al. 2012, Keeler-Wolf and Thomas 2000, Klein and Evens 2005, Root 1978, Sawyer et al. 2009, VegCAMP and AIS 2013

Surveys (with Sample Sizes) Used in Description

MOJN: N=17

LAKE (n=1): LAKE9394

DEVA (n=7): DEVAR097, DEVAR108, DEVAR110, DEVAR134, MOJC0488, MOJC0497, MOJC0709

MOJA (n=2): MOJA9378, MOJA9809

MOJN-Johnson (n=7): MOJJE392, MOJJE552, MOJJE556, MOJJE559, MOJJE743, MOJJE916, MOJJE932

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Tree	<i>Yucca brevifolia</i>	30	30	0.1	0.2	0.5				
Shrub	<i>Lycium andersonii</i>	70	26	2.8	2	8				x
	<i>Larrea tridentata</i>	60	7.5	0.8	0.5	3.5				x
	<i>Hymenoclea salsola</i>	50	2.8	0.2	0.2	1				x
	<i>Ambrosia dumosa</i>	40	3.8	0.4	0.2	3				
	<i>Ephedra</i>	40	3	0.2	0.2	1				
	<i>Krascheninnikovia lanata</i>	30	3.9	0.4	0.5	3				
	<i>Eriogonum fasciculatum</i>	30	1.8	0.2	0.2	2				
	<i>Atriplex confertifolia</i>	30	2.7	0.2	0.2	1.5				
	<i>Coleogyne ramosissima</i>	30	2	0.2	0.5	0.5				
	<i>Thamnosma montana</i>	30	2	0.1	0.2	0.5				
Herb	<i>Sphaeralcea ambigua</i>	70	14	0.3	0.2	0.5				x
	<i>Bromus rubens</i>	60	16	1.8	0.2	15				x
	<i>Eriogonum inflatum</i>	60	20	0.3	0.2	0.5				x
	<i>Achnatherum speciosum</i>	30	11	0.5	0.5	3				

***Mortonia utahensis* Shrubland Alliance**

Common Name: Utah Mortonia Scrub

Group Assignment: G296; **Alliance Code:** A4158

Alliance Concept

The Utah Mortonia Scrub Alliance forms an open shrub layer. The emergent tree layer is typically sparse, and the herbaceous layer is open. The alliance is found primarily on skeletal rocky slopes of various aspects. Soils are typically calcareous, and textures include clay loam, silty clay loam, and sandy loam. Elevations range from approximately 900 to 1700 meters. *Mortonia utahensis* is dominant or co-dominant in the shrub layer, and those shrubs often present include *Echinocactus polycephalus*, *Echinocereus engelmannii*, *Eriogonum heermannii*, and *Gutierrezia sarothrae*. Dominant and characteristic herbs include *Bromus rubens* and *Sphaeralcea ambigua*, and *Aristida purpurea* is often present. Cryptogammic crust is often present in this alliance.

Diagnostic Criteria: This alliance is characterized by an open shrub layer of *Mortonia utahensis* as a dominant or co-dominant shrub. The overall shrub cover ranges from 4 to 29 percent.

Alliance Distribution

The alliance is found in LAKE NE of Iceberg Canyon, in MOJA in the Clark Mountains, and in DEVA in the Funeral Mountains.

States: CA, NV

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (13): 322Ad, 322Aj, 322At

Park Sampling Zones: **DEVA:** Funeral Mtns; **LAKE:** Gold Butte; **MOJA:** Clark Mountain

Associations

Association Scientific Name [NVC Code]	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Mortonia utahensis</i> [CEGL005153]	13	x	x	x	

Association Notes: None.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 1237 m, Range 916 – 1692 m

Aspect: N (1), NE (1), E (1), NW (2), SE (1), SW (3), W (2), S (2)

Slope: Mean 30.6 degrees, Range 7 – 56 degrees

Macro Topography: High level/summit (1), High slope (3), Midslope (5)

Tree Cover: Mean 0.0%, Range 0 – 0.5%
Shrub Cover: Mean 12.6%, Range 4.2 – 29%
Herb Cover: Mean 5.6%, Range 2 – 12%

Large Rock: Mean 62.3%, Range 7.5 – 93%
Small Rock: Mean 31.1%, Range 4 – 75%
Fines Cover: Mean 3.3%, Range 0 – 10%
Litter Cover: Mean 2.1%, Range 0 – 5%

Geology: dolostone (dolomite) (1), gneiss (3), sandstone with dolostone (dolomite) (9)
Soil Texture: Clay loam (3), Medium loam (1), Medium silt loam (1), Moderately fine silty clay loam (2), Sandy clay (1), Sandy loam (2)

Environment: The alliance is found primarily on skeletal rocky slopes of various aspects. Soils are typically calcareous, and textures include clay loam, silty clay loam, and sandy loam. The alliance occurs at mid to high elevations.

Vegetation Description

Vegetation Structure: The Alliance forms an open shrub layer, and the overall shrub cover ranges from 4 to 29 percent. The tree layer is typically sparse, and the herb layer is sparse to open. Non-vascular plants are typically sparse.

Vegetation Floristics: *Mortonia utahensis* is dominant or co-dominant in the shrub layer, and those shrubs often present include *Echinocactus polycephalus*, *Echinocereus engelmannii*, *Eriogonum heermannii*, and *Gutierrezia sarothrae*. Dominant and characteristic herbs include *Bromus rubens* and *Sphaeralcea ambigua*, and *Aristida purpurea* is often present. Cryptogammic crust is often present in this alliance.

Dynamics: *Mortonia utahensis* stands occur on steep, rocky slopes with nutrient-poor sedimentary substrates including limestone and sandstone.

Classification Comments

Mortonia utahensis associations have been previously placed in the Mojave Mid-Elevation Mixed Desert Scrub Group (G296) and Western Madrean Chaparral Group (G281) of the NVC hierarchy. Stands within the study area are ecologically related to those within G296 and within the Colorado Plateau Blackbrush - Mormon-tea Shrubland Group (G312), and the NVC hierarchy has since been updated for this alliance to be placed only within G296. Other related associations include those with *Eriogonum heermannii*, *Buddleja utahensis*, *Coleogyne ramosissima*, and *Purshia stansburiana*.

Classification Confidence of Alliance: Moderate

Conservation Status Rank

Global: G3?

State (California): S2?

References

Keeler-Wolf and Thomas 2000, NatureServe 2012

Surveys (with Sample Sizes) Used in Description

MOJN: N=13

LAKE (n=5): LAKE9287, LAKE9288, LAKE9446, LAKE9530, LAKE9531

DEVA (n=5): DEVA0527, DEVAS170, MOJC0937, MOJC0938, MOJC0939

MOJA (n=3): MOJA0171, MOJA9170, MOJC0943

MOJN-Johnson (n=0)

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Shrub	<i>Mortonia utahensis</i>	100	32	3.8	1	6.5	x		x	
	<i>Gutierrezia sarothrae</i>	61.5	3.3	0.4	0.2	2				x
	<i>Echinocereus engelmannii</i>	61.5	1.8	0.2	0.2	0.5				x
	<i>Echinocactus polycephalus</i>	61.5	1.7	0.2	0.11	0.5				x
	<i>Eriogonum heermannii</i>	53.8	2.4	0.3	0.2	2				x
	<i>Thamnosma montana</i>	46.2	1	0.2	0.2	0.5				
	<i>Opuntia basilaris</i>	46.2	1.3	0.1	0.2	0.5				
	<i>Ferocactus cylindraceus</i>	46.2	1.2	0.1	0.2	0.5				
	<i>Agave utahensis</i>	38.5	4	0.5	0.2	4				
	<i>Ephedra nevadensis</i>	38.5	1.6	0.1	0.2	1				
	<i>Ephedra funerea</i>	30.8	1.1	0.1	0.11	0.5				
	<i>Eriogonum fasciculatum</i>	30.8	1.3	0.1	0.2	1				
	<i>Stephanomeria pauciflora</i>	30.8	1.1	0.1	0.2	0.5				
	<i>Krameria erecta</i>	30.8	1	0.1	0.2	0.5				
	<i>Larrea tridentata</i>	30.8	1.2	0.1	0.2	0.5				
Herb	<i>Bromus rubens</i>	92.3	27	1.3	0.2	5	x			
	<i>Sphaeralcea ambigua</i>	76.9	3.8	0.2	0.11	0.5	x			
	<i>Aristida purpurea</i>	53.8	9.4	0.6	0.11	4				x
	<i>Eriogonum inflatum</i>	46.2	3.3	0.2	0.2	1				
	<i>Achnatherum speciosum</i>	38.5	2.4	0.2	0.2	1				
	<i>Cheilanthes parryi</i>	38.5	2.3	0.1	0.2	0.5				
	<i>Pleuraphis rigida</i>	30.8	2.8	0.3	0.2	3				
	<i>Thymophylla pentachaeta</i> var. <i>belenidium</i>	30.8	1.6	0.1	0.2	0.5				
	<i>Xylorhiza tortifolia</i>	30.8	1.3	0.1	0.11	0.5				
Non-vasc	Cryptogamic crust	61.5	40	0.4	0.2	3				x
	Unknown Moss	38.5	17	0.1	0.2	0.5				

***Opuntia acanthocarpa* Shrubland Alliance**

Common Name: Buckhorn Cholla Scrub

Group Assignment: G296; **Alliance Code:** A4156

Alliance Concept

The Buckhorn Cholla Scrub Alliance forms an open to intermittent shrub layer. The emergent tree layer is typically sparse, and the herbaceous layer is open. The alliance is found from lowslopes to highslopes at east to southwest aspects. Soils are rocky and derived from a variety of substrates and textures range from fine sand to clay loam. Elevations range from approximately 650 to 1450 meters. *Cylindropuntia acanthocarpa* (= *Opuntia acanthocarpa*) is a characteristic shrub and is dominant or co-dominant. Other characteristic shrubs include *Echinocereus engelmannii*, *Ephedra nevadensis*, *Ferocactus cylindraceus*, and *Krameria erecta*. Shrubs that are often present include *Ambrosia dumosa*, *Encelia farinosa*, *Larrea tridentata*, *Viguiera parishii*, and *Yucca schidigera*. Herbs that are often present include *Bromus rubens*, *Eriogonum inflatum*, *Erodium cicutarium*, *Pleuraphis rigida*, *Porophyllum gracile*, and *Sphaeralcea ambigua*.

Diagnostic Criteria: This alliance is characterized by an open to intermittent shrub layer with *Cylindropuntia acanthocarpa* (= *Opuntia acanthocarpa*) dominant or co-dominant. The overall shrub cover ranges from 11 to 35 percent.

Alliance Distribution

The alliance was sampled at two Parks. It occurs in MOJA in Fenner and Lanfair Valley, in the Ivanpah and Providence Mountains, and in the Paiute Range. It also occurs at Temple Bar in LAKE. The alliance occurs at mid to upper elevations.

States: AZ, CA

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (7): 322Aj, 322Al, 322Av

Park Sampling Zones: **LAKE:** Temple Bar; **MOJA:** Fenner Villy West, Ivanpah Mtns, Lanfair Villy, Piute Range, Providence Mtns

Associations

Association Scientific Name	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Cylindropuntia acanthocarpa</i>	13	x		x	x

Association Notes: None.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 1146.4 m, Range 664 – 1433 m
Aspect: E (1), SE (4), SW (3), S (5)
Slope: Mean 11 degrees, Range 2 – 26 degrees
Macro Topography: High slope (2), Lowslope (1), Midslope (2)

Tree Cover: Mean 0.1%, Range 0 – 0.5%
Shrub Cover: Mean 19.3%, Range 11 – 35%
Herb Cover: Mean 8.9%, Range 3 – 24%

Large Rock: Mean 8.6%, Range 0 – 22.5%
Small Rock: Mean 73%, Range 37.7 – 90%
Fines Cover: Mean 8.5%, Range 0 – 37.5%
Litter Cover: Mean 3.1%, Range 0.2 – 10%

Geology: alluvium (3), gneiss (1), sandstone (1), schist (2)
Soil Texture: Clay loam (4), Fine sand (1), Medium to very fine sandy loam (1), Sandy loam (1)

Environment: The alliance occurs at mid to high elevations on low to high slopes with east to southwest aspects. Soils are rocky and range from sand to clay loam derived from a variety of substrates.

Vegetation Description

Vegetation Structure: The Alliance forms an open to intermittent shrub layer and the overall shrub cover ranges from 11 to 35 percent. The tree layer is typically sparse, and the herb layer is sparse to open. Non-vascular plants are typically sparse.

Vegetation Floristics: *Cylindropuntia acanthocarpa* (= *Opuntia acanthocarpa*) is a characteristic and dominant to co-dominant shrub. Other characteristic shrubs include *Echinocereus engelmannii*, *Ephedra nevadensis*, *Ferocactus cylindraceus*, and *Krameria erecta*. Shrubs that are often present include *Ambrosia dumosa*, *Encelia farinosa*, *Larrea tridentata*, *Viguiera parishii*, and *Yucca schidigera*. Herbs that are often present include *Bromus rubens*, *Eriogonum inflatum*, *Erodium cicutarium*, *Pleuraphis rigida*, *Porophyllum gracile*, and *Sphaeralcea ambigua*.

Dynamics: *Cylindropuntia acanthocarpa* (= *Opuntia acanthocarpa*) occurs in a fine-scale matrix with other mid-elevation shrubland types in the Mojave Desert where soils are shallow and sites are exposed and rocky.

Classification Comments

None.

Classification Confidence of Alliance: Moderate

Conservation Status Rank

Global: G4?

State (California): S

References

cf. Keeler-Wolf et al. 1998

Surveys (with Sample Sizes) Used in Description

MOJN: N=13

LAKE (n=2): LAKE0367, LAKE0449

DEVA (n=0)

MOJA (n=5): MOJA0213, MOJA9584, MOJA9636, MOJC1174, MOJC1222

MOJN-Johnson (n=6): MOJJE086, MOJJE091, MOJJE097, MOJJE116, MOJJE247, MOJJE250

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Tree	<i>Yucca brevifolia</i>	28.6	29	0.1	0.01	0.5				
Shrub	<i>Cylindropuntia acanthocarpa</i>	100	33	6.5	3	17	x		x	
	<i>Echinocereus engelmannii</i>	100	1.7	0.3	0.2	0.5	x			
	<i>Ferocactus cylindraceus</i>	85.7	12	1.9	0.5	5	x			
	<i>Ephedra nevadensis</i>	85.7	1.7	0.4	0.2	1	x			
	<i>Krameria erecta</i>	85.7	1.7	0.3	0.2	0.5	x			
	<i>Ambrosia dumosa</i>	71.4	18	3.4	0.5	10				x
	<i>Larrea tridentata</i>	71.4	5.4	0.8	0.2	3				x
	<i>Yucca schidigera</i>	71.4	2.1	0.3	0.01	1				x
	<i>Encelia farinosa</i>	57.1	5.7	0.9	0.2	4				x
	<i>Viguiera parishii</i>	57.1	2.9	0.6	0.2	3				x
	<i>Eriogonum fasciculatum</i>	42.9	2.2	0.6	0.5	3				
	<i>Opuntia basilaris</i>	42.9	0.7	0.1	0.2	0.5				
	<i>Opuntia polyacantha</i> var. <i>erinacea</i>	42.9	0.7	0.1	0.2	0.5				
	<i>Stephanomeria pauciflora</i>	42.9	0.7	0.1	0.2	0.5				
	<i>Acacia greggii</i>	42.9	0.5	0.1	0.01	0.5				
	<i>Ephedra viridis</i>	28.6	0.6	0.1	0.2	0.5				
	<i>Mammillaria tetrancistra</i>	28.6	0.6	0.1	0.2	0.5				
	<i>Tiquilia canescens</i>	28.6	0.5	0.1	0.2	0.2				
Herb	<i>Erodium cicutarium</i>	71.4	8.7	0.7	0.2	3				x
	<i>Pleuraphis rigida</i>	71.4	7.3	0.6	0.01	3				x
	<i>Porophyllum gracile</i>	71.4	2.5	0.2	0.2	0.5				x
	<i>Eriogonum inflatum</i>	71.4	1.9	0.1	0.2	0.2				x
	<i>Bromus rubens</i>	57.1	4.9	0.4	0.2	2				x

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
	<i>Sphaeralcea ambigua</i>	57.1	2.1	0.2	0.2	0.5				x
	<i>Astragalus nutans</i>	42.9	4.4	0.3	0.2	1				
	<i>Gilia</i>	42.9	3.8	0.3	0.6	0.6				
	<i>Plantago ovata</i>	42.9	3.5	0.2	0.2	1				
	<i>Mentzelia</i>	42.9	2.3	0.2	0.4	0.4				
	<i>Adenophyllum porophylloides</i>	42.9	1.6	0.1	0.2	0.5				
	<i>Dasyochloa pulchella</i>	42.9	1.6	0.1	0.2	0.5				
	<i>Muhlenbergia porteri</i>	42.9	1.1	0.1	0.2	0.5				
	<i>Amsinckia</i>	42.9	1.1	0.1	0.2	0.2				
	<i>Lepidium lasiocarpum</i>	42.9	1	0.1	0.2	0.2				
	<i>Phacelia crenulata</i>	42.9	1.1	0.1	0.2	0.2				
	<i>Xylorhiza tortifolia</i>	42.9	1	0.1	0.2	0.2				
	<i>Mirabilis laevis</i>	28.6	3.5	0.4	0.5	2				
	<i>Schismus</i>	28.6	4.4	0.4	0.5	2				
	<i>Chorizanthe brevicornu</i>	28.6	3.4	0.3	0.2	2				
	<i>Cryptantha</i>	28.6	1.7	0.2	0.6	0.6				
	<i>Chaenactis</i>	28.6	1.1	0.1	0.4	0.4				
	<i>Linanthus</i>	28.6	1.4	0.1	0.4	0.4				
	<i>Achnatherum hymenoides</i>	28.6	0.8	0.1	0.2	0.5				
	<i>Chamaesyce</i>	28.6	1.7	0.1	0.2	0.5				
	<i>Eriogonum</i>	28.6	1.4	0.1	0.2	0.4				
	<i>Allionia incarnata</i>	28.6	0.6	0.1	0.2	0.2				
	<i>Cryptantha nevadensis</i>	28.6	0.6	0.1	0.2	0.2				
	<i>Lotus</i>	28.6	0.6	0.1	0.2	0.2				
	<i>Malacothrix glabrata</i>	28.6	0.6	0.1	0.2	0.2				
Non-vascular										
	Cryptogamic crust	28.6	29	0.1	0.2	0.2				

***Yucca brevifolia* Wooded Shrubland Alliance**

Common Name: Joshua Tree Wooded Shrubland

Group Assignment: G296; **Alliance Code:** A3148

Alliance Concept

The Joshua Tree Woodland Alliance forms a sparse to open tree canopy with an open to intermittent shrub understory. It is found on channel beds and bottoms to summits at variable aspects. Soils are derived from a variety of substrates and textures are variable. Elevations range from approximately 800 to 2200 meters. The dominant tree is *Yucca brevifolia*. Commonly associated shrubs include *Ephedra nevadensis*, *Cylindropuntia acanthocarpa*, *Menodora spinescens*, and *Lycium andersonii*. Commonly associated herbs include *Bromus rubens*, *Erodium cicutarium*, *Achnatherum speciosum*, and *Sphaeralcea ambigua*.

Diagnostic Criteria: This alliance is characterized by a sparse to open tree canopy of *Yucca brevifolia*, which ranges from 1 to 19 percent cover. The overall tree cover ranges from 1 to 19 percent cover.

Alliance Distribution

The alliance is well-defined in sampling at all three Parks. It is scattered throughout MOJA, in the northwest half of DEVA and near Pearce Ferry Rd. in LAKE. It is found at mid to upper elevations.

States: AZ, CA

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (88): 322Aj, 322Ak, 322Al, 322Av; Southeastern Great Basin; (28): 341Fb, 341Fc, 341Fe

Park Sampling Zones: **DEVA:** CottonWood Mtns, Joshua Flat, Last Chance Range, Last Chance Vlly, Nelson Range; **LAKE:** Pearce Ferry; **MOJA:** Baker-Halloran, Cima Dome NW, Cima Dome SE, Cinder Cones, Clark Mountain, Clark Mtn, Clark Mtn West, Hart Peak, Ivanpah Mtns, Ivanpah Vlly, Kelso Mtns, Lanfair Vlly, Marl Mtns, New York Mtns, Piute Range, Solomons Knob

Associations

Association Scientific Name [NVC Code]	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Yucca brevifolia</i> (alliance)	1			x	
<i>Yucca brevifolia</i> [CEGL003116]	3		x	x	
<i>Yucca brevifolia</i> / (<i>Artemisia tridentata</i> – <i>Atriplex confertifolia</i>)	9		x		
<i>Yucca brevifolia</i> / (<i>Yucca baccata</i>) / <i>Pleuraphis (rigida, jamesii)</i> [CEGL002725]	35	x		x	x
<i>Yucca brevifolia</i> / <i>Coleogyne ramosissima</i> [CEGL005294]	23		x	x	
<i>Yucca brevifolia</i> / <i>Cylindropuntia acanthocarpa</i>	12			x	
<i>Yucca brevifolia</i> / <i>Ephedra nevadensis</i>	7			x	x
<i>Yucca brevifolia</i> / <i>Larrea tridentata</i> – <i>Yucca schidigera</i> / <i>Pleuraphis rigida</i>	14	x		x	x

Association Scientific Name [NVC Code]	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Yucca brevifolia</i> / <i>Lycium andersonii</i>	19	x	x	x	x
<i>Yucca brevifolia</i> / <i>Prunus fasciculata</i>	4			x	
<i>Yucca brevifolia</i> / <i>Salazaria mexicana</i>	6			x	

Association notes: One sample was classified only to alliance level in which *Eriogonum heermanii* and *Ephedra viridis* were present with higher cover than *Yucca brevifolia*.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 1445.5 m, Range 813 – 2144 m

Aspect: Flat, Variable (1), N (18), NE (14), E (17), NW (18), SE (23), SW (7), W (4), SW (12), S (17)

Slope: Mean 6.9 degrees, Range 0 – 28 degrees

Macro Topography: Channel bed (4), Entire slope (1), High level/summit (9), Highslope (11), Low level/bottom (7), Lowslope (16), Midslope (26), Step in slope (4), Toeslope (alluvial fan/bajada) (2)

Tree Cover: Mean 2.6%, Range 1 – 19%

Shrub Cover: Mean 16.7%, Range 5.2 – 40.6%

Herb Cover: Mean 7.6%, Range 0.1 – 26%

Large Rock: Mean 7.0%, Range 0 – 82%

Small Rock: Mean 69.9%, Range 0 – 97%

Fines Cover: Mean 16.5%, Range 0 – 84%

Litter Cover: Mean 2.9%, Range 0 – 20%

Geology: alluvium (35), basalt (3), conglomerate (1), dolostone (dolomite) (3), gneiss (5), granodiorite (26), gravel (1), landslide (3), limestone (4), rhyolite (16), sand (2), sandstone (9), shale (3), tephrite (basanite) (5)

Soil Texture: Clay (2), Clay loam (9), Coarse sand (5), Fine sand (1), Fine sandy clay (1), Loam (7), Loamy sand (16), Medium sand (3), Medium silt loam (2), Medium to very fine sandy loam (11), Moderately coarse loamy sand (5), Moderately coarse sandy loam (1), Moderately fine clay loam (1), Moderately fine sandy clay loam (4), Sand (2), Sandy clay (2), Sandy loam (32), Silt loam (2), Silty clay (1)

Environment: The alliance is found at mid to upper elevations and at all aspects. It is found in channel beds and bottoms and up to summits. Soils are derived from a variety of substrates and textures are variable.

Vegetation Description

Vegetation Structure: The Alliance forms a sparse to open tree layer with a sparse to intermittent shrub layer and sparse or intermittent herbaceous understory.

Vegetation Floristics: The dominant tree is *Yucca brevifolia*. Commonly associated shrubs include *Ephedra nevadensis*, *Cylindropuntia acanthocarpa*, *Menodora spinescens*, and *Lycium andersonii*. Commonly associated herbs include *Bromus rubens*, *Erodium cicutarium*, *Achnatherum speciosum*, and *Sphaeralcea ambigua*.

Dynamics: *Yucca brevifolia* is an emergent small tree over a shrub or grass canopy. *Yucca brevifolia* is a relatively long-lived and fast-growing plant. Vegetative reproduction by adventitious roots and stems following disturbance is the most important mode of regeneration on many sites. There is a high degree of stand-to-stand variation in structure and species composition. Stands are threatened by grazing and vandalism.

Classification Comments

None

Classification Confidence of Alliance: High

Conservation Status Rank

Global: G4

State (California): S3

References

Evens et al. 2012, Keeler-Wolf and Thomas 2000, Keeler-Wolf et al. 2005, NatureServe 2012, Sawyer et al. 2009, VegCAMP and AIS 2013

Surveys (with Sample Sizes) Used in Description

MOJN: N=134

LAKE (n=4): LAKE0270, LAKE0423, LAKE0427, LAKE0429

DEVA (n=28): DEVA0144, DEVA0149, DEVA0236, DEVA9121, DEVA9135, DEVA9145, DEVA9227, DEVA9241, DEVA9263, DEVA9265, DEVA9323, DEVA9324, DEVA9326, DEVA9453, DEVA9568, DEVA9572, DEVA9907, DEVAD175, DEVAS054, DEVAS058, DEVAS070, DEVAS090, DEVAS091, DEVAS124, MOJC0065, MOJC0598, MOJC1069, MOJC1070

MOJA (n=84): MOJA0107, MOJA0131, MOJA0216, MOJA0228, MOJA0233, MOJA0237, MOJA0298, MOJA0318, MOJA0339, MOJA9106, MOJA9109, MOJA9110, MOJA9112, MOJA9128, MOJA9129, MOJA9134, MOJA9146, MOJA9173, MOJA9174, MOJA9176, MOJA9208, MOJA9214, MOJA9219, MOJA9238, MOJA9240, MOJA9242, MOJA9243, MOJA9244, MOJA9246, MOJA9258, MOJA9266, MOJA9278, MOJA9279, MOJA9295, MOJA9321, MOJA9325, MOJA9327, MOJA9328, MOJA9331, MOJA9341, MOJA9356, MOJA9358, MOJA9364, MOJA9395, MOJA9396, MOJA9399, MOJA9578, MOJA9579, MOJA9580, MOJA9610, MOJA9642, MOJA9643, MOJAJC01, MOJAJC02, MOJC0006, MOJC0074, MOJC0075, MOJC0079, MOJC0080, MOJC0081, MOJC0194, MOJC0941, MOJC0974, MOJC0975, MOJC0976, MOJC0995, MOJC0998, MOJC1000, MOJC1001, MOJC1002, MOJC1079, MOJC1080, MOJC1082, MOJC1083, MOJC1084, MOJC1085, MOJC1094, MOJC1097, MOJC1145, MOJC1146, MOJC1176, MOJC1179, MOJC1180, MOJC1181

MOJN-Johnson (n=18): MOJJE241, MOJJE244, MOJJE248, MOJJE385, MOJJE456, MOJJE548, MOJJE566, MOJJE630, MOJJE632, MOJJE633, MOJJE668, MOJJE670, MOJJE681, MOJJE686, MOJJE756, MOJJE759, MOJJE881, MOJJE883

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Tree										
	<i>Yucca brevifolia</i>	100	93	2.4	0.2	19	x	x		
Shrub										
	<i>Ephedra nevadensis</i>	88.7	7.9	1.2	0.11	5.7	x			
	<i>Cylindropuntia acanthocarpa</i>	60	5.4	0.9	0.2	8.5				x
	<i>Lycium andersonii</i>	54.8	3	0.4	0.2	3.5				x
	<i>Menodora spinescens</i>	51.3	5.7	0.9	0.11	10				x
	<i>Eriogonum fasciculatum</i>	47.8	2.9	0.5	0.2	4				
	<i>Krascheninnikovia lanata</i>	41.7	2.8	0.4	0.1	4				
	<i>Echinocereus engelmannii</i>	41.7	1	0.2	0.1	3				
	<i>Hymenoclea salsola</i>	40	3.5	0.6	0.11	17.5				
	<i>Yucca schidigera</i>	40	3.7	0.6	0.01	6				
	<i>Yucca baccata</i>	35.7	4.1	0.7	0.2	4.5				
	<i>Thamnosma montana</i>	35.7	1	0.2	0.2	1.7				
	<i>Gutierrezia sarothrae</i>	34.8	2.9	0.4	0.1	6				
	<i>Ericameria cooperi</i>	31.3	2.3	0.4	0.2	5				
	<i>Krameria erecta</i>	31.3	1	0.2	0.2	3				
	<i>Salazaria mexicana</i>	30.4	2.9	0.5	0.2	10.5				
	<i>Opuntia polyacantha</i> var. <i>erinacea</i>	30.4	1	0.1	0.11	2				
	<i>Larrea tridentata</i>	27.8	3.9	0.6	0.1	7.5				
	<i>Coleogyne ramosissima</i>	27	10	2.3	0.11	25				
	<i>Cylindropuntia echinocarpa</i>	26.1	0.5	0.1	0.11	0.5				
	<i>Salvia dorrii</i>	25.2	2	0.3	0.01	8				
Herb										
	<i>Bromus rubens</i>	85.2	13	1.2	0.11	10	x			
	<i>Sphaeralcea ambigua</i>	64.3	3.1	0.2	0.1	1				x
	<i>Erodium cicutarium</i>	59.1	7.9	0.8	0.2	13				x
	<i>Achnatherum speciosum</i>	53	5.4	0.3	0.2	3				x
	<i>Eriogonum inflatum</i>	45.2	2.2	0.2	0.1	1.5				
	<i>Muhlenbergia porteri</i>	44.3	3.3	0.3	0.2	8				
	<i>Pleuraphis jamesii</i>	39.1	7.8	1	0.2	20.5				
	<i>Dasyochloa pulchella</i>	37.4	2.7	0.2	0.1	4				
	<i>Achnatherum hymenoides</i>	34.8	1.3	0.1	0.01	0.5				
	<i>Amsinckia</i>	31.3	1.1	0.1	0.11	1				
	<i>Bouteloua eriopoda</i>	26.1	4.2	0.6	0.2	12				
	<i>Cryptantha</i>	26.1	2.7	0.2	0.6	1.5				
Non-vascular										
	Cryptogamic crust	33	27	0.3	0.2	6				

***Yucca schidigera* Shrubland Alliance**

Common Name: Mojave Yucca Scrub

Group Assignment: G296; **Alliance Code:** A3147

Alliance Concept

The Mojave Yucca Scrub Alliance forms an open to intermittent shrub layer. The emergent tree layer is typically sparse to open, and the herbaceous layer is sparse to open. The alliance is found on a variety of upland landforms including hills and upper bajadas at various aspects. Soils are derived from a variety of substrates including alluvium, gneiss, and granodiorite and textures were highly variable. Elevations range from approximately 550 to 1850 meters. *Yucca schidigera* is typically co-dominant in the shrub layer, and other characteristic species include *Cylindropuntia acanthocarpa*, *Echinocereus engelmannii*, *Ephedra nevadensis* and *Eriogonum fasciculatum*. Shrubs that are often present include *Acacia greggii*, *Ferocactus cylindraceus*, *Krameria erecta*, *Larrea tridentata*, *Thamnosma montana* and *Viguiera parishii*. Dominant and characteristic herbs include *Bromus rubens* and *Erodium cicutarium*, and those often present are *Eriogonum inflatum* and *Sphaeralcea ambigua*.

Diagnostic Criteria: This alliance is characterized by an open to intermittent shrub layer of *Yucca schidigera* co-dominant with other shrubs including *Coleogyne ramosissima*, *Cylindropuntia acanthocarpa*, *Echinocereus engelmannii*, *Ephedra nevadensis*, and *Eriogonum fasciculatum*. *Yucca schidigera* is at least 2% or more in absolute cover in stands, and the overall shrub cover ranges from 8 to 44 percent.

Alliance Distribution

The alliance is well-defined in sampling at all three Parks. It is scattered throughout LAKE and MOJA in mid to upper elevations.

States: AZ, CA, NV

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (95): 322Ai, 322Aj, 322Ak, 322Al, 322Am, 322Av

Park Sampling Zones: **LAKE:** Katherine, Pearce Ferry, Temple Bar; **MOJA:** Baker-Halloran, Cima Dome NW, Cima Dome SE, Cinder Cones, Clark Mountain, Clark Mtn, Clark Mtn West, Clipper Villy, Fenner Villy, Fenner Villy West, Granite Mtns, HackberryVontrigger, Hart Peak, Ivanpah Mtns, Ivanpah Villy, Kelso Mtns, Kelso-Cima, Lanfair Villy, Marl Mtns, Mid Hills, Mineral Hill, New York Mtns, Piute Range, Providence Mtns, Valley Wells, Van Winkle Mtn, Vulcan Mine, Woods Mtns

Associations

Association Scientific Name	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Yucca schidigera</i> – <i>Coleogyne ramosissima</i>	17			x	
<i>Yucca schidigera</i> – <i>Cylindropuntia acanthocarpa</i>	17			x	
<i>Yucca schidigera</i> – <i>Eriogonum fasciculatum</i>	32	x		x	
<i>Yucca schidigera</i> – <i>Larrea tridentata</i> – <i>Ambrosia dumosa</i> [CEGL005295]	18	x		x	
<i>Yucca schidigera</i> – <i>Larrea tridentata</i> – <i>Ephedra nevadensis</i>	12			x	x

Association Notes: None.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 1180 m, Range 592 – 1809 m

Aspect: N (10), NE (10), E (18), NW (8), SE (8), SW (26), W (1), S (14)

Slope: Mean 10.7 degrees, Range 1 – 35 degrees

Macro Topography: High level/summit (5), High slope (14), Low level/bottom (4), Lowslope (24), Midslope (21), Toeslope (alluvial fan/bajada) (3)

Tree Cover: Mean 0.2%, Range 0 – 2%

Shrub Cover: Mean 20.3%, Range 7.6 – 43.5%

Herb Cover: Mean 6.8%, Range 0 – 22%

Large Rock: Mean 14.3%, Range 0 – 93%

Small Rock: Mean 70.0%, Range 0 – 97.5%

Fines Cover: Mean 10.3%, Range 0 – 62.5%

Litter Cover: Mean 2.3%, Range 0 – 10.2%

Geology: alkali-granite (alaskite) (5), alluvium (24), gneiss (14), granodiorite (19), gravel (1), limestone (4), rhyolite (13), sand (1), sandstone (9), schist (1), tephrite (basanite) (4)

Soil Texture: Clay (4), Clay loam (13), Fine sand (1), Fine silty clay (1), Loam (6), Loamy sand (11), Medium loam (1), Medium sand (3), Medium silt loam (2), Medium to very fine sandy loam (7), Moderately coarse loamy sand (1), Moderately fine clay loam (1), Moderately fine sandy clay loam (2), Moderately fine silty clay loam (2), Sand (2), Sandy clay (1), Sandy loam (26), Silt loam (1), Silty clay (3)

Environment: The alliance is found on a variety of upland landforms including hills and upper bajadas at various aspects. Soils are derived from a variety of substrates including alluvium, gneiss, and granodiorite and textures were highly variable.

Vegetation Description

Vegetation Structure: The Alliance forms an open to intermittent shrub layer and the overall shrub cover ranges from 8 to 44 percent cover. The tree layer is typically sparse to open, and the herb layer is sparse to open. Non-vascular plants are typically sparse to open.

Vegetation Floristics: *Yucca schidigera* is typically co-dominant in the shrub layer, and other characteristic species include *Cylindropuntia acanthocarpa*, *Echinocereus engelmannii*, *Ephedra nevadensis* and *Eriogonum fasciculatum*. Shrubs that are often present include *Acacia greggii*, *Ferocactus cylindraceus*, *Krameria erecta*, *Larrea tridentata*, *Thamnosma montana* and *Viguiera parishii*. Dominant and characteristic herbs include *Bromus rubens* and *Erodium cicutarium*, and those often present are *Eriogonum inflatum* and *Sphaeralcea ambigua*.

Dynamics: *Yucca schidigera* stands are floristically diverse and occur in a matrix with other mid-elevation mixed desert scrub types in the Mojave Desert including alliances with *Coleogyne ramosissima*, *Cylindropuntia acanthocarpa*, *Ephedra nevadensis*, *Eriogonum fasciculatum*, and *Viguiera parishii*.

Classification Comments

Associations of *Yucca schidigera*–*Coleogyne ramosissima* and *Yucca schidigera*–*Eriogonum fasciculatum* were difficult to separate in the classification from associations in the *Coleogyne ramosissima* and *Eriogonum fasciculatum*–*Viguiera parishii* alliances, respectively. Current rules (cf. Thomas et al. 2004) allow co-dominance or dominance of other shrubs as long as *Yucca schidigera* is at least 2% cover to classified in this *Yucca* alliance.

Classification Confidence of Alliance: High

Conservation Status Rank

Global: G4

State (California): S4

References

Evens et al. 2012, Keeler-Wolf and Thomas 2000, cf. Keeler-Wolf et al. 1998b, NatureServe 2012, Sawyer et al. 2009, VegCAMP and AIS 2013

Surveys (with Sample Sizes) Used in Description

MOJN: N=96

LAKE (n=7): LAKE0175, LAKE0618, LAKE0621, LAKE0623, LAKE9166, LAKE9614, LAKE9615

DEVA (n=0)

MOJA (n=88): MOJA0103, MOJA0154, MOJA0251, MOJA0340, MOJA9125, MOJA9153, MOJA9179, MOJA9252, MOJA9253, MOJA9254, MOJA9255, MOJA9284, MOJA9296, MOJA9301, MOJA9310, MOJA9313, MOJA9315, MOJA9330, MOJA9333, MOJA9336, MOJA9337, MOJA9338, MOJA9362, MOJA9373, MOJA9376, MOJA9397, MOJA9415, MOJA9419, MOJA9420, MOJA9422, MOJA9429, MOJA9437, MOJA9457, MOJA9461, MOJA9500, MOJA9520, MOJA9523, MOJA9531, MOJA9532, MOJA9533, MOJA9534, MOJA9536, MOJA9537, MOJA9538, MOJA9565, MOJA9568, MOJA9569, MOJA9576, MOJA9582, MOJA9585, MOJA9586, MOJA9592, MOJA9608, MOJA9622, MOJA9623, MOJA9625, MOJA9632, MOJA9634, MOJA9641, MOJA9668, MOJA9903,

MOJA9904, MOJA9905, MOJA9918, MOJC0011, MOJC0077, MOJC0085, MOJC0094, MOJC0097, MOJC0098, MOJC0189, MOJC0191, MOJC0195, MOJC0211, MOJC0297, MOJC0352, MOJC0353, MOJC0354, MOJC0981, MOJC0982, MOJC0997, MOJC1074, MOJC1076, MOJC1081, MOJC1154, MOJC1211, MOJC1212, MOJC1231
 MOJN-Johnson (n=1): MOJJE700

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Shrub	<i>Yucca schidigera</i>	100	18	3.3	1	7	x			
	<i>Cylindropuntia acanthocarpa</i>	83.2	7.4	1.4	0.2	12.5	x			
	<i>Eriogonum fasciculatum</i>	77.9	8.6	1.6	0.2	10	x			
	<i>Echinocereus engelmannii</i>	77.9	1.5	0.3	0.2	2	x			
	<i>Ephedra nevadensis</i>	76.8	5	0.9	0.2	4.5	x			
	<i>Larrea tridentata</i>	74.7	7.8	1.3	0.2	8				x
	<i>Krameria erecta</i>	68.4	1.6	0.3	0.2	1.5				x
	<i>Ferocactus cylindraceus</i>	65.3	3.2	0.6	0.2	5				x
	<i>Acacia greggii</i>	57.9	2.4	0.5	0.2	4				x
	<i>Viguiera parishii</i>	54.7	2.8	0.6	0.2	6				x
	<i>Thamnosma montana</i>	51.6	1.4	0.3	0.2	2				x
	<i>Ambrosia dumosa</i>	44.2	6.1	1	0.2	9				
	<i>Salazaria mexicana</i>	41.1	2	0.5	0.1	16.5				
	<i>Ericameria cooperi</i>	40	2.5	0.5	0.2	8				
	<i>Opuntia basilaris</i>	37.9	0.7	0.1	0.2	1.5				
	<i>Stephanomeria pauciflora</i>	36.8	0.6	0.1	0.2	1				
	<i>Coleogyne ramosissima</i>	35.8	6.1	1.2	0.2	11				
	<i>Lycium andersonii</i>	32.6	1.6	0.3	0.2	6.5				
	<i>Gutierrezia sarothrae</i>	32.6	1.4	0.3	0.2	8				
	<i>Encelia virginensis</i>	29.5	0.9	0.2	0.2	2				
	<i>Hymenoclea salsola</i>	26.3	1.5	0.3	0.2	7				
	<i>Psilostrophe cooperi</i>	25.3	0.7	0.1	0.2	5				
Herb	<i>Bromus rubens</i>	94.7	23	2.2	0.2	18	x			
	<i>Erodium cicutarium</i>	83.2	14	1.2	0.2	12	x			
	<i>Sphaeralcea ambigua</i>	57.9	2.8	0.2	0.2	0.5				x
	<i>Eriogonum inflatum</i>	54.7	2.9	0.2	0.2	3				x
	<i>Amsinckia</i>	47.4	2.9	0.2	0.2	2				
	<i>Pleuraphis rigida</i>	46.3	8.9	0.9	0.2	12				
	<i>Achnatherum speciosum</i>	45.3	3.4	0.2	0.2	6				
	<i>Xylorhiza tortifolia</i>	41.1	2.1	0.1	0.2	1				
	<i>Schismus</i>	36.8	3.8	0.3	0.2	6				
	<i>Dasyochloa pulchella</i>	32.6	1.8	0.1	0.2	1				
	<i>Porophyllum gracile</i>	28.4	1.4	0.1	0.1	0.5				
	<i>Mirabilis laevis</i>	27.4	1	0.1	0.2	0.5				
Non-vasc	Unknown Lichen	43.2	34	0.2	0.4	2				
	Cryptogamic crust	34.7	26	0.4	0.2	8				

3. Desert & Semi-Desert Class

3.B.1. Cool Semi-Desert Scrub & Grassland Formation

3.B.1.Ne. Western North American Cool Semi-Desert Scrub & Grassland Division

M171. Great Basin & Intermountain Dry Shrubland & Grassland Macrogroup

G310. Intermountain Semi-Desert Shrubland & Steppe Group

***Gutierrezia sarothrae* - *Gutierrezia microcephala* Dwarf-Shrubland Alliance**

Common Name: Snakeweed Scrub

Group Assignment: G310; **Alliance Code:** A3203

Alliance Concept

The Snakeweed Scrub Alliance forms an open shrub layer. The emergent tree layer, when present, is typically sparse, and the herbaceous layer is sparse to open. The alliance is found primarily on a variety of landforms and aspects. Soils are derived from a variety of substrates and textures include clay loam, loam, and loamy sand. Elevations range from approximately 850 to 2050 meters. The dominant and characteristic shrub is *Gutierrezia sarothrae* or *G. microcephala*, and those that are often present at low cover include *Larrea tridentata* and *Opuntia polyacantha* var. *erinacea*. Dominant herbs include *Bromus rubens*, and characteristic herbs include *Bromus rubens*, and *Sphaeralcea ambigua*, and those often present are *Achnatherum speciosum*, *Bromus tectorum*, *Elymus elymoides*, *Erodium cicutarium* and *Pleuraphis rigida*.

Diagnostic Criteria: This alliance is characterized by an open shrub layer with *Gutierrezia sarothrae* or *G. microcephala* dominant. The overall shrub cover ranges from 6 to 10 percent.

Alliance Distribution

The alliance is well-defined in sampling at eastern MOJA and is represented in DEVA by one sample in Warm Springs Canyon in the Panamint Mountains. It was not field documented but was mapped in LAKE along the border with Grand Canyon - Parashant National Monument. It is found at mid to high elevations.

States: (AZ); CA

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (7): 322Af, 322Aj, 322Ak, 322Al, (322Av)

Park Sampling Zones: **DEVA:** Panamint Mtns; **(LAKE:** Parashant); **MOJA:** Clark Mtn, Hackberry/Vontrigger, Mid Hills, New York Mtns

Associations

Association Scientific Name [NVC Code]	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Gutierrezia sarothrae</i> -(<i>Opuntia</i> spp.) / <i>Sphaeralcea ambigua</i> [cf. CEG002690]	7	(x)	x	x	

Association Notes: None.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 1428m, Range 869 – 2022 m

Aspect: N (3), NE (1), E (1), NW (1)

Slope: Mean 18.5 degrees, Range 3 – 49 degrees

Macro Topography: High level/summit (1), Lowslope (4), Midslope (2)

Tree Cover: Mean 0.1%, Range 0 – 0.6%

Shrub Cover: Mean 7.2%, Range 6.1 – 9.8%

Herb Cover: Mean 17.4%, Range 0 – 35%

Large Rock: Mean 24.4%, Range 0 – 96%

Small Rock: Mean 56.1%, Range 2 – 92%

Fines Cover: Mean 15.7%, Range 0 – 49%

Litter Cover: Mean 3.7%, Range 2 – 7%

Geology: alluvium (1), granodiorite (2), rhyolite (3), sandstone (1)

Soil Texture: Clay loam (2), Loam (1), Loamy sand (1), Sandy loam (2)

Environment: The Snakeweed Scrub Alliance is found on a variety of landforms and aspects at mid to high elevations. Soils are derived from a variety of substrates and textures include clay loam, loam, and loamy sand.

Vegetation Description

Vegetation Structure: The alliance forms an open shrub layer and the overall shrub cover ranges from 6 to 10 percent. The tree layer is typically sparse, and the herb layer is sparse to open. Non-vascular plants are typically sparse.

Vegetation Floristics: The dominant and characteristic shrubs is *Gutierrezia sarothrae* or *G. microcephala*, and those that are often present at low cover include *Larrea tridentata* and *Opuntia polyacantha* var. *erinacea*. Dominant herbs include *Bromus rubens*, and characteristic herbs include *Bromus rubens*, and *Sphaeralcea ambigua*, and those often present are

Achnatherum speciosum, *Bromus tectorum*, *Elymus elymoides*, *Erodium cicutarium* and *Pleuraphis rigida*.

Dynamics: *Gutierrezia sarothrae* was the dominant sampled in the parks, though *G. microcephala* may be also found dominant in the region for this alliance. Stands have been sampled in recently burned areas and along steep cliffs with colluvial disturbance; they also have been observed in rocky minor drainages that are intermittently flooded in mountains.

Classification Comments

Stands in this alliance have *Gutierrezia* species apparently dominant in disturbed areas; though, a variety of other alliances can have *Gutierrezia* species co-dominant. This alliance is currently placed in G310 Intermountain Semi-Desert Shrubland & Steppe Group and related alliances are in G296 Mojave Mid-Elevation Mixed Desert Scrub Group in the NVC hierarchy.

Classification Confidence of Alliance: Moderate

Conservation Status Rank

Global: G3

State (California): S3

References

NatureServe 2012, cf. Sawyer et al. 2009

Surveys (with Sample Sizes) Used in Description

MOJN: N=7

LAKE (n=0)

DEVA (n=1): DEVA9280

MOJA (n=6): MOJA0111, MOJA0322, MOJA9268, MOJA9269, MOJA9614, MOJA9615

MOJN-Johnson (n=0)

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Tree										
	<i>Yucca brevifolia</i>	28.6	18	0.1	0.2	0.21				
	<i>Juniperus osteosperma</i>	28.6	5.4	0	0.01	0.2				
Shrub										
	<i>Gutierrezia sarothrae</i>	100	45	3.1	2	5	x		x	
	<i>Larrea tridentata</i>	57.1	5.4	0.5	0.01	3				x
	<i>Opuntia polyacantha</i> var. <i>erinacea</i>	57.1	1.6	0.1	0.2	0.2				x
	<i>Cylindropuntia acanthocarpa</i>	42.9	3.3	0.2	0.01	1.5				
	<i>Yucca schidigera</i>	42.9	1.9	0.1	0.2	0.5				
	<i>Eriogonum wrightii</i>	42.9	1.5	0.1	0.1	0.5				
	<i>Ephedra nevadensis</i>	42.9	1.3	0.1	0.2	0.2				
	<i>Stephanomeria pauciflora</i>	42.9	1.1	0.1	0.2	0.2				
	<i>Prunus fasciculata</i>	42.9	0.9	0.1	0.01	0.2				
	<i>Ephedra viridis</i>	28.6	1.4	0.1	0.2	0.5				
	<i>Eriogonum heermannii</i>	28.6	0.8	0.1	0.2	0.2				
	<i>Krameria erecta</i>	28.6	0.8	0.1	0.2	0.2				
	<i>Lycium andersonii</i>	28.6	0.8	0.1	0.2	0.2				
	<i>Menodora scabra</i>	28.6	0.8	0.1	0.2	0.2				
	<i>Salazaria mexicana</i>	28.6	0.8	0.1	0.2	0.2				
	<i>Yucca baccata</i>	28.6	0.9	0.1	0.2	0.2				
	<i>Ericameria cooperi</i>	28.6	0.4	0	0.01	0.2				
Herb										
	<i>Bromus rubens</i>	100	33	10	0.2	25	x		x	
	<i>Sphaeralcea ambigua</i>	100	22	2.9	0.2	5	x			
	<i>Erodium cicutarium</i>	71.4	2.9	0.8	0.2	5				x
	<i>Pleuraphis rigida</i>	71.4	3.4	0.7	0.2	3				x
	<i>Bromus tectorum</i>	57.1	2.9	0.7	0.2	2				x
	<i>Achnatherum speciosum</i>	57.1	3	0.2	0.2	0.5				x
	<i>Elymus elymoides</i>	57.1	1.5	0.2	0.2	0.5				x
	<i>Amsinckia</i>	42.9	2	0.2	0.2	1				
	<i>Aristida purpurea</i>	42.9	1.4	0.1	0.2	0.5				
	<i>Eriogonum inflatum</i>	42.9	2.4	0.1	0.2	0.2				
	<i>Gilia</i>	28.6	6.4	0.2	0.6	0.6				
	<i>Arabis</i>	28.6	0.5	0.1	0.2	0.2				
	<i>Chaetopappa ericoides</i>	28.6	0.7	0.1	0.2	0.2				
	<i>Hymenoxys cooperi</i>	28.6	0.7	0.1	0.2	0.2				
	<i>Mirabilis multiflora</i>	28.6	0.7	0.1	0.2	0.2				
Non-vascular										
	Unknown Lichen	42.9	29	0.2	0.4	0.4				
	Cryptogamic crust	28.6	19	0.1	0.2	0.2				
	Unknown Moss	28.6	9.5	0.1	0.2	0.2				

***Krascheninnikovia lanata* Dwarf-shrubland & Dwarf-Shrub Herbaceous Alliance**

Common Name: Winterfat Scrubland

Group Assignment: G310; **Alliance Code:** A3202

Alliance Concept

The Winterfat Scrubland Alliance forms an open shrub layer. The emergent tree layer, when present, is typically sparse to open, and the herbaceous layer is sparse to open. The alliance is found on a variety of landforms and aspects, though usually alkaline flats around playas and along drainage terraces, plains, and old lakebeds above current drainages. Soils are derived from a variety of substrates including alluvium, rhyolite, and sandstone, and textures include clay loam, silt, and sandy loam. Elevations range from approximately 950 to 2050 meters. The dominant and characteristic shrub is *Krascheninnikovia lanata*, and those that are often present include *Atriplex confertifolia* and *Lycium andersonii*. Herbaceous plants often present are *Achnatherum hymenoides*, *Bromus rubens*, and *Sphaeralcea ambigua*. Cryptogamic crust is commonly associated with this vegetation alliance.

Diagnostic Criteria: This alliance is characterized by an open shrub layer with *Krascheninnikovia lanata* dominant. The overall shrub cover ranges from 6 to 25 percent.

Alliance Distribution

The alliance is well-defined in sampling in the northern portion of DEVA and in the Providence Mountain Range in MOJA. There was one sample from LAKE in the Willow Beach area. The elevations range from mid to high.

States: AZ, CA

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (3) 322Al, 322Av; Southeastern Great Basin (16): 341Fa, 341Fb, 341Fc, 341Fe, 341Ff

Park Sampling Zones: **DEVA:** CottonWood Mtns, Joshua Flat, Last Chance Range, Nelson Range, Panamint Mtns; **LAKE:** Willow Beach; **MOJA:** Lanfair Vly, Mid Hills

Associations

Association Scientific Name [NVC Code]	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Krascheninnikovia lanata</i> [CEGL001320]	18	x	x	x	x
<i>Krascheninnikovia lanata</i> (alliance)	2		x		

Association Notes: None.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 1503.2 m, Range 955 – 2017 m

Aspect: Flat, Variable (2), N (4), NE (2), E (6), NW (1), SE (1), W (1), SW (1)

Slope: Mean 7.5 degrees, Range 0 – 29 degrees

Macro Topography: High level/summit (1), High slope (3), Low level/bottom (4), Lowslope (2), Midslope (4)

Tree Cover: Mean 0.2%, Range 0 – 2.2%

Shrub Cover: Mean 13.1%, Range 5.8 – 25.2%

Herb Cover: Mean 7.7%, Range 1 – 39%

Large Rock: Mean 2.5%, Range 0 – 12%

Small Rock: Mean 60.7%, Range 0 – 95%

Fines Cover: Mean 34.0%, Range 2 – 98%

Litter Cover: Mean 1.8%, Range 0 – 5%

Geology: alluvium (5), dolostone (dolomite) (3), granodiorite (1), limestone (1), rhyolite (3), sandstone (5), shale (1)

Soil Texture: Clay loam (4), Loam (1), Loamy sand (3), Medium silt (1), Sandy clay (1), Sandy loam (5)

Environment: The alliance is found on a variety of landforms and aspects, though usually alkaline flats around playas and along drainage terraces, plains, and old lakebeds above current drainages. Sometimes stands are on north-facing slopes where soils have high clay content. Soils are derived from a variety of substrates including alluvium, rhyolite, and sandstone, and textures include clay loam, silt, and sandy loam. The alliance was found at mid to high elevations.

Vegetation Description

Vegetation Structure: The alliance forms an open shrub layer and the overall shrub cover ranges from 6 to 25 percent. The tree layer is typically sparse to open, and the herb layer is sparse to intermittent. Non-vascular plants are typically not present or sparse.

Vegetation Floristics: The dominant and characteristic shrub is *Krascheninnikovia lanata*, and those that are often present include *Atriplex confertifolia* and *Lycium andersonii*. Herbaceous plants often present are *Achnatherum hymenoides*, *Bromus rubens*, and *Sphaeralcea ambigua*. Cryptogamic crust is commonly associated with this vegetation alliance.

Dynamics: *Krascheninnikovia lanata* stands occur in a fine-scale matrix with other mid to high elevation shrubland alliances including *Artemisia tridentata*, *Atriplex canescens*, *Atriplex confertifolia*, *Coleogyne ramosissima*, *Grayia spinosa* and *Yucca brevifolia*.

Classification Comments

None.

Classification Confidence of Alliance: Moderate

Conservation Status Rank

Global: G4

State (California): S2

References

Keeler-Wolf and Thomas 2000, NatureServe 2012, Root 1978, Sawyer et al. 2009, VegCAMP and AIS 2013

Surveys (with Sample Sizes) Used in Description

MOJN: N=20

LAKE (n=1): LAKE9310

DEVA (n=16): DEVA0134, DEVA0141, DEVA0233, DEVA9103, DEVA9106, DEVA9123, DEVA9142, DEVA9201, DEVA9246, DEVA9251, DEVA9255, DEVA9357, DEVAR031, DEVAR086, MOJC0042, MOJC0494

MOJA (n=2): MOJA9360, MOJA9810

MOJN-Johnson (n=1): MOJJE773

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Tree	<i>Yucca brevifolia</i>	26.3	26	0.2	0.2	2				
Shrub	<i>Krascheninnikovia lanata</i>	100	56	7.6	2	25	x	x		
	<i>Lycium andersonii</i>	52.6	6.4	0.7	0.2	4.5				x
	<i>Atriplex confertifolia</i>	52.6	4.4	0.5	0.2	2				x
	<i>Ephedra nevadensis</i>	42.1	0.9	0.1	0.2	0.5				
	<i>Picrothamnus desertorum</i>	42.1	1	0.1	0.2	0.5				
	<i>Atriplex canescens</i>	31.6	3.1	0.3	0.2	3				
	<i>Psoralea arborescens</i>	31.6	1.4	0.1	0.2	1				
	<i>Menodora spinescens</i>	26.3	2.7	0.2	0.2	3				
	<i>Acamptopappus shockleyi</i>	26.3	2.4	0.2	0.2	3				
Herb	<i>Achnatherum hymenoides</i>	63.2	8.3	0.3	0.2	3				x
	<i>Sphaeralcea ambigua</i>	63.2	2.9	0.2	0.2	1				x
	<i>Bromus rubens</i>	52.6	5.1	0.5	0.2	3				x
	<i>Eriogonum inflatum</i>	47.4	6.4	0.1	0.2	0.5				
	<i>Oxytheca perfoliata</i>	42.1	4.3	0.3	0.2	2				
	<i>Amsinckia</i>	42.1	4.6	0.2	0.2	2				
	<i>Xylorhiza tortifolia</i>	36.8	2.2	0.1	0.2	1				
	<i>Gilia</i>	31.6	3.3	0.2	0.6	0.6				
	<i>Pleuraphis jamesii</i>	26.3	5.2	0.7	0.2	6				
	<i>Chaenactis</i>	26.3	3.7	0.2	0.4	2				
	<i>Salsola</i>	26.3	2	0.1	0.2	0.5				
	<i>Eriogonum nidularium</i>	26.3	0.8	0.1	0.2	0.2				
	<i>Phacelia fremontii</i>	26.3	1.1	0.1	0.2	0.2				
Non-vasc	Cryptogamic crust	57.9	54	0.1	0.2	0.2				x

3. Desert & Semi-Desert Class

3.B.1. Cool Semi-Desert Scrub & Grassland Formation

3.B.1.Ne. Western North American Cool Semi-Desert Scrub & Grassland Division

M171. Great Basin & Intermountain Dry Shrubland & Grassland Macrogroup

G311. Intermountain Semi-Desert Grassland Group

***Achnatherum hymenoides* - *Pseudoroegneria spicata* - *Muhlenbergia pungens* Herbaceous Alliance**

Common Name: Indian Ricegrass - Bluebunch Wheatgrass - Sandhill Muhly Grassland

Group Assignment: G311, G775; **Alliance Code:** A1262, A4011

Alliance Concept

The Indian Ricegrass - Bluebunch Wheatgrass - Sandhill Muhly Grassland Alliance forms a sparse to intermittent herbaceous layer. The shrub layer is sparse and the tree layer, if present, is sparse. The alliance is found primarily along sand dunes and sand sheets, often with north and northwest aspects. Soils are derived from alluvium and textures fine to medium sand. Elevations range from approximately 900 to (3400) meters. *Achnatherum hymenoides* is characteristically present and may be co-dominant to dominant in the herbaceous layer with other herbs such as *Sphaeralcea ambigua* at low cover. Those often present are *Oenothera deltoides* and *Salsola* spp. In the shrub layer, *Psoralea* spp. is sometimes present.

Diagnostic Criteria: This alliance is characterized by a sparse to intermittent herbaceous layer with *Achnatherum hymenoides* characteristically present, co-dominant or dominant. The overall herbaceous cover ranges from 1.5 to 34 percent cover.

Alliance Distribution

The alliance was sampled at DEVA near the Eureka Dunes at mid elevations, and stands have also been observed in MOJA such as at Devil's Playground and Kelso Dunes. Stands are also likely to occur at LAKE in sandy areas.

States: CA

Ecoregion Section Names (Sample Size) and Subsection Codes: Southeastern Great Basin (3): 341Fc; (Mojave Desert: 322Ai)

Park Sampling Zones: **DEVA:** Eureka Valley, (Inyo and Coso Mtns); **MOJA:** (Devil's Playground)

Associations

Association Scientific Name [NVC Code]	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Achnatherum hymenoides</i> Sand Sheet [cf. CEG002343]	3		x		

Association Notes: None.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 921 m, Range 914 – 930 m

Aspect: N (2), NW (1)

Slope: Mean 1 degrees, Range 1 – 1 degrees

Macro Topography:

Tree Cover: Mean 0%, Range 0 – 0%

Shrub Cover: Mean 0.5%, Range 0 – 1.5%

Herb Cover: Mean 12.8%, Range 1.5 – 34%

Large Rock: Mean 0%, Range 0 – 0.2%

Small Rock: Mean 28.5%, Range 10 – 37.7%

Fines Cover: Mean 62.5%, Range 62.5 – 62.5%

Litter Cover: Mean 3.5%, Range 0.2 – 10%

Geology: alluvium (3)

Soil Texture: Fine sand (1), Medium sand (2)

Environment: The alliance occurs at mid elevations in sandy areas including sand dunes and sheets. Aspects include north and northwest. Soils are fine to medium sand derived from alluvium.

Vegetation Description

Vegetation Structure: The alliance forms a sparse to intermittent herbaceous layer, and the overall herbaceous cover ranges from 1.5 to 34 percent cover. The shrub layer is typically sparse. The tree layer and non-vascular plants, when present, are sparse.

Vegetation Floristics: *Achnatherum hymenoides* is characteristically present and may be co-dominant to dominant in the herbaceous layer with other herbs such as *Sphaeralcea ambigua*. Those often present are *Oenothera deltoides* and *Salsola* spp. In the shrub layer, *Psoralea* spp. is sometimes present.

Dynamics: *Achnatherum hymenoides* stands occur throughout the Great Basin, but are rare in the Mojave Desert. Stands occur along sandy areas, including sand dunes and flats, and can

tolerate low nutrient and water levels. Along Death Valley Highway near the junction of Darwin Road, *Acnatherum hymenoides* can locally dominate on degraded areas of *Atriplex confertifolia*.

Classification Comments

Acnatherum hymenoides associations are currently placed in the Intermountain Semi-Desert Grassland Group (G311) and the Intermountain Sparsely Vegetated Dune Scrub & Grassland (G775). For this Mojave Desert Network classification, we have described one alliance in the G311 group.

Classification Confidence of Alliance: Moderate

Conservation Status Rank

Global: G4

State (California): S1

References

Buck-Diaz et al. 2012, cf. Keeler-Wolf and Thomas 2000, Sawyer et al. 2009, VegCAMP and AIS 2013

Surveys (with Sample Sizes) Used in Description

MOJN: N=3

LAKE (n=0)

DEVA (n=3): MOJC0626, MOJC0627, MOJC1238

MOJA (n=0)

MOJN-Johnson (n=0)

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Shrub	<i>Psoralea</i>	33	33	0.5	1.5	1.5				
Herb	<i>Achnatherum hymenoides</i>	100	27	4	0.5	11	x			
	<i>Sphaeralcea ambigua</i>	100	19	1	0.5	2	x			
	<i>Salsola</i>	67	32	7.5	0.5	22				x
	<i>Oenothera deltoidea</i>	67	6	0.3	0.5	0.5				x
	<i>Abronia</i>	33	5.6	0.2	0.5	0.5				
	<i>Baileya pleniradiata</i>	33	5.6	0.2	0.5	0.5				
	<i>Oenothera</i>	33	5.6	0.2	0.5	0.5				

***Sphaeralcea ambigua* Herbaceous Alliance**

Common Name: Apricot Globemallow Herbaceous Vegetation

Group Assignment: G311; **Alliance Code:** None

Alliance Concept

The Apricot Globemallow Herbaceous Alliance forms a sparse to intermittent herbaceous layer. The shrub layer is open and the tree layer is sparse. The alliance is found from valley bottoms and channel beds to summits at all aspects, especially in post-burn areas and along steep, rocky lava flows. Soils are derived from a variety of substrates and textures are variable. Elevations range from approximately 750 to 1950 meters. The characteristic herb is *Sphaeralcea ambigua*. Those often present are non-natives *Bromus rubens* and *Erodium cicutarium*. Shrubs that are sometimes present at low cover include *Thamnosma montana*, *Lycium andersonii*, *Stephanomeria pauciflora*, *Coleogyne ramosissima*, *Eriogonum fasciculatum*, *Gutierrezia sarothrae*, and *Larrea tridentata*.

Diagnostic Criteria: This alliance is characterized by a sparse to intermittent herbaceous layer with *Sphaeralcea ambigua* characteristically present and variable in cover. The overall herbaceous cover ranges from 0.2 to 46 percent cover.

Alliance Distribution

The alliance is well-defined with sampling from two Parks. It is scattered at mid to upper elevations throughout MOJA and in DEVA in the Black and Panamint Mountains, often in post-fire disturbance areas and other harsh sites. It is also expected at LAKE in post-disturbance areas.

States: CA

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (12): 322Ad, 322Aj, 322Al; Southeastern Great Basin (2): 341Ff

Park Sampling Zones: **DEVA:** Black Mtns, Panamint Mtns; **MOJA:** Baker-Halloran, Cinder Cones, Mid Hills, New York Mtns, Piute Range, Woods Mtns

Associations

Association Scientific Name [NVC Code]	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Sphaeralcea ambigua</i> (alliance)	1	(x)		x	
<i>Sphaeralcea ambigua</i> (post-burn) [cf. CEPS009532]	13		x	x	x
<i>Sphaeralcea ambigua</i> – <i>Lupinus</i> spp. (provisional)	1		x		

Association Notes: One sample, identified at alliance level, is found on a steep, rocky lava field, and another sample is in a valley bottom with high cover of *Lupinus* and *Mentzelia* spp. with characteristic presence of the *Sphaeralcea ambigua*.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 1376.4 m, Range 792 – 1913 m

Aspect: Flat, Variable (1), N (1), NE (3), E (1), SE (1), SW (2), W (1), S (5)

Slope: Mean 9.2 degrees, Range 0 – 25 degrees

Macro Topography: Channel bed (1), High level/summit (1), High slope (1), Low level/bottom (1), Lowslope (4), Midslope (4)

Tree Cover: Mean 0%, Range 0 – 0.5%

Shrub Cover: Mean 0.9%, Range 0.2 – 2%

Herb Cover: Mean 8.9%, Range 0.2 – 46%

Large Rock: Mean 20.5%, Range 0 – 70%

Small Rock: Mean 48.6%, Range 0 – 97.5%

Fines Cover: Mean 25.5%, Range 1 – 95%

Litter Cover: Mean 2.7%, Range 0 – 7%

Geology: alluvium (1), granodiorite (4), rhyolite (5), sandstone (3), tephrite (basanite) (1)

Soil Texture: Clay loam (1), Loam (2), Sand (1), Sandy loam (4), Silt (1)

Environment: The alliance occurs at mid to upper elevations on various landforms including valley bottoms and channel beds to summits at all aspects, especially in post-burn areas and steep, rocky lava flows. Soil texture is variable and derived from a variety of substrates.

Vegetation Description

Vegetation Structure: The alliance forms a sparse to intermittent herbaceous layer, and the overall herbaceous cover ranges from 0.2 to 46 percent cover. The tree layer is typically sparse, and the shrub layer is sparse to open. Non-vascular plants are typically sparse.

Vegetation Floristics: The characteristic herb is *Sphaeralcea ambigua*, which is variable in cover along with other herbs. Those often present are non-natives *Bromus rubens* and *Erodium cicutarium*. Shrubs that are sometimes present at low cover include *Thamnosma montana*, *Lycium andersonii*, *Stephanomeria pauciflora*, *Coleogyne ramosissima*, *Eriogonum fasciculatum*, *Gutierrezia sarothrae*, and *Larrea tridentata*.

Dynamics: *Sphaeralcea ambigua* and various desert annuals including *Salvia columbariae* readily germinate after disturbance, including fire, and interannual cover varies depending on moisture availability. These stands can naturally transition to shrub and tree stands within 5-10 years after disturbance, though invasion by non-natives, including *Bromus rubens*, can act as principal fuels and increase fire threat.

Classification Comments

None.

Classification Confidence of Alliance: Moderate

Conservation Status Rank

Global: GNR

State (California): GNR

References

None

Surveys (with Sample Sizes) Used in Description

MOJN: N=15

LAKE (n=0)

DEVA (n=6): DEVA9163, DEVAS135, DEVAS136, DEVAS138, DEVAS139, DEVAS147

MOJA (n=8): MOJA9108, MOJA9160, MOJA9175, MOJA9294, MOJA9512, MOJA9604, MOJC1099, MOJC1100

MOJN-Johnson (n=1): MOJJE278

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Shrub	<i>Thamnosma montana</i>	43	5.4	0.2	0.1	1				
	<i>Lycium andersonii</i>	43	4.9	0.1	0.1	0.5				
	<i>Stephanomeria pauciflora</i>	43	6.7	0.1	0.2	0.5				
	<i>Coleogyne ramosissima</i>	36	4.8	0.1	0.1	0.5				
	<i>Eriogonum fasciculatum</i>	36	3.4	0.1	0.1	0.2				
	<i>Gutierrezia sarothrae</i>	29	4.1	0.1	0.1	1				
	<i>Larrea tridentata</i>	29	3.3	0.1	0.1	0.5				
Herb	<i>Sphaeralcea ambigua</i>	100	11	1	0.1	4.5	x			
	<i>Bromus rubens</i>	71	9.4	0.8	0.1	4				x
	<i>Erodium cicutarium</i>	50	18	1.8	0.2	10				x
	<i>Cryptantha</i>	36	4.5	0.2	0.3	0.6				
	<i>Eriogonum inflatum</i>	36	1.7	0.1	0.1	0.5				
	<i>Salvia columbariae</i>	36	1.6	0	0.1	0.2				
	<i>Eriogonum nidularium</i>	36	1.7	0	0.1	0.1				
	<i>Achnatherum speciosum</i>	29	0.8	0.1	0.1	0.5				
	<i>Bromus tectorum</i>	29	1.2	0.1	0.1	0.5				
	<i>Amsinckia</i>	29	1.1	0.1	0.1	0.2				
	<i>Antheropeas</i>	29	1.3	0	0.1	0.1				

3. Desert & Semi-Desert Class

3.B.1. Cool Semi-Desert Scrub & Grassland Formation

3.B.1.Ne. Western North American Cool Semi-Desert Scrub & Grassland Division

M171. Great Basin & Intermountain Dry Shrubland & Grassland Macrogroup

G312. Colorado Plateau Blackbrush – Mormon-tea Shrubland

***Ephedra viridis* Colorado Plateau Shrubland Alliance**

Common Name: Mormon Tea Scrub

Group Assignment: G312; **Alliance Code:** A3201

Alliance Concept

The Mormon Tea Scrub Alliance forms an open to intermittent shrub layer. The emergent tree layer is typically sparse to open, and the herbaceous layer is sparse to open. The alliance is found on upland sites at various aspects typically in higher elevations along mountain slopes. Elevations range from approximately 600 to 2150 meters. Soils are rocky and well-drained, derived from a variety of substrates including granodiorite, rhyolite and shale, and textures include clay loam, loamy sand, and silt loam. *Ephedra viridis* is dominant or co-dominant in the shrub layer, and those shrubs often present include *Purshia tridentata* var. *glandulosa*. *Achnatherum speciosum* and *Bromus tectorum* are often present in the herbaceous layer.

Diagnostic Criteria: This alliance is characterized by an open to intermittent shrub layer with *Ephedra viridis* dominant or co-dominant. The overall shrub cover ranges from 3 to 35 percent.

Alliance Distribution

The alliance is well-defined in sampling at DEVA, with points scattered throughout the park. There are two samples from LAKE in the Boulder Canyon area, and there is one plot from MOJA near Kessler Peak. It was found at mid to high elevation.

States: AZ, CA, NV

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (5): 322Ac, 322Ad, 322Aj, 322Av, 322Ay; Southeastern Great Basin (12): 341Fc, 341Fd, 341Ff, 341Fg

Park Sampling Zones: **DEVA:** CottonWood Mtns, Grapevine Mtns, Green Water Rng/Vlly, Joshua Flat, Nelson Range, Nevada Triangle, Owlshead Mtns; **LAKE:** Callville, Willow Beach; **MOJA:** Ivanpah Mtns

Associations

Association Scientific Name	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Ephedra viridis</i> (provisional)	8	x	x	x	
<i>Ephedra viridis</i> – <i>Purshia tridentata</i> var. <i>glandulosa</i>	9		x		

Association Notes: None.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 1585 m, Range 613 – 2139 m

Aspect: N (4), NE (5), E (1), NW (2), SE (1), SW (1), S (3)

Slope: Mean 24 degrees, Range 2 – 42 degrees

Macro Topography: Channel bed (1), High level/summit (1), High slope (4), Lowslope (3), Midslope (8)

Tree Cover: Mean 0.3%, Range 0 – 2%

Shrub Cover: Mean 17.0%, Range 3.0 – 35.1%

Herb Cover: Mean 4.7%, Range 0 – 22%

Large Rock: Mean 37.5%, Range 0.2 – 94%

Small Rock: Mean 45.2%, Range 0 – 89%

Fines Cover: Mean 7.9%, Range 0 – 48%

Litter Cover: Mean 8.9%, Range 0 – 41%

Geology: alluvium (1), claystone (1), granodiorite (7), limestone (1), rhyolite (5), sandstone (1), shale (1)

Soil Texture: Clay loam (4), Loamy sand (2), Sand (1), Sandy loam (2), Silt loam (1)

Environment: The alliance is found on upland sites at various aspects primarily in higher elevations of the Mojave Desert along mountain slopes. Soils are typically rocky and well-drained, derived from a variety of substrates including granodiorite, rhyolite and shale, and textures include clay loam, loamy sand, and silt loam.

Vegetation Description

Vegetation Structure: The Alliance forms an open to intermittent shrub layer and the overall shrub cover ranges from 3 to 35 percent. The tree layer is typically sparse to open, and the herb layer is sparse to open. Non-vascular plants are sparse to intermittent

Vegetation Floristics: *Ephedra viridis* is dominant or co-dominant in the shrub layer, and those shrubs often present include *Purshia tridentata* var. *glandulosa*. *Achnatherum speciosum* and *Bromus tectorum* are often present in the herbaceous layer.

Dynamics: *Ephedra viridis* stands occur primarily on well-drained, rocky and shallow soils including steep slopes, as compared to related *Artemisia tridentata* stands that tolerate moister and deeper soils and residual alluvium.

Classification Comments

Associations with *Ephedra viridis* dominant or codominant are currently placed in two Groups in the NVC hierarchy: Colorado Plateau Blackbrush - Mormon-tea Shrubland Group (G312) and Intermountain Basins Cliff, Scree & Badland Sparse Vegetation Group (G570). Similarities between these two groups and related alliances/associations will undergo further review. For the Mojave Network classification, we have placed associations into one alliance in the G312 group. However, the stands sampled are also related to Mojave Mid-Elevation Mixed Desert Scrub (G296).

Additionally, associations of one or more *Ephedra* spp. co-dominant with *Artemisia tridentata* have been currently placed in a mixed *Artemisia tridentata* alliance per the NVC hierarchy. However, co-dominant stands were placed in the *Ephedra viridis* Alliance per Sawyer et al. (2009) and Thomas et al. (2004). We have placed these co-dominant stands in *Artemisia tridentata* ssp. *vaseyana* alliance, instead, as that taxon was co-dominant with *Ephedra viridis* in the study area.

Classification Confidence of Alliance: High

Conservation Status Rank

Global: G4

State (California): S4

References

Buck-Diaz et al. 2012, Keeler-Wolf and Thomas 2000, NatureServe 2012, Peterson 1984a, Sawyer et al. 2009, VegCAMP and AIS 2013

Surveys (with Sample Sizes) Used in Description

MOJN: N=17

LAKE (n=2): LAKE9199, LAKE9450

DEVA (n=14): DEVA0664, DEVA9295, DEVA9379, DEVA9479, DEVA9580, DEVA9594, DEVA9650, DEVA9656, DEVAS059, DEVAS121, DEVAS197, DEVAS199, DEVAS200, DEVAS212

MOJA (n=1): MOJA0109

MOJN-Johnson (n=0)

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Tree	<i>Yucca brevifolia</i>	29.4	26	0.1	0.11	0.2				
Shrub	<i>Ephedra viridis</i>	100	33	5.5	1	20	x		x	
	<i>Purshia tridentata</i> var. <i>glandulosa</i>	52.9	17	3.3	3	11				x
	<i>Eriogonum fasciculatum</i>	47.1	3.1	0.7	0.2	4				
	<i>Ericameria nauseosa</i>	47.1	0.9	0.1	0.11	0.5				
	<i>Prunus fasciculata</i>	35.3	2.8	0.4	0.2	2				
	<i>Grayia spinosa</i>	35.3	0.9	0.1	0.11	1				
	<i>Ericameria linearifolia</i>	29.4	4.9	1.4	0.11	20				
	<i>Gutierrezia sarothrae</i>	29.4	2.2	0.3	0.2	4				
Herb	<i>Achnatherum speciosum</i>	64.7	12	0.3	0.11	1				x
	<i>Bromus tectorum</i>	58.8	14	1.2	0.11	8				x
	<i>Bromus rubens</i>	41.2	12	1.2	0.2	15				
	<i>Mentzelia</i>	41.2	4.7	0.4	0.22	4				
	<i>Amsinckia</i>	35.3	2.1	0.1	0.11	0.2				
	<i>Elymus elymoides</i>	35.3	7.2	0.1	0.11	0.2				
	<i>Sphaeralcea ambigua</i>	35.3	1.9	0.1	0.11	0.2				
	<i>Phacelia vallis-mortae</i>	29.4	1.3	0.1	0.2	0.2				
Non-vasc	Unknown Lichen	47.1	39	7.5	0.2	100				
	Unknown Moss	35.3	8.9	0.2	0.1	2				
	Cryptogamic crust	29.4	11	0.1	0.2	0.2				

7. Agricultural & Developed Vegetation

7.C.2. Other Developed Vegetation Formation

7.C.2.1 Other Developed Vegetation Division

CGR040. Tree Developed Vegetation Macrogroup and CGR039. Shrub & Herb Developed Vegetation Macrogroup

CSG047. Temperate Tree Developed Vegetation Group and CSG045. Temperate Shrub & Herb Developed Vegetation Group

***Tamarix* spp. Planted Alliance**

Common Name: Tamarisk (Athel) Planted Stands

Group Assignment: CSG047 and CSG045, **Alliance Code:** None

Alliance Concept

The Tamarisk (Athel) Planted Stands Alliance forms an intermittent to continuous tree canopy with a sparse to open shrub understory. The alliance is found planted at alkali springs in DEVA along lowslopes, and it also is observed as planted stands in LAKE and MOJA in ornamental settings. Soils are derived from alluvium and texture is sand. Elevations range from approximately 200 to 750 meters. The dominant tree is *Tamarix aphylla*. The commonly associated shrubs include *Larrea tridentata* and *Nerium oleander*.

Diagnostic Criteria: This alliance is characterized by an intermittent to continuous tree canopy dominated by *Tamarix aphylla*. The overall tree cover ranges from 63 to 81 percent cover.

Alliance Distribution

The alliance was sampled at DEVA at low to mid elevations at Panamint, Warm, Shoot me up, and Ratatat Springs, and it was mapped as individuals and stands at the Travertine Springs complex (Thomas 2006). It also was observed as planted stands at Kelso in MOJA and at LAKE.

States: CA, (AZ, NV)

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (3): 322Ab, 322Af, (322Ak); Southeastern Great Basin (1): 341Fe

Park Sampling Zones: **DEVA:** Death Valley, Nelson Range, Panamint Mtns; **MOJA:** (Kelso-Cima)

Associations

Association Scientific Name	Sample Size	LAKE	DEVA	MOJA	Johnson
<i>Tamarix aphylla</i> Planted	4	(x)	x	(x)	

Association notes: None.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 573.3 m, Range 240 – 735 m

Aspect: NE (1)

Slope: 2 degrees

Macro Topography: Lowslope (1)

Tree Cover: Mean 76.3%, Range 63 – 81%

Shrub Cover: Mean 12.1%, Range 0.2 – 27%

Herb Cover: 0%

Large Rock: 0%

Small Rock: 4%

Fines Cover: 0%

Litter Cover: Mean 24%, Range 0 – 96%

Geology: alluvium (1)

Soil Texture: Sand (1)

Environment: The alliance is found planted in or near alkali springs in DEVA, primarily on low slopes at low to mid elevations. It also was observed as planted stands at Kelso in MOJA and in ornamental settings at LAKE. It occurs on sand derived from alluvium.

Vegetation Description

Vegetation Structure: The alliance forms an intermittent to continuous tree layer with a sparse to open shrub layer. The herbaceous layer, if present, is sparse.

Vegetation Floristics: The dominant tree is *Tamarix aphylla* in the overstory. Dominant and characteristic shrubs include *Larrea tridentata* and *Nerium oleander*.

Dynamics: *Tamarix aphylla* is an introduced, fast-growing tree and is tolerant of alkaline and saline soils. It mainly reproduces through vegetative re-sprouting on-site, as most of the seeds are sterile. It has been planted as windbreaks and for shade in various locations within the Mojave Desert, including in MOJA, where it does not appear to be invasively spreading. However, it occurs localized and naturalizing as individuals and small stands in DEVA, including

at the Travertine Springs complex where it has been mapped with least 15 point locations and 6 polygons, and it has been removed from some locations in that area (Thomas 2006). It also has been found along saline portions of the lower Colorado River (Tesky 1992).

Classification Comments

Planted stands of *Tamarix aphylla* may be best placed in the Temperate Tree Developed Vegetation Group (CSG047) or Temperate Shrub & Herb Developed Vegetation Group (CSG045) within the Other Developed Vegetation Division of the NVC hierarchy since this tamarix (athel) occurs often in planted/developed areas. The ornamental stands mapped at LAKE are placed within a Mixed Ornamental & Semi-Natural Woodland mapping unit. However, stands sampled in this project are also related to the Interior West Ruderal Riparian Forest & Scrub Group (G510) since a few trees have naturalized in the spring sites.

Classification Confidence of Alliance: Low

Conservation Status Rank

Global: GNR

State (California): GNR

References

cf. Sawyer et al. 2009, Thomas 2006, Tesky 1992

Surveys (with Sample Sizes) Used in Description

MOJN: N=4

LAKE (n=0)

DEVA (n=4): DEVA8001, DEVA8002, DEVA8003, DEVA9348

MOJA (n=0)

MOJN-Johnson (n=0)

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Tree										
	<i>Tamarix aphylla</i>	100	100	76	63	81	x	x		
Shrub										
	<i>Nerium oleander</i>	75	71	9.3	1	27	x	x		
	<i>Larrea tridentata</i>	25	4.2	0.1	0.2	0.2				

12. Natural Surface Bare Area Class

12.B.x. Unconsolidated Natural Bare Areas Landform

12.B.x.x. Unconsolidated Natural Bare Areas Landform

U002. Unconsolidated Natural Bare Areas Landform

Playa Mapping Unit

Common Name: Playa Mapping Unit

Group Assignment: None; **Alliance Code:** None

Alliance Concept

The Desert Playa Mapping Unit forms a non-vegetated to very sparse herbaceous layer. The shrub and tree layers if present are very sparse. The mapping unit is found on basin floors and dry lake beds (playas) that are primarily flat in aspect and alkaline or saline. Soils are derived from alluvium, and textures are variable though usually clayey. Elevations range from approximately -90 to 1300 meters.

Diagnostic Criteria: This alliance is characterized by a non-vegetated to very sparse herbaceous layer without characteristic presence of a certain plant species, instead the substrate and landform defines the type. The overall herbaceous cover ranges from 0 to 6 percent cover.

Alliance Distribution

The alliance occurs in all three parks and is defined with samples from two of the Parks. Stands sampled are scattered throughout DEVA at low to upper elevations and in MOJA at Soda Lake.

States: CA

Ecoregion Section Names (Sample Size) and Subsection Codes: Mojave Desert (14): 322Ab, 322Af, 322Ai, Southeastern Great Basin (3): 341Fc

Park Sampling Zones: **DEVA:** Black Mtns, CottonWood Mtns, Death Valley, Joshua Flat, Owlshead Mtns, Saline Valley; **MOJA:** Soda Lake

Associations

Association Scientific Name	Sample Size	LAKE	DEVA	MOJA	Johnson
Playa	17		x	x	

Association Notes: None.

Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 172.6 m, Range -90 – 1274 m

Aspect: Flat, Variable (10), N (1), Flat, Variable (1), E (1), Flat, Variable (1), Flat, Variable (2)

Slope: Mean 0.2 degrees, Range 0 – 1 degrees

Macro Topography: Basin floor/wetland (1), Low level/bottom (9)

Tree Cover: Mean 0%, Range 0 – 0%

Shrub Cover: Mean 0.2%, Range 0 – 1.8%

Herb Cover: Mean 0.5%, Range 0 – 1%

Large Rock: Mean 0%, Range 0 – 0%

Small Rock: Mean 0.2%, Range 0 – 2%

Fines Cover: Mean 79.6%, Range 0 – 100%

Litter Cover: Mean 0%, Range 0 – 0.4%

Geology: alluvium (16), water (1)

Soil Texture: Clay (6), Fine silty clay (3), Sand (1), Sandy clay (1), Sandy loam (1), Silty clay (2)

Environment: The alliance is found at low to upper elevations on basin floors with dry lake beds (playas) that are relatively flat in aspect and alkaline or saline. Soils are derived from alluvium, and textures are variable but primarily clayey.

Vegetation Description

Vegetation Structure: The alliance forms a non-vegetated to very sparse herbaceous layer, and the overall herbaceous cover ranges from 0 to 6 percent cover. The shrub and tree layers, if present are very sparse (0 – 1% total vegetation cover).

Vegetation Floristics: Unknown

Dynamics: Playa edges can vary in the presence and abundance of herbaceous plants depending on rainfall and temperature patterns. At the time of sampling these stands, indeterminate annual plants and alkaline shrubs had relatively sparse if any cover.

Classification Comments

Desert Playa stands are ecologically related to the unclassified herbaceous seep and playa vegetation stands, which had higher cover of unidentified herbaceous plants.

Classification Confidence of Alliance: Moderate

Conservation Status Rank

Global: GNR

State (California): GNR

References

NatureServe 2012, VegCAMP and AIS 2013

Surveys (with Sample Sizes) Used in Description

MOJN: N=17

LAKE (n=0)

DEVA (n=15): DEVA0380, DEVA0601, DEVA9260, DEVA9292, DEVA9382, DEVA9518, DEVA9616, DEVA9619, DEVA9809, DEVAD101, MOJC0723, MOJC0766, MOJC0849, MOJC0850, MOJC0851

MOJA (n=2): MOJC0852, MOJC0853

MOJN-Johnson (n=0)

Alliance Stand Table

Layer	Species Name	Con	RelCov	Avg	Min	Max	C	D	cD	Often
Unknown	Unknown	29	29	0	0.1	0.1				

Glossary of Terms Used in the Keys and Descriptions

The following terms with their respective definitions have been established in developing the vegetation classification, keys, and descriptions.

- **Constancy, Cover-Abundance, and Related Terms** – Used in the key, descriptions and the vegetation constancy tables (codes from tables in parentheses):
 - **Constancy** (Con) – Number of occurrences divided by the number of samples X 100%
 - **Diagnostic** – A species or group of species whose relative constancy or abundance differentiates one vegetation type from another; the term can include character, constant, differential, and indicator species (Jennings et al. 2006).
 - **Dominant** (D) – Must be in at least 75% of the samples, with at least 50% relative cover in all samples.
 - **Co-dominant** (cD) – Must be in at least 75% of the samples, with at least 30% relative cover in all samples.
 - **Characteristic** (C) – Present in at least 75% of the samples for that vegetation type, with no restriction on cover.
 - **Abundant** – Present in 50 to 75% of the samples, with at least 50% relative cover.
 - **Usually/Often** (Often) – Present in 50 to 75% of the samples, with no restriction on cover.
 - **Sometimes** – Present in 25 to 50% of the samples, with no restriction on cover.
 - **Average** (Avg) and **Relative Cover** (RelCov) – Average cover for a taxon in a vegetation type is calculated as the sum of its ‘absolute’ cover values divided by the total sample size; relative cover is calculated as the comparative sum of cover values for one taxon compared to the sum of cover values of other taxa, in which proportional numbers are derived (see **Cover** section for more details).
 - **Minimum** (Min) and **Maximum** (Max) – The minimum and maximum cover values that a taxon had from the surveys of a vegetation type. Values could be an absolute cover value (e.g., 1%) and/or a mid-point value of a cover class (e.g., 2.5% for a cover class of 1–5 %) depending on data available
- **Cover** – The primary metric used to quantify the abundance of a particular species or a particular vegetation layer within a plot. It was measured by estimating the aerial extent of the living plants, or the “bird’s-eye view” looking from above for each category. Various subcategories of cover for species and vegetation are defined as follows:
 - **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 5% and 10% of the stand. Absolute cover of all species or groups if added in a stand or plot may total greater or less than 100% because it is not a proportional number.

- **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% 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% for each stand (sample).
- **Dense/Continuous cover** – Used to describe individual layers of vegetation (tree, shrub, herb, or subdivisions of them) where there is greater than 66 percent absolute cover.
- **Intermittent cover** – Used to describe individual layers of vegetation (tree, shrub, herb, or subdivisions of them) where there is 33-66 percent absolute cover.
- **Open cover**– Used to describe individual layers of vegetation (tree, shrub, herb, or subdivisions of them) where the cover is less than 33 percent absolute cover.
- **Sparse cover** – Used to describe individual layers of vegetation (tree, shrub, herb, or subdivisions of them) where the *average* cover value is <2% absolute cover (though the range in cover could be <1-9% cover).
- **Emergent** – A plant (or vegetation layer) is considered emergent if it includes plants that rises above a predominant vegetation layer, but that are sparse in cover. It is considered as a member of the next tallest layer, but typically has an absolute cover < 10%.
- **Lifeform terms:**
 - **Tree** – Is a one-stemmed woody plant that normally grows to be greater than 5 meters tall. In some cases trees may be multiple-stemmed (ramifying) after fire or other disturbance, but size of mature plants is typically greater than 5 m and undisturbed individuals of these species are usually single stemmed.
 - **Shrub** – Is normally a multi-stemmed woody plant that generally has several erect, spreading, or prostrate stems and that is usually between 0.2 meters and 5 meters tall, giving it a bushy appearance. Definitions are blurred at the low and the high ends of the height scales. At the tall end, shrubs may approach trees based on disturbance frequencies (e.g., old-growth re-sprouting chaparral species such as *Quercus turbinella*, etc., may frequently attain “tree size”). At the low end, woody perennial herbs or sub-shrubs of various species are often difficult to categorize into a single life-form; usually sub-shrubs (per USDA-NRCS 2011) were categorized in the “shrub” category.
 - **Herb** – Is any vascular plant species that has no main woody stem-development, and includes grasses, forbs, and perennial species that die-back seasonally.
 - **Cryptogam** - Is a nonvascular plant or plant-like organism without specialized water or fluid conducting vascular tissue (i.e., xylem and phloem). Includes mosses, lichens, liverworts, hornworts, and algae.

- **Stand** – Is the basic physical unit of vegetation in a landscape. It has no set size. Some vegetation stands are very small such as wetland seeps, and some may be several square kilometers in size such as desert or forest types. A stand is defined by two main unifying characteristics:
 - 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 gradual.
 - 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.
- **Vegetation:**
 - **Woodland and forest vegetation:** 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 and a forest is defined as a tree-dominated stand of vegetation with 60 percent or greater cover of trees.
 - **Shrubland 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.
 - **Herbaceous 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, and the stand cannot be characterized as a tree or shrub stand.
 - **Nonvascular vegetation:** Nonvascular organisms provide a consistent (even if sparse) structural component and play an important role in ecological processes within the stand.
 - **Semi-natural/ruderal vegetation:** Stands characterized by naturalized non-native species. Examples include *Tamarix* spp., and *Brassica* spp. Note: the terminology for semi-natural versus ruderal plant communities is still under discussion with ESA Vegetation Panel and Hierarchy Review Working Group, and in the last 5 years the classification names have gone back and forth between these two terms.
- **National Vegetation Classification Hierarchy Levels:**
 - **Group** – A vegetation classification unit of intermediate rank (6th level) defined by combinations of relatively narrow sets of diagnostic plant species (including dominants and co-dominants), broadly similar composition, and diagnostic growth forms that reflect biogeographic differences in mesoclimate, geology, substrates, hydrology, and disturbance

regimes (FGDC 2008).

- **Alliance** – A classification unit of vegetation of low rank (7th level), containing one or more associations and defined by one or more diagnostic species, often of high cover, in the uppermost layer or the layer with the highest canopy cover. Alliances reflect physiognomy as well as regional to subregional climates, substrates, hydrology, and disturbance regimes (Jennings et al. 2006, FGDC 2008).
- **Association** – A vegetation classification unit of low rank (8th level) defined by a diagnostic species, a characteristic range of species composition, physiognomy, and distinctive habitat conditions (Jennings et al. 2006). Associations reflect local topo-edaphic climates, substrates, hydrology, and disturbance regimes.

- **Other Classification Terms:**

- **Provisional Type** – A vegetation type that is not yet formally described, but expected to be an addition to the existing list of NVC types for a project area. The type may be represented by plot samples (e.g., <10 samples), while it may or may not be particularly common or because it is localized in extent; however, it could be documented in additional location(s) outside of the study area.
- **Park Special Type (or Special Stands)** – A vegetation type that is not yet formally described except from a locally defined project area. The type is represented by very few plots (often <5 samples), because it is an oddity or rarity, and its relationships with other vegetation types are poorly known. It typically has not been documented in literature beforehand, and it is unknown if the type may occur elsewhere.

- **Conservation Rank** – Listed by the state Nature Conservancy Heritage Programs, including the California Department of Fish and Wildlife's Vegetation Classification and Mapping Program, these are the "Global" and "State" ranks, as seen below:

- **G1 and S1** – Critically Imperiled—At very high risk of extinction due to extreme rarity. Often 5 or fewer viable occurrences and/or up to 518 hectares.
- **G2 and S2** – Imperiled—At high risk of extinction due to very restricted range, very few occurrences, steep declines, or other factors. Often 6–20 viable occurrences, and/or 518–2,590 hectares
- **G3 and S3** – Vulnerable—At moderate risk of extinction due to a restricted range, relatively few populations, recent and widespread declines, or other factors. Often 21–100 viable occurrences and/or 2,590–12,950 hectares.
- **G4 and S4** – Apparently Secure—Uncommon but not rare; some cause for long-term concern due to declines or other factors. Often greater than 100 viable occurrences and/or more than 12,950 hectares.
- **G5 and S5** – Secure—Common; widespread and abundant.

- **Landform and Other Descriptive Terms:**

- **Bajada** – An alluvial plain formed at the base of a mountain by the coalescing of several alluvial fans.
- **Elevation** – Denoted in meters for the project, and as general categories:

<u>Category</u>	<u>Range</u>
High	>1,219 m (>4,000+ ft)
Mid -	609–1,219 m (2,000–4,000 ft)
Low	<609 m (< 2,000 ft)

- **Park Sampling Zones** – Areas designated by NPS park staff during the MOJN I&M sampling effort for stratifying the sampling locations.
- **Steepness** – Inclination of a slope, including the following categories:

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	>100	>300%

- **Surveys (with Sample Sizes):** In the vegetation descriptions, the survey numbers and sample sizes are provided for each classified vegetation type. The survey numbers come from the compiled set of databases, which typically begin with an alpha code and then a number modifier: For example, "LAKE0101" denotes the first classification plot sample and "LAKE9103" denotes the first observation sample of the 439 plots collected and analyzed for this network project in 2010, and " LAMEN" denotes the plots revisited in the Newberry Mountains by the Roberts and Holland between 2007–2008, etc.

Literature Cited in Appendix D

- Annable, C. R. 1985. Vegetation and flora of the Funeral Mountains, Death Valley National Monument, California–Nevada. Master’s thesis. University of Nevada, Las Vegas, NV.
- Atwater, B. F., S. G. Conrad, J. N. Dowden, C. W. Hedel, R. L. MacDonald, and W. Savage. 1979. History, landforms and vegetation of the estuary’s tidal marshes. Pages 347–400 in T. J. Conomas, editor. San Francisco Bay: The urbanized estuary. American Association of Advanced Science, Pacific Division, San Francisco, CA.
- Barrows, C. W., E. B. Allen, M. L. Brooks, and M. F. Allen. 2009. Effects of an invasive plant on a desert sand dune landscape. *Biological Invasions* **11**:673–686.
- Bradley, W. G. 1970. The vegetation of Saratoga Springs, Death Valley National Monument. *Southwest Naturalist* 15:111–129.
- Buck-Diaz, J., and J. M. Evens 2011. Carrizo Plain National Monument vegetation classification and mapping project. Report to USDI, Bureau of Land Management, California Department of Fish and Game, and The Nature Conservancy. California Native Plant Society, Sacramento, CA.
- Buck-Diaz, J., S. J. Batiuk, and J. M. Evens. 2012. Vegetation alliances and associations of the Great Valley Ecoregion, California. Unpublished report. California Native Plant Society, Sacramento, CA.
- Cogan, D., M. Reid, K. Schulz, and M. Pucherelli. 2004. Zion National Park, Utah 1999–2003 Vegetation Mapping Report. Technical Memorandum 8260-03-01. Bureau of Reclamation Technical Service Center, Denver, CO.
- Dilts, T., and P. Weisberg. 2010. Death Valley springs monitoring dataset. Great Basin Landscape Ecology Lab, University of Nevada Reno, NV.
- Evens, J. M. 2000. Water course vegetation on granitic and calcareous substrates in the eastern Mojave Desert, California. Master’s thesis. Humboldt State University, Arcata, CA.
- Evens, J. M., and S. Hartman. 2007. Vegetation survey and classification for the Northern and Eastern Colorado Desert Coordinated Management Plan (NECO). CNPS Vegetation Program, Sacramento, CA.
- Evens, J., and S. San. 2005. Vegetation alliances of the San Dieguito River Park region, San Diego County, California. Unpublished report, revised 2006. California Native Plant Society, Sacramento, CA.
- Evens, J. M., D. Roach-McIntosh, and D. Stout. 2012. Vegetation descriptions for Joshua Tree National Park. Unpublished report submitted to USDI, National Park Service, Mojave Desert Inventory and Monitoring Network. California Native Plant Society, Sacramento, CA.

- Ferren, W. R., and F. W. Davis. 1991. Biotic inventory and ecosystem characterization of Fish Slough in Inyo and Mono counties. Unpublished report. California Department of Fish and Game, Sacramento, CA.
- Hart, K. C., B. A. Stein, and S. F. Warrick. 1979. Vegetation and flora. Pages 59–108 in B. A. Stein and S. F. Warrick, editors. Granite Mountains Resource Survey. Environmental Field Program, University of California, Santa Cruz, CA.
- Hamerlynck, E. P., J. R. McAuliffe, E. V. McDonald, and S. D. Smith. 2002. Ecological response of two Mojave Desert shrubs to soil horizon development and soil water dynamics. *Ecology* 83:768–779.
- Hickson, D., and T. Keeler-Wolf. 2007. Vegetation and land use classification and map of the Sacramento-San Joaquin River delta. Unpublished report. California Department of Fish and Game, Vegetation Classification and Mapping Program, Bay Delta Region, Sacramento, CA.
- Junak, S., D. A. Knapp, J. R. Haller, R. Philbrick, A. Schoenherr, and T. Keeler-Wolf. 2007. The California Channel Islands. Pages 229–252 in M. G. Barbour, T. Keeler-Wolf, and A. Schoenherr, editors. Terrestrial vegetation of California, 3rd edition. University of California Press, Berkeley, CA.
- Keeler-Wolf, T. 2007b. Mojave Desert scrub. Pages 609–656 in M. G. Barbour, T. Keeler-Wolf, and A. Schoenherr, editors. Terrestrial vegetation of California, 3rd edition. University of California Press, Berkeley, CA.
- Keeler-Wolf, T., and J. Evens. 2006. Vegetation classification of the Santa Monica Mountains National Recreation Area and environs in Ventura and Los Angeles counties, California. Unpublished report to National Park Service. California Department of Fish and Game and California Native Plant Society, Sacramento, CA.
- Keeler-Wolf, T., and K. Thomas. 2000. Draft list of vegetation alliances and associations for the Mojave ecosystem mapping project. Unpublished report. California Department of Fish and Game, Wildlife Habitat Data Analysis Branch, Sacramento, CA.
- Keeler-Wolf, T., and M. Vaghti. 2000. Vegetation mapping of Suisun Marsh, Solano County: a report to the California Department of Water Resources. California Department of Fish and Game, California Natural Diversity Database, Sacramento, CA.
- Keeler-Wolf, T., C. Roye, and K. Lewis. 1998b. Vegetation classification and mapping of Anza-Borrego Desert State Park. Unpublished report. California Department of Fish and Game, Sacramento, CA.
- Keeler-Wolf, T., D. Schirokauer, J. Meinke, and P. van derLeeden. 2003a. Classification of the vegetation of Point Reyes National Seashore, Golden Gate National Recreation area, Samuel P. Taylor, Mount Tamalpais, and Tomales state parks, Marin, San Francisco, and San Mateo

- counties, California. California Department of Fish and Game, Wildlife Habitat Data Analysis Branch, Sacramento, CA.
- Keeler-Wolf, T., M. Schindel, S. San, P. Moore, and D. Hickson. 2003. Classification of the vegetation of Yosemite National Park and surrounding environs in Tuolumne, Mariposa, Madera and Mono Counties, California. California Department of Fish and Game, Wildlife and Habitat Data Analysis Branch, Sacramento, CA.
- Keeler-Wolf, T., S. San, and D. Hickson. 2005. Vegetation classification of Joshua Tree National Park, Riverside and San Bernardino counties, California. Unpublished report to the National Park Service. USDI, National Park Service, California Department of Fish and Game and California Native Plant Society, Sacramento, CA.
- Klein, A., and J. Evens. 2005. Vegetation alliances of western Riverside County, California. Unpublished report, revised 2006, prepared for California Department of Fish and Game, Habitat Conservation Division. California Native Plant Society, Sacramento, CA.
- Klein, A., J. Crawford, J. Evens, T. Keeler-Wolf, and D. Hickson. 2007. Classification of the vegetation alliances and associations of the northern Sierra Nevada foothills, California, Volumes 1 and 2. Report prepared for California Department of Fish and Game, Habitat Conservation Division. California Native Plant Society, Sacramento, CA.
- Lancaster, J. T., R. Boul, and T. Keeler-Wolf. 2014. The influence of surficial processes on vegetation patterns in southern Johnson Valley: A collaborative study between California Department of Fish and Wildlife ecologists and California Geological Survey geologists. Eolian System Mapping Grant # P1382002/01. Report prepared for California Department of Fish and Wildlife, Sacramento, CA.
- MacMahon, J. A., and F. H. Wagner. 1985. The Mojave, Sonoran and Chihuahuan deserts of North America. Pages 139–174 in M. Evenari, I. Noy-Meir, and D. W. Goodall, editors. *Ecosystems of the world 12A: hot deserts and arid shrublands*. Elsevier Scientific Publishing Company, New York, NY.
- Marushia, R. G. 2009. *Brassica tournefortii*: Phenology, interactions and management of an invasive mustard. Dissertation. University of California, Riverside, CA.
- Matthews, R. F. 2000. *Pleuraphis rigida*. In Fire Effects Information System [Online]. USDA, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer).
- McHargue, L. T. 1973. A vegetational analysis of the Coachella Valley, California. Dissertation. University of California, Irvine, CA.
- Minnich, R. A., and A. C. Sanders. 2000. *Brassica tournefortii* Gouan. Pages 68–72 in C. C. Bossard, J. M. Randall and M. C. Hoshovsky, editors. *Invasive Plants of California's Wildlands*. University of California Press, Berkeley, CA.

- Minnich, R. A., A. Sanders, S. Wood, K. Barrows, and J. Lyman. 1993. Natural resources management plan, Marine Corps Air-Ground Combat Center, Twentynine Palms, CA. Unpublished report. University of California, Riverside, CA.
- NatureServe. 2007. Alliances and associations of Pinnacles National Monument, California. In International ecological classification standard: terrestrial ecological classifications. NatureServe Central Databases. Arlington, VA.
- NatureServe. 2010. Vegetation Associations of Grand Canyon National Park. In International ecological classification standard: terrestrial ecological classifications. NatureServe Central Databases. Arlington, VA.
- NatureServe. 2012+. International ecological classification standard: terrestrial ecological classifications. NatureServe Explorer [Online] and NatureServe Central Databases, Arlington, VA. Available online at: <http://www.natureserve.org/explorer/> (accessed Jan 2012 to Aug 2014).
- Newton, A. C. 2012. Threats research and monitoring on the invasive species Sahara mustard (*Brassica tournefortii*). D 39-Final Project Reports For Experimental Designs Testing Hypothesis #6 and Summary Report for Hypotheses #1-6 , 2009-2011. National Park Service, Lake Mead National Recreation Area, Boulder City, NV.
- Newton, G. B. 1989. Evaluation of restoration and enhancement at Elk River Wildlife Area, a wetland mitigation site. Master's thesis. Humboldt State University, Arcata, CA.
- Odion, D. C., R. M. Callaway, W. R. Ferren, and F. W. Davis. 1992a. Vegetation of Fish Slough, an Owens Valley wetland ecosystem. Pages 171–196 in J. C. Hall, V. Doyle-Jones, and B. Widawski, editors. The history of water: eastern Sierra Nevada, Owens Valley, White-Inyo mountains. White Mountains Research Station Symposium 4. University of California, White Mountain Research Station, Los Angeles, CA.
- Paysen, T. E., J. A. Derby, H. Black, V. C. Bleich, and J. W. Mincks. 1980. A vegetation classification system applied to southern California. General Technical Report PSW-45. USDA, Forest Service, Pacific Southwest Research Station, Berkeley, CA.
- Peinado, M., F. Alcaraz, J. Delgadillo, M. D. L. Cruz, J. Alvarez, and J. L. Aguirre. 1994. The coastal salt marshes of California and Baja California. *Plant Ecology* **110**:55–66.
- Peterson, P. M. 1984. Flora and physiognomy of the Cottonwood Mountains, Death Valley National Monument, California. Cooperative National Park Resources Study Report CPSU/UNLV 022/06, University of Nevada, Las Vegas, NV.
- Pickart, A. J. 2006. Vegetation of the diked herbaceous wetlands of Humboldt Bay National Wildlife Refuge: classification, description, and ecology. Unpublished report, USDI, U.S. Fish and Wildlife Service, Humboldt Bay National Wildlife Refuge, Arcata, CA.

- Potter, D. A. 2005. Riparian community classification: west slope, central and southern Sierra Nevada, California. Technical Report R5-TP-022, USDA, Forest Service, Pacific Southwest Region, Berkeley, CA.
- Root, R. 1978. Unpublished dataset from Death Valley National Park, California.
- Sada, D. W., and D. J. Cooper. 2012. Furnace Creek springs restoration and adaptive management plan, Death Valley National Park, California. Report for Death Valley National Park. Desert Research Institute, Reno, NV, and Colorado State University, Fort Collins, CO.
- Sawyer, J. O., T. Keeler-Wolf, and J. M. Evens. 2009. A Manual of California Vegetation. California Native Plant Society, Sacramento, CA.
- Schulz, K. A., and M. E. Hall. 2011. Vegetation inventory project: Great Basin National Park [Draft Final Report]. Unpublished Report submitted to USDI, National Park Service, Mojave Desert Inventory and Monitoring Network. NatureServe, Western Regional Office, Boulder, Colorado.
- Shiflet, T. N., editor. 1994. Rangeland cover types of the United States. Society for Range Management, Denver, CO.
- Solomeshch, A., and M. Barbour. 2006. Defining restoration targets for Great Valley Grassland State Park. *Grasslands* 16:1, 12–17.
- Spolsky, A. M. 1979. An overview of the plant communities of Anza-Borrego Desert State Park. Unpublished report. State of California, The Resources Agency, Department of Parks and Recreation, Anza- Borrego Desert State Park, Borrego Springs, CA.
- Stillwater Sciences and URS. 2007. Santa Clara River Parkway floodplain restoration feasibility study: Riparian vegetation mapping and preliminary classification for the lower Santa Clara River, Ventura County, California. Report for the California State Coastal Conservancy and the Santa Clara River Trustee Council. Stillwater Sciences and URS Corporation, Berkeley, CA.
- Taylor, D. W. 1979. Ecological survey of the vegetation of White Mountain Natural Area, Inyo National Forest, California. Unpublished report. USDA, Forest Service, Pacific Southwest Research Station, Berkeley, CA.
- Tesky, J. L. 1992. *Tamarix aphylla*. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). [<http://www.fs.fed.us/database/feis/>, accessed Jan 2014].
- Thomas, K. A. 2006. Death Valley National Park Travertine Springs complex vegetation. Technical Report. US Geological Survey Southwest Biological Science Center. Flagstaff, AZ.
- Thomas, K. A., T. Keeler-Wolf, J. Franklin, and P. Stine. 2004. Mojave Desert Ecosystem Program: Central Mojave vegetation database. United States Geological Survey, Western Ecological Research Center and Southwest Biological Research Center, Sacramento, CA.

USDA-NRCS (2010-2014). The PLANTS Database. National Plant Data Team, Greensboro, NC [http://plants.usda.gov, accessed from August 2010 to August 2014].

USFWS. 1996. National list of vascular plant species that occur in wetlands: 1996 National Summary. U.S. Fish and Wildlife Service, Ecology Section, National Wetlands Inventory, Washington, DC. Available online at: http://library.fws.gov/Pubs9/wetlands_plantlist96.pdf (accessed January 2014).

Vaghti, M. G. 2003. Riparian vegetation classification pursuant to floodplain age and relative elevation, Colusa to Woodson Bridge, Sacramento River, California. Master's thesis. University of California, Davis, CA.

Vegetation Classification and Mapping Program (VegCAMP) and Aerial Information Systems Inc. (AIS). 2013. 2012 Vegetation map in support of the Desert Renewable Energy Conservation Plan. California Department of Fish and Wildlife, Biogeographic Data Branch, Vegetation Classification and Mapping Program. Sacramento, CA.

Appendix E. List of Plant Taxa

The plant taxa were identified and documented from vegetation samples from Lake Mead National Recreation Area (LAKE) and the Newberry Mountains, which were used in the vegetation classification. Note that this list includes taxa identified to the genus, species, and sub-specific level. This list is not intended to be comprehensive of every taxon at LAKE. The plant taxa list is organized alphabetically by scientific name. Nomenclature follows the PLANTS database (downloaded in 2014), which is managed by the U.S. Department of Agriculture and can be accessed at <http://plants.usda.gov>.

Scientific Name	Common Name	Life Form	Family	Samples
<i>Abronia villosa</i>	desert sand verbena	Herb	Nyctaginaceae	10
<i>Acacia greggii</i>	catclaw acacia	Shrub	Fabaceae	225
<i>Acamptopappus</i>	goldenhead	Shrub	Asteraceae	1
<i>Acamptopappus sphaerocephalus</i>	rayless goldenhead	Shrub	Asteraceae	64
<i>Achnatherum</i>	needlegrass	Herb	Poaceae	1
<i>Achnatherum aridum</i>	Mormon needlegrass	Herb	Poaceae	4
<i>Achnatherum hymenoides</i>	Indian ricegrass	Herb	Poaceae	14
<i>Achnatherum speciosum</i>	desert needlegrass	Herb	Poaceae	52
<i>Achyronychia cooperi</i>	onyxflower	Herb	Caryophyllaceae	3
<i>Acourtia wrightii</i>	brownfoot	Herb	Asteraceae	1
<i>Adenophyllum cooperi</i>	Cooper's dogweed	Herb	Asteraceae	11
<i>Adenophyllum porophylloides</i>	San Felipe dogweed	Herb	Asteraceae	31
<i>Adiantum capillus-veneris</i>	common maidenhair	Herb	Pteridaceae	1
<i>Agave utahensis</i>	Utah agave	Shrub	Agavaceae	8
<i>Aliciella leptomeria</i>	sand gilia	Herb	Polemoniaceae	3
<i>Aliciella micromeria</i>	dainty gilia	Herb	Polemoniaceae	6
<i>Allenrolfea occidentalis</i>	iodinebush	Shrub	Chenopodiaceae	23
<i>Allionia incarnata</i>	trailing windmills	Herb	Nyctaginaceae	13
<i>Allium</i>	onion	Herb	Liliaceae	1
<i>Aloysia wrightii</i>	Wright's beebrush	Shrub	Verbenaceae	4
<i>Amaranthus albus</i>	prostrate pigweed	Herb	Amaranthaceae	1
<i>Amaranthus fimbriatus</i>	fringed amaranth	Herb	Amaranthaceae	2
<i>Ambrosia dumosa</i>	burrobush	Shrub	Asteraceae	390
<i>Ambrosia eriocentra</i>	woolly fruit bur ragweed	Shrub	Asteraceae	9
<i>Amorpha fruticosa</i>	false indigo bush	Shrub	Fabaceae	2
<i>Amphipappus fremontii</i>	Fremont's chaffbush	Shrub	Asteraceae	47
<i>Amsinckia</i>	fiddleneck	Herb	Boraginaceae	266
<i>Amsonia tomentosa</i>	woolly bluestar	Herb	Apocynaceae	3
<i>Andropogon glomeratus</i>	bushy bluestem	Herb	Poaceae	3
<i>Androstephium breviflorum</i>	pink funnel lily	Herb	Liliaceae	22
<i>Anemopsis californica</i>	yerba mansa	Herb	Saururaceae	12
<i>Anisocoma acaulis</i>	scalebud	Herb	Asteraceae	2
<i>Antheropeas</i>	easterbonnets	Herb	Asteraceae	155
<i>Anulocaulis leiosolenus</i>	southwestern ringstem	Herb	Nyctaginaceae	10
<i>Apocynum cannabinum</i>	Indianhemp	Herb	Apocynaceae	1

Scientific Name	Common Name	Life Form	Family	Samples
<i>Arabis</i>	rockcress	Herb	Brassicaceae	6
<i>Arabis perennans</i>	perennial rockcress	Herb	Brassicaceae	7
<i>Arabis puberula</i>	silver rockcress	Herb	Brassicaceae	1
<i>Arctomecon californica</i>	California bearpoppy	Herb	Papaveraceae	16
<i>Arctostaphylos nevadensis</i>	pinemat manzanita	Shrub	Ericaceae	2
<i>Arenaria</i>	sandwort	Herb	Caryophyllaceae	2
<i>Arenaria macradenia</i>	Mojave sandwort	Herb	Caryophyllaceae	1
<i>Argemone</i>	pricklypoppy	Herb	Papaveraceae	2
<i>Argemone munita</i>	flatbud pricklypoppy	Herb	Papaveraceae	2
<i>Argythamnia neomexicana</i>	New Mexico silverbush	Herb	Euphorbiaceae	12
<i>Aristida purpurea</i>	purple threeawn	Herb	Poaceae	47
<i>Artemisia ludoviciana</i>	white sagebrush	Shrub	Asteraceae	19
<i>Asclepias nyctaginifolia</i>	Mojave milkweed	Herb	Asclepiadaceae	2
<i>Asclepias subulata</i>	rush milkweed	Herb	Asclepiadaceae	13
<i>Asteraceae</i>		Herb		4
<i>Astragalus</i>	milkvetch	Herb	Fabaceae	35
<i>Astragalus amphioxys</i>	Crescent milkvetch	Herb	Fabaceae	4
<i>Astragalus geyeri</i> var. <i>triquetrus</i>	Geyer's milkvetch	Herb	Fabaceae	11
<i>Astragalus lentiginosus</i>	freckled milkvetch	Herb	Fabaceae	2
<i>Astragalus nutans</i>	Providence Mountain milkvetch	Herb	Fabaceae	12
<i>Astragalus nuttallianus</i>	smallflowered milkvetch	Herb	Fabaceae	25
<i>Astragalus preussii</i>	Preuss' milkvetch	Herb	Fabaceae	2
<i>Astragalus sabulorum</i>	gravel milkvetch	Herb	Fabaceae	9
<i>Atrichoseris platyphylla</i>	parachute plant	Herb	Asteraceae	21
<i>Atriplex</i>	saltbush	Shrub	Chenopodiaceae	1
<i>Atriplex canescens</i>	fourwing saltbush	Shrub	Chenopodiaceae	6
<i>Atriplex confertifolia</i>	shadscale saltbush	Shrub	Chenopodiaceae	25
<i>Atriplex hymenelytra</i>	desertholly	Shrub	Chenopodiaceae	28
<i>Atriplex lentiformis</i>	big saltbush	Shrub	Chenopodiaceae	4
<i>Atriplex polycarpa</i>	cattle saltbush	Shrub	Chenopodiaceae	7
<i>Baccharis</i>	baccharis	Shrub	Asteraceae	1
<i>Baccharis brachyphylla</i>	shortleaf baccharis	Shrub	Asteraceae	1
<i>Baccharis emoryi</i>	Emory's baccharis	Shrub	Asteraceae	11
<i>Baccharis salicifolia</i>	mule-fat	Shrub	Asteraceae	5
<i>Baccharis sarothroides</i>	desertbroom	Shrub	Asteraceae	1
<i>Baccharis sergiloides</i>	desert baccharis	Shrub	Asteraceae	32
<i>Baileya multiradiata</i>	desert marigold	Herb	Asteraceae	7
<i>Bassia scoparia</i>	burningbush	Herb	Chenopodiaceae	1
<i>Bebbia juncea</i>	sweetbush	Shrub	Asteraceae	141
<i>Boraginaceae</i>		Herb		7
<i>Bouteloua aristidoides</i>	needle grama	Herb	Poaceae	1
<i>Bouteloua barbata</i>	sixweeks grama	Herb	Poaceae	4
<i>Bouteloua curtipendula</i>	sideoats grama	Herb	Poaceae	1
<i>Bouteloua trifida</i>	red grama	Herb	Poaceae	1
<i>Brassica tournefortii</i>	Asian mustard	Herb	Brassicaceae	63

Scientific Name	Common Name	Life Form	Family	Samples
<i>Brassicaceae</i>		Herb		7
<i>Brickellia</i>	brickellbush	Shrub	Asteraceae	2
<i>Brickellia arguta</i>	pungent brickellbush	Shrub	Asteraceae	22
<i>Brickellia atractyloides</i>	spearleaf brickellbush	Shrub	Asteraceae	2
<i>Brickellia californica</i>	California brickellbush	Shrub	Asteraceae	2
<i>Brickellia desertorum</i>	desert brickellbush	Shrub	Asteraceae	6
<i>Brickellia incana</i>	woolly brickellbush	Shrub	Asteraceae	1
<i>Brickellia longifolia</i>	longleaf brickellbush	Shrub	Asteraceae	2
<i>Brickellia microphylla</i>	littleleaf brickellbush	Shrub	Asteraceae	1
<i>Bromus</i>	brome	Herb	Poaceae	5
<i>Bromus arizonicus</i>	Arizona brome	Herb	Poaceae	1
<i>Bromus berterianus</i>	Chilean chess	Herb	Poaceae	2
<i>Bromus diandrus</i>	ripgut brome	Herb	Poaceae	1
<i>Bromus rubens</i>	red brome	Herb	Poaceae	249
<i>Bromus tectorum</i>	cheatgrass	Herb	Poaceae	26
<i>Buddleja utahensis</i>	Utah butterflybush	Shrub	Buddlejaceae	1
<i>Calochortus</i>	mariposa lily	Herb	Liliaceae	2
<i>Calochortus clavatus</i>	clubhair mariposa lily	Herb	Liliaceae	1
<i>Calochortus flexuosus</i>	winding mariposa lily	Herb	Liliaceae	35
<i>Calycoseris</i>	tackstem	Herb	Asteraceae	14
<i>Camissonia</i>	suncup	Herb	Onagraceae	63
<i>Camissonia boothii</i>	Booth's evening primrose	Herb	Onagraceae	10
<i>Camissonia brevipes</i>	yellow cups	Herb	Onagraceae	68
<i>Camissonia californica</i>	California suncup	Herb	Onagraceae	4
<i>Camissonia chamaenerioides</i>	longcapsule suncup	Herb	Onagraceae	1
<i>Camissonia claviformis</i>	browneyes	Herb	Onagraceae	8
<i>Camissonia multijuga</i>	froststem suncup	Herb	Onagraceae	20
<i>Camissonia refracta</i>	narrowleaf suncup	Herb	Onagraceae	54
<i>Carex</i>	sedge	Herb	Cyperaceae	1
<i>Castilleja</i>	Indian paintbrush	Herb	Scrophulariaceae	3
<i>Castilleja angustifolia</i>	northwestern Indian paintbrush	Herb	Scrophulariaceae	6
<i>Castilleja linariifolia</i>	Wyoming Indian paintbrush	Herb	Scrophulariaceae	1
<i>Caulanthus cooperi</i>	Cooper's wild cabbage	Herb	Brassicaceae	28
<i>Centrostegia thurberi</i>	red triangles	Herb	Polygonaceae	6
<i>Chaenactis</i>	pincushion	Herb	Asteraceae	108
<i>Chaenactis carphoclinia</i>	pebble pincushion	Herb	Asteraceae	19
<i>Chaenactis fremontii</i>	pincushion flower	Herb	Asteraceae	110
<i>Chaenactis macrantha</i>	bighead dustymaiden	Herb	Asteraceae	5
<i>Chaenactis stevioides</i>	Esteve's pincushion	Herb	Asteraceae	18
<i>Chaenactis xantiana</i>	fleshcolor pincushion	Herb	Asteraceae	1
<i>Chamaesyce</i>	sandmat	Herb	Euphorbiaceae	56
<i>Chamaesyce albomarginata</i>	whitemargin sandmat	Herb	Euphorbiaceae	8
<i>Chamaesyce fendleri</i>	Fendler's sandmat	Herb	Euphorbiaceae	1
<i>Chamaesyce micromera</i>	Sonoran sandmat	Herb	Euphorbiaceae	1
<i>Chamaesyce ocellata</i>	Contura Creek sandmat	Herb	Euphorbiaceae	2

Scientific Name	Common Name	Life Form	Family	Samples
<i>Chamaesyce parryi</i>	Parry's sandmat	Herb	Euphorbiaceae	1
<i>Chamaesyce polycarpa</i>	smallseed sandmat	Herb	Euphorbiaceae	33
<i>Cheilanthes parryi</i>	Parry's lipfern	Herb	Pteridaceae	3
<i>Chenopodium</i>	goosefoot	Herb	Chenopodiaceae	1
<i>Chilopsis linearis</i>	desert willow	Tree	Bignoniaceae	14
<i>Chorisiva nevadensis</i>	Nevada sumpweed	Herb	Asteraceae	1
<i>Chorizanthe brevicornu</i>	brittle spineflower	Herb	Polygonaceae	121
<i>Chorizanthe corrugata</i>	wrinkled spineflower	Herb	Polygonaceae	4
<i>Chorizanthe rigida</i>	devil's spineflower	Herb	Polygonaceae	84
<i>Cirsium</i>	thistle	Herb	Asteraceae	1
<i>Cirsium mohavense</i>	Mojave thistle	Herb	Asteraceae	3
<i>Cirsium neomexicanum</i>	New Mexico thistle	Herb	Asteraceae	13
<i>Cirsium occidentale</i>	cobwebby thistle	Herb	Asteraceae	2
<i>Cirsium virginense</i>	virgin thistle	Herb	Asteraceae	1
<i>Cistanthe monandra</i>	common pussypaws	Herb	Portulacaceae	3
<i>Cladium californicum</i>	California sawgrass	Herb	Cyperaceae	11
<i>Claytonia perfoliata</i>	miner's lettuce	Herb	Portulacaceae	1
<i>Coleogyne ramosissima</i>	blackbrush	Shrub	Rosaceae	34
<i>Conyza</i>	horseweed	Herb	Asteraceae	2
<i>Croton californicus</i>	California croton	Herb	Euphorbiaceae	8
<i>Cryptantha</i>	cryptantha	Herb	Boraginaceae	219
<i>Cryptantha angustifolia</i>	Panamint cryptantha	Herb	Boraginaceae	41
<i>Cryptantha barbiger</i>	bearded cryptantha	Herb	Boraginaceae	27
<i>Cryptantha circumscissa</i>	cushion cryptantha	Herb	Boraginaceae	9
<i>Cryptantha maritima</i>	Guadalupe cryptantha	Herb	Boraginaceae	3
<i>Cryptantha micrantha</i>	redroot cryptantha	Herb	Boraginaceae	32
<i>Cryptantha nevadensis</i>	Nevada cryptantha	Herb	Boraginaceae	99
<i>Cryptantha pterocarya</i>	wingnut cryptantha	Herb	Boraginaceae	104
<i>Cryptantha recurvata</i>	curvenut cryptantha	Herb	Boraginaceae	8
<i>Cryptantha utahensis</i>	scented cryptantha	Herb	Boraginaceae	12
<i>Cryptogamic crust</i>		Non-vasc		232
<i>Cucurbita palmata</i>	coyote gourd	Herb	Cucurbitaceae	1
<i>Cuscuta</i>	dodder	Herb	Cuscutaceae	54
<i>Cylindropuntia acanthocarpa</i>	buck-horn cholla	Shrub	Cactaceae	126
<i>Cylindropuntia bigelovii</i>	teddybear cholla	Shrub	Cactaceae	17
<i>Cylindropuntia echinocarpa</i>	Wiggins' cholla	Shrub	Cactaceae	32
<i>Cylindropuntia ramosissima</i>	branched pencil cholla	Shrub	Cactaceae	29
<i>Cymopterus multinervatus</i>	purplenerve springparsley	Herb	Apiaceae	2
<i>Cymopterus purpurascens</i>	widewing springparsley	Herb	Apiaceae	1
<i>Cynanchum utahense</i>	Utah swallow-wort	Herb	Asclepiadaceae	2
<i>Cynodon dactylon</i>	Bermudagrass	Herb	Poaceae	8
<i>Dalea mollis</i>	hairy prairie clover	Herb	Fabaceae	5
<i>Dalea mollissima</i>	soft prairie clover	Herb	Fabaceae	1
<i>Dasyochloa pulchella</i>	low woollygrass	Herb	Poaceae	32
<i>Datura wrightii</i>	sacred thorn-apple	Herb	Solanaceae	6

Scientific Name	Common Name	Life Form	Family	Samples
<i>Delphinium parishii</i>	desert larkspur	Herb	Ranunculaceae	31
<i>Descurainia</i>	tansymustard	Herb	Brassicaceae	1
<i>Descurainia pinnata</i>	western tansymustard	Herb	Brassicaceae	30
<i>Descurainia sophia</i>	herb sophia	Herb	Brassicaceae	8
<i>Dichelostemma capitatum</i>	bluedicks	Herb	Liliaceae	4
<i>Dicoria canescens</i>	desert twinbugs	Herb	Asteraceae	7
<i>Distichlis spicata</i>	saltgrass	Herb	Poaceae	17
<i>Dithyrea californica</i>	California shieldpod	Herb	Brassicaceae	8
<i>Draba cuneifolia</i>	wedgeleaf draba	Herb	Brassicaceae	50
<i>Dudleya pulverulenta</i>	chalk dudleya	Herb	Crassulaceae	3
<i>Echinocactus polycephalus</i>	cottontop cactus	Shrub	Cactaceae	27
<i>Echinocereus engelmannii</i>	Engelmann's hedgehog cactus	Shrub	Cactaceae	76
<i>Echinocereus mojavensis</i>	Mojave kingcup cactus	Shrub	Cactaceae	3
<i>Echinochloa crus-galli</i>	barnyardgrass	Herb	Poaceae	2
<i>Echinomastus johnsonii</i>	Johnson's fishhook cactus	Shrub	Cactaceae	19
<i>Eleocharis</i>	spikerush	Herb	Cyperaceae	1
<i>Eleocharis geniculata</i>	Canada spikesedge	Herb	Cyperaceae	1
<i>Eleocharis palustris</i>	common spikerush	Herb	Cyperaceae	1
<i>Eleocharis rostellata</i>	beaked spikerush	Herb	Cyperaceae	6
<i>Elymus elymoides</i>	squirreltail	Herb	Poaceae	6
<i>Emmenanthe penduliflora</i>	whisperingbells	Herb	Hydrophyllaceae	9
<i>Encelia</i>	brittlebush	Shrub	Asteraceae	1
<i>Encelia farinosa</i>	brittlebush	Shrub	Asteraceae	210
<i>Encelia frutescens</i>	button brittlebush	Shrub	Asteraceae	14
<i>Encelia resinifera</i>	sticky brittlebush	Shrub	Asteraceae	1
<i>Encelia virginensis</i>	Virgin River brittlebush	Shrub	Asteraceae	31
<i>Enceliopsis argophylla</i>	silverleaf sunray	Herb	Asteraceae	21
<i>Ephedra</i>	jointfir	Shrub	Ephedraceae	79
<i>Ephedra nevadensis</i>	Nevada jointfir	Shrub	Ephedraceae	146
<i>Ephedra torreyana</i>	Torrey's jointfir	Shrub	Ephedraceae	52
<i>Ephedra viridis</i>	mormon tea	Shrub	Ephedraceae	30
<i>Epipactis gigantea</i>	stream orchid	Herb	Orchidaceae	1
<i>Eragrostis cilianensis</i>	stinkgrass	Herb	Poaceae	1
<i>Eremalche rotundifolia</i>	desert fivespot	Herb	Malvaceae	2
<i>Eriastrum</i>	woollystar	Herb	Polemoniaceae	8
<i>Eriastrum diffusum</i>	miniature woollystar	Herb	Polemoniaceae	4
<i>Eriastrum eremicum</i>	desert woollystar	Herb	Polemoniaceae	10
<i>Eriastrum pluriflorum</i>	Tehachapi woollystar	Herb	Polemoniaceae	1
<i>Eriastrum sparsiflorum</i>	Great Basin woollystar	Herb	Polemoniaceae	1
<i>Ericameria</i>	goldenbush	Shrub	Asteraceae	1
<i>Ericameria cuneata</i>	cliff goldenbush	Shrub	Asteraceae	8
<i>Ericameria laricifolia</i>	turpentine bush	Shrub	Asteraceae	11
<i>Ericameria linearifolia</i>	narrowleaf goldenbush	Shrub	Asteraceae	21
<i>Ericameria nana</i>	dwarf goldenbush	Shrub	Asteraceae	3
<i>Ericameria nauseosa</i>	rubber rabbitbrush	Shrub	Asteraceae	1

Scientific Name	Common Name	Life Form	Family	Samples
<i>Ericameria paniculata</i>	Mojave rabbitbrush	Shrub	Asteraceae	11
<i>Eriogonum</i>	buckwheat	Herb	Polygonaceae	25
<i>Eriogonum brachypodum</i>	Parry's buckwheat	Herb	Polygonaceae	7
<i>Eriogonum corymbosum</i> var. <i>glutinosum</i>	crispleaf buckwheat	Shrub	Polygonaceae	1
<i>Eriogonum deflexum</i>	flatcrown buckwheat	Herb	Polygonaceae	82
<i>Eriogonum divaricatum</i>	divergent buckwheat	Herb	Polygonaceae	1
<i>Eriogonum fasciculatum</i>	Eastern Mojave buckwheat	Shrub	Polygonaceae	221
<i>Eriogonum heermannii</i>	Heermann's buckwheat	Shrub	Polygonaceae	10
<i>Eriogonum inflatum</i>	desert trumpet	Herb	Polygonaceae	201
<i>Eriogonum maculatum</i>	spotted buckwheat	Herb	Polygonaceae	3
<i>Eriogonum microthecum</i>	slender buckwheat	Shrub	Polygonaceae	1
<i>Eriogonum nidularium</i>	birdnest buckwheat	Herb	Polygonaceae	1
<i>Eriogonum palmerianum</i>	Palmer's buckwheat	Herb	Polygonaceae	6
<i>Eriogonum plumatella</i>	yucca buckwheat	Shrub	Polygonaceae	4
<i>Eriogonum pusillum</i>	yellowturbans	Herb	Polygonaceae	7
<i>Eriogonum saxatile</i>	hoary buckwheat	Herb	Polygonaceae	1
<i>Eriogonum thomasi</i>	Thomas' buckwheat	Herb	Polygonaceae	15
<i>Eriogonum trichopes</i>	little deserttrumpet	Herb	Polygonaceae	5
<i>Eriogonum viscidulum</i>	sticky buckwheat	Herb	Polygonaceae	2
<i>Eriogonum wrightii</i>	bastardsage	Shrub	Polygonaceae	23
<i>Eriophyllum</i>	woolly sunflower	Herb	Asteraceae	2
<i>Erodium cicutarium</i>	redstem stork's bill	Herb	Geraniaceae	216
<i>Erodium texanum</i>	Texas stork's bill	Herb	Geraniaceae	32
<i>Eschscholzia</i>	California poppy	Herb	Papaveraceae	19
<i>Eschscholzia glyptosperma</i>	desert poppy	Herb	Papaveraceae	23
<i>Eschscholzia minutiflora</i>	pygmy poppy	Herb	Papaveraceae	41
<i>Eucnide urens</i>	desert stingbush	Shrub	Loasaceae	23
<i>Eucrypta</i>	hideseed	Herb	Hydrophyllaceae	3
<i>Eucrypta chrysanthemifolia</i>	spotted hideseed	Herb	Hydrophyllaceae	10
<i>Eucrypta micrantha</i>	dainty desert hideseed	Herb	Hydrophyllaceae	45
<i>Euphorbia</i>	spurge	Herb	Euphorbiaceae	4
<i>Fallugia paradoxa</i>	Apache plume	Shrub	Rosaceae	1
<i>Ferocactus cylindraceus</i>	California barrel cactus	Shrub	Cactaceae	140
<i>Fouquieria splendens</i>	ocotillo	Tree	Fouquieriaceae	20
<i>Funastrum cynanchoides</i>	fringed twinevine	Herb	Asclepiadaceae	10
<i>Funastrum hirtellum</i>	hairy milkweed	Herb	Asclepiadaceae	18
<i>Galium aparine</i>	stickywilly	Herb	Rubiaceae	1
<i>Galium proliferum</i>	limestone bedstraw	Herb	Rubiaceae	1
<i>Galium stellatum</i>	starry bedstraw	Shrub	Rubiaceae	38
<i>Garrya flavescens</i>	ashy silktassel	Shrub	Garryaceae	1
<i>Geraea canescens</i>	hairy desertsunflower	Herb	Asteraceae	16
<i>Gilia</i>	gilia	Herb	Polemoniaceae	139
<i>Gilia latiflora</i>	hollyleaf gilia	Herb	Polemoniaceae	5
<i>Gilia minor</i>	little gilia	Herb	Polemoniaceae	3

Scientific Name	Common Name	Life Form	Family	Samples
<i>Gilia scopulorum</i>	rock gilia	Herb	Polemoniaceae	22
<i>Gilia sinuata</i>	rosy gilia	Herb	Polemoniaceae	4
<i>Gilia transmontana</i>	transmontane gilia	Herb	Polemoniaceae	3
<i>Glandularia gooddingii</i>	southwestern mock vervain	Herb	Verbenaceae	1
<i>Glyptopleura marginata</i>	carveseed	Herb	Asteraceae	3
<i>Grayia spinosa</i>	spiny hopsage	Shrub	Chenopodiaceae	8
<i>Grusonia</i>	cholla	Shrub	Cactaceae	3
<i>Grusonia parishii</i>	matted cholla	Shrub	Cactaceae	7
<i>Guillenia lasiophylla</i>	California mustard	Herb	Brassicaceae	46
<i>Gutierrezia</i>	snakeweed	Shrub	Asteraceae	4
<i>Gutierrezia microcephala</i>	threadleaf snakeweed	Shrub	Asteraceae	5
<i>Gutierrezia sarothrae</i>	broom snakeweed	Shrub	Asteraceae	50
<i>Hedeoma nana</i>	dwarf false pennyroyal	Herb	Lamiaceae	2
<i>Helianthus</i>	sunflower	Herb	Asteraceae	1
<i>Heliotropium curassavicum</i>	salt heliotrope	Herb	Boraginaceae	10
<i>Hesperocallis undulata</i>	desert lily	Herb	Liliaceae	3
<i>Hesperostipa comata</i>	needle and thread	Herb	Poaceae	1
<i>Hibiscus denudatus</i>	paleface	Shrub	Malvaceae	1
<i>Hordeum murinum</i>	mouse barley	Herb	Poaceae	4
<i>Hydrophyllaceae</i>		Herb		1
<i>Hymenoclea salsola</i>	burrobrush	Shrub	Asteraceae	127
<i>Hyptis emoryi</i>	desert lavender	Shrub	Lamiaceae	13
<i>Ipomopsis polycladon</i>	manybranched ipomopsis	Herb	Polemoniaceae	5
<i>Isocoma acradenia</i>	alkali goldenbush	Shrub	Asteraceae	19
<i>Juncus acutus</i>	spiny rush	Herb	Juncaceae	10
<i>Juncus arcticus</i>	arctic rush	Herb	Juncaceae	4
<i>Juncus bufonius</i>	toad rush	Herb	Juncaceae	2
<i>Juncus cooperi</i>	Cooper's rush	Herb	Juncaceae	2
<i>Juncus xiphioides</i>	irisleaf rush	Herb	Juncaceae	5
<i>Juniperus californica</i>	California juniper	Tree	Cupressaceae	34
<i>Keckiella antirrhinoides</i>	snapdragon penstemon	Shrub	Scrophulariaceae	15
<i>Krameria erecta</i>	littleleaf ratany	Shrub	Krameriaceae	233
<i>Krameria grayi</i>	white ratany	Shrub	Krameriaceae	74
<i>Krascheninnikovia lanata</i>	winterfat	Shrub	Chenopodiaceae	16
<i>Lactuca</i>	lettuce	Herb	Asteraceae	2
<i>Langloisia</i>	langloisia	Herb	Polemoniaceae	2
<i>Langloisia setosissima</i>	Great Basin langloisia	Herb	Polemoniaceae	33
<i>Larrea tridentata</i>	creosote bush	Shrub	Zygophyllaceae	455
<i>Lepidium</i>	pepperweed	Herb	Brassicaceae	4
<i>Lepidium densiflorum</i>	common pepperweed	Herb	Brassicaceae	1
<i>Lepidium fremontii</i>	desert pepperweed	Shrub	Brassicaceae	39
<i>Lepidium lasiocarpum</i>	shaggyfruit pepperweed	Herb	Brassicaceae	97
<i>Leptochloa fusca</i>	Malabar sprangletop	Herb	Poaceae	1
<i>Leptosiphon aureus</i>	golden linanthus	Herb	Polemoniaceae	5
<i>Lesquerella tenella</i>	Moapa bladderpod	Herb	Brassicaceae	27

Scientific Name	Common Name	Life Form	Family	Samples
<i>Linanthus</i>	linanthus	Herb	Polemoniaceae	64
<i>Linanthus arenicola</i>	sanddune linanthus	Herb	Polemoniaceae	2
<i>Linanthus bigelovii</i>	Bigelow's linanthus	Herb	Polemoniaceae	2
<i>Linanthus demissus</i>	desertsnow	Herb	Polemoniaceae	33
<i>Linanthus dichotomus</i>	eveningsnow	Herb	Polemoniaceae	1
<i>Linanthus filiformis</i>	yellow gilia	Herb	Polemoniaceae	1
<i>Linanthus jonesii</i>	Jones' linanthus	Herb	Polemoniaceae	21
<i>Linanthus pungens</i>	granite prickly phlox	Herb	Polemoniaceae	3
<i>Linum</i>	flax	Herb	Linaceae	2
<i>Loeseliastrum</i>	calico	Herb	Polemoniaceae	7
<i>Lolium rigidum</i>	Wimmera ryegrass	Herb	Poaceae	2
<i>Lomatium parryi</i>	Utah desertparsley	Herb	Apiaceae	1
<i>Lotus</i>	trefoil	Herb	Fabaceae	39
<i>Lotus humistratus</i>	foothill deervetch	Herb	Fabaceae	2
<i>Lotus rigidus</i>	shrubby deervetch	Shrub	Fabaceae	33
<i>Lotus salsuginosus</i>	coastal bird's-foot trefoil	Herb	Fabaceae	3
<i>Lupinus</i>	lupine	Herb	Fabaceae	61
<i>Lupinus arizonicus</i>	Arizona lupine	Herb	Fabaceae	14
<i>Lupinus concinnus</i>	bajada lupine	Herb	Fabaceae	7
<i>Lupinus shockleyi</i>	purple desert lupine	Herb	Fabaceae	8
<i>Lupinus sparsiflorus</i>	Coulter's lupine	Herb	Fabaceae	25
<i>Lycium</i>	desert-thorn	Shrub	Solanaceae	3
<i>Lycium andersonii</i>	water jacket	Shrub	Solanaceae	46
<i>Lycium californicum</i>	California desert-thorn	Shrub	Solanaceae	4
<i>Lycium cooperi</i>	peach thorn	Shrub	Solanaceae	4
<i>Lycium pallidum</i>	pale desert-thorn	Shrub	Solanaceae	15
<i>Lycium torreyi</i>	Torrey wolfberry	Shrub	Solanaceae	3
<i>Machaeranthera pinnatifida</i>	lacy tansyaster	Shrub	Asteraceae	42
<i>Malacothrix</i>	desertdandelion	Herb	Asteraceae	2
<i>Malacothrix coulteri</i>	snake's head	Herb	Asteraceae	3
<i>Malacothrix glabrata</i>	smooth desertdandelion	Herb	Asteraceae	59
<i>Malcolmia africana</i>	African mustard	Herb	Brassicaceae	13
<i>Malva neglecta</i>	common mallow	Herb	Malvaceae	1
<i>Mammillaria tetrancistra</i>	common fishhook cactus	Shrub	Cactaceae	22
<i>Marah fabaceus</i>	California manroot	Herb	Cucurbitaceae	5
<i>Marah macrocarpus</i>	Cucamonga manroot	Herb	Cucurbitaceae	4
<i>Marina parryi</i>	Parry's false prairie-clover	Herb	Fabaceae	2
<i>Maurandella antirrhiniflora</i>	roving sailor	Herb	Scrophulariaceae	1
<i>Melilotus</i>	sweetclover	Herb	Fabaceae	1
<i>Menodora scabra</i>	rough menodora	Shrub	Oleaceae	3
<i>Menodora spinescens</i>	spiny menodora	Shrub	Oleaceae	9
<i>Mentzelia</i>	blazingstar	Herb	Loasaceae	81
<i>Mentzelia albicaulis</i>	whitestem blazingstar	Herb	Loasaceae	43
<i>Mentzelia nitens</i>	shining blazingstar	Herb	Loasaceae	1
<i>Mentzelia oreophila</i>	Argus blazingstar	Herb	Loasaceae	2

Scientific Name	Common Name	Life Form	Family	Samples
<i>Mentzelia tricuspid</i>	spinyhair blazingstar	Herb	Loasaceae	33
<i>Microseris lindleyi</i>	Lindley's silverpuffs	Herb	Asteraceae	5
<i>Mimulus</i>	monkeyflower	Herb	Scrophulariaceae	2
<i>Mimulus bigelovii</i>	Bigelow's monkeyflower	Herb	Scrophulariaceae	13
<i>Mimulus cardinalis</i>	scarlet monkeyflower	Herb	Scrophulariaceae	1
<i>Mimulus fremontii</i>	Fremont's monkeyflower	Herb	Scrophulariaceae	1
<i>Mimulus guttatus</i>	seep monkeyflower	Herb	Scrophulariaceae	8
<i>Mimulus parryi</i>	annual redspot monkeyflower	Herb	Scrophulariaceae	3
<i>Mimulus rubellus</i>	little redstem monkeyflower	Herb	Scrophulariaceae	1
<i>Mirabilis</i>	four o'clock	Herb	Nyctaginaceae	3
<i>Mirabilis laevis</i>	desert wishbone-bush	Herb	Nyctaginaceae	56
<i>Mirabilis multiflora</i>	Colorado four o'clock	Herb	Nyctaginaceae	3
<i>Mohavea breviflora</i>	golden desert-snapdragon	Herb	Scrophulariaceae	1
<i>Mohavea confertiflora</i>	ghost flower	Herb	Scrophulariaceae	1
<i>Monardella linoides</i>	flaxleaf monardella	Shrub	Lamiaceae	1
<i>Monoptilon</i>	desertstar	Herb	Asteraceae	11
<i>Mortonia utahensis</i>	Utah mortonia	Shrub	Celastraceae	8
<i>Muhlenbergia asperifolia</i>	scratchgrass	Herb	Poaceae	1
<i>Muhlenbergia porteri</i>	bush muhly	Herb	Poaceae	21
<i>Nama demissum</i>	purplemat	Herb	Hydrophyllaceae	35
<i>Nama pusillum</i>	eggleaf fiddleleaf	Herb	Hydrophyllaceae	4
<i>Nemacaulis</i>	cottonheads	Herb	Polygonaceae	13
<i>Nemacladus</i>	threadplant	Herb	Campanulaceae	22
<i>Neogaerrhinum filipes</i>	yellow twining snapdragon	Herb	Scrophulariaceae	10
<i>Nerium oleander</i>	oleander	Shrub	Apocynaceae	1
<i>Nicolletia occidentalis</i>	Mojave hole-in-the-sand plant	Herb	Asteraceae	1
<i>Nicotiana attenuata</i>	coyote tobacco	Herb	Solanaceae	2
<i>Nicotiana obtusifolia</i>	desert tobacco	Herb	Solanaceae	18
<i>Nolina bigelovii</i>	Bigelow's nolina	Shrub	Liliaceae	12
<i>Oenothera</i>	evening primrose	Herb	Onagraceae	4
<i>Oenothera caespitosa</i>	tufted evening primrose	Herb	Onagraceae	5
<i>Oenothera deltoides</i>	birdcage evening primrose	Herb	Onagraceae	15
<i>Oligomeris linifolia</i>	lineleaf whitepuff	Herb	Resedaceae	5
<i>Opuntia basilaris</i>	beavertail pricklypear	Shrub	Cactaceae	188
<i>Opuntia chlorotica</i>	dollarjoint pricklypear	Shrub	Cactaceae	3
<i>Opuntia engelmannii</i>	cactus apple	Shrub	Cactaceae	1
<i>Opuntia polyacantha</i> var. <i>erinacea</i>	grizzlybear pricklypear	Shrub	Cactaceae	43
<i>Palafoxia arida</i>	desert palafox	Herb	Asteraceae	17
<i>Parietaria hespera</i>	rillita pellitory	Herb	Urticaceae	7
<i>Parkinsonia</i>	paloverde	Tree	Fabaceae	1
<i>Parkinsonia aculeata</i>	Jerusalem thorn	Tree	Fabaceae	1
<i>Parkinsonia microphylla</i>	yellow paloverde	Tree	Fabaceae	11
<i>Pectocarya</i>	combseed	Herb	Boraginaceae	34
<i>Pectocarya heterocarpa</i>	chuckwalla combseed	Herb	Boraginaceae	20
<i>Pectocarya platycarpa</i>	broadfruit combseed	Herb	Boraginaceae	111

Scientific Name	Common Name	Life Form	Family	Samples
<i>Pectocarya recurvata</i>	curvenut combseed	Herb	Boraginaceae	85
<i>Pectocarya setosa</i>	moth combseed	Herb	Boraginaceae	12
<i>Pediomelum castoreum</i>	beaver Indian breadroot	Herb	Fabaceae	2
<i>Penstemon</i>	beardtongue	Herb	Scrophulariaceae	4
<i>Penstemon eatonii</i>	firecracker penstemon	Herb	Scrophulariaceae	2
<i>Penstemon palmeri</i>	Palmer's penstemon	Herb	Scrophulariaceae	3
<i>Perityle emoryi</i>	Emory's rockdaisy	Herb	Asteraceae	17
<i>Petalonyx nitidus</i>	shinyleaf sandpaper plant	Shrub	Loasaceae	1
<i>Petalonyx parryi</i>	Parry's sandpaper plant	Shrub	Loasaceae	7
<i>Petalonyx thurberi</i>	Thurber's sandpaper plant	Shrub	Loasaceae	3
<i>Peucephyllum schottii</i>	Schott's pygmycedar	Shrub	Asteraceae	43
<i>Phacelia</i>	phacelia	Herb	Hydrophyllaceae	79
<i>Phacelia affinis</i>	limestone phacelia	Herb	Hydrophyllaceae	1
<i>Phacelia calthifolia</i>	calthaleaf phacelia	Herb	Hydrophyllaceae	1
<i>Phacelia crenulata</i>	clefleaf wildheliotrope	Herb	Hydrophyllaceae	121
<i>Phacelia distans</i>	distant phacelia	Herb	Hydrophyllaceae	11
<i>Phacelia fremontii</i>	Fremont's phacelia	Herb	Hydrophyllaceae	18
<i>Phacelia ivesiana</i>	Ives' phacelia	Herb	Hydrophyllaceae	2
<i>Phacelia lemmonii</i>	Lemmon's phacelia	Herb	Hydrophyllaceae	2
<i>Phacelia neglecta</i>	alkali phacelia	Herb	Hydrophyllaceae	4
<i>Phacelia palmeri</i>	Palmer's phacelia	Herb	Hydrophyllaceae	5
<i>Phacelia pulchella</i>	beautiful phacelia	Herb	Hydrophyllaceae	34
<i>Phacelia rotundifolia</i>	roundleaf phacelia	Herb	Hydrophyllaceae	8
<i>Phacelia vallis-mortae</i>	Death Valley phacelia	Herb	Hydrophyllaceae	25
<i>Phlox</i>	phlox	Herb	Polemoniaceae	1
<i>Pholistoma membranaceum</i>	white fiestaflower	Herb	Hydrophyllaceae	6
<i>Phoradendron californicum</i>	mesquite mistletoe	Shrub	Viscaceae	47
<i>Phragmites australis</i>	common reed	Herb	Poaceae	32
<i>Physalis</i>	groundcherry	Herb	Solanaceae	3
<i>Physalis crassifolia</i>	yellow nightshade groundcherry	Herb	Solanaceae	6
<i>Physalis hederifolia</i>	ivyleaf groundcherry	Herb	Solanaceae	2
<i>Pinus monophylla</i>	singleleaf pinyon	Tree	Pinaceae	9
<i>Plagiobothrys</i>	popcornflower	Herb	Boraginaceae	16
<i>Plantago</i>	plantain	Herb	Plantaginaceae	18
<i>Plantago ovata</i>	desert Indianwheat	Herb	Plantaginaceae	197
<i>Plantago patagonica</i>	woolly plantain	Herb	Plantaginaceae	7
<i>Pleuraphis rigida</i>	big galleta	Herb	Poaceae	91
<i>Pleurocoronis pluriseta</i>	bush arrowleaf	Shrub	Asteraceae	31
<i>Pluchea odorata</i>	sweetscent	Herb	Asteraceae	2
<i>Pluchea sericea</i>	arrowweed	Shrub	Asteraceae	54
<i>Poa</i>	bluegrass	Herb	Poaceae	4
<i>Poa fendleriana</i>	muttongrass	Herb	Poaceae	1
<i>Polygala acanthoclada</i>	desert polygala	Shrub	Polygalaceae	1
<i>Polypogon interruptus</i>	ditch rabbitsfoot grass	Herb	Poaceae	1
<i>Polypogon monspeliensis</i>	annual rabbitsfoot grass	Herb	Poaceae	11

Scientific Name	Common Name	Life Form	Family	Samples
<i>Polypogon viridis</i>	beardless rabbitsfoot grass	Herb	Poaceae	3
<i>Populus angustifolia</i>	narrowleaf cottonwood	Tree	Salicaceae	1
<i>Populus fremontii</i>	Fremont cottonwood	Tree	Salicaceae	7
<i>Porophyllum gracile</i>	slender poreleaf	Herb	Asteraceae	84
<i>Prenanthes exigu</i>	brightwhite	Herb	Asteraceae	9
<i>Prosopis glandulosa</i>	honey mesquite	Tree	Fabaceae	40
<i>Prosopis pubescens</i>	screwbean mesquite	Tree	Fabaceae	18
<i>Prunus fasciculata</i>	desert almond	Shrub	Rosaceae	13
<i>Psathyrotes annua</i>	annual psathyrotes	Herb	Asteraceae	1
<i>Psathyrotes pilifera</i>	hairybeast turtleback	Herb	Asteraceae	1
<i>Psathyrotes ramosissima</i>	velvet turtleback	Herb	Asteraceae	2
<i>Psilostrophe cooperi</i>	whitestem paperflower	Shrub	Asteraceae	5
<i>Psoralea argophylla</i>	Mojave indigobush	Shrub	Fabaceae	1
<i>Psoralea argophylla</i>	Fremont's dalea	Shrub	Fabaceae	130
<i>Psoralea argophylla</i>	smoketree	Tree	Fabaceae	1
<i>Pterostegia drymarioides</i>	woodland pterostegia	Herb	Polygonaceae	25
<i>Quercus chrysolepis</i>	canyon live oak	Tree	Fagaceae	1
<i>Quercus turbinella</i>	Sonoran scrub oak	Shrub	Fagaceae	21
<i>Rafinesquia</i>	plumeseed	Herb	Asteraceae	1
<i>Rafinesquia neomexicana</i>	New Mexico plumeseed	Herb	Asteraceae	127
<i>Rhamnus ilicifolia</i>	hollyleaf redberry	Shrub	Rhamnaceae	1
<i>Rhus trilobata</i>	skunkbush sumac	Shrub	Anacardiaceae	14
<i>Ribes velutinum</i>	desert gooseberry	Shrub	Grossulariaceae	2
<i>Salazaria mexicana</i>	Mexican bladdersage	Shrub	Lamiaceae	43
<i>Salix</i>	willow	Tree	Salicaceae	1
<i>Salix exigua</i>	narrowleaf willow	Shrub	Salicaceae	10
<i>Salix gooddingii</i>	Goodding's willow	Tree	Salicaceae	3
<i>Salix tracyi</i>	Tracy's willow	Shrub	Salicaceae	2
<i>Salsola</i>	Russian thistle	Herb	Chenopodiaceae	25
<i>Salvia</i>	sage	Shrub	Lamiaceae	1
<i>Salvia columbariae</i>	chia	Herb	Lamiaceae	56
<i>Salvia dorrii</i>	purple sage	Shrub	Lamiaceae	9
<i>Salvia mohavensis</i>	Mojave sage	Shrub	Lamiaceae	18
<i>Samolus valerandi ssp. parviflorus</i>	seaside brookweed	Herb	Primulaceae	1
<i>Schismus</i>	Mediterranean grass	Herb	Poaceae	271
<i>Schoenoplectus americanus</i>	chairmaker's bulrush	Herb	Cyperaceae	10
<i>Scirpus</i>	bulrush	Herb	Cyperaceae	1
<i>Selinocarpus nevadensis</i>	desert moonpod	Herb	Nyctaginaceae	2
<i>Senecio flaccidus</i>	threadleaf ragwort	Shrub	Asteraceae	6
<i>Senecio mohavensis</i>	Mojave ragwort	Herb	Asteraceae	2
<i>Senna armata</i>	desertsenna	Shrub	Fabaceae	4
<i>Senna covesii</i>	Coues' cassia	Shrub	Fabaceae	9
<i>Sesuvium verrucosum</i>	verrucose seapurslane	Herb	Aizoaceae	1
<i>Silene antirrhina</i>	sleepy silene	Herb	Caryophyllaceae	2
<i>Sisymbrium</i>	hedgemustard	Herb	Brassicaceae	11

Scientific Name	Common Name	Life Form	Family	Samples
<i>Solidago canadensis</i>	Canada goldenrod	Herb	Asteraceae	2
<i>Solidago spectabilis</i> var. <i>confinis</i>	Nevada goldenrod	Herb	Asteraceae	3
<i>Sonchus asper</i>	spiny sowthistle	Herb	Asteraceae	2
<i>Sonchus oleraceus</i>	common sowthistle	Herb	Asteraceae	3
<i>Sphaeralcea ambigua</i>	desert globemallow	Herb	Malvaceae	164
<i>Sporobolus airoides</i>	alkali sacaton	Herb	Poaceae	18
<i>Sporobolus cryptandrus</i>	sand dropseed	Herb	Poaceae	4
<i>Standing snag</i>		Non-vasc		98
<i>Stanleya pinnata</i>	desert princesplume	Herb	Brassicaceae	9
<i>Stephanomeria exigua</i>	small wirelettuce	Herb	Asteraceae	2
<i>Stephanomeria minor</i>	lesser wirelettuce	Herb	Asteraceae	1
<i>Stephanomeria parryi</i>	Parry's wirelettuce	Herb	Asteraceae	1
<i>Stephanomeria pauciflora</i>	brownplume wirelettuce	Shrub	Asteraceae	136
<i>Stillingia linearifolia</i>	queen's-root	Herb	Euphorbiaceae	7
<i>Streptanthella longirostris</i>	longbeak streptanthella	Herb	Brassicaceae	20
<i>Stylocline</i>	neststraw	Herb	Asteraceae	37
<i>Suaeda moquinii</i>	Mojave seablite	Shrub	Chenopodiaceae	32
<i>Tamarix</i>	tamarisk	Tree	Tamaricaceae	1
<i>Tamarix aphylla</i>	Athel tamarisk	Tree	Tamaricaceae	3
<i>Tamarix ramosissima</i>	saltcedar	Shrub	Tamaricaceae	44
<i>Tetracoccus hallii</i>	Hall's shrubby-spurge	Shrub	Euphorbiaceae	2
<i>Tetradymia spinosa</i>	shortspine horsebrush	Shrub	Asteraceae	2
<i>Tetradymia stenolepis</i>	Mojave cottonthorn	Shrub	Asteraceae	8
<i>Thamnosma montana</i>	turpentinebroom	Shrub	Rutaceae	34
<i>Thelypodium integrifolium</i>	entireleaved thelypody	Herb	Brassicaceae	1
<i>Thymophylla pentachaeta</i> var. <i>belenidium</i>	fiveneedle pricklyleaf	Herb	Asteraceae	6
<i>Thysanocarpus curvipes</i>	sand fringe-pod	Herb	Brassicaceae	24
<i>Tidestromia</i>	honeysweet	Shrub	Amaranthaceae	8
<i>Tiquilia canescens</i>	woody crinklemat	Shrub	Boraginaceae	30
<i>Tiquilia lator</i>	matted crinklemat	Shrub	Boraginaceae	16
<i>Tiquilia plicata</i>	fanleaf crinklemat	Herb	Boraginaceae	3
<i>Tricardia watsonii</i>	threehearts	Herb	Hydrophyllaceae	1
<i>Trichoptilium incisum</i>	yellowdome	Herb	Asteraceae	2
<i>Tridens muticus</i>	slim tridens	Herb	Poaceae	7
<i>Typha</i>	cattail	Herb	Typhaceae	14
Unknown		Unknown		8
Unknown Algae		Non-vasc		5
Unknown Forb (herbaceous, not grass nor grasslike)		Herb		37
Unknown Fungus		Non-vasc		1
Unknown Graminoid (grass or grasslike)		Herb		6
Unknown Lichen		Non-vasc		23
Unknown Liverwort		Non-vasc		1
Unknown Moss		Non-vasc		27

Scientific Name	Common Name	Life Form	Family	Samples
Unknown Shrub		Shrub		4
<i>Viguiera parishii</i>	Parish's goldeneye	Shrub	Asteraceae	108
<i>Vitis arizonica</i>	canyon grape	Shrub	Vitaceae	29
<i>Vitis girdiana</i>	desert wild grape	Shrub	Vitaceae	1
<i>Vulpia</i>	fescue	Herb	Poaceae	95
<i>Washingtonia filifera</i>	California fan palm	Tree	Arecaceae	3
<i>Xanthium strumarium</i>	rough cocklebur	Herb	Asteraceae	1
<i>Xylorhiza tortifolia</i>	Mojave woodyaster	Herb	Asteraceae	64
<i>Yucca baccata</i>	banana yucca	Shrub	Agavaceae	3
<i>Yucca brevifolia</i>	Joshua tree	Tree	Agavaceae	13
<i>Yucca elata</i>	soaptree yucca	Tree	Agavaceae	2
<i>Yucca schidigera</i>	Mojave yucca	Shrub	Agavaceae	128
<i>Ziziphus obtusifolia</i>	lotebush	Shrub	Rhamnaceae	2

Appendix F. Gradsect Analysis for Lake Mead National Recreation Area

National Park Service
U.S. Department of the Interior



Lake Mead National Recreation Area

Gradsect Analysis for Lake Mead National Recreation Area

December 2009



On the Cover:

Aerial View of Lake Mead

Photographer: Unknown – Source www.destination360.com/north-america/us/nevada/las-vegas

**Stratified Sampling for Field Survey for Vegetation Description of
Lake Mead National Recreation Area**

December 4, 2009

Produced for:

Alice Chung-MacCoubrey
National Park Service Mojave Desert Network
601 Nevada Highway
Boulder City, NV 89005

Produced by: David E. Salas
U.S. Bureau of Reclamation
Denver Federal Center
Denver, CO 80225

Overview

The description and products delivered are in accordance with Inter/Intra-Agency Agreement # F2340090049 between the National Park Service and the Bureau of Reclamation. The agreement is for the delivery of a vegetation sampling plan for Lake Mead NRA, Mojave National Preserve, and Death Valley National Park. This sampling plan described in this report is part 1 of the 3 part sampling plan.

The National Park Service has an ongoing vegetation mapping program for most of the units under its purview. The vegetation mapping program provides baseline information to the NPS Inventory and Monitoring (I&M) Program. A vegetation sampling plan is part of the initial phases of the entire mapping process and is a critical step in quantifying the existing vegetation communities for the park in question. Lake Mead NRA is part of collective effort to describe the vegetation within the Mojave Network. Vegetation sampling and description will be conducted at Lake Mead NRA, Mojave National Preserve, and Death Valley National Park concurrently. The Lake Mead NRA portion of the project area encompasses over 1,100,000 acres of land and water (Figure 1 and 2). This gradient directed sampling approach will assist the field crews in sampling representative vegetation of Lake Mead NRA.

Principal guidance for this sampling effort comes from a few sources although others are referenced. The documents that provide overall procedures and methods include “12 Step Guidance” (Brown, 2009) which provides updated guidance on the entire vegetation mapping process. The section on sampling references a number of other documents. We used the “Guidance of the Design of Sampling Schemes for Inventory and Monitoring of Biological Resources” (Fancy 2000). Other references focused more on a more local or regional interest include the “Mojave Desert Ecosystem Program: Central Mojave Vegetation Database” by Thomas et al. 2004 and “Stratified Sampling for Field Survey on environmental Gradients in the Mojave Desert Ecoregion” by Franklin et al. (2001). The chapter by Franklin et al. (2001) describes in detail the sampling plan by Thomas et al. (2004).

This document details the methods and rationale used in developing a vegetation sampling plan. Included as deliverables are tables with the selected points in Universal Transverse Mercator coordinates, a GIS layer, and a map book that shows the location of each of these points. The map book is provided in three separate volumes which represent roughly equal portions of the Park.

Table of Contents

Overview	F-7
Figures.....	F-9
Tables	F-9
Introduction.....	F-10
Methods.....	F-11
Overview	F-11
Climate	F-14
Temperatures:	F-14
Precipitation:.....	F-18
Soils	F-23
Terrain Classes	F-28
Bioclimatic Grid	F-29
Sampling.....	F-29
Products	F-30
Summary	F-35
References.....	F-36

Figures

Figure 1. Project area boundaries.....	F-12
Figure 2. Elevational gradient for LAME.....	F-13
Figure 3. July average maximumtemp (°C).	F-15
Figure 4. January average minimum temp (°C).	F-16
Figure 5. July average maximum temperature classes (°C).	F-17
Figure 6. January average minimum temperature classes (°C).	F-18
Figure 7. Total summer precipitation (mm).	F-20
Figure 8. Total winter precipitation (mm).....	F-21
Figure 9. Total summer precipitation-classes (mm).	F-22
Figure 10. Total winter precipitation classes (mm).	F-23
Figure 11. Soils “Parent Material” data layer.	F-25
Figure 12. Soil parent material classes.....	F-28
Figure 13. Bioclimatic model of LAME.	F-31
Figure 14. First stage sample.....	F-32
Figure 15. Vegetation Sample Locations.	F-33
Figure 16. Detail of vegetation sampling locations.....	F-34

Tables

Table 1. Classification of climate variables used in vegetation sample site selection.	F-14
Table 2. Soil parent material types in for LAME.....	F-26
Table 3. Compiled soil parent material classes.	F-27
Table 4. Terrain classification.....	F-29

Introduction

Sampling protocols may serve a variety of purposes and the desired results depend very much on the purpose of the sampling. In this particular case, we desire to select plot locations such that the results will provide the best representation of the vegetation communities within the Park, given available resources for the sampling. The plots themselves serve two purposes. These are:

1. to serve as the raw data from which to build the park ecological classification, and thus, the map classification
2. as a permanent record of the floristic characteristics of each vegetation type (Brown 2009)

To achieve this representative sample we would like the allocation of samples to represent the distribution of vegetation throughout the Park. There has been abundant research precedence on this topic. Gillison and Brewer 1985, Austin and Heyligers 1989, 1991, Margules and Austin 1994, Austin 1998, reviewed by Bourgeron et al. 1994 are some earlier papers that addressed methods to sample and describe. Gradient directed sampling is the approach most often used currently within the Park mapping program and some of the methods applied to vegetation sampling in the national parks are derived from these authors. More recently, and specific to the vegetation mapping program is a paper by Fancy (2000) where a number of designs are discussed. One of those designs is similar to gradient directed sampling in that it includes a stratified random sample approach. We modify that design slightly using the methods described by Franklin et al. (2001) and Thomas et al. 2004 where a two stage random sample is used. We chose the methods by Franklin et al. (2001) because many of the authors in both the Franklin and Thomas papers will be collecting the plot data and we presume that similar methods to those they used in the past would be acceptable. The methods used here differ somewhat from those suggested and described in the “Vegetation Classification and Mapping Work Plan – Mojave Inventory and Monitoring Network” Cogan (2008).

Methods

Overview

The methods followed here to select vegetation sampling points for the Lake Mead National Recreation Area (LAME) Vegetation Map follow very closely the methods developed for the Central Mojave Vegetation Database (Thomas et al. 2004, Franklin et al. 2001). In that product a great amount of effort was put into determining the best parameters that were used as explanatory variables for the vegetation of the Mojave Desert. LAME also lies within the Mojave Desert, albeit on the southern most extent, adjacent to the Sonoran Desert. We presume that roughly the same variables can be used for this effort although the parsing of the data may vary slightly.

The plots were chosen using two stage stratification. The first stage was sampled from a model that included macro variables of soils and climate grids. Thomas et al. (2004) and Franklin et al. (2001) used a geology layer for their model, however, at LAME, the existing geology digital dataset covers only the northern most portion of the study area. To substitute the missing geology layer we use soil data derived from the SSURGO dataset provided by the USDA. The soils data were then gridded and used in conjunction with the climate variables to produce a digital representation of the bioclimatic regimes in the Park. The cell size for the bioclimatic model was 1 km. The second stage stratification required a finer scale representation of the topographic influences on vegetation. For this second phase, we developed a terrain model using as base data the USGS 10 m DEM's. Terrain variables included flow accumulation, slope, and aspect. Figure 1 shows the limits of the project area with an aerial photograph (ESRI I3 Aerial Photography) as a backdrop.

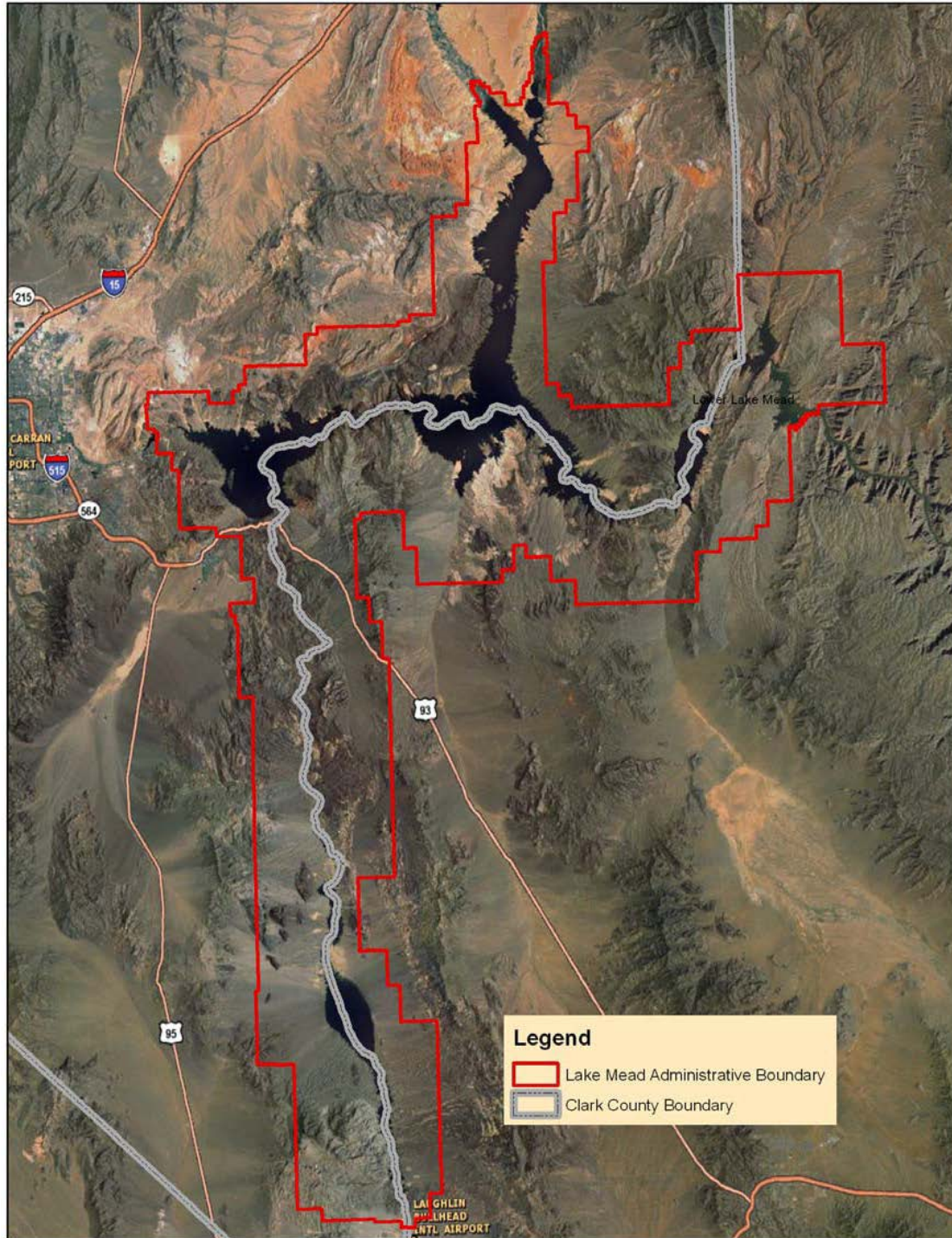


Figure 1. Project area boundaries.

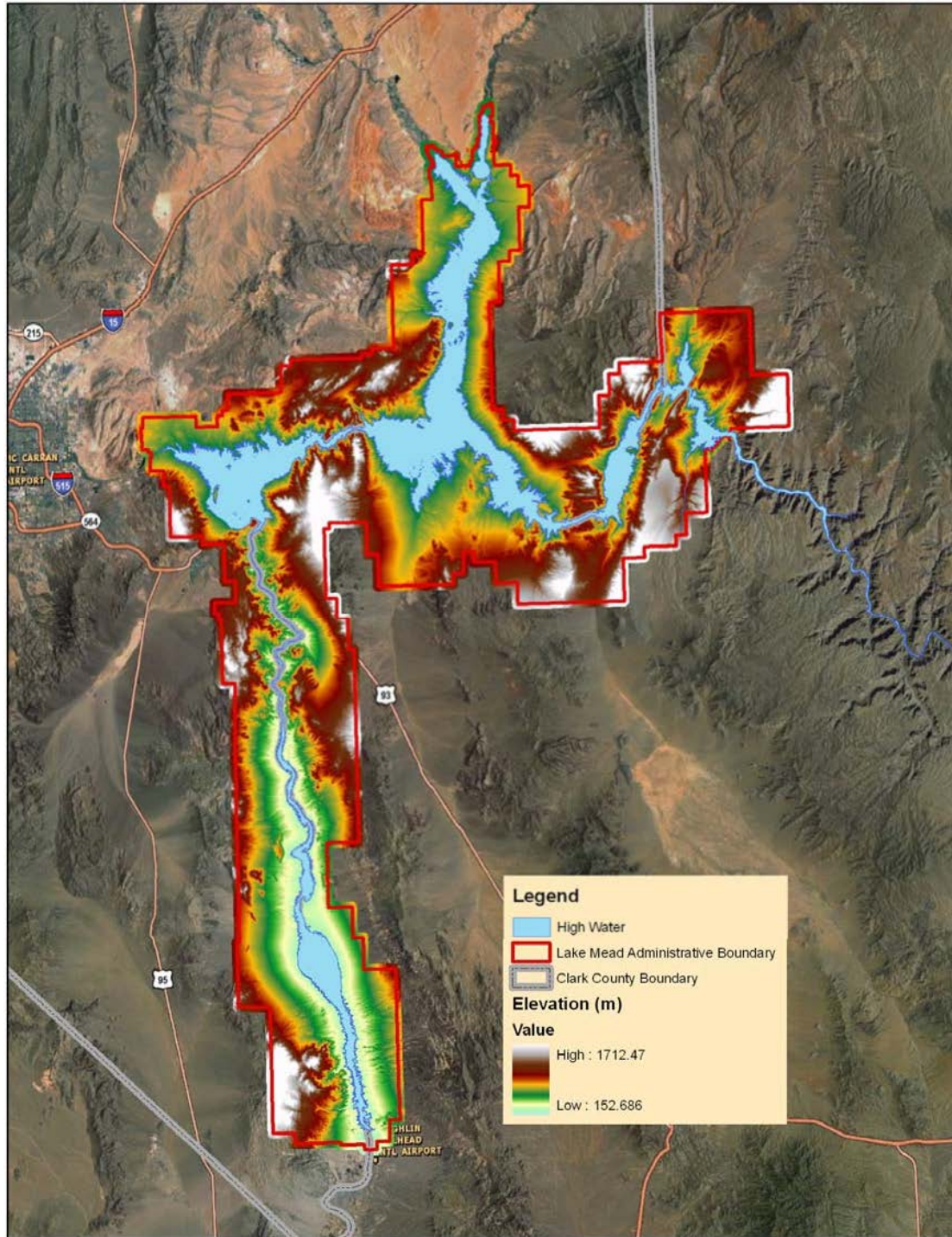


Figure 2. Elevational gradient for LAME.

Climate

Temperature (min and max) and precipitation (summer and winter) variables were used by Franklin et al. (2001) and Thomas et al. (2004) and we used the same for this exercise (Figure 3-Figure 6). Data for the four climate variables were downloaded from the PRISM (PRISM Climate Group, Oregon State University) site. These data represent the averages for the time period 1971 – 2000. Data were clipped and projected from Geographic to UTM for the project area. Summer and winter precipitation values were obtained by deriving the mean pixel value for the six months of each season. Table 1 details the various statistics and reclassifications for each of the variables for the project area.

Table 1. Classification of climate variables used in vegetation sample site selection.

Climate Variable	Mean and Range	Reclassified Category	Standard Deviation Of Variable
July average maximum temperature	39.6 °C (32.0 – 43.6 °C)	<=40.6°C > 40.6°C	2.49
January average minimum temperature	2.7 °C (-2.3 – 6.2 °C)	<= 0.9°C >0.9°C – <= 1.8°C >1.8°C – <= 2.5°C >2.5°C – <= 3.5°C >3.5°C - <= 4.4°C > 4.4°C	1.84
Mean Total Summer precipitation (May – October)	75.0 mm (37.5 – 174.7 mm)	< 84 mm > 84 mm	25.5
Mean Total Winter precipitation (November – April)	100.3 mm (61.8 – 164.8 mm)	< = 86 mm > 86 mm – < = 102 mm > 102 mm - < 119 mm > 119 mm	17.6

Temperatures:

Figure 3 shows the average July maximum temperature over the entire project area. Figure 4 shows the January average minimum temperature over the entire project area. Figures 5 and 6 show the average July maximum and average January minimum temperature classes respectively. The number of classes used follows those in Franklin et al. 2001. The class breaks were determined using natural breaks in the data.

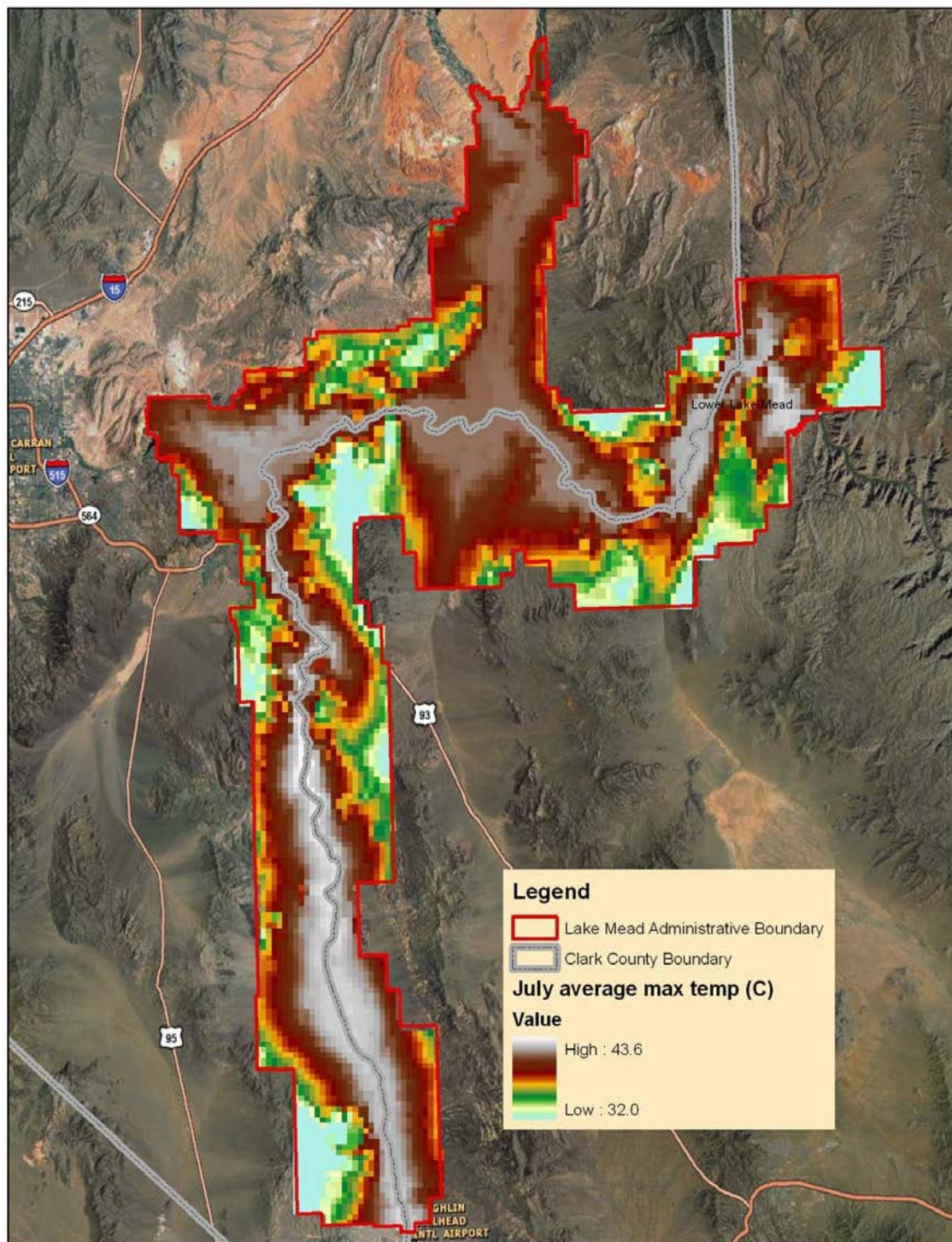


Figure 3. July average maximumtemp (°C).

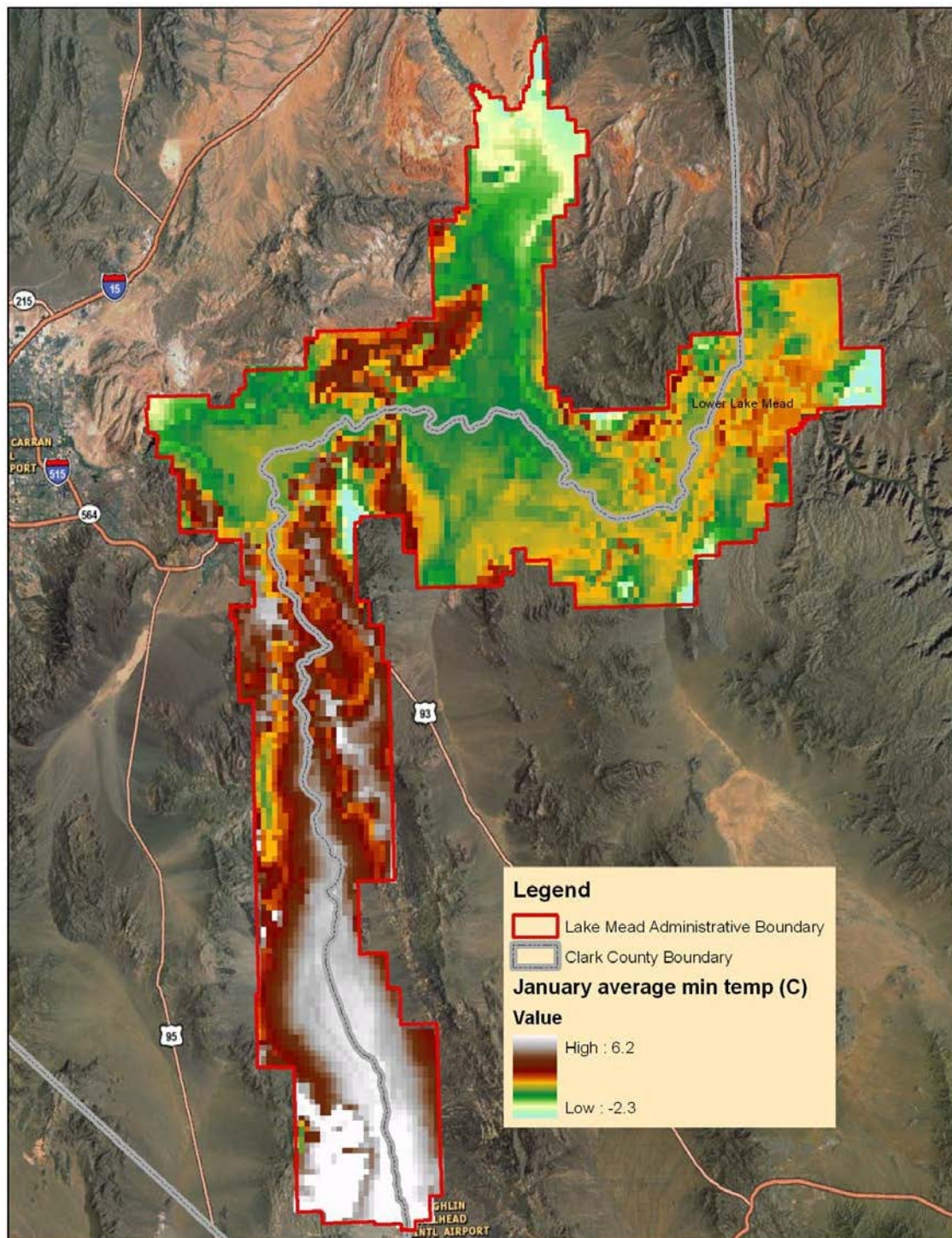


Figure 4. January average minimum temp (°C).

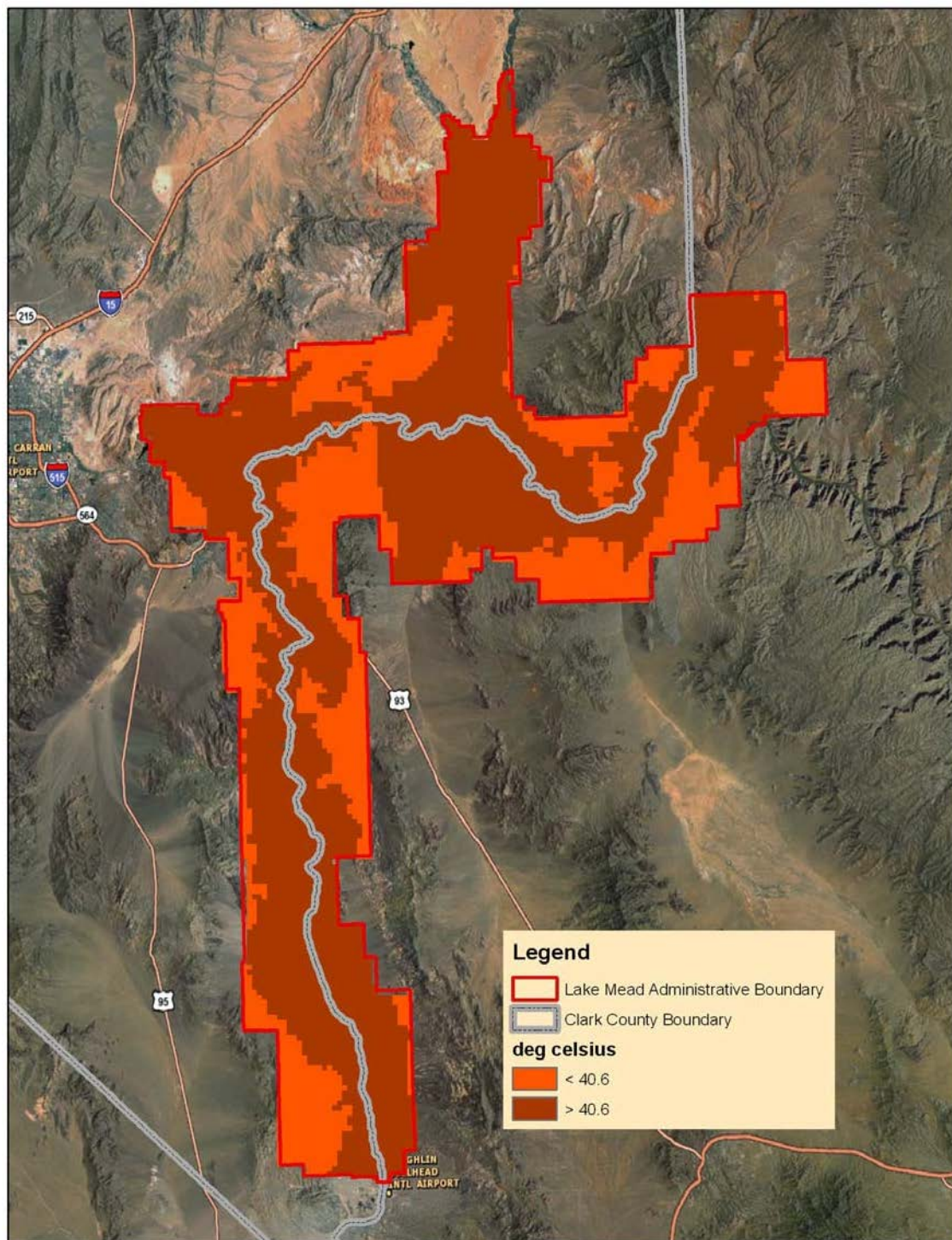


Figure 5. July average maximum temperature classes (°C).

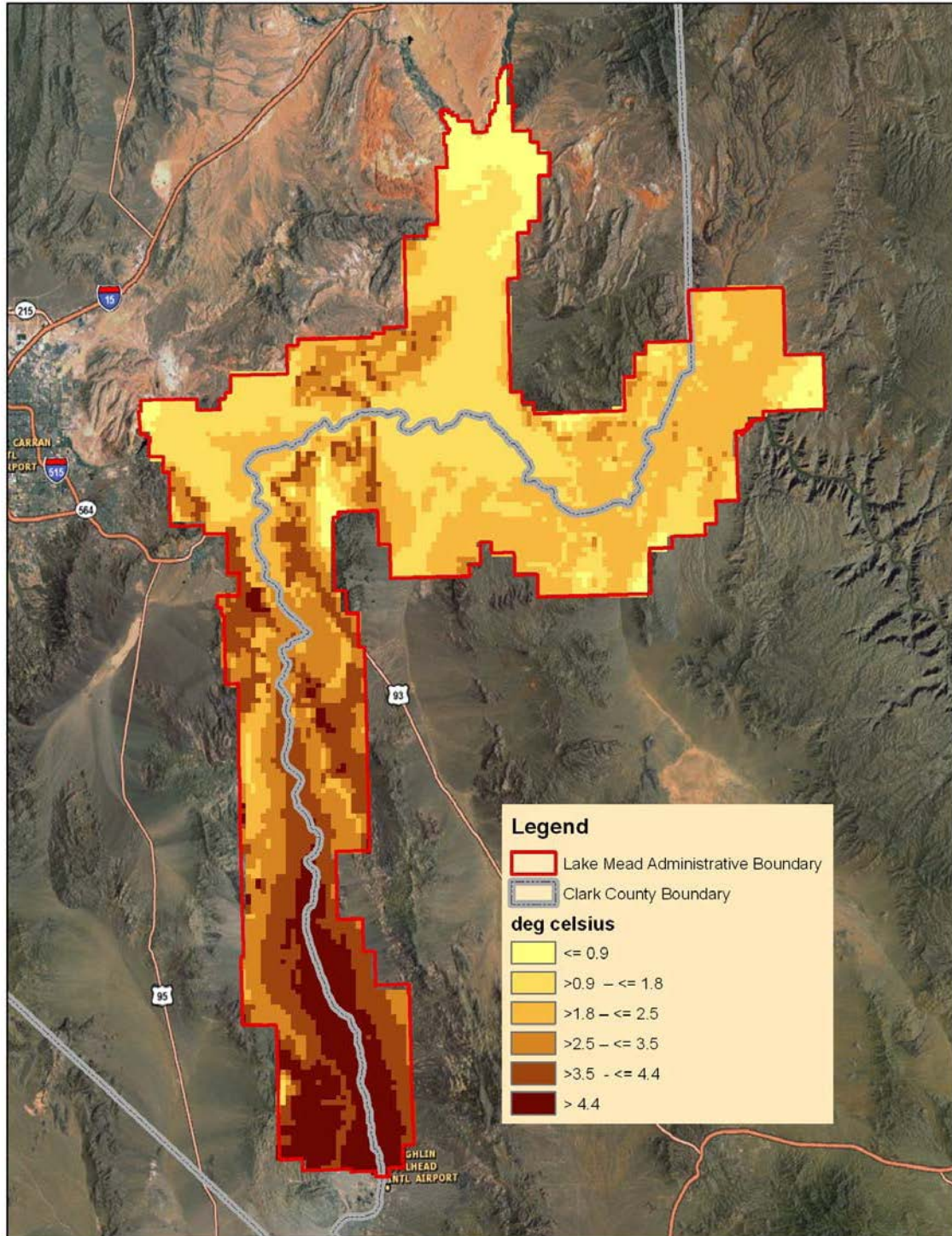


Figure 6. January average minimum temperature classes (°C).

Precipitation:

The total summer precipitation appears to correlate well with elevation. Figure 7 shows the total summer precipitation distribution over the project area. Comparison of Figure 7 with the elevation gradient in Figure 2 shows this rather clearly. Winter precipitations also appear to correlate well with

elevation as shown in Figure 8. There is a notable change in higher precipitation values at the extreme north and east portion of the study area where LAME abuts to Grand Canyon National Park.

The number of classes for the precipitation grids was determined iteratively. More than two classes for summer precipitation and three classes for winter precipitation increased the number of possible environmental grid types too much. The class breaks were chosen using natural breaks in the data. Figure 9 and Figure 10 show the classes and distribution.

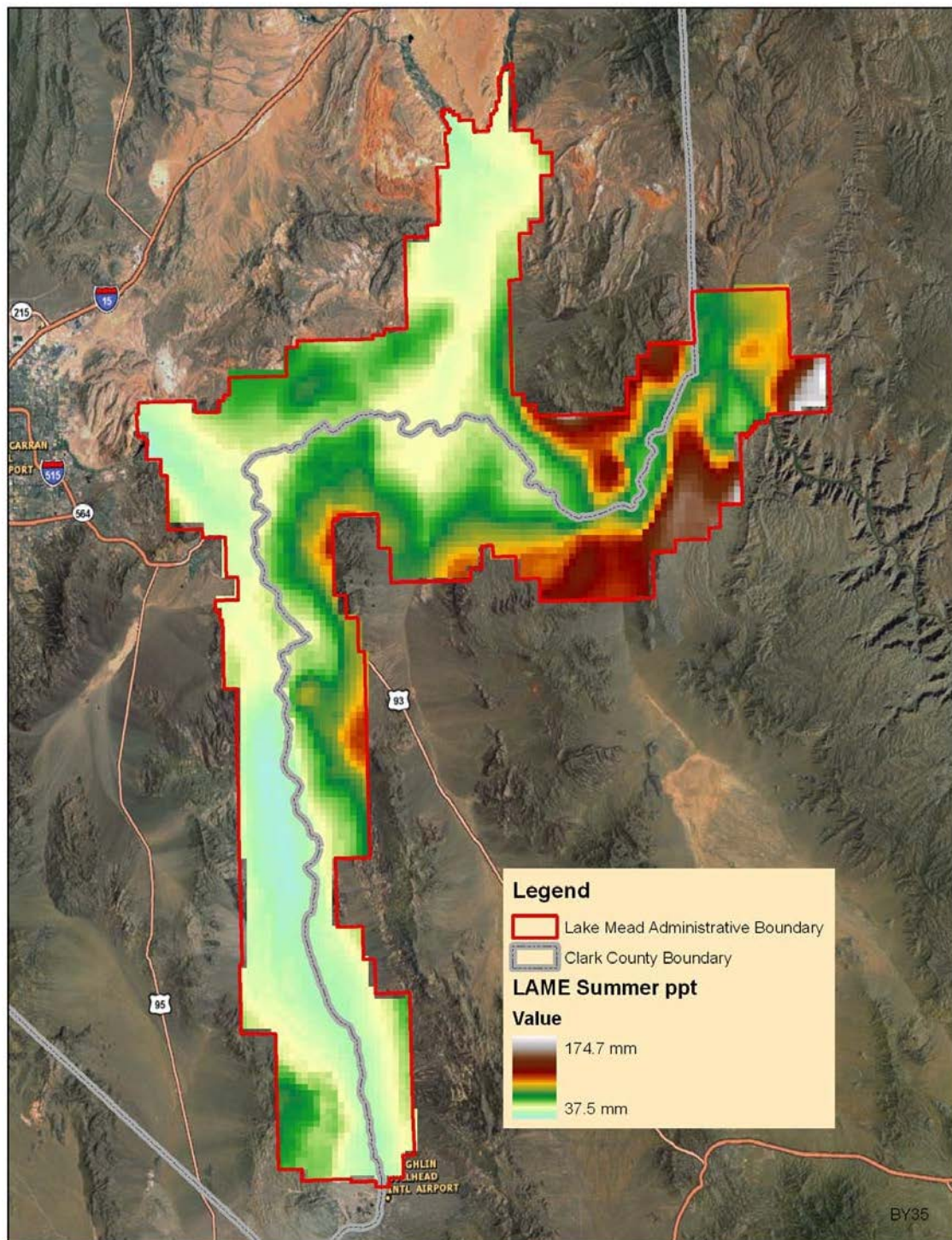


Figure 7. Total summer precipitation (mm).

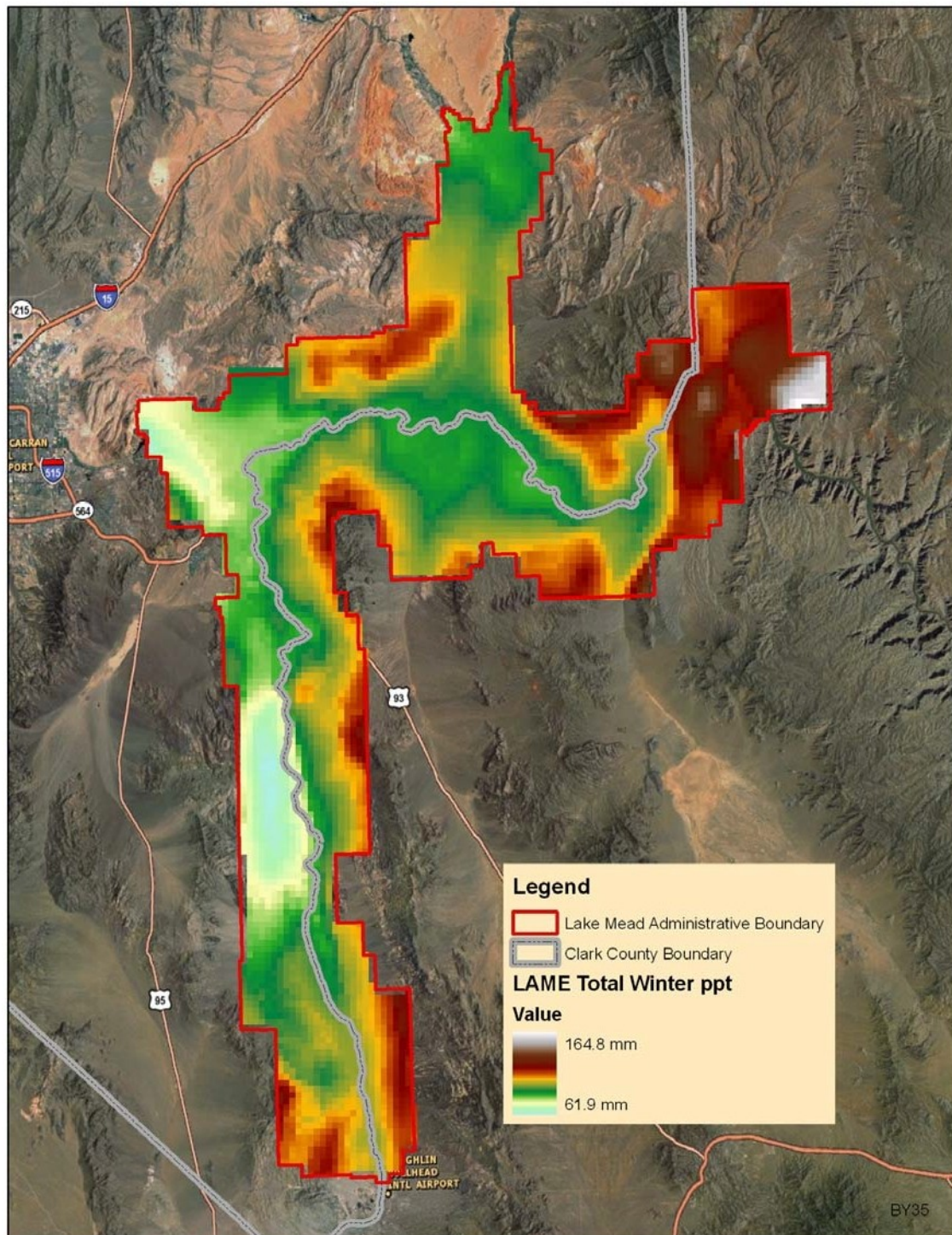


Figure 8. Total winter precipitation (mm).

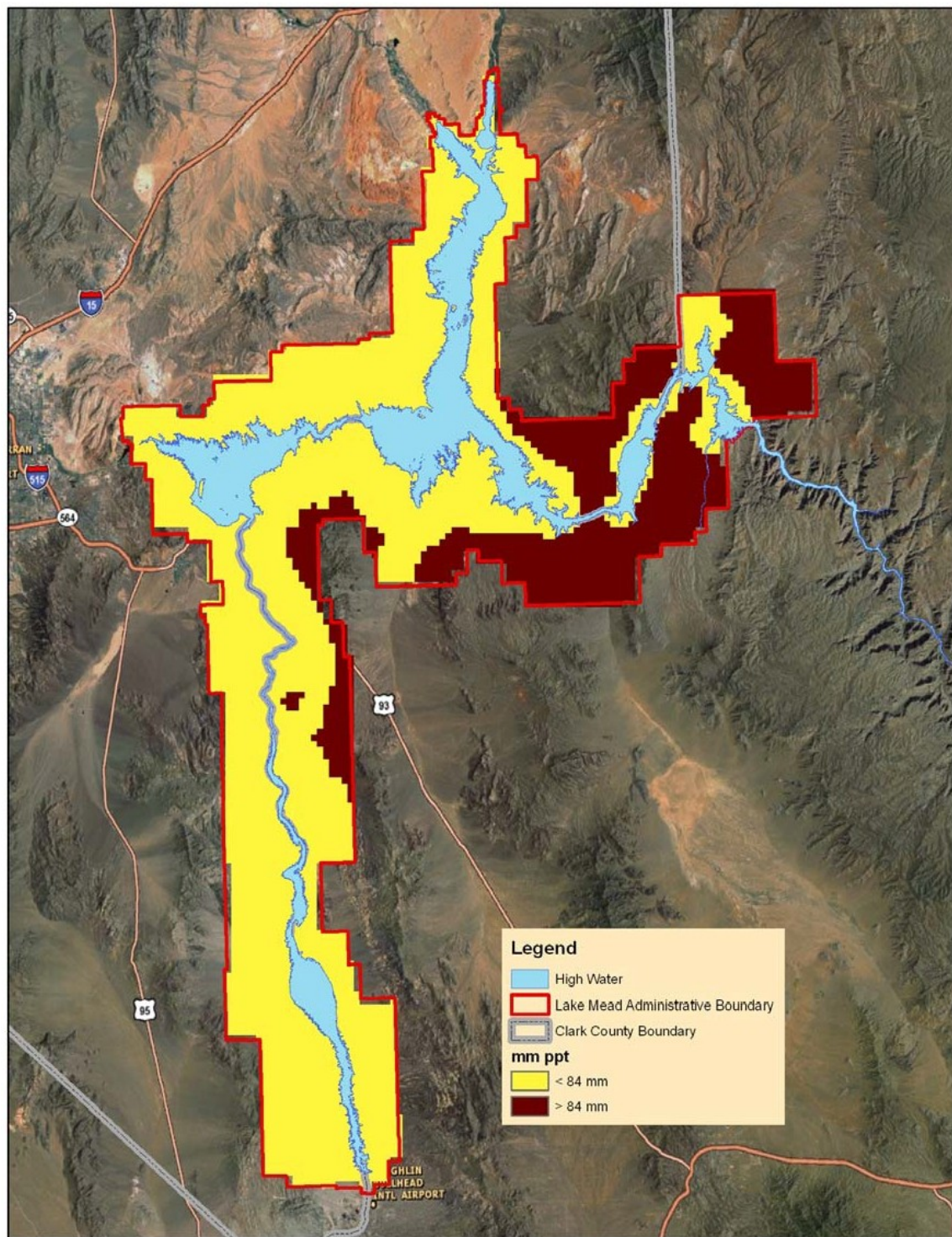


Figure 9. Total summer precipitation-classes (mm).

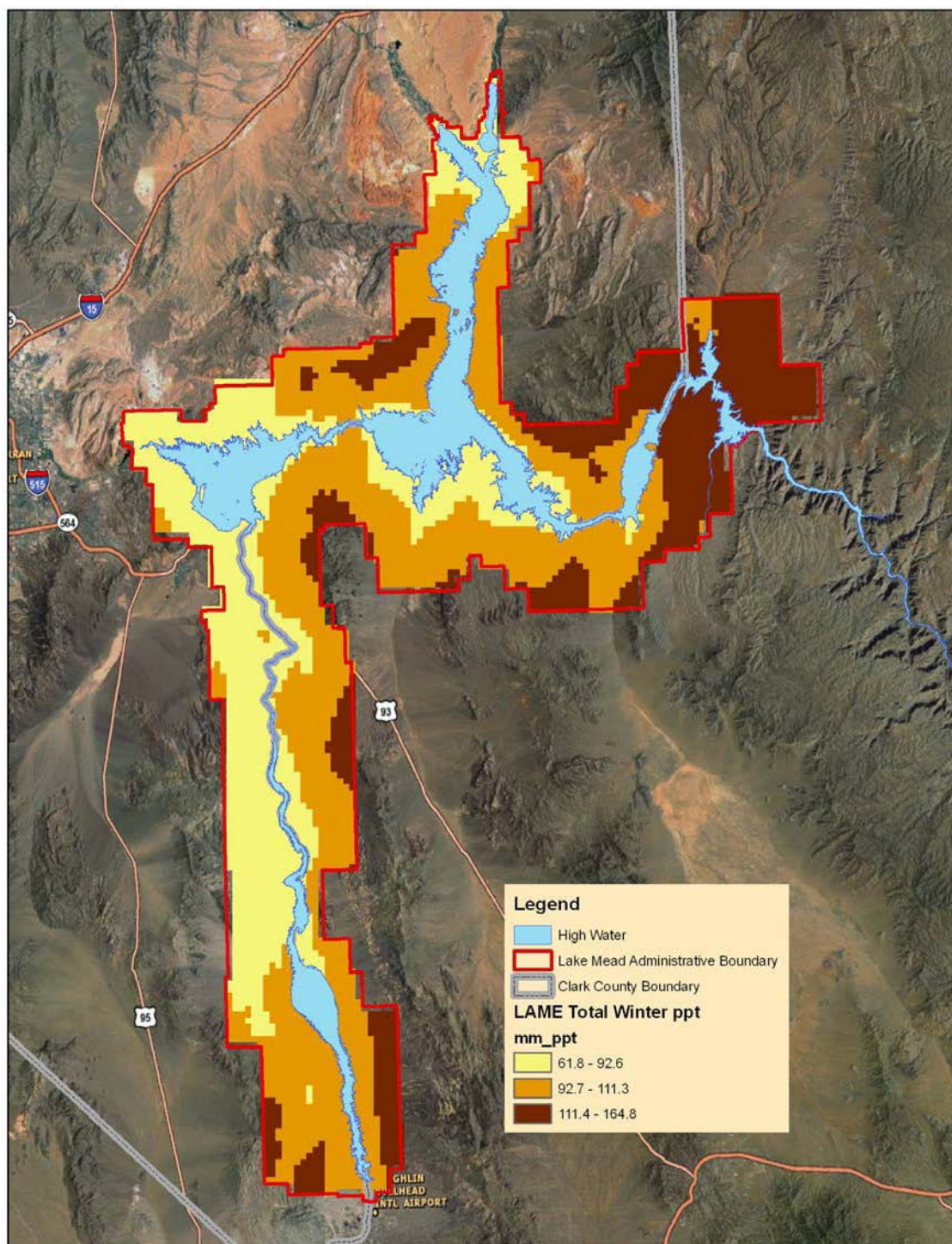


Figure 10. Total winter precipitation classes (mm).

Soils

There are many attributes available for the creation of a data layers with the Soils Data Viewer and the salient soils data. We chose “Parent Material” as a close proxy to the geology classes created for this exercise. Many additional variables are available from within the SSURGO dataset but these are

too numerous to create. Briefly these include various parameters for land classifications, soil chemical properties, soil erosion properties, soil physical properties, soil qualities, vegetative productivity, and water features in addition to others not salient to this product.

Parent Material: We created this layer as a potential replacement of the geology layer for the creation of the environmental types grid (Figure 11). The legend is too large to show at this scale so we present the Parent Material types in Table 2 along with the polygon frequency and area for each type. These types have been combined into eight classes (Table 3). Figure 12 shows the compiled class distribution.

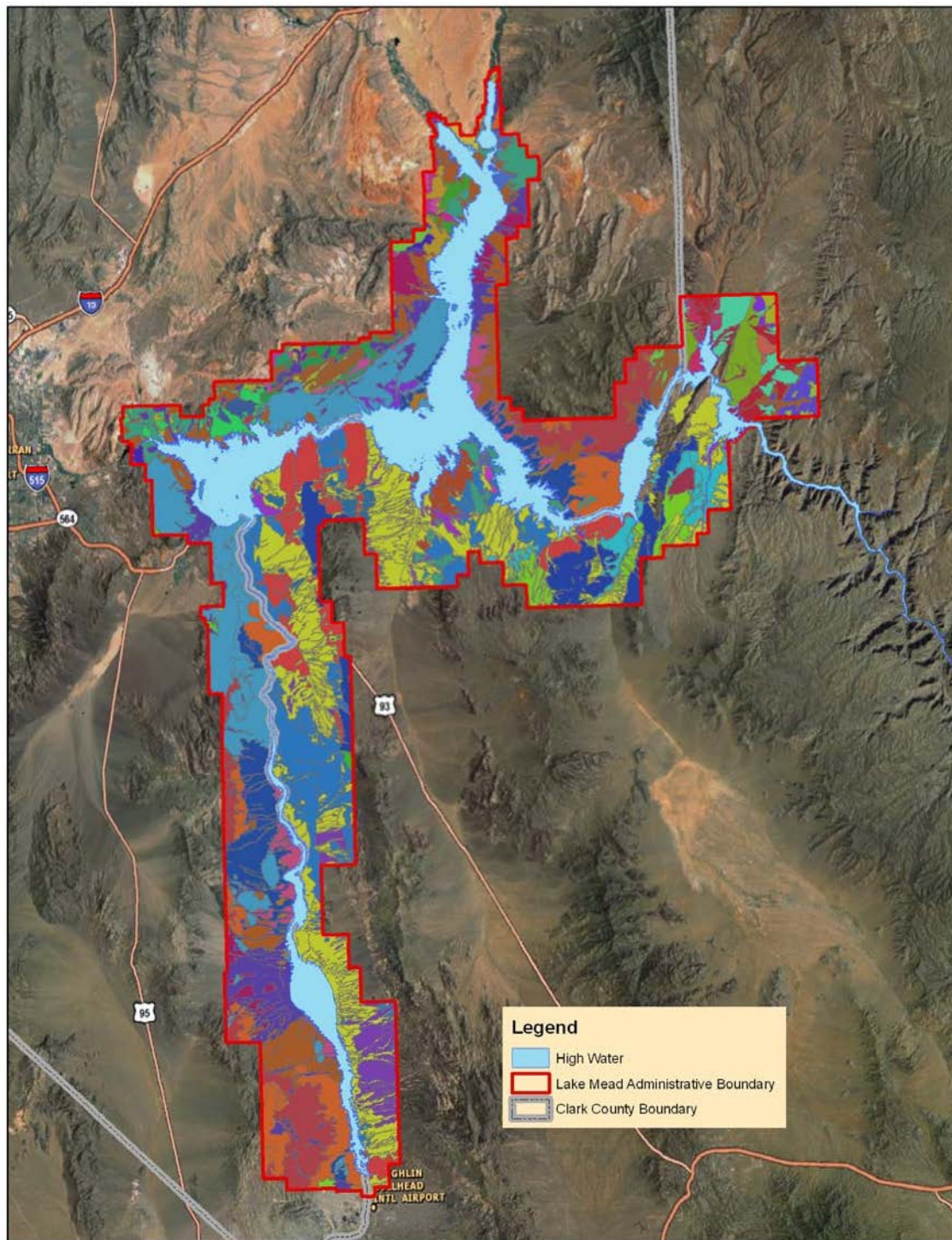


Figure 11. Soils “Parent Material” data layer.

Table 2. Soil parent material types in for LAME.

Parent Material Name	Frequency	Acres
Unclassified	36	182995
alluvium	53	15364
alluvium and colluvium derived from granite	13	35402
alluvium and colluvium derived from limestone	30	17533
alluvium and colluvium derived from tuff	1	1006
alluvium and colluvium derived from volcanic rock	8	951
alluvium and/or colluvium derived from granite and/or metamorphic rock	2	152
alluvium and/or colluvium derived from limestone and sandstone over colluvium	1	58
alluvium derived from basalt	23	5579
alluvium derived from basalt and gypsum	2	1648
alluvium derived from fanglomerate	27	15263
alluvium derived from granite	57	15163
alluvium derived from gypsum	6	5255
alluvium derived from gypsum over residuum weathered from gypsum	19	10553
alluvium derived from igneous and metamorphic rock	67	21628
alluvium derived from igneous, metamorphic and sedimentary rock	5	3068
alluvium derived from limestone	55	23776
alluvium derived from limestone and granite	1	2291
alluvium derived from limestone and sandstone	4	2003
alluvium derived from mixed	544	163400
alluvium derived from mixed sources	16	951
alluvium derived from sandstone	9	2950
alluvium derived from sandstone and shale	6	336
alluvium derived from shale	21	6132
calcareous alluvium derived from sedimentary rock	17	2068
calcareous loess influenced alluvium derived from igneous and metamorphic rock	48	14463
colluvium and/or residuum	10	4049
colluvium and/or residuum weathered from andesite	30	7625
colluvium and/or residuum weathered from calcareous conglomerate	20	10644
colluvium and/or residuum weathered from granite	30	48787
colluvium and/or residuum weathered from gypsum	1	49
colluvium and/or residuum weathered from limestone	25	16119
colluvium and/or residuum weathered from metamorphic rock	3	129
colluvium and/or residuum weathered from noncalcareous conglomerate	7	13759
colluvium and/or residuum weathered from sandstone and siltstone	14	841
colluvium and/or residuum weathered from volcanic rock	76	96774
colluvium derived from limestone and dolomite over residuum weathered from	3	646
colluvium derived from limestone and sandstone	2	5439

Table 3. Compiled soil parent material classes.

Code	Class	Description
0	Water	Open Water
100	Alluvium	Alluvium (and colluvium) derived from a multitude of rock types
200	Calcareous Alluvium	Calcareous alluvium derived from sedimentary rock
300	Loess	Loess over residuum, calcareous loess
400	Eolian	Eolian sands and deposits from mixed sources
500	Residuum	Residuum from mixed sources
600	Colluvium	Colluvium from mixed sources
700	Lacustrine	Tertiary lacustrine deposits
800	Pedisediment	Gravelly pedisediment derived from limestone

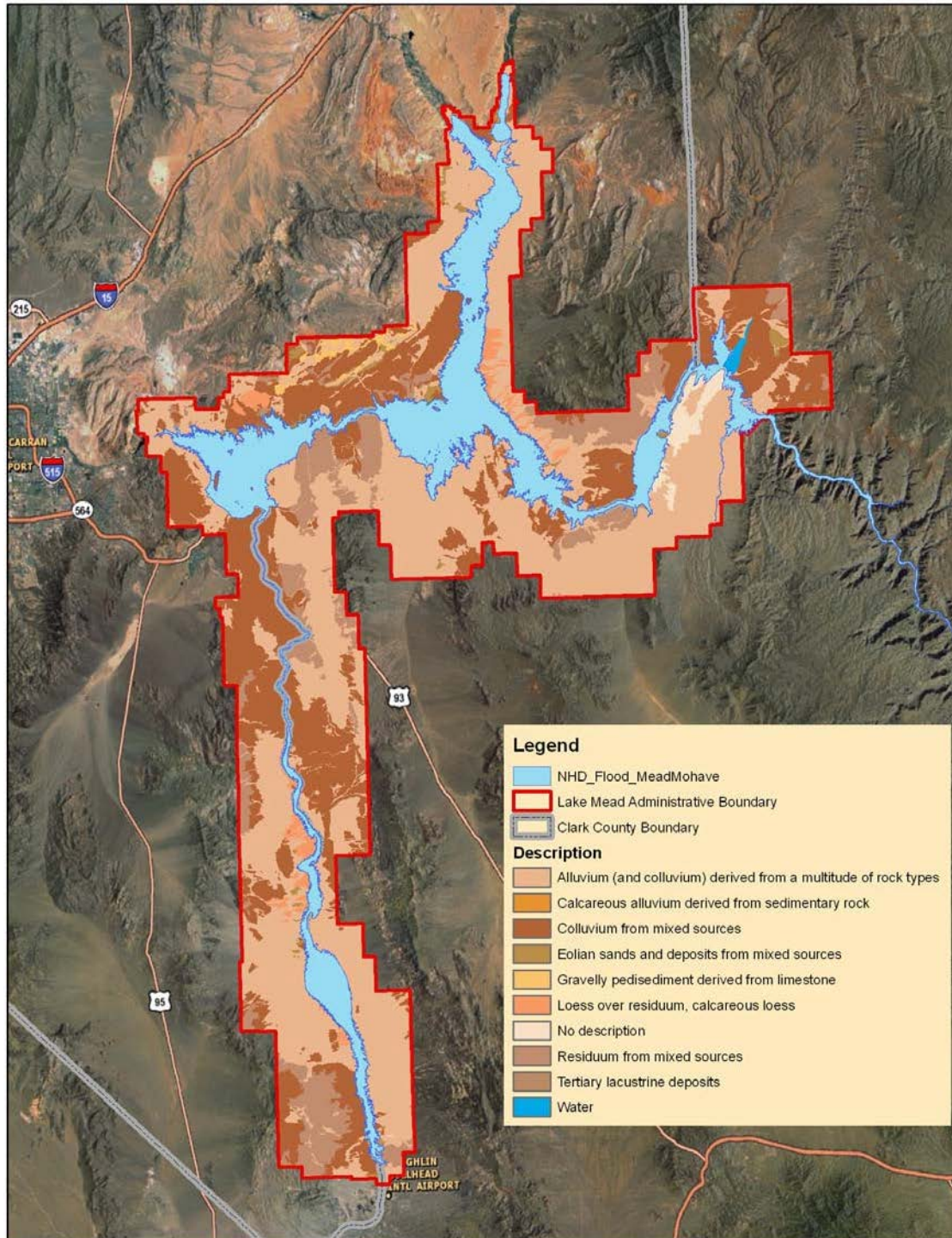


Figure 12. Soil parent material classes.

Terrain Classes

A terrain model was developed using slope-aspect, slope and flow accumulation and follows those used by Franklin et al 2001. A 10 m digital terrain model (USGS NED dataset) was used as the base data for the development of additional layers. We used 6 classes for the terrain model as described by

Franklin et al. 2001. Table 4 shows the individual classes and their descriptions. This model was used in the second stage stratified random sample.

Table 4. Terrain classification

Code	Class	Description (hierarchical decision rules)
1	Drainage	Flow accumulation
2	Flat (<1% slope)	Slope < 1%
3	Gentle Slope (1 – 10 % slope)	Slope < 10 %
4	Northeast aspect	Slope >= 10% and aspect 0 - 90°
5	Southwest aspect	Slope >= 10% and aspect 180 -270°
6	Neutral aspect	Slope >= 10% and aspect 90-180° or 270-360°

Bioclimatic Grid

All themes were rasterized if not already in a raster format. The climate variables have a 1 km pixel size. The soils layer was resampled to the same size. All grids were added together using functions in ArcMap. The final bioclimatic grid contained a possible 768 types (8x2x6x2x4) however, only 188 unique combinations exist. We then converted this raster file to vector and clipped with the lake boundary to create a final macro bioclimatic model of LAME. This model is shown in Figure 13.

Sampling

A two stage random sample was used to select the final sample points. The first stage selected primary sample units (PSU) from the bioclimatic model. Using a sampling design program we selected a stratified random sample of bioclimatic cells based upon proportion of the final environmental types. The program allows the user to declare how many cells would be included in the random sample. To make this determination we had to look ahead at the potential number of plots that we would require to sample the Park. We estimated about 2000 plots will be needed to sample the Park (based on previous experience). Because we anticipate a number of selected points will be prohibitively expensive or dangerous to acquire, we would ask the program to attempt to produce 3000 points to allow for some flexibility in the field. Given that in the second phase of the sample we use a terrain model with potentially 6 terrain classes per bioclimatic cell and if we selected for two points from each terrain class within each bioclimatic cell we could potentially get 12 points per cell. Therefore, it follows that $3000 \text{ pts} / 12 \text{ potential terrain types} = 250 \text{ bioclimatic cells}$. Because the selection process was proportional to the frequency of bioclimatic cell grid codes (unique environmental combinations) some very low frequency types were not selected. The distribution of the first stage sample is shown in Figure 14. A separate program written in house selected the second stage sample (SSU). We selected cells from the terrain model by clipping the terrain model with the PSU. The in house program attempted to select two of each terrain type within each cell. If only one or two terrain types cells were available within a bioclimatic cell those were immediately chosen. If there were more than two of each terrain type available then those terrain cells were then subjected to a random selection and two were selected. Once these terrain model cells were selected, a random point was selected within each terrain cell to mark the plot location. A total of 2,735 points were processed. Figure 15 shows the distribution over the entire Park for the vegetation sampling locations. Figure 16 shows a detail of a portion of the Park with the vegetation sample locations. The

obvious clustering of the points comes from the first stage sample selection where 1 km cells were randomly selected.

Products

Each of the sample points has an x and y descriptor. A shape file is provided that shows the location of the sample points. The table for this shape file has also been exported to an excel format so that these points may be further manipulated outside of a GIS environment and uploaded into portable GPS units. In addition, we provide a map book series that shows the Park at 1:12,000 scale and the locations of each plot. The map book has been subdivided into three roughly equivalent sections representing the north, central, and southern portions of the Park. The initial delivery of the map series is only in electronic format until this process and sample selection is accepted. When this is done then we will provide bound paper copies for the field crews and supervisors.

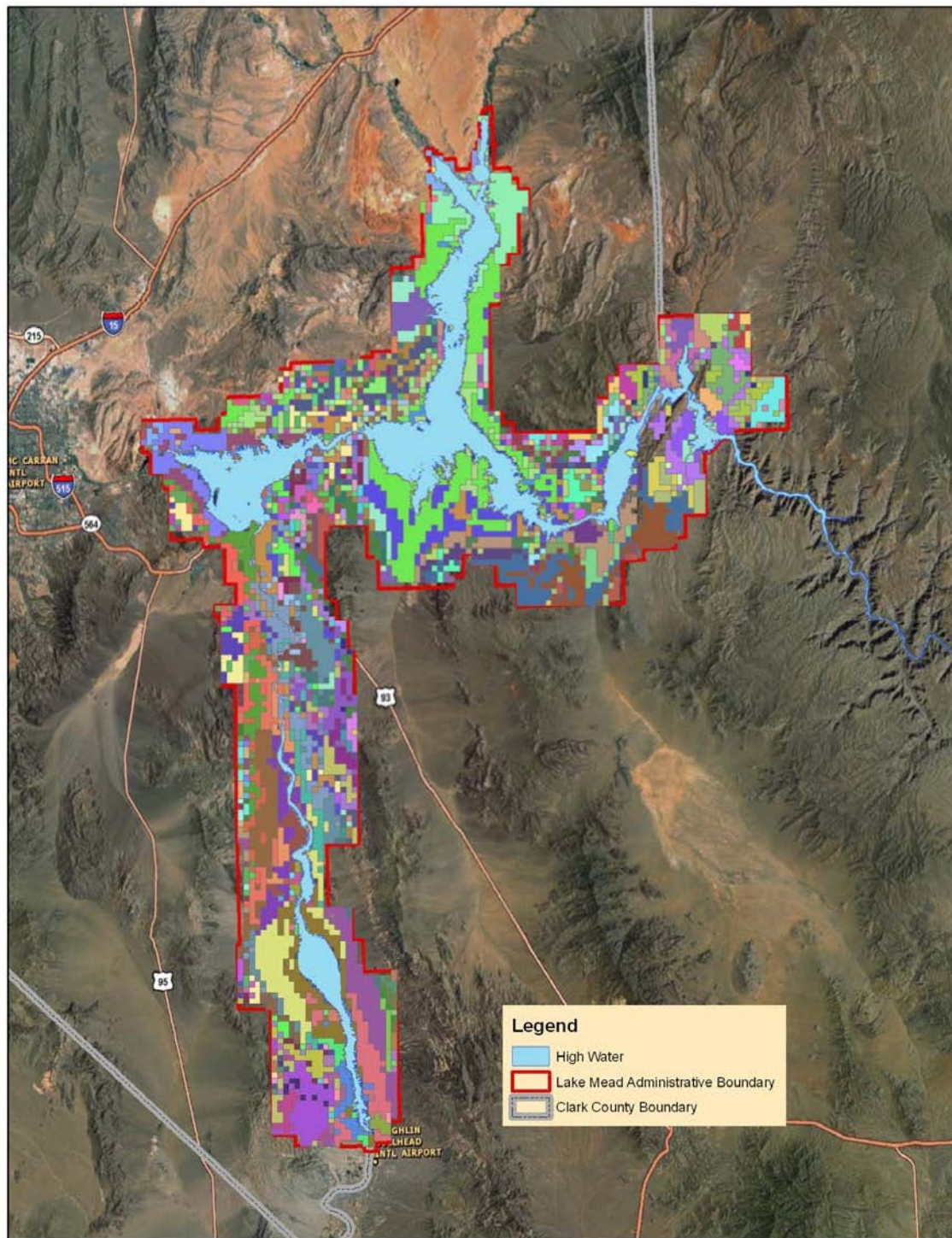


Figure 13. Bioclimatic model of LAME.

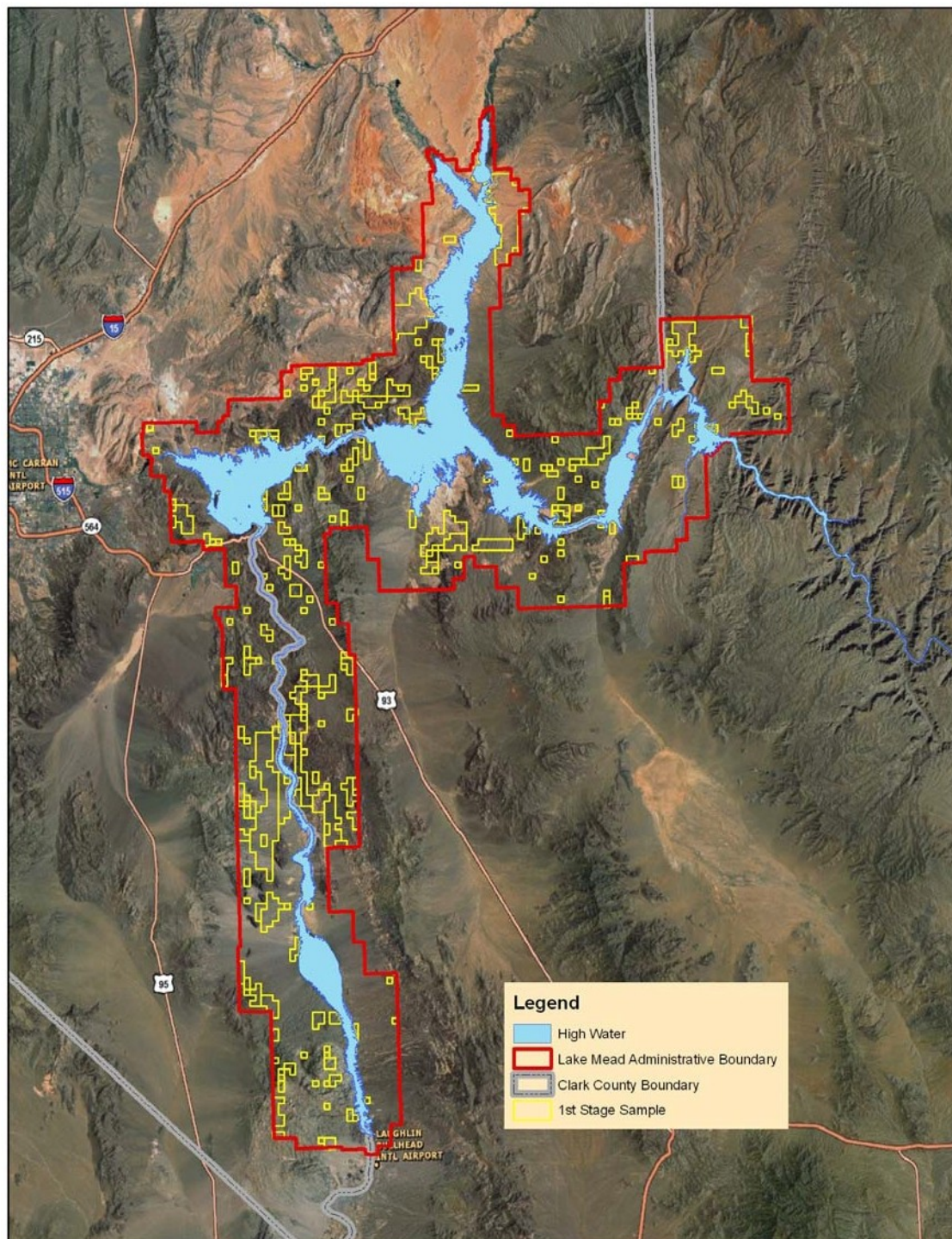


Figure 14. First stage sample.

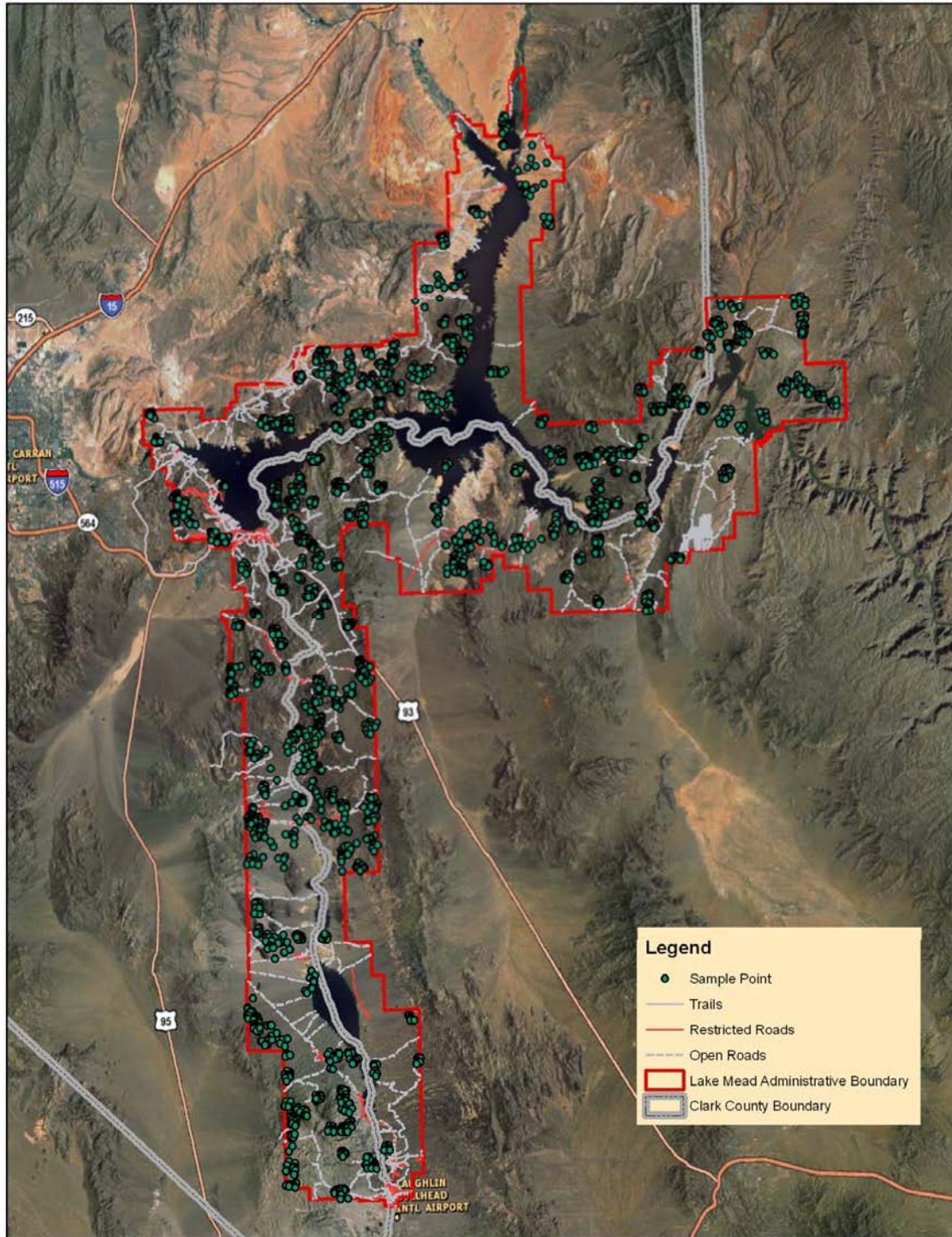


Figure 15. Vegetation Sample Locations.

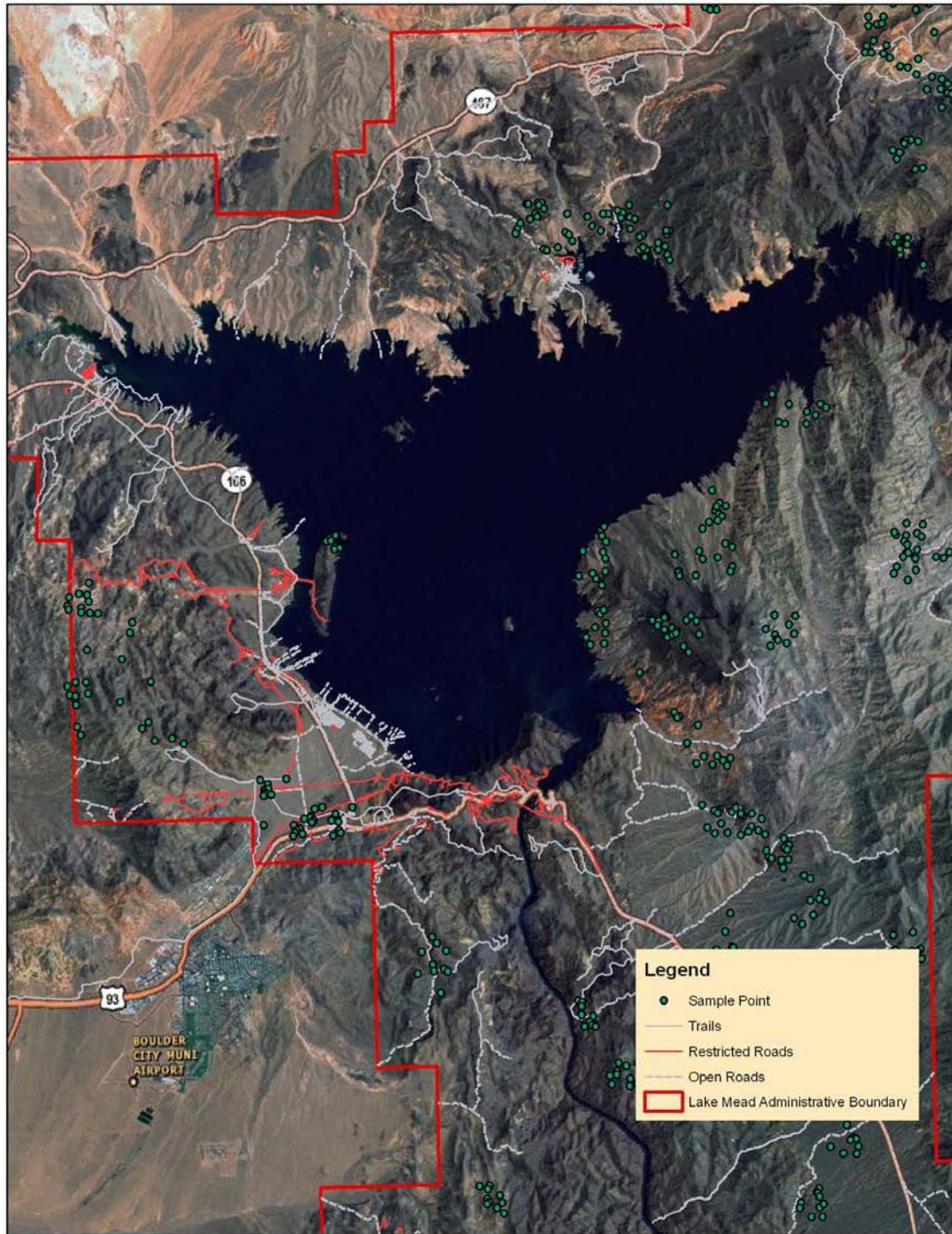


Figure 16. Detail of vegetation sampling locations.

Summary

The Mojave Classification and Mapping Work Plan (Cogan 2008) recommends the collection of about 450 plots. Previous sample plans in other parks less than half the size of Lake Mead NRA provided for over a thousand plots. It is for this reason that we provide 2735 potential plot locations here. However, given the reduced environmental variability at Lake Mead NRA compared to other mountainous parks, a reduced number of plots may be justified. We anticipate feedback and suggestions as to the number of plots to be collected and adjustments may be made.

All draft deliverables for this project were forwarded electronically or posted on the NPS Mojave Network ftp site (<ftp://63.220.43.40/LAME/VegMapping/>) for comments and review. Adjustments to the sampling protocol will be made upon receipt of the review. We anticipate a follow-up meeting or conference call to finalize these products.

References

- Austin, M. P., and Heyligers, P.C. 1989. Vegetation survey design for conservation: gradsect sampling of forests in Northeastern New South Wales. *Biological Conservation* 50:13-32.
- Austin, M. P. 1998. An ecological perspective on biodiversity investigations: examples from Australian eucalypt forests. *Annals of the Missouri Botanical Garden* 85:2-17.
- Austin, M. P., and P. C. Heyligers. 1991. New approaches to vegetation survey design: gradsect sampling. Pages 31-37 in C. R. Margules and M. P. Austin, editors. *Nature conservation: cost effective survey and data analysis*. CSIRO, Melbourne, Australia.
- Bourgeron, P. S., H. C. Humphries, and M. E. Jensen. 1994. General sampling design considerations for landscape evaluation. Pages 109-120 in M. E. Jensen and P. S. Bourgeron, technical editors. Volume II: Ecosystem management: Principles and applications. Gen. Tech. Rep. PNW-GTR-318. USDA Forest Service, Pacific Northwest Research Station, Portland, OR.
- Brown, K. 2009. 12-Step guidance for NPS vegetation inventories. Updated November 5, 2009. Available online at:
http://science.nature.nps.gov/im/inventory/veg/docs/Veg_Inv_12step_Guidance_v1.0.pdf.
- Cogan, D. 2008. Mojave Network vegetation classification and mapping work plan. Natural Resource Report NPS/2008.
- Fancy, S. 2000. Guidance for the design of sampling schemes for Inventory and Monitoring in National Parks. National Park Service. Available online at:
http://science.nature.nps.gov/im/monitor/docs/nps_sg.doc and at:
<http://science.nature.nps.gov/im/monitor/docs/examples.doc>
- Franklin, J., T. Keeler-Wolf, K. Thomas, D. A. Shaari, P. Stine, J. Michaelsen, and J. Miller. 2001. Stratified sampling for field survey of environmental gradients in the Mojave Desert Ecoregion. Pages 229-253 in A. Millington, S. J. Walsh and P. Osborne, editors. *GIS and Remote Sensing Applications in Biogeography and Ecology*. Kluwer Academic Publishers, Netherlands.
- Gillison, A. N., and K. R. W. Brewer. 1985. The use of gradient directed transects or gradsects in natural resource survey. *Journal of Environmental Management* 20:103-127.
- Margules, C. R., and M. P. Austin. 1994. Biological models for monitoring species decline: The construction and use of data bases. *Philosophical Transactions of the Royal Society B* 344:69-75.
- Thomas, K. A., J. Franklin, T. Keeler-Wolf, and P. Stine. 2005. Central Mojave vegetation database. U.S. Geological Survey Fact Sheet. USGS FFS-2205-3098.

Appendix G. 'Landform' Raster

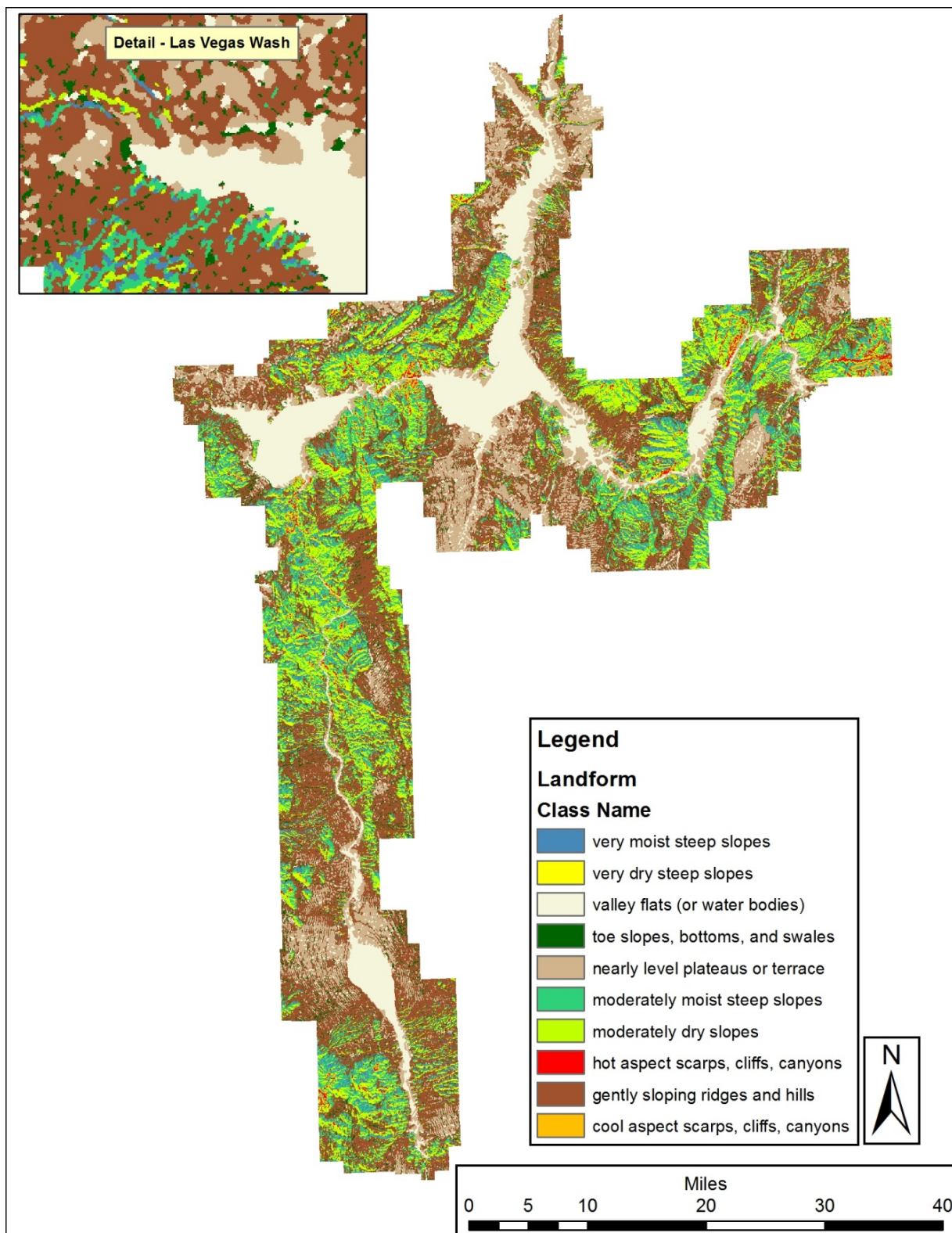
From Metadata:

Abstract:

Ten landform position classes were defined by topographic position and slope gradients using a GIS model. The 10 landform classes are: 1) Valley flats, 2) Gently sloping toe slopes, 3) Gently sloping ridges, fans and hills, 4) Nearly level terraces and plateaus, 5) Very moist steep slopes, 6) Moderately moist steep slopes, 7) Moderately dry steep slopes, 8) Very dry steep slopes, 9) Cool aspect scarps, cliffs and canyons, and 10) Hot aspect scarps, cliffs and canyons. The GIS model was created using ArcInfo AML and a 30 meter DEM (digital elevation model). DEM data was from the USGS National Elevation Dataset (1999). The geographic extent for the modeling area was the states of Arizona, Colorado, New Mexico, Nevada and Utah. While the modeling area encompassed these 5 southwestern states, the actual GIS dataset accompanying this metadata file may be a subset of the 5-state region.

Purpose:

The landform GIS dataset may be used for various purposes with user's discretion. Specifically, this dataset was created to be used in conjunction with several other predictor datasets for regional vegetation modeling/mapping. Formal validation of this dataset has not been conducted.



Appendix H. 'NED – Digital Elevation Model'

From Metadata:

Abstract:

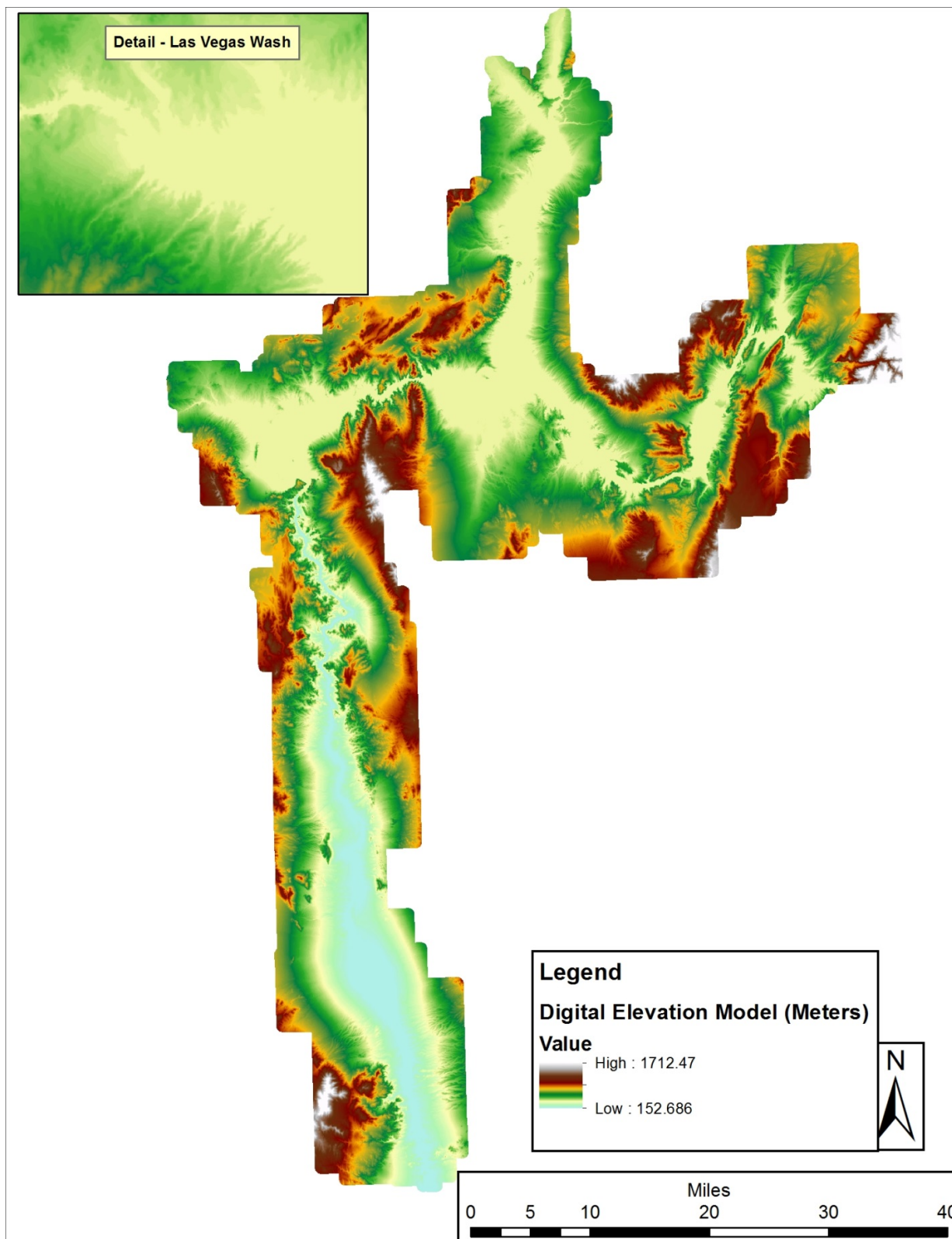
The U.S. Geological Survey has developed a National Elevation Dataset (NED). The NED is a seamless mosaic of best-available elevation data. The 7.5-minute elevation data for the conterminous United States are the primary initial source data. In addition to the availability of complete 7.5-minute data, efficient processing methods were developed to filter production artifacts in the existing data, convert to the NAD83 datum, edge-match, and fill slivers of missing data at quadrangle seams. One of the effects of the NED processing steps is a much-improved base of elevation data for calculating slope and hydrologic derivatives. The specifications for the NED 1 arc second and 1/3 arc second data are geographic coordinate system Horizontal datum of NAD83, except for AK which is NAD27 Vertical datum of NAVD88, except for AK which is NAVD29.

The horizontal units (elevation) are in CENTIMETERS.

The USEPA used a "clipgrid" program to clip the GRID from each 8 digit HUC code boundary with a one mile buffer for the United States and it's territories.

Purpose:

Geospatial elevation data are utilized by the scientific and resource management communities for global change research, hydrologic modeling, resource monitoring, mapping, and visualization applications.



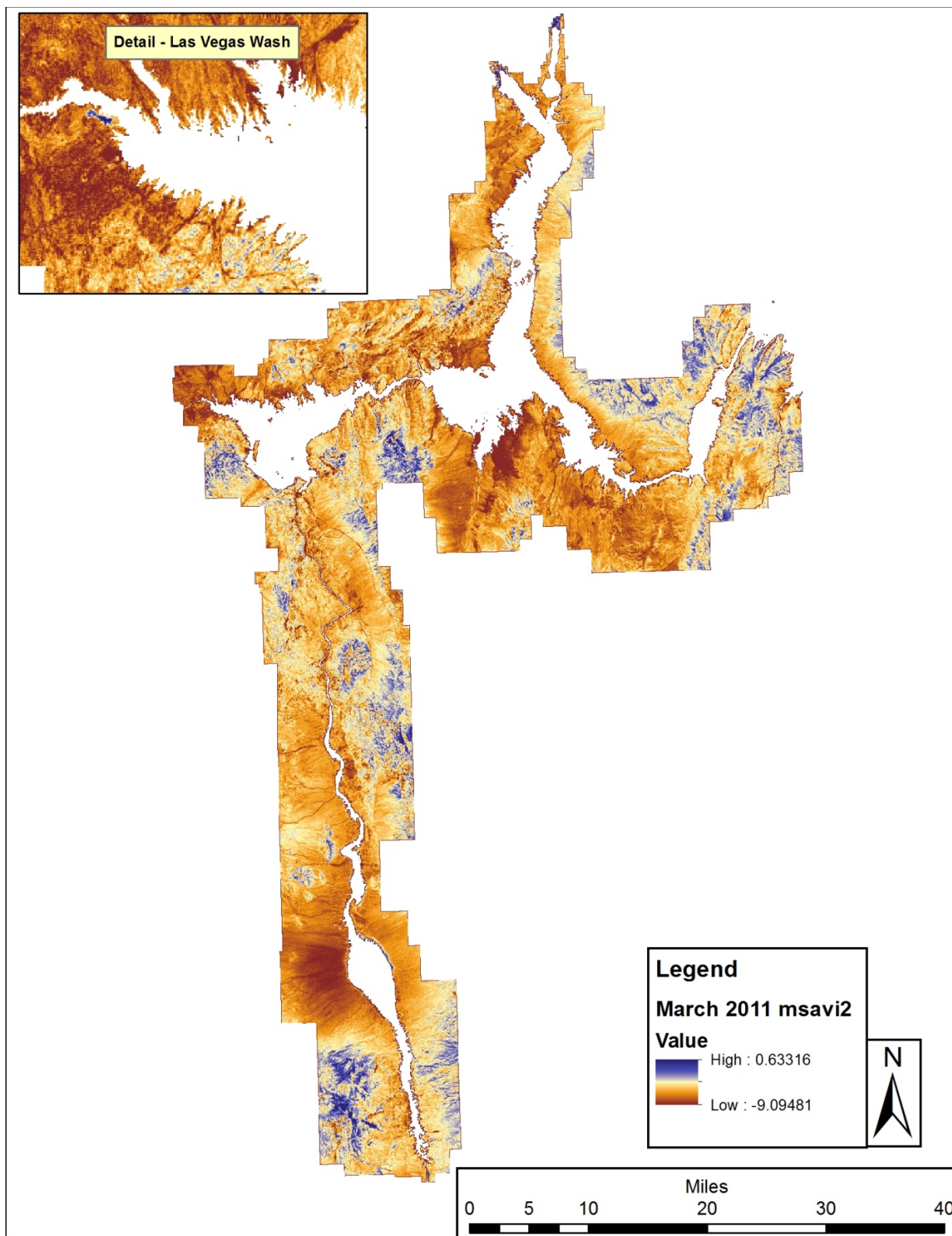
Appendix I. Vegetation Density' Raster

Summary:

The data set was created to determine areas of regional plant-cover information for use in classifying and identifying vegetation densities in Lake Mead National Recreation Area for the 2016 vegetation map.

Description:

The raster-based Modified Soil Adjusted Vegetation Index was derived from Landsat Thematic Mapper imagery data acquired during March 23, 2011, for the Lake Mead National Recreation Area Vegetation Mapping Project. The index has been shown to increase the dynamic range of the vegetation signal while further minimizing the soil background influences, resulting in greater vegetation sensitivity as defined by a "vegetation signal" to "soil noise" ratio. The data set was used in determining vegetation densities.



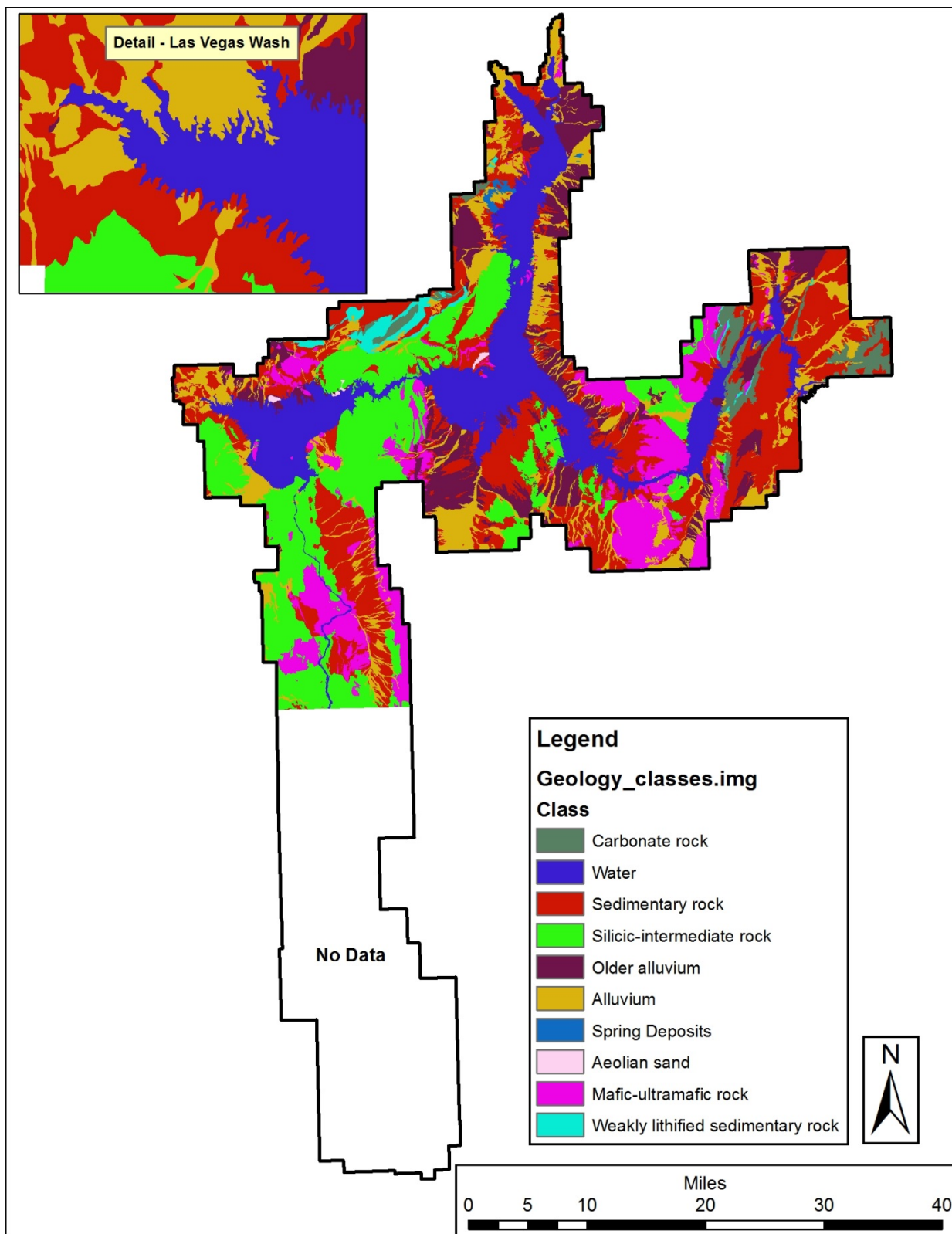
Appendix J. 'Geology' Raster

Summary:

The geology of the Lake Mead 30' x 60' quadrangle was compiled for the U.S. Geological Survey's Las Vegas Urban Corridor Project and the National Parks Project, National Cooperative Geologic Mapping Program. Lake Mead, which occupies the northern part of the Lake Mead National Recreation Area (LAME), mostly lies within the Lake Mead quadrangle and provides recreation for about 9 million visitors annually. The recreation area and surrounding Bureau of Land Management lands face increasing public pressure from rapid urban growth in the Las Vegas area to the west. This database and the accompanying map and pamphlet provide baseline earth science information that can be used in future studies of hazards, groundwater resources, mineral and aggregate resources, and of soils and vegetation.

Description:

This digital database, which was compiled from existing published and unpublished maps, as well as new mapping, contains geologic data used to produce the 1:100,000-scale Geologic Map of the Lake Mead 30' x 60' Quadrangle, Clark County, Nevada, and Mohave County, Arizona. The geologic features mapped as part of this project include: geologic contacts and faults, bedrock and surficial geologic units, structural data, fold axes, and dikes. The data were digitized and attributed from a variety of source maps. Refer to the Process Description section of this metadata report, and the accompanying map pamphlet for more information.



Appendix K. 'Soils' Layer

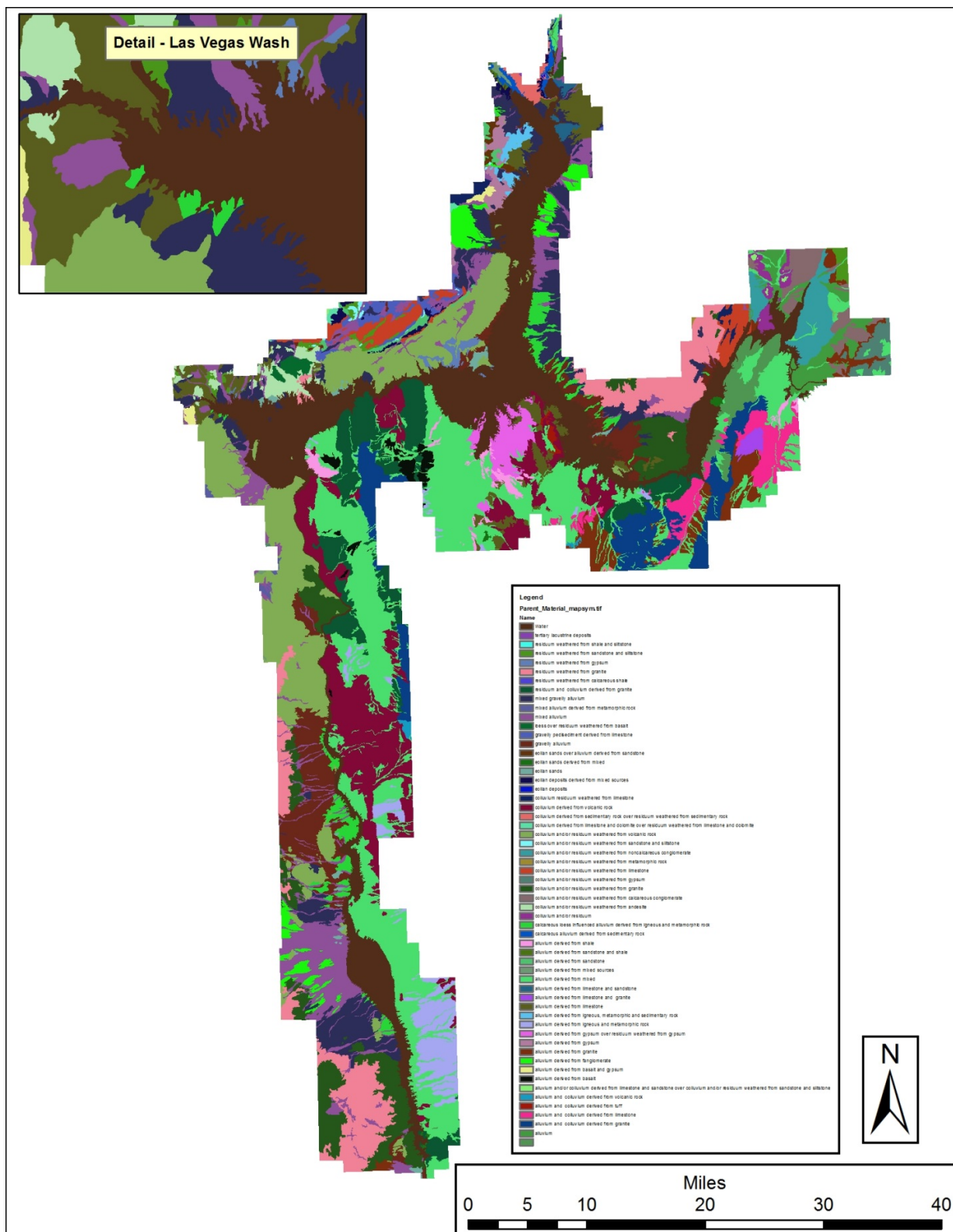
SSURGO Metadata – USDA NRCS

The SSURGO database contains information about soil as collected by the National Cooperative Soil Survey over the course of a century. The information can be displayed in tables or as maps and is available for most areas in the United States and the Territories, Commonwealths, and Island Nations served by the USDA-NRCS. The information was gathered by walking over the land and observing the soil. Many soil samples were analyzed in laboratories. The maps outline areas called map units. The map units describe soils and other components that have unique properties, interpretations, and productivity. The information was collected at scales ranging from 1:12,000 to 1:63,360. More details were gathered at a scale of 1:12,000 than at a scale of 1:63,360. The mapping is intended for natural resource planning and management by landowners, townships, and counties. Some knowledge of soils data and map scale is necessary to avoid misunderstandings.

The maps are linked in the database to information about the component soils and their properties for each map unit. Each map unit may contain one to three major components and some minor components. The map units are typically named for the major components. Examples of information available from the database include available water capacity, soil reaction, electrical conductivity, and frequency of flooding; yields for cropland, woodland, rangeland, and pastureland; and limitations affecting recreational development, building site development, and other engineering uses.

SSURGO datasets consist of map data, tabular data, and information about how the maps and tables were created. The extent of a SSURGO dataset is a soil survey area, which may consist of a single county, multiple counties, or parts of multiple counties. SSURGO map data can be viewed in the Web Soil Survey or downloaded in ESRI® Shapefile format. The coordinate systems are Geographic. Attribute data can be downloaded in text format that can be imported into a Microsoft® Access® database.

This soils layer was extracted from the USDA SSURGO soils dataset to assist in the interpretation of vegetation patterns. The attribute extracted was the 'Parent Material' information and converted to a raster format.



Appendix L. Accuracy Assessment Form

MOJN Vegetation Classification and Mapping Program Lake Mead National Recreation Area
ACCURACY ASSESSMENT FIELD FORM

Section 1: Accuracy Assessment Point/GPS/Photographic Information

Surveyor(s): _____ Survey Date: _____

Park Code: LAKE Park Site or Quad Name: _____ AA Point #: LAKE AA _____

GPS Unit: _____ Waypoint #: _____

Datum: NAD 83 UTM: 11N UTME: _____ UTMN: _____ Error +/-: _____

Is GPS at plot center? Yes / No. If No, distance from GPS to plot center: _____ (m) and bearing: _____ (degrees)

GPS comments: _____

Slope: _____ degrees Aspect: _____ degrees (360 for N) Elev. (m): _____ Declination: 11°49'E

Camera: _____ Photo # (North): _____

Section 2: Observation Area Size/Shape/Location Comments

☐ Standard Observation Area: 0.5 ha Shape: circular (a circle with a radius of 40m)

☐ Alternate Observation Area: _____ ha Shape: _____ Length (m): _____ Width (m): _____

☐ If the AA point location is an intentional offset from the original point coordinates, circle the explanation:

- a. The stand is too heterogeneous to key because there are one or more clearly distinct types within the observation area
- b. Physical constraints in reaching waypoint
- c. Other (explain): _____

Section 3: Ground Cover (Percent)

_____ Bedrock – Rocks connected to the underlying geology

_____ Large rock – Loose rock >10cm

_____ Small rock – Loose rock btwn 0.2-10cm

_____ Sand – Grain size btwn 0.1-2.0mm

_____ Bare soil – Native soil matrix without other cover

_____ Wood – Downed woody debris >1cm diameter

_____ Nonvascular species – Biotic crusts, mosses, lichens

_____ Plant basal area – Surface area of plant stems at ground surface

_____ Other: _____

Must sum to 100%

Section 4: AA Point Location / Environmental / General Comments:

LAKE AA _____

Survey Date: _____

Section 5: Vegetation Description – Species and Stratum % Cover (*record the full scientific species name and absolute cover values for the dominant and/or diagnostic species in each stratum and the total cover by stratum*)

Strata	Height Class	Cover Class	Dominant species (mark Diagnostic species with a *)	Cover Class
T1 Emergent	_____	_____	_____	_____
T2 Canopy	_____	_____	_____	_____
T3 Sub-canopy	_____	_____	_____	_____
S1 Tall shrub	_____	_____	_____	_____
S2 Short Shrub	_____	_____	_____	_____
S3 Dwarf-shrub	_____	_____	_____	_____
H Herbaceous	_____	_____	_____	_____
N Non-vascular	_____	_____	_____	_____

Strata: T1 Emergent, T2 Canopy, T3 Sub-canopy, S1 Tall Shrub (>2m), S2 Short Shrub (0.5-2m), S3 Dwarf Shrub (<0.5m), H1 Graminoids, H2 Forbs, N Nonvascular
 Height Classes: 1=<0.5m, 2=0.5-1m, 3=1-2m, 4=2-5m, 5=5-10m, 6=10-15m, 7=15-20m, 8=20-35m

Cover Classes: 01 = Trace 02 = 0.1-1% 03 = 1-2% 04 = 2-5% 05 = 5-10% 06 = 10-25% 07 = 25-50% 08 = 50-75% 09 = 75-95% 10 = > 95%

Section 6: Field Key to Alliance

Primary Alliance: _____ Code: _____

Secondary Alliance: _____ Code: _____

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

Steps through key: _____

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

Appendix M. Merging of LAKE Vegetation Map with PARA Portion

Several steps were required to merge and reconcile the two vegetation maps. These included; clipping the PARA map with the LAKE administrative boundaries to include only LAKE vegetation, identifying vegetation map classes not within the LAKE vegetation map (crosswalk), merging GRCA polygons to match the LAKE map classes, adding new map classes unique to the GRCA map, editing and merging the boundaries between the two datasets, and editing GRCA -PARA polygons. The merged portion of the PARA vegetation map is shown below in Figure 1 below.

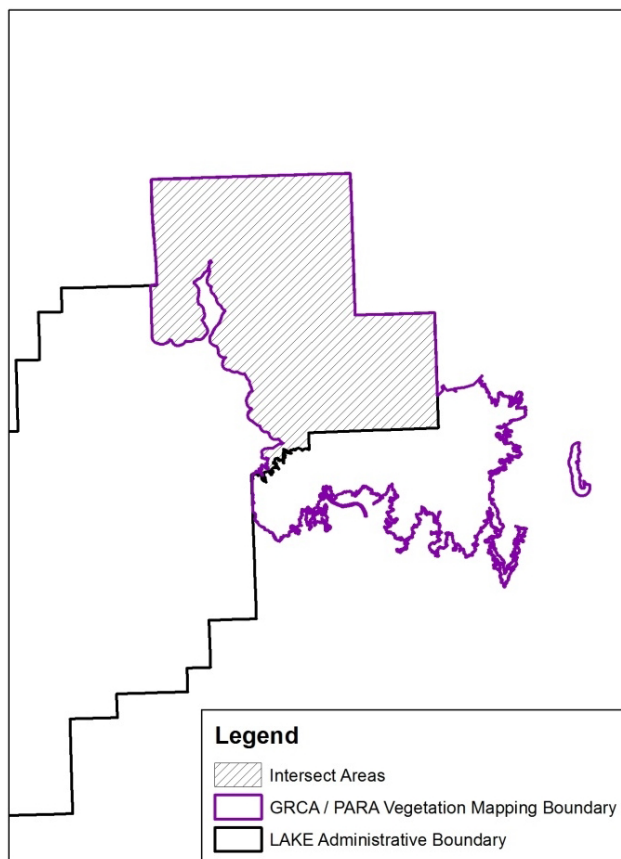


Figure 1. Overlap area between LAKE administrative area and the GRCA / PARA vegetation map.

Clipping

Using the LAKE administrative boundary, the GRCA vegetation map portion was isolated. Figure 2 below shows the clipped area.

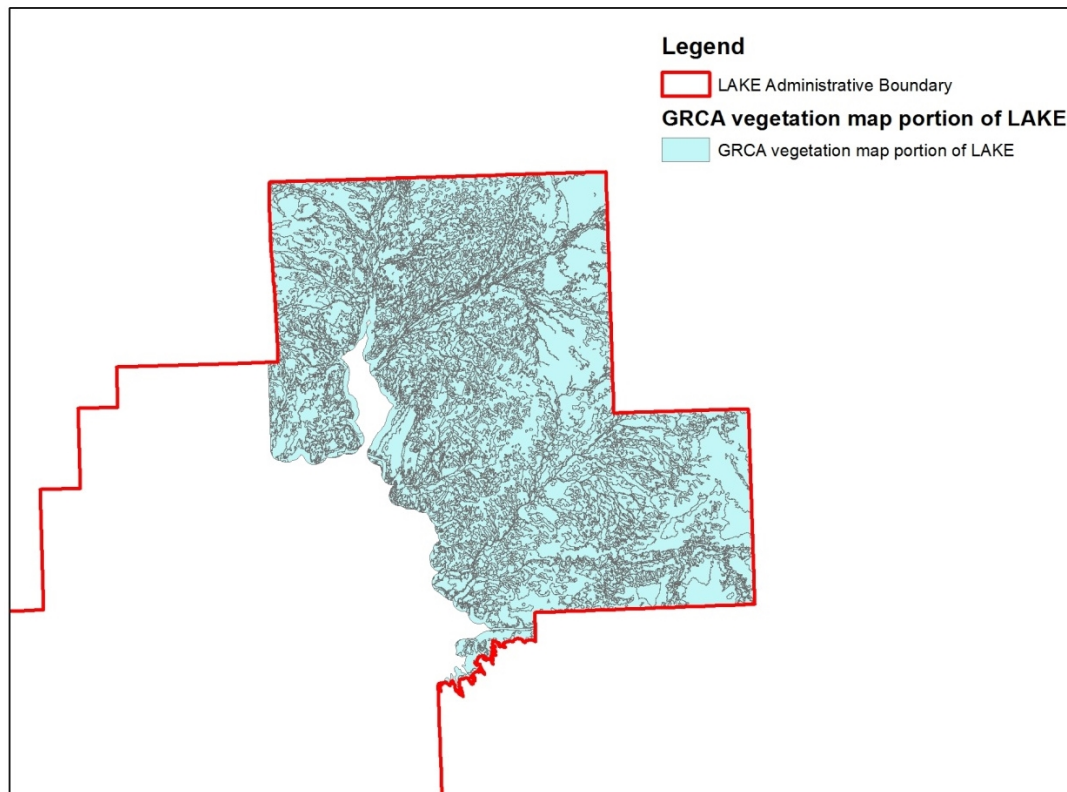


Figure 2. Clipped GRCA / PARA vegetation map to be included into LAKE vegetation map.

Map Class Crosswalk

Most of the area within the GRCA vegetation map to be merged shared identical map classes, however, there are several map classes unique to the merged area. Within the merge area there are 25 map classes, 15 which match closely or exactly the LAKE vegetation map class classification. The crosswalk and those map classes unmatched are listed in Table 1.

Table 1. Crosswalk between GRCA / PARA and LAKE vegetation map classes.

LAKE Map Class Name	Crosswalk from GRCA / PARA to LAKE
Semi-Desert Wash Woodland/Scrub	<i>Acacia greggii</i> Shrublands
Semi-Desert Scrub	<i>Ambrosia (dumosa, eriocentra)</i> Dwarf-shrubland Alliance
Riparian wash scrub	<i>Baccharis</i> spp. - <i>Salix exigua</i> - <i>Pluchea sericea</i> Shrubland Alliance
Black Brush	<i>Coleogyne ramosissima</i> Shrublands
Semi-Desert Scrub	<i>Encelia (farinosa, resinifera)</i> Shrubland Alliance
Sparse Vegetation	<i>Ephedra (torreyana, viridis)</i> / Mixed Semi-desert Grasses Shrubland
Creosote Bush	<i>Larrea tridentata</i> - <i>Ambrosia</i> spp. Shrubland Alliance
Pinyon Woodlands	<i>Pinus monophylla</i> - <i>Juniperus osteosperma</i> / Shrub Understory Woodland Alliance
Riparian Woodlands	<i>Populus fremontii</i> - <i>Salix gooddingii</i> Woodland Alliance
Semi-Desert Wash Woodland/Scrub	<i>Prosopis glandulosa</i> var. <i>torreyana</i> Shrubland
Salt Basin	<i>Suaeda moquinii</i> Shrubland Alliance

LAKE Map Class Name	Crosswalk from GRCA / PARA to LAKE
Tamarisk	<i>Tamarix</i> spp. Temporarily Flooded Semi-natural Shrubland
Yucca Shrub	<i>Yucca schidigera</i> Mojave Desert Shrubland Alliance
Open Water	Water
Urban	Unvegetated Surfaces and Built Up Areas
No Match	<i>Brickellia longifolia</i> - <i>Fallugia paradoxa</i> - <i>Isocoma acradenia</i> Shrubland
SDS	<i>Canotia holacantha</i> [Grand Canyon] Shrubland
No Match	Colorado Plateau Hanging Garden Seep Group
No Match	<i>Ephedra fasciculata</i> Mojave Desert Shrubland Alliance
No Match	<i>Ephedra trifurca</i> Badlands Shrubland
No Match	<i>Gutierrezia (sarothrae, microcephala)</i> - <i>Ephedra (torreyana, viridis)</i> Mojave Desert Shrubland Alliance
No Match	<i>Pleuraphis rigida</i> Herbaceous Vegetation
No Match	<i>Arctostaphylos</i> - <i>Quercus turbinella</i> Shrubland Alliance

The unmatched GRCA map classes need to be either merged into the existing LAKE map or kept as is and the new GRCA map classes added to the LAKE map classes. Table 2 below shows the final crosswalk and for those unmatched GRCA / PARA map classes.

Table 2. Classification of unique GRCA / PARA vegetation with no direct cross walk to LAKE.

LAKE Classification	GRCA / PARA Map Class
Colorado Plateau Hanging Garden Seep Group	Colorado Plateau Hanging Garden Seep Group
Big Galleta Herbaceous Vegetation	<i>Pleuraphis rigida</i> Herbaceous Vegetation
Semi-Desert Scrub	<i>Canotia holacantha</i> [Grand Canyon] Shrubland
Manzanita - Sonoran scrub oak Shrubland Alliance	<i>Arctostaphylos</i> - <i>Quercus turbinella</i> Shrubland Alliance
Semi-Desert Wash Woodland	<i>Brickellia longifolia</i> - <i>Fallugia paradoxa</i> - <i>Isocoma acradenia</i> Shrubland
Mid-Elevation Mixed Desert Scrub	<i>Ephedra fasciculata</i> Mojave Desert Shrubland Alliance
Bare Rock and Sparse Vegetation	<i>Ephedra trifurca</i> Badlands Shrubland
Mid-Elevation Mixed Desert Scrub	<i>Gutierrezia (sarothrae, microcephala)</i> - <i>Ephedra (torreyana, viridis)</i> Mojave Desert Shrubland Alliance

Editing and merging GRCA and LAKE Vegetation maps

Although the two map boundaries match up closely in most areas, adjacent polygons of the same type have to be merged, while other areas with different interpretations have to be reconciled with additional heads up digitizing using an image background to guide the merge. Figure 3 below shows a portion of the seam area between the two vegetation datasets that need to be merged into one seamless map. Map attributes between the two disparate sets have also to be updated. Density, elevation, soils, geology, landforms, and geometries have to be updated as these are not present in the PARA dataset. Other editing tasks within the PARA area included recoding a few obvious errors

such as non-existent urban areas or washes coded as roads, and deleting many of the polygons that were below the minimum mapping unit.

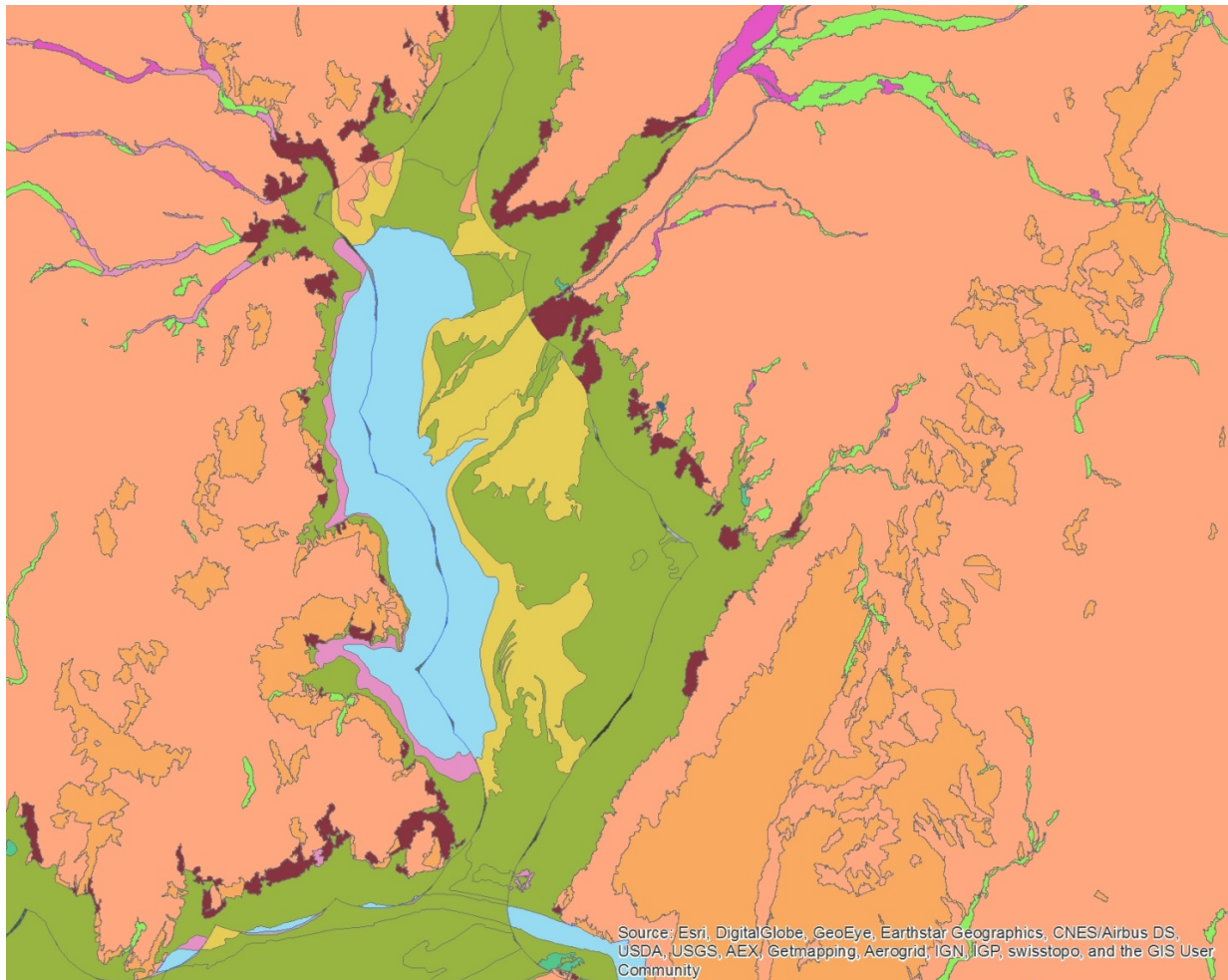


Figure 3. Example of seam between GRCA / PARA and LAKE vegetation maps.

Appendix N. Field Reconnaissance and Validation Trip Reports

Map Verification TRIP #2 and Validation Training Summary Report

Lake Mead National Recreation Area –Vegetation Inventory Project



Summary of the Map Verification Trip #2 and Validation Training in Support of
the Vegetation inventory Project for the Lake Mead National Recreation Area,

Nevada-Arizona

Cogan Technology, Inc.
November 18, 2013



Table of Contents

Introduction and Background	N-5
Validation Meeting	N-5
Trip Report – Field Site Visit Map.....	N-6
Trip Report – Daily Summary	N-7
Data Collection – Ground-Truthing Points.....	N-13
Attachment 1 – Validation Meeting Notes	N-15
Meeting Notes:	N-16

Figures

Figure 1. General Field Site Visit Vicinity Map for the LAKE Vegetation Inventory Project – Trip 2.	N-6
Figure 2. Map of Ground-Truthing Points Collected at LAKE.	N-14

Introduction and Background

In 2012, Cogan Technology, Inc. (CTI) was awarded an order for services (Order No. R12PD8031) by the Bureau of Reclamation (BOR) to provide technical support to the National Vegetation Classification and Inventory project at Lake Mead Recreation Area, Nevada – Arizona (LAKE). As part of this service order, CTI was tasked to participate in field verification trips (Item No. 0003) throughout the project as requested by BOR staff. The second of these field verification trips occurred during the week of November 18 - 22, 2013 and coincided with the training and start of the validation process by LAKE Staff and volunteers. Participants on this trip included:

Dan Cogan – CTI Senior Ecologist and GIS Specialist,

David Salas – BOR Principal Investigator and Project Lead,

Joe Stevens – Colorado National Heritage Program (CNHP) – Team Leader and Ecologist

Beth Morrison – CNHP Botanist and Accuracy Assessment (AA) Field Lead.

A summary of the second verification trip is presented in this report and the validation meeting is included as Attachments 1. In addition to the written materials supplied in this document, other digital data created by CTI during the course of the verification trip will be supplied to the BOR. Associated digital data products include:

Various ground-based field photos of representative sites and general landscape overviews;

An ArcGIS spatial shapefile of the ground-truthing points collected by CTI.

Validation Meeting

During the morning of November 19, the verification team met with representatives from LAKE and the Mojave Desert Inventory and Monitoring Program (MOJN) at MOJN offices in Boulder City, Nevada. Meeting discussions included a review of the trip itinerary and an overview of the safety procedures. The team also obtained field equipment from the MOJN including a park radio, maps, GPS receivers, and official travel documents and reporting forms. Field staff submitted safety and daily trip itineraries to MOJN and LAKE staff as part of the official backcountry safety protocol. The park radio was subsequently used daily by the field team to check in and out of service while traveling throughout the LAKE area.

Following the review of safety by MOJN staff, the mapping and AA teams gave an overview of the vegetation inventory project to various members of the validation team. Review items included program background information, overview of the steps completed so far, and training on how to complete the validations work using the vegetation key and validation field form. After lunch the mapping and AA team trained the validation crews on how to validate the vegetation at three representative sites located near Kingman Wash. For more information on the validation meeting please see the meeting notes in Attachment 1

Trip Report – Field Site Visit Map

The following map (Figure 1) highlights the general areas visited by the field verification team. Sites are separated by days in the field and correspond to Day 1 = 11/19/13, Day 2 = 11/20/13, Day 3 = 11/21/13, and Day 4 = 4/22/13.

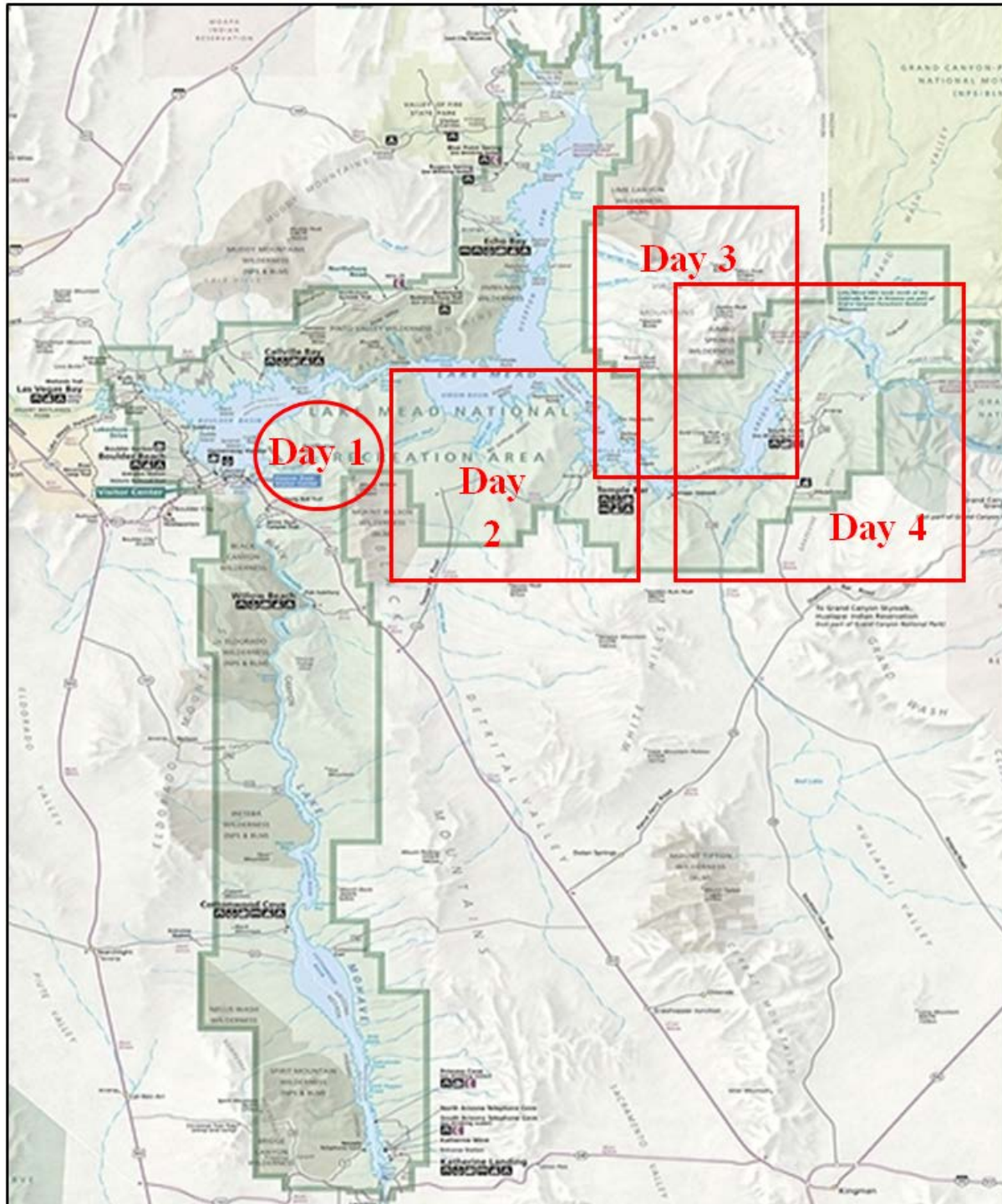


Figure 1. General Field Site Visit Vicinity Map for the LAKE Vegetation Inventory Project – Trip 2.

Trip Report – Daily Summary

Travel Day - November 18, 2013

[All Day]

Travel to LAKE via Las Vegas International Airport.

Day 1 - November 19, 2013

[9:00 – Noon]

Field staff attended the validation meeting with representatives from LAKE and MOJN at MOJN offices in Boulder City, Nevada (see **Attachment 1**).

[1 – 4 pm]

Field staff drove to Kingman Wash to conduct the validation training at three sites including a semi-desert shrub, creosote bush, and semi-desert wash classes.



Day 1 - Validation training in Kingman Wash.

Day 2 - November 20, 2013

8:00 – 9:00 am

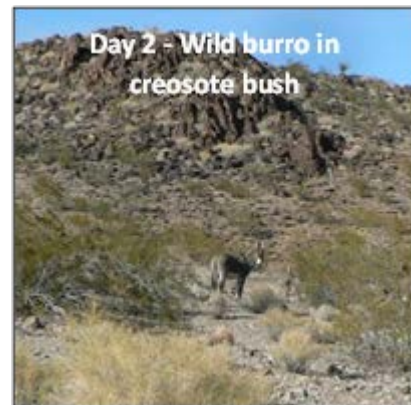
Conducted a morning meeting at MOJN offices and the LAKE Ranger Station in Boulder City, NV to check in and submit itinerary for the day.

9:00 – 10:00 am

Field staff traveled from Boulder City, Nevada to the Temple Bar Road on the Arizona side of LAKE.

10:00 am – Noon

Field staff conducted verification of vegetation types in and around the Temple Bar area. Map classes verified included the salt cedar (*Tamarix ramosissima*) shrublands and riparian willow (Gooding's willow (*Salix gooddingii*) woodlands) in and around the Temple Bar boat ramp. Ground-truthing was also conducted on the planted ornamental trees and shrubs next to the Temple Bar facilities and campgrounds. On the drive out of the Temple Bar area, field crews also observed the various patterns of mixed semi-desert scrub, semi-desert wash, and creosote bush (*Larrea tridentata*) shrub communities. Time was also spent in a large wash to verify that the large shrubs occurring here were in fact cat claw acacia (*Acacia greggii*) shrubs and not Palo Verde (*Parkinsonia microphylla*) trees.



Day 2 - Vegetation type verification.

Noon – 1:30 pm

Fieldwork proceeded to the Bonellii Bay Area to verify the mixed aged stands of salt cedar growing in the drawdown zones along the shoreline.

1:30 – 4:00 pm

4x4 roads were used by the field crew to access various sites in and around the Petroglyph Wash area. Here, creosote bush communities were common on the rolling terraces and alluvial fans, extending into desert washes and up the sides of some of the rock formations. Sparse vegetation occurred on the highest rock outcrops and semi-desert scrub was noted on badland-like formations and mid elevation slopes. Common species in this area included: *Larrea tridentata*, *Encelia farinosa*, *Ambrosia dumosa*, *Ephedra torreyana*, *Salsola tragus*, *Yucca schidigera*, and *Ambrosia psilostachya*. The field crews in this area observed wild burros and horses.

Day 3 - November 21, 2013

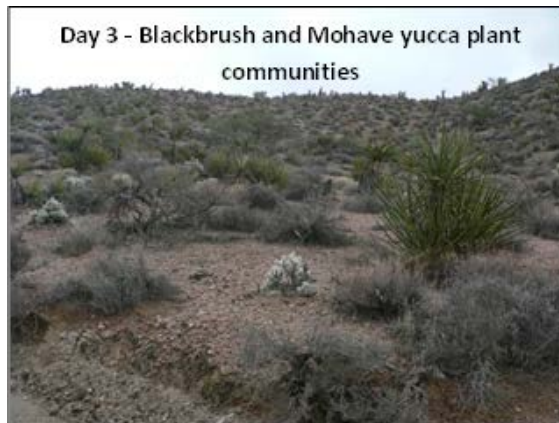
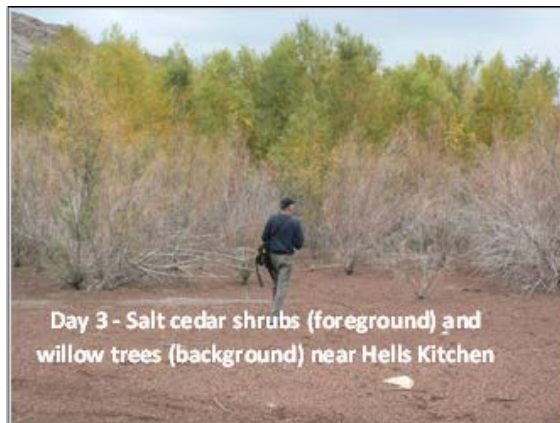
7:30 am – Noon

Field staff traveled from Las Vegas, Nevada to the Gold Butte and Hells Kitchen areas with Alice Newton (NPS-LAKE Vegetation Manager).

Noon – 4 pm

Initial observations in the Hells Kitchen area were spent in the small bay and floodplain associated with the Lake Mead drawdown zone. Salt cedar and Gooding's willow was the dominant vegetation observed in the floodplain/silted areas and the rockier areas below the high water line were either non-vegetated or had scattered, sparse salt-cedar and other early successional shrubs.

Working back towards Gold Butte, the field crew collected information in the various creosote bush, semi-desert scrub, and semi-desert wash communities. The large wash that extended through the entire Hells Kitchen area contained large stands of cheesebush (*Hymenoclea salsola*) and other riparian species like desert willow (*Chilopsis linearis*) and cat claw acacia. Towards the end of the wash, near the park boundary unique stands of blackbrush (*Coleogyne ramosissima*) and Mohave yucca (*Yucca schidigera*) were observed and documented.



Day 3 - Field crew replanting a barrel cactus that was on the road.

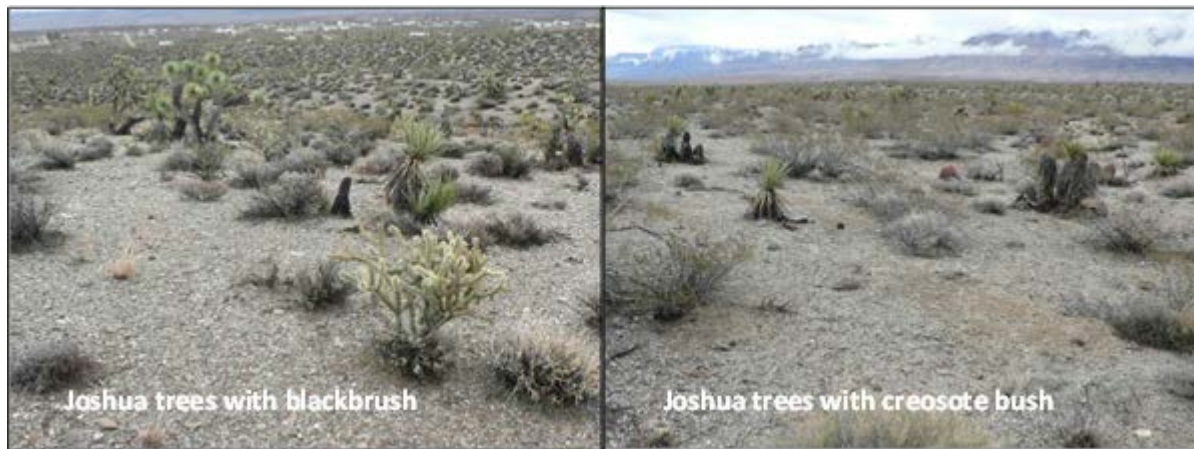
Day 4 - November 22, 2013

8:00 – 10:00 am

Dan Cogan (CTI) and David Salas (BOR) traveled from Las Vegas, Nevada to the Meadview, Arizona and South Cove areas of LAKE. [Note: Beth Morrison and Joe Stevens were attending an AA planning meeting with MOJN].

10:00 am – Noon

Verification work was conducted on the upland Joshua tree (*Yucca brevifolia*) communities located at the Meadview entrance into the park that extend north across Grapeview Mesa. Here the field crew documented the high levels of blackbrush in the understory at higher elevations and creosote bush in lower areas. The Joshua tree woodlands appeared to dissipate along the ridgeline and some Mohave yucca stands were observed just below and along the various drainages.



Day 4 - Verification Work near Meadview .

Noon – 4 pm

Towards Pearce Ferry, the field crew observed large salt cedar flats in the drawdown zone and large upland areas supporting creosote bush and semi-desert scrub vegetation. This pattern continued towards the South Cove area although the salt cedar was less pronounced in this vicinity. Throughout the lower regions in the Meadview area, creosote bush communities were common on the rolling terraces and alluvial fans, extending into desert washes and up the sides of some of the rock formations. Sparse vegetation occurred on the highest rock outcrops and semi-desert scrub was noted on badland-like formations and mid elevation slopes.



Day 4 - Verification Work near South Cove.

Travel Day - November 23, 2013

[All Day]

Travel Home via Las Vegas International Airport.

Data Collection – Ground-Truthing Points

During the course of the fieldwork efforts at LAKE, CTI investigators with assistance from CNHP and BOR staff collected ground-truthing information along multiple roads and trails. The ground-truthing information consisted of a GPS point and the vegetation map class designation. Ground-truthing data was recorded in the following map classes:

Map Class Code	Map Class Name	Number of Ground-truthing Points
BB	Black Brush Shrubland	3
BE	Beach and Barren Drawdown Area	1
CB	Creosote bush Shrubland	76
JT	Joshua Tree Woodland	17
RIPW	Riparian Woodlands	3
SD_WASH	Semi-Desert Wash Woodland / Scrub	28
SDS	Semi-Desert Scrub Shrubland	52
SV	Sparse Vegetation	10
TAM	Salt Cedar Shrubland	17
TRANS	Transitional Area	2
YS	Mohave yucca Shrubland	14
Total		223

All the tabulated data was imported into an ArcGIS shapefile using the X and Y coordinates recorded in the field from a GPS receiver. All of the digital spatial data was recorded in NAD83 datum, UTM projection, UTM zone 11 and units = meters.

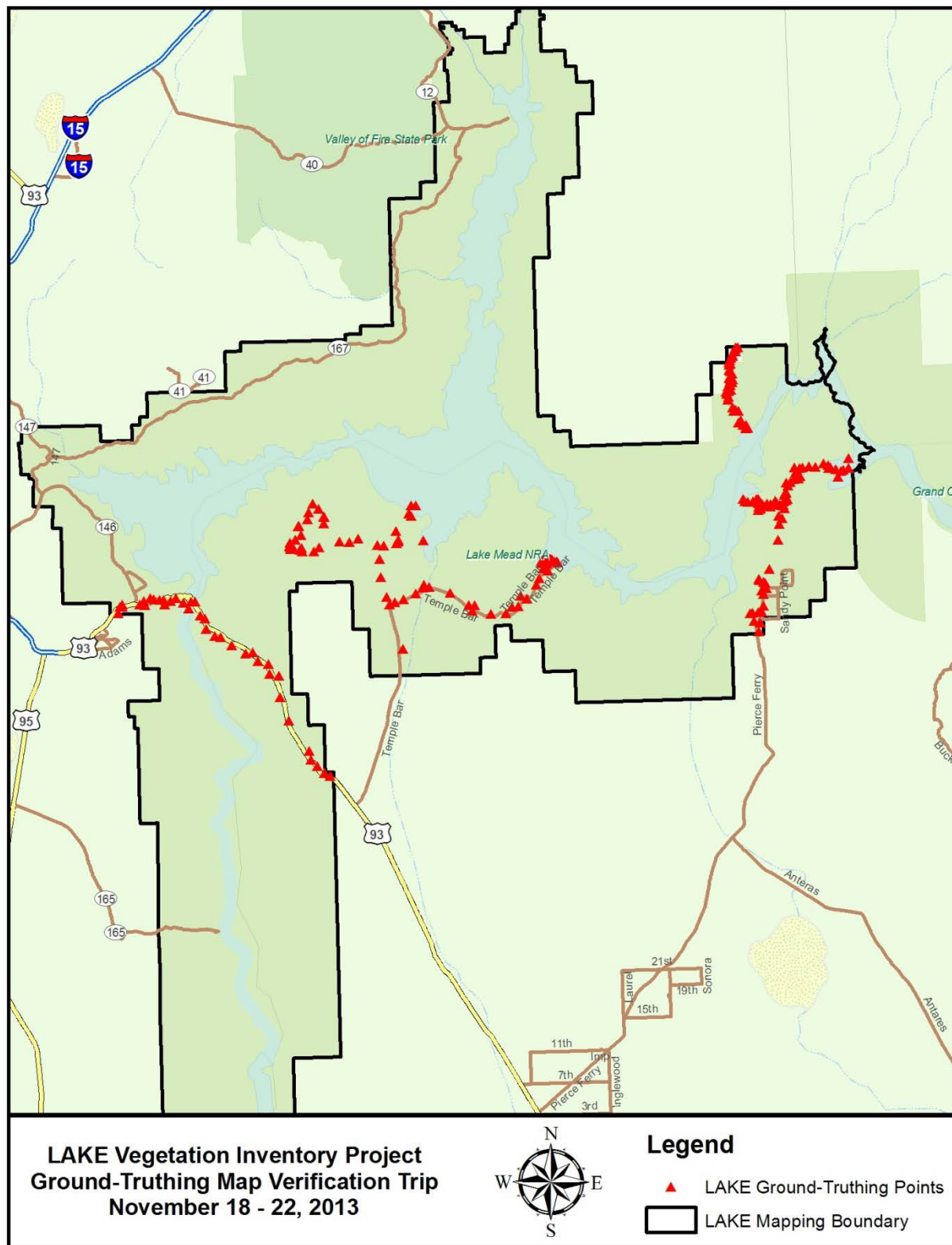


Figure 2. Map of Ground-Truthing Points Collected at LAKE.

Attachment 1 – Validation Meeting Notes

Lake Mead Validation Meeting

Location: Mojave Desert Inventory and Monitoring Network Training Room

Date: 11/9/13

Time: 9:00 am

Attendees:

Nita Tallent – MOJN Coordinator

David Salas – BOR GIS Professional

Dan Cogan –Cogan Technology Inc.

Joe Stevens – Colorado Natural Heritage

Bob Truitt - MOJN

Beth Morrison - Colorado Natural Heritage

Jean Pan – MOJN

David –MOJN GIS

Jennifer Bailard - SCA

Toshi Yoshida - LAKE

David Merz – NPS - MOJN

Carrie Norman – Lake

Mary Levandowski –NPS

Michelle -SCA

Emma Bernard – SCA

Kristin Koeper – SCA

Alex Whalen – SCA

Guillame Oui – IVIP

Jan Kirchheim - IVIP

Meeting Notes:

9:00 am-Initial Side Discussion (Nita Tallent and Mapping/AA Teams) about Back-county permits – Gold Butte in Northeast inaccessible – Law Enforcement Issues with locals, filing travel plans, park superintendent support, safety procedures, etc...

9:15 am - Introductions: Everyone

9:30 am - Project Overview (David Salas) – National Vegetation Inventory Program and Project Outline, Methods, Standards, Major Steps, Field Data Collection, Mapping, and Products.

9:50 am - Classification Overview (Joe Stevens) Presented copies of the keys, vegetation types and supporting documents for the AA and validation. Explained the key and how it works. Discussed how the associations/alliances crosswalk to the map classes and briefly reviewed the ½ hectare size of the validation point (40 meter radius) to be accessed in the field and how to determine the size of the area using football field comparison.

-10:10 am - Validation Fieldwork Overview (David and Joe). Field form review, map book overview, and answers to questions. Road layer on the maps maybe questionable in some areas -add approved road names in the future would be helpful. Discussed field methods including how to take ground photos (cardinal directions), how to fill in each blank, environmental comments including OHV use, archeological sites, presence of mistletoe, etc...Discussed relative versus absolute cover, how to define the strata, height classes (use ranges), steps through the key, log points and keeping track of the data.

11:25 (Nita) Safety, back county plans and permits, and check-in-outs... Need to file backcountry plan with details on where you going, how you are getting there, etc...important due to recent events. Assigned field crews and their safety equipment and reviewed call in times, checking-in procedures, no longer than 10 hours driving requirements, call in if you are going to be late, and other procedures as specified by both the park and the network.

12 pm – Lunch

1 - 4 pm – (All) Validation Point Training in the field at representative sites. Discussed how to calculate cover, take field photos, identify plants and use the key to determine NVC associations/alliances and crosswalk them to map classes. Training was done at 3 sites including a Semi-Desert Wash Site, Creosote Bush Shrubland, and a Sparse Vegetation sites.

4 – 5 pm – (All) Wrap-up meetings with LAKE Natural Resource staff to discuss logistics, radios, travel to Gold Butte, etc...

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 602/135443, December 2016

National Park Service
U.S. Department of the Interior



Natural Resource Stewardship and Science

1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525

www.nature.nps.gov

2016

NationalParkService.
CENTENNIAL

EXPERIENCE YOUR AMERICA™