Vegetation classification for the Mojave Desert Inventory and Monitoring Network of National Parks

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Background/Question/Methods:

Through a collaboration with the National Park Service, CNPS and NatureServe ecologists compiled over 9,000 new and existing vegetation surveys and analyzed over 4,000 surveys from three parks and other areas in the Mojave Desert and related ecoregions. A vegetation classification was developed, identifying approximately 105 alliances and related types from Lake Mead National Recreation Area (NRA), Mojave National Preserve, and Death Valley National Park within the Mojave Desert Inventory & Monitoring Network Inventory & Monitoring (MOJN I&M). This project's data analyses of three park areas spanned more than 4 million acres of area, plus enabled cross-analyses with other parks and preserves such as Joshua Tree National Park in California and Red Rock Canyon National Conservation Area in Nevada. We used classification and ordination methods such as agglomerative cluster analysis, indicator species analysis, and Nonmetric Multidimensional Scaling (NMS) to inform the vegetation classification of the park areas (Evens et al. 2017*).

*The project classification report is in peer review; vegetation mapping is in progress through 2019, see Salas et al. (2016) for the mapping report for Lake Mead NRA. This project is supported by the National Park Service's Vegetation Mapping Inventory Program and MOJN I&M, with technical assistance by Karl Brown, Tammy Cook, and others.

References:

Evens, J. M., K. G. Sikes, D. Hastings, J. Curtis, K. Schulz, and J. S. Ratchford. 2014 (Revised 2017). Vegetation Classification and Mapping at Lake Mead National Recreation Area, Mojave National Preserve and Death Valley National Park, Final Report. Natural Resource Data Series NPS/MOJN/NRDS—2017/XXX. National Park Service, Fort Collins, Colorado.

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.

1. Study Area and Sampling

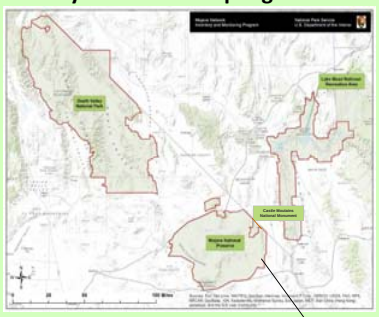

Figure 1. Vegetation mapping project boundaries of Death Valley National Park, Lake Mead National Recreation Area, and Mojave National Preserve and Castle Mountains National Monument (from north to south).

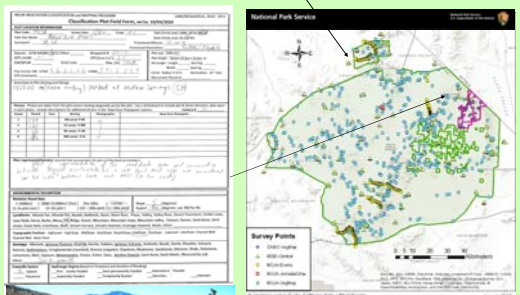

Figure 2. Location of field surveys for the vegetation classification for MOJA (various colors) and CAMO (outlined in magenta).

Figure 3. Example datasheet and photograph for survey of *Yucca brevifolia / (Yucca baccata) / Pleuraphis jamesii–Bouteloua eriopoda* Association, photo from UNLV.

2. Data Analysis

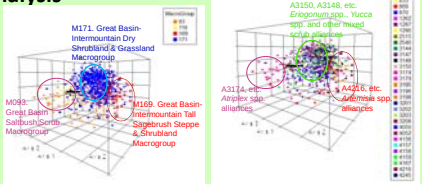

Figure 4. Ordination diagrams displaying the Macrogroup and Alliance levels for a subset of the data.

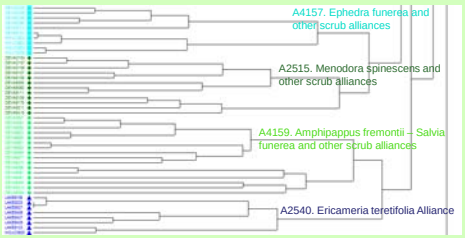

Figure 5. Agglomerative cluster analysis diagram for a subset of the data.

3. Classification Results

The dynamic analysis process allowed for broad development and interpretation of the U.S. National Vegetation Classification (USNVC) hierarchy, resulting in updates for the USNVC especially at the macrogroup, group, alliance, and association levels. This project promoted a networking of ecologists in the western U.S. to increase exposure and peer review of the USNVC. Changes to the classification include expanding and describing new vegetation alliances and associations, collapsing and merging of some alliances, and reorganization of other parts of the USNVC hierarchy.

For example, the *Pleuraphis rigida* Desert Grassland Alliance was previously placed in a mid-elevation mixed desert scrub group, and now has been moved in-part to a desert dune & sand flat group in a different macrogroup, and the *Cylindropuntia acanthocarpa / Pleuraphis rigida* Shrubland Alliance has been newly described within that former desert scrub group. Also, nine previously described desert wash alliances have been merged into four alliances, including the *Acacia greggii - Hyptis emoryi - Justicia californica, Encelia actonii - Encelia virginensis - Viguiera reticulata, Chilopsis linearis - Psorothamnus spinosus,* and *Prunus fasciculata - Salazaria mexicana* Northern Mojave Desert Wash desert wash scrub alliances. Still a diversity of wash scrub alliances occur in the region.

Table 1. Excerpt of vegetation classification from three parks of MOJN I&M.

Class	Subclass	Formation	Division	Macrogroup	Group	Alliance
1. Forest to Open Woodland						
	1.B. Temperate & Boreal Forest					
		1.B.1. Warm Temperate Forest & Woodland				
			1.B.1.Nc. Californian Warm Temperate Forest			
				M009. Californian Forest & Woodland		
					G186. Californian Broadleaf Forest & Woodland	*Quercus chrysolepis - Quercus kelloggii*
	1.B.2. Cool Temperate Forest & Woodland					
		1.B.2.Nb. Rocky Mountain Forest & Woodland				
				M020. Rocky Mountain Subalpine-High Montane Conifer Forest		
					G224. Intermountain Basins Subalpine Limber Pine - Bristlecone Pine Woodland	*Pinus flexilis*
						Pinus longaeva
				M022. Southern Rocky Mountain Lower Montane Forest		
					G228. Southern Rocky Mountain White Fir - Douglas-fir Dry Forest	*Abies concolor* Dry
	1.B.2.Nc. Western North American Pinyon - Juniper Woodland & Scrub					
				M026. Intermountain Singleleaf Pinyon - Juniper Woodland	G246. Colorado Plateau-Great Basin Juniper Open Woodland	*Juniperus osteosperma* / Shrub Understory
					G247. Great Basin Pinyon - Juniper Woodland	*Pinus monophylla - Juniperus osteosperma* / Shrub Understory

Figure 7. *Pinus monophylla – Juniperus osteosperma* / Shrub Understory in Caruthers Canyon, Mojave National Park.

4. Documentation

- Report includes summary of the classification for approximately 150 vegetation alliances.
- Appendices include diagnostic keys, vegetation descriptions for alliances with stand composition tables, descriptions of new associations, and photographs of rare plant communities.

Vegetation Classification and Mapping at Lake Mead National Recreation Area, Mojave National Preserve and Death Valley National Park

Final Report

Figure 8. Excerpt of the Title page and an Appendix key from the report for the project.

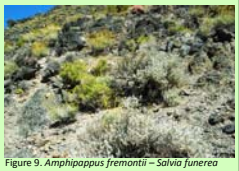

Figure 9. *Amphipappus fremontii – Salvia funerea* alliance in Titus Canyon, Death Valley National Park is a newly described alliance in the region. photo by UNLV.

Figure 10. *Mortonia utahensis* alliance on limestone in Clark Mountains, Mojave National Preserve, is a newly described, rare alliance in the region, photo by UNLV.

Figure 11. *Salix gooddingii - Salix laevigata* Riparian Forest Alliance at Darwin Falls, Death Valley is a combined alliance, photo by UNLV.

5. Mapping

The National Park Service (NPS) vegetation map inventory is a process to document the composition, distribution and abundance of vegetation types across the landscape involving the skills and interactions of several parties; including NPS ecologists, a vegetation classification team, and a mapping team. It is a multi-year approach with several broadly linked phases: (1) vegetation classification using the National Vegetation Classification Standard, (2) digital vegetation map production, and (3) map accuracy assessment. The inventory provides baseline information that park managers need to effectively manage and protect park resources. The mapping effort has been completed first at Lake Mead NRA, and then is being followed by Mojave National Preserve and Death Valley National Park.

The digital maps are based on National Agricultural Imagery Program (NAIP) imagery, Google Earth Imagery, other local and satellite imagery, visual interpretation, and field reconnaissance to interpret the complex vegetation patterns. Mapping in LAKE began with automated mapping methods using eCognition to classify the imagery, and was subsequently refined to correct line-work and mis-allocation of map classes and serves as the final map. The resulting mapping includes map classes that crosswalk to one or more USNVC alliances, groups or macrogroups, and land-use classes. The interpreted and remotely sensed data are converted to Geographic Information System (GIS) databases and are included in a comprehensive geodatabase. Mapping is field-tested and revised, and then independent ecologists conduct an field-based and statistical assessment of the map's thematic accuracy.

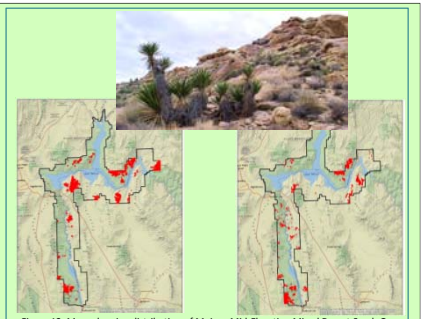

Figure 12. Maps showing distribution of Mojave Mid-Elevation Mixed Desert Scrub Group (left; 12,737 hectares) and more specifically, *Yucca schidigera* and *Eriogonum fasciculatum - Viguira parishii* Scrub Alliances (right; 6,192 hectares), at Lake Mead NRA.

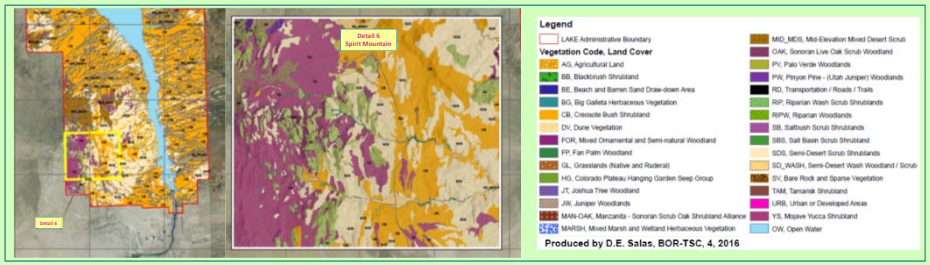

Figure 13. Vegetation map from Lake Mead NRA (excerpt from the south end of the lake), with mapping of types at the alliance, group and macrogroup levels of the US National Vegetation Classification hierarchy (see legend).

6. Conclusions and Applications

Significant changes to the classification at the alliance and association levels have included describing over 10 new alliances and 140 new associations in the USNVC, expanding or merging concepts for at least 15 vegetation alliances, and reorganization of parts of the USNVC hierarchy.

The richest number of alliances are nested within two USNVC groups. The Warm Semi-Desert Shrub & Herb Dry Wash & Colluvial Slope Group (G541) has 9 alliances, and the Mojave Mid-Elevation Mixed Desert Scrub Group (G296) has 13 alliances. These groups confer a significant importance to the ecological and regional types of the Mojave Desert, exhibiting an incredible diversity of vegetation along alluvial washes and mid-elevation transition zones. Additionally, DEVA has the highest number of vegetation alliances (i.e. 84 alliances, 20 more compared to MOJA), reflecting this parks' tremendous variation in elevation range, climatic variability, topographic features, and geomorphic surfaces.

Figure 14. *Encelia actonii - Encelia virginensis - Viguiera reticulata* Wash Scrub Alliance with calcareous alluvium in Echo Canyon, Death Valley National Park, photo by UNLV.

Figure 15. Diverse hillslopes with *Eriogonum fasciculatum - Viguiera parishii* Scrub Alliance and *Yucca brevifolia* Wooded Scrub Alliance (above, right) on granitic parent material, and *Purshia stansburiana* Shrubland Alliance (right) on limestone parent material, Mojave National Preserve, photo by J. Evens.

Figure 16. A post-fire stand of non-native *Bromus rubens* in Greenwater Valley, Death Valley National Park, photo by UNLV.

Figure 17. Remnant *Pinus monophylla - Juniperus osteosperma* Woodland; in distance is post-fire stand of *Prunus fasciculata – Salazaria mexicana* scrub in the Providence Mountains, photo by UNLV.

Uses of the Vegetation Mapping Inventory Data:

- Climate change modeling
- Ecological integrity and diversity analysis
- Long-term monitoring of plants and vegetation
- Fire behavior fuels modeling
- Landscape management
- Restoration planning
- Wildlife habitat modeling and relationships
- Wildlife management, and many others....