From: John Kessler
To: Docket Optical System
CC: Carolyn Chainey-Davis; Misa Milliron; Rick York
Date: 1/11/2010 8:08 AM
Subject: Fwd: Comments on ISEGS Plant Avoidance Plan
Attachments: BPBiogNovt09[1].doc; BMPCVSept09.doc

Dear Docket Staff:

Please docket the attached to Ivanpah (07-AFC-5) and include in the file name, "Opinion of Dr. Bruce Pavilek on BSE's Plant Avoidance Plan".

Thank you,
John

John S. Kessler
CEC - Project Manager
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>>> Misa Milliron 1/10/2010 6:32 PM >>>
Hi John, We got the OK to docket this from Bruce Pavlik, so please do so with the info below and attached.

Letter to Commission from Dr. Bruce Pavlik, conservation biologist, Mills College, on ISEGS Avoidance Plan

Date: January 10, 2010
To: California Energy Commission
From: Bruce M. Pavlik, Ph.D

The document (Ivanpah SEGS Special-Status Plant Avoidance and Protection Plan, Eastern Mojave Desert, San Bernardino County, California, Exhibit 81) makes three fundamental errors: 1) It does not address the issue of how to conserve genetic diversity within these plant taxa across the greater Ivanpah region, 2) It does not address how to conserve (sub)populations, especially seed banks, of these plant taxa across the greater Ivanpah region. 3) It does not incorporate existing knowledge regarding plant salvage, translocation, and re-establishment of eastern Mojave Desert plants when devising mitigation efforts. Given these severe deficiencies in the document and its approach, I find it highly unlikely that the proposed avoidance and mitigation measures will effectively conserve the rare plants in the Ivanpah project area.

1) Genetic diversity is key to resilience of populations (acknowledged on pgs 42 and 43), but no mitigation efforts are included that address the

preservation of genetic diversity in these plants. Although it may be difficult to obtain genetic data on these taxa directly (e.g. through isozyme or microsatellite DNA techniques), there would be little difficulty in conducting an ecogeographic analysis (Pavlik et al. 2009) that would indirectly assess genetic diversity using GIS techniques. The analysis would provide a surrogate measure of genetic diversity that could then be used to prioritize avoidance of occurrences and establish the design of mitigation efforts.

2) Self-sustaining populations are the only way species persist (acknowledged on pgs 11, 42), but no mitigation efforts are included that address the preservation of these plant populations. Preserving short-lived individual plants is not the same as preserving populations. For one thing, populations move by the process of seed dispersal. In fact they must move in order to respond to environmental conditions. This dynamism is essential for persistence. Any alternation to the project footprint that leaves rare plants adjacent to large, undisturbed tracts of habitat in order to accommodate dispersal is a better solution than fragmentation and inadequate or untested mitigation.

But more importantly, these populations (or subpopulations) have not been adequately described for conservation purposes. They are only indicated by relatively few, above-ground plants observed during the surveys. Undoubtedly, the actual populations of these taxa will show themselves in the future, in a year with ample fall and winter rains (unlike 2007 and 2008 when the surveys were done). It is possible that more plants will emerge from quiescent seed banks, just as they did for Enneapogon desvauxii in 2007 (pg 24). And as the CH2MHill Exhibit 81 argues (also pg 24), it is the extent, heterogeneity and density of the seed bank that ultimate defines the population, informs conservation efforts and determines avoidance and mitigation actions. This is especially important in desert species whose seed banks are the only hedge against extinction in the face of prolonged drought. These seed banks, and therefore the populations, remain undefined and at risk with respect to this document and the Ivanpah project.

3) More is known about salvage, translocation, and re-establishment of eastern Mojave Desert plants, including rare plants, than this document indicates. There is no reference to the extensive studies conducted during revegetation efforts for the Viceroy and Castle Mountain mine projects. A critical examination of lessons learned from those projects, which were not unlike the Ivanpah project in scope and complexity, seems to absolutely essential for decided what measures are likely to be effective.

Furthermore, this precedent-setting project exploits an intentional and harmful deficiency in the management of rare plant resources by the BLM, its applicant developers and their consultants. In short, the deficiency may be stated as "ignorance of the biology is a built-in excuse for failure to conserve or restore the resource".

While it is true that we don't know much about the ecology of rare desert plants, how many times is it appropriate for a land management agency and its petitioners to don this "cloak of ignorance" while achieving development goals? In the rush to meet project timelines and financial constraints, construction (and environmental degradation) comes first and only after the installation of all roads, buildings and operational structures will efforts be put in place to learn what we don't know about the resource. Consequently, we often learn that our understanding of even the most basic biology was inadequate and that proposed mitigation efforts were thereby doomed to failure. This is a pattern repeated again and again across our public lands, and the cumulative effect is widespread erosion of biological diversity and ecosystem functioning. With so many solar and wind projects now proposed for public lands in the near future, when will BLM attempt to shed its cloak of ignorance? When will BLM establish and fund a research center that is capable of providing basic biological and restoration information for the resources they are supposed to steward? Donning the cloak of ignorance again and again and again will only insure that our natural resources are continually and intentionally degraded for short-term, economic gain.

Given these scientific deficiencies in the document and its approach, I find it highly unlikely that the proposed avoidance and mitigation measures will effectively conserve the rare plants in the Ivanpah project area.

Any alternation to the project footprint that leaves rare plant populations adjacent to large, undisturbed tracts of habitat is a better solution than fragmentation and mitigation. However, my concerns about genetic diversity and population structure remain.

Bruce M. Pavlik, Ph.D

Bruce M. Pavlik
November 2009

Biography

Bruce M. Pavlik received his Ph.D in Botany from the University of California at Davis, working on the physiological ecology of grasses with Professor Michael Barbour. His research has focused on the ecology and physiology of plants native to western North America, including the conservation of endangered species. Ecological restoration has become central to his research program and recent projects have emphasized the design and active management of populations and communities using field-based, experimental approaches. Most of his projects have been associated with grasslands and deserts, but unusual ecosystems (dunes, lakeshores, geothermal springs, serpentinite outcrops, vernal pools) have received special attention. His current challenge is to make adaptive management work to benefit resources *in situ.* He is currently Professor of Biology at Mills College in Oakland, California and author or co-author of more than 50 scientific and popular publications, including *Oaks of California* (1991, Cachuma Press), *California's Changing Landscapes* (1993, California Native Plant Society), the fifth edition of the *Inventory of Rare and Endangered Vascular Plants of California* (1994, California Native Plant Society) and *The California Deserts: An Ecological Rediscovery* (2008, University of California Press). He runs a science consulting business that assists agencies and companies in resolving resource management problems. BMP Ecosciences was established in 2000 to provide solutions that avoid listing of endangered species, to develop “best management practices”, and to find common ground among environmental adversaries. In June 2010 he will become Head of Restoration Ecology at the Royal Botanic Gardens, Kew (London).

Bruce M. Pavlik
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Present Status: Professor of Biology, Mills College and
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Born: June l8, l953

Education:

Ph.D. Department of Botany, University of California at Davis, l982
M.S. Department of Botany, University of California at Davis, l979
B.A. Department of Biology, California State University at Northridge, l975

Current Research Interests:

Restoration of ecosystems and plant diversity
Making adaptive management work for conservation and restoration
Ecology of rarity in vascular plants
Biogeography and ecology of desert sand dunes

Honors, Awards and Offices:

Certificates of Appreciation, U.S. Fish and Wildlife Service, 2003, 2009
Gibbons-Young Professor of Biology, Mills College, 1994-1997, 2003-2006, 2009-
Rare Plant Conservation Award, California Native Plant Society, 1994
Benjamin Franklin Award for *Oaks of California*, 1992
Vice President for Rare Plants, California Native Plant Society, 1989 - 1994
Outstanding Teaching Assistant Award, l979, U.C. Davis
Magna Cum Laude, Cal State University, Northridge
Outstanding Biology Graduate of l975, Cal State University, Northridge

Professional Societies:

California Botanical Society
California Exotic Pest Plant Council
California Native Plant Society
Royal Geographic Society (Fellow)
Society for Conservation Biology
Society for Ecological Restoration

Administrative Experience:

Director, Mills College Botanic Garden and Gaia House (1985-present)

Owner, BMP Ecosciences (2000-present)

Chair, Department of Biology, Mills College (1988-1991, 1994 and 1999-2004)

Vice President, California Native Plant Society (1989-1994)

Research Publications and Reviews:

Pavlik, B.M. A. E. Stanton, and M. Falkner. 2009. Developing a Conservation and Restoration Strategy for Tahoe Yellow Cress (*Rorippa subumbellata*): I. Using Long-term Monitoring to Characterize Metapopulation Dynamics. (in prep)

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Pavlik, B.M. and A. Enberg. 2001. Developing an ecosystem perspective from experimental monitoring programs: I. Demographic responses of a rare geothermal grass to soil temperature. Environmental Management 28, 225-242.

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Coats, R., M.A. Showers, and B.M. Pavlik. 1993. Management plan for an alkali sink and its endangered plant *Cordylanthus palmatus* . Environmental Management 17, 115-127.

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Books and Popular Articles:

Pavlik, B. 2008. The California Deserts: An Ecological Rediscovery. University of California Press, Berkeley, CA. 365 pp.

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Skinner, M. and B. Pavlik. (eds.) 1994. Inventory of Rare and Endangered Vascular Plants of California. California Native Plant Society, Sacramento, Ca. 338 p.

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Coats, R. M.A. Showers, and B.M. Pavlik. 1989. The Springtown alkali sink: An endangered ecosystem. Fremontia 17, 20-23.

Teaching Experience:

Professor of Biology (1985-present) – Mills College

General Biology (year-long, with lab)
Ecology and Environmentalism (non-majors, cross-disciplinary)
Exploring the World of Plants (non-majors)
Critical Thinking (sophomore core, cross-disciplinary)
Natural History of California (non-majors)
Plant Physiology with lab
Plant Ecology with lab
California Flora and Vegetation with lab
Conservation Biology with lab
Restoration Ecology with lab
Ecosystems of California with lab
Senior Seminar

Instructor (2000) - National Conservation Training Center, U.S. Fish and Wildlife Service

Monitoring and Adaptive Management for Endangered Species Conservation with lab

Instructor (1987-1992) - National Park Service Training Program, U.C. Davis

Physiological Ecology and its Management Implications

Assistant Professor of Botany (l98l-l984) - Iowa State University

General Ecology with lab
Plant Ecology with lab
Physiological Ecology of Plants with lab (graduate level)
Techniques in Physiological Ecology with lab (graduate level)
Colloquium on Adaptations in Plants (graduate level)

Instructor and Teaching Assistant (l977-81) - University of California at Davis

Introductory Biology with lab
Introductory Botany with lab
Plant Physiology
Plant Ecology with lab
Plant Communities of California with lab

Business Experience

BMP Ecosciences is a research consulting firm dedicated to providing science for managing and restoring biological resources. It was founded as a logical outgrowth of my academic research on the ecology, conservation, and restoration of native species and ecosystems. BMP Ecosciences became an organized business venture in January 2000 and has employed more than 50 biologists since that time to work on a wide variety of projects. “BMP” not only refers to the initials of its owner, but also to the paradigm of “best management practices” that all environmental scientists aspire to discover and implement on behalf of clients and natural resources.

A complete portfolio, including reports, funding and example projects, is available upon request.

Referee for Journals, Institutions and Granting Agencies:

American Journal of Botany
American Midland Naturalist
Biological Conservation
Canadian Journal of Botany
Conservation Biology
Environmental Conservation
Journal of Biogeography
Journal of Coastal Research
Journal of Tropical Ecology
Madrono
National Research Council
The Ocean Research Institute
Oecologia
Plant, Cell and Environment
Restoration Ecology
Rhodes University, South Africa
United States Department of Agriculture
University of California at Davis
University of Western Australia

Consulting Experience:

United States Fish and Wildlife Service, Office of Endangered Species, Sacramento, CA
United States Department of the Interior, Bureau of Land Management, Desert Plan Staff, CA
United States Department of Agriculture, Forest Service, Lake Tahoe Basin, CA
State of California, Department of Fish and Game, Endangered Plant Program, Sacramento, CA
State of California, Department of Parks and Recreation, Sacramento, CA
Tahoe Regional Planning Agency, Zephyr Cove, NV
Jones and Stokes Associates, Sacramento, CA
Phillip Williams and Associates, San Francisco, CA
Sponamore and Associates, Santa Rosa, CA
Team Engineering, Bishop, CA
Thomas Reid and Associates, Redwood City, CA
California Institute of Technology (Caltech), Pasadena, CA
Pacific Gas and Electric Company, San Ramon, CA
Sierra Club Legal Defense Fund, San Francisco, CA
Wilderness Society, San Francisco, CA

Professional References

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Dr. Michael Barbour, Plant Sciences, University of California, Davis, CA 95616 mgbarbour@ucdavis.edu

Dr. John Harris, Biology, Mills College, Oakland, CA 94602 johnh@mills.edu

Class Project December 2009:

Using Ecogeographic Heterogeneity as a Surrogate Measure of Genetic Variation among Subpopulations of Five Rare Plant Taxa in the Vicinity of the Ivanpah Solar Energy Project, San Bernardino County, California

Bruce M. Pavlik, Ghazal Ghafari, Emma Giboney, Dyamond Keith-Littlefield, Tara La Valley Sandoval, Ashika Narayan and Ilana Stein

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Introduction

There is considerable political will and economic incentive for establishing facilities in the southwest U.S. that generate electrical power using solar and wind energy. Beginning with the passage of the Energy Policy Act of 2005, there are so now many requests for permits (over 140 applications) to construct these facilities on public lands in California, Nevada and Arizona that large swaths of desert ecosystems (over two million acres) could be permanently altered or destroyed. The cumulative impacts on biological diversity at the level of species and natural communities have yet to be assessed.

The single facility that is closest to being permitted for construction (early 2010) is Brightsource Energy's Ivanpah Solar Facility, in the Ivanpah Valley of eastern California. The plant will be built on BLM land and many federal and state agencies will participate in the permit process, including environmental impact studies (under NEPA and CEQA).

Biologists at one state agency, the California Energy Commission (CEC) are being asked to determine how many subpopulations and individuals of five rare plant taxa (Table 1) need to be conserved to maintain the "viability" of each species in the Ivanpah region, and conversely, how many can be permitted for "take" (i.e. extirpation) as the result of project construction. There is no easy answer to the question, especially for species we know so little about in terms of demography, population genetics, and responses to ecosystem disturbance and environmental stochasticity. One taxon, Rusby's desert mallow (*Sphaeralcea rusbyi* var. *eremicola*, "SPRUER") is represented by 23 occurrences in the greater Ivanpah valley and highlands region (data from CNDDB 2009), but only 15 individual (aboveground) plants in the Ivanpah Project Area (CH2MHill 2008). Although seed dormancy during prolonged drought can make desert plant subpopulation sizes look small (especially since the winter of 2004-2005), it appears that SPRUER falls well below minimum viable population size for short-lived herbaceous perennials (in the range of 1,500 to 2,500 individuals, CPC 1991). In contrast, nine-awned pappus grass (*Enneapogon desvauxii*, "ENDE") has 17 occurrences in the greater Ivanpah valley and highlands region (data from CNDDB 2009) and 8,145 individual (aboveground) plants in the Ivanpah Project Area (CH2MHill 2008).

But the numbers of individuals and populations to conserve is one question, genetic conservation is another. Ideally, each subpopulation (roughly equivalent to "occurrence" in the absence of complete data) would be characterized with respect to inherent variation (i.e. isozyme, microsatellite DNA) during project planning and mitigation. More genetically diverse subpopulations would have higher priority for avoidance or mitigation and the conserved subset of subpopulations of a given taxon would be chosen to contain the known spectrum of variation. That is not the case under existing project timelines.

Herein we suggest that ecogeographic variation could be used as a surrogate for genetic characterization. A plant taxon with occurrences on multiple geological substrates, topographic positions (elevation, slope, aspect) and vegetation types is more ecogeographically heterogeneous, and therefore, is likely to be more genetically differentiated than another taxon with occurrences on few substrates, positions and vegetation types. More heterogeneity would then require conserved occurrences (those avoided by the project footprint) be drawn from across the landscape and include as many ecological variations as possible. Ultimately, an ecogeographic approach seeks to conserve the maximum amount of genetic variation within each taxon while minimizing the redundancy (preservation of multiple, similar subpopulations) that interferes with the footprint of the project.

This short paper is a demonstration of the ecogeographic approach to assessing genetic variation, conducted by the students of the senior author's Conservation Biology class at Mills College, Fall 2009. Given the restrictions we faced in terms of time and data availability, it should be regarded as a demonstration and not the definitive assessment. We found that three taxa (*Coryphantha chlorantha, Enneapogon desvauxii,* and *Sphaeralcea rusbyi var. eremicola*) had relatively high levels of ecogeographic heterogeneity while two (*Grusonia parishii* and *Asclepias nyctaginifolia*) had moderate to low levels, respectively, based on overlaying occurrences on the available geology and vegetation GIS layers. The approach could be strengthened by adding GIS layers and ecogeographic categories (e.g. topography, site-specific vegetation maps) and by analyzing occurrences of the same taxa in other parts of the desert southwest. Different configurations of the project footprint could be overlain to see which configuration conserves the most subpopulations, individuals and ecogeographic variations.

Methods

We obtained the most recently archived occurrences of the five plant taxa from the California Natural Diversity Database (CNDDB November 2009), accessed using the RareFind 3.1 program. All occurrences in the greater Ivanpah Valley and adjacent highland region were included, while those in other regions of the desert were excluded. The number of occurrences for each taxon ranged from 10 (*Grusonia*) to 23 (*Sphaeralcea*). It appears that not all occurrences recorded during field surveys conducted by CH2M Hill might not have been entered into the CNDDB by the time we used the data. Therefore, we refer to the 82 total occurrences we used as the "CNDDB occurrences" to reflect this possibility.

GIS data on geologic substrates and vegetation types were obtained from the Mojave Desert Ecosystem Project (http://www.mojavedata.gov/dataindex.php) and imported into ArcGIS. Attempts to use the available topographic data failed, so we could not incorporate elevation, slope and aspect into our analysis. A total of six geology and six vegetation units were mapped in the greater Ivanpah Valley and highlands region that overlapped with the CNDDB occurrences.

Once the occurrences were incorporated into the GIS, we simply tallied the number of occurrences on each mapped units of geology and vegetation. An "index of ecogeographic heterogeneity" scored each taxon for the number of mapped units, summed for geology and vegetation. A single occurrence within a unit, however, was treated as 0.5 index units to minimize the effect of accidental occupation. A maximum index value would be 12 for a taxon that had two or more occurrences within all 12 map units (high heterogeneity) and the minimum value would be 0.5 for a taxon with only one occurrence within a single map unit (low heterogeneity = homogeneity).

Results

Using the geology and vegetation data (Figures 1 and 2), we found that three taxa (*Coryphantha chlorantha, Enneapogon desvauxii,* and *Sphaeralcea rusbyi var. eremicola*) had relatively high levels of ecogeographic heterogeneity (index values ranging from 7 to 8.5 out of 12) while two (*Grusonia parishii* and *Asclepias nyctaginifolia*) had moderate (5.5) to low (3) levels within the greater Ivanpah Valley and highlands region Tables 2, 3 and 4). Maps for the taxon with the lowest index value (*Asclepias nyctaginifolia*, Figures 3 and 4) and the taxon with the highest value (*Enneapogon desvauxii*, Figures 5 and 6) are included below for comparison. All maps are available from the senior author upon request.

Asclepias nyctaginifolia (ASNY)

This species is a perennial herb found in San Bernardino County, California, as well as in Nevada, Arizona, and New Mexico. Across this wide range its habitats can include Mojave desert scrub, pinyon and juniper woodland, creosote bush scrub, arroyos and dry slopes. ASNY is found at elevations between 1000-1700 meters, blooming during May and June.

All 18 occurrences of ASNY in the greater Ivanpah Valley and upland area were in the same vegetation type (creosote bush shrubland), with little variation in geologic substrate (Figures 3 and 4). Four occurrences were on older alluvial deposits, while fourteen were found on recent bajadas. Thirteen of the occurrences were clustered in the same geographic area within a radius of about 20 km. It is not evident that there is much ecogeographic variation among the majority of occurrences of ASNY in the greater Ivanpah Valley and upland area.

Coryphantha chlorantha (COCH)

This species is a stem-succulent cactus found in Inyo and San Bernardino counties, as well as Nevada, Arizona, and Utah. Across this wide range its habitats include Mojave desert scrub, pinyon and juniper woodland, and Joshua Tree woodland on rocky, gravelly, carbonate and limestone rich substrates. In the Ivanpah Valley and upland area COCH is found at elevations between 300-2400 meters and the blooming period is April to September.

In the greater Ivanpah Valley and upland area, COCH occurred among creosote bush, blackbrush, Mojave yucca shrublands, mid-elevation wash and Joshua tree woodland vegetation types. Of the 14 occurrences in the greater Ivanpah Valley and upland area, 5 were found in Joshua tree woodland and 6 in creosote bush shrubland. With respect to geologic substrate, occurrences were fairly evenly distributed among four units (bajada, old alluvial deposit, erosional highland, and lacustrine terrace). This species appears to have considerable ecogeographic variation across the greater Ivanpah Valley and upland area.

Enneapogon desvauxi (ENDE)

This species is a perennial grass found in San Bernardino county. Its habitats include woodlands and scrub juniper on calcareous substrates, decomposed granite, and rocky gravelly limestone soils. ENDE is found at elevations between 1275-1825 meters with a blooming period in August and September.

The 17 occurrences of ENDE in the greater Ivanpah Valley and upland area were rather evenly distributed among five vegetation types (creosote bush shrubland, Mojave yucca, mid elevation wash, high elevation wash, and Joshua tree woodland) and four geologic units (bajada, old alluvial deposit, erosional highland, and canyon bottom) (Figures 5 and 6). The overall distribution of the occurrences showed little spatial clumping. Eight occurrences were on bajadas and 5 on erosional highlands. This species appears to have considerable ecogeographic variation across the greater Ivanpah Valley and upland area.

Grusonia parishii (GRPA)

This species is a stem succulent cactus found in Riverside and San Bernardino counties, as well as Nevada, Arizona, and Texas. Across this wide range its habitats include Mojave desert scrub, Joshua tree woodland, Sonoran desert scrub on sandy, gravelly substrates. GRPA can be found at elevations between 300 and 1524 meters, blooming between May and June.

Half of the occurrences of GRPA in the greater Ivanpah Valley and upland area were located in creosote bush shrubland, four in Joshua tree woodland, and only one in Mojave yucca shrubland. In terms of geology, half of the occurrences were found on bajadas, three on old alluvial deposit, one on erosional highland, and one on bedrock plain. It is evident that the substrate habitat for this species is more varied than its vegetation associations. There is high ecogeographic variation for this species in the greater Ivanpah Valley and upland area.

Sphaeralcea rusbyi var*. eremicola* (SPRUER)

This taxon is a perennial herb or subshrub found in Inyo and San Bernardino counties. Its habitats include scrub and woodland in sandy washes and on carbonate substrates. SPRUER has an elevation range between 965 and 1500 meters, blooming between March and June.

This taxon had 11 occurrences on bajadas and 8 on erosional highlands, although several were ecotonal and may not be differentiated with respect to geology. In terms of vegetation, the occurrences were well-distributed between four of the mapped types, but most commonly associated with creosote bush shrubland. Overall, there was moderate to high ecogeographic heterogeneity for this taxon in the greater Ivanpah Valley and upland area.

Conclusions

We found that three taxa (*Coryphantha chlorantha, Enneapogon desvauxii,* and *Sphaeralcea rusbyi var. eremicola*) had relatively high levels of ecogeographic heterogeneity (index values ranging from 7 to 8.5 out of 12) while two (*Grusonia parishii* and *Asclepias nyctaginifolia*) had moderate (5.5) to low (3) levels within the greater Ivanpah Valley and highlands region. Those with high levels could be genetically differentiated into ecotypes and are not, therefore, equivalent with respect to conservation and take. In addition to considering the numbers of subpopulations and aboveground individuals, placement of the project footprint should conserve such occurrences across all ecogeographic units. Taxa with low heterogeneity could be considered undifferentiated, each genetically similar and belonging to few ecotypes. These should then be conserved based only on the number of subpopulations and individuals, not ecogeographic heterogeneity.

The approach could be strengthened by adding GIS layers and ecogeographic categories (e.g. topography, site-specific vegetation maps) and by analyzing occurrences of the same taxa in other parts of the desert southwest. All available data on occurrences, especially those which may not be currently included in the CNDDB, should be included. Then different configurations of the project footprint (not made available to us) could be overlain to determine which configuration conserves the most subpopulations, individuals and ecogeographic variations.

Table 1. Rare (special status) plants in different portions of the Ivanpah Project Area. Total numbers of tallied individual plants are shown.

Taxon **Scientific name** (Common name)	Ivanpah 1	Ivanpah 2	Ivanpah 3	Utility Corridor	Logistics Area	Total Individual Plants[1]
Asclepias nyctaginifolia (Mojave milkweed)	37	16	127	5	17	202
Coryphantha chlorantha (desert pincushion)	39	21	143	383	13	599
Enneapogon desvauxii (nine-awned pappus grass)	552	0	855	5,910	828	8,145
Grusonia parishii (Parish's club-cholla)	110	0	39	55	135	339
Sphaeralcea rusbyi var. *eremicola* **(Rusby's desert-mallow)**	1	2	2	9	1	15

[1] Total individual plants in Project Area and subtotals by project feature as defined in Table 5-1: *Technical Report: Botanical Resources of the Ivanpah Solar Electric Generating System* (CH2M Hill 2008c).

Table 2. Number of occurrences for each taxon by mapped geologic unit.

taxon	bajada	old alluvial deposit	erosional highland	lacustrine terrace	canyon bottomland	bedrock plain	**Total**
Asclepias nyctaginifolia	14	4	0	0	0	0	18
Coryphantha chlorantha	6	4	1	3	0	0	14
Enneapogon desvauxii	8	3	5	0	1	0	17
Grusonia parishii	5	3	1	0	0	1	10
Sphaeralcea rusbyi var. eremicola	11	3	8	1	0	0	23

Table 3. Number of CNDDB occurrences of each taxon by vegetation type.

taxon	CBS	BS	MYS	MEW	HEW	JTW	**Total**
Asclepias nyctaginifolia	18	0	0	0	0	0	18
Coryphantha chlorantha	6	1	1	1	0	5	14
Enneapogon desvauxii	4	0	3	3	3	4	17
Grusonia parishii	5		1			4	10
Sphaeralcea rusbyi var. eremicola	8		6	4		5	23

CBS=creosote bush shrubland
BS=blackbrush shrubland
MYS=Mojave yucca shrubland
MEW=mid-elevation wash
HEW=high-elevation wash
JTS=Joshua tree woodland

Table 4. Indices of ecogeographic heterogeneity, with 12 being maximum and 0.5 minimum.

	Asclepias nyctaginifolia	*Coryphantha chlorantha*	*Enneapogon desvauxii*	*Grusonia parishii*	*Sphaeralcea rusbyi var. eremicola*
Index Value	3.0	7.0	8.5	5.5	7.5

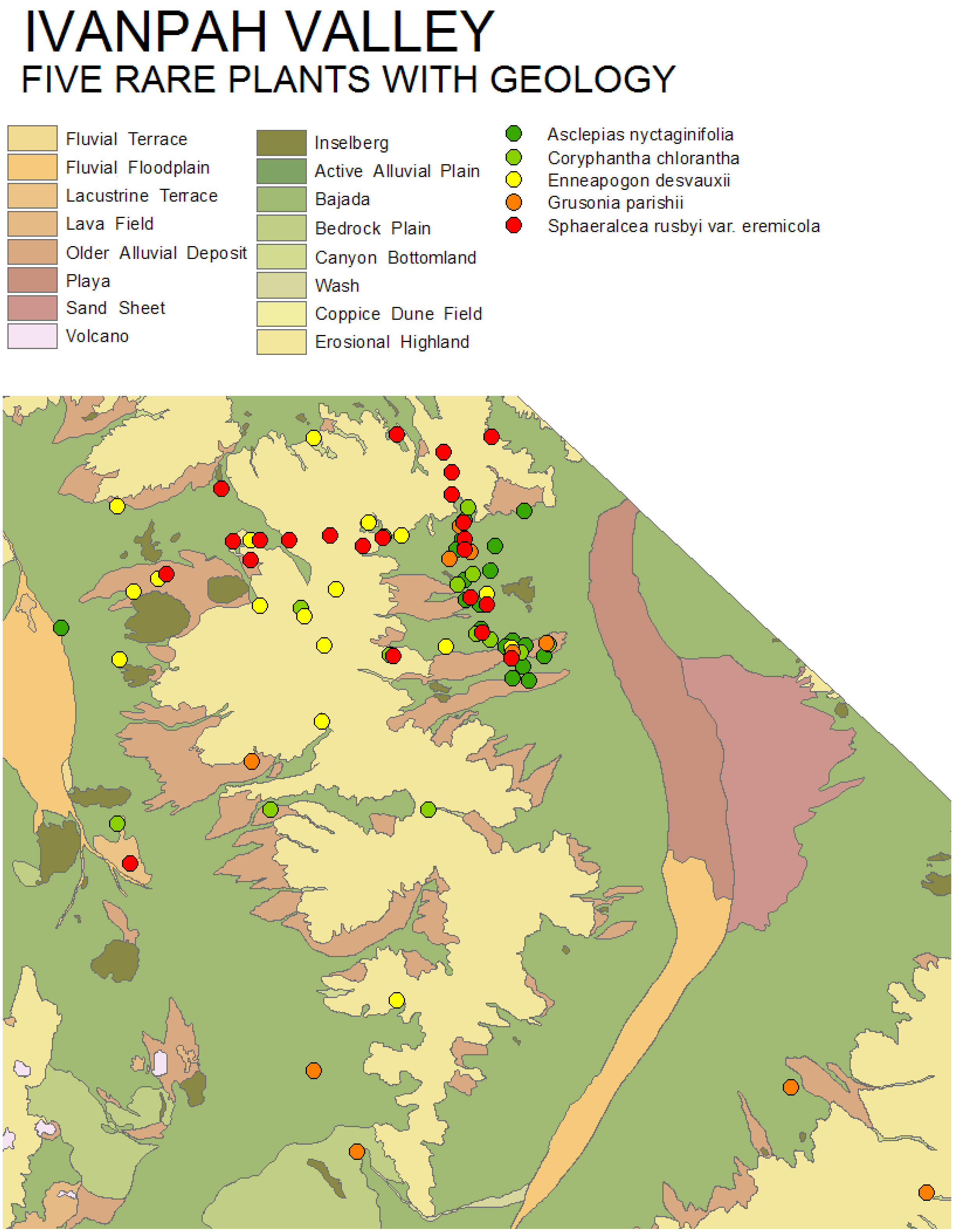

Figure 1. Overlay of all CNDDB occurrences of five rare plant taxa on mapped geology units within the greater Ivanpah Valley and highlands region.

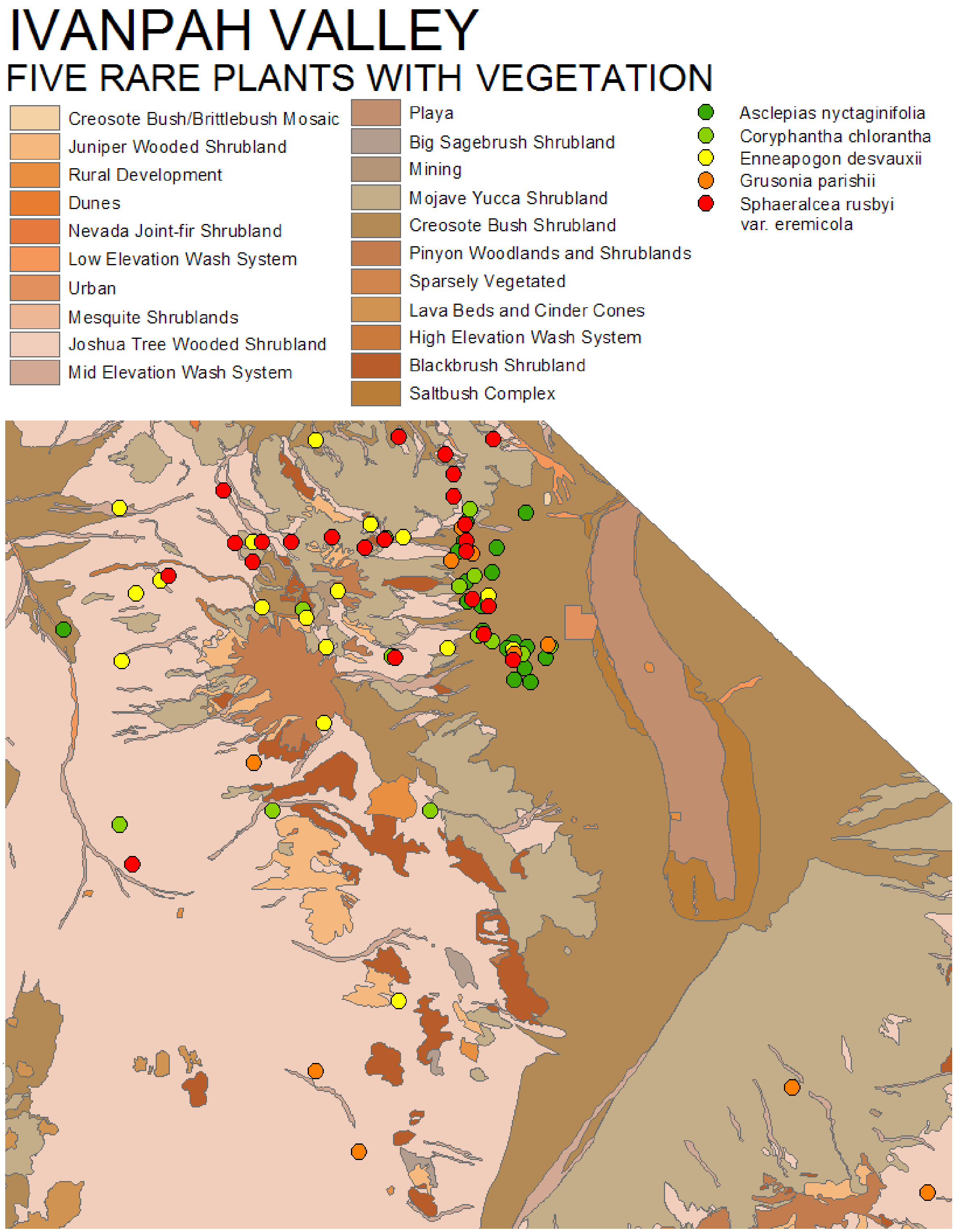

Figure 2. Overlay of all CNDDB occurrences of five rare plant taxa on mapped vegetation units within the greater Ivanpah Valley and highlands region.

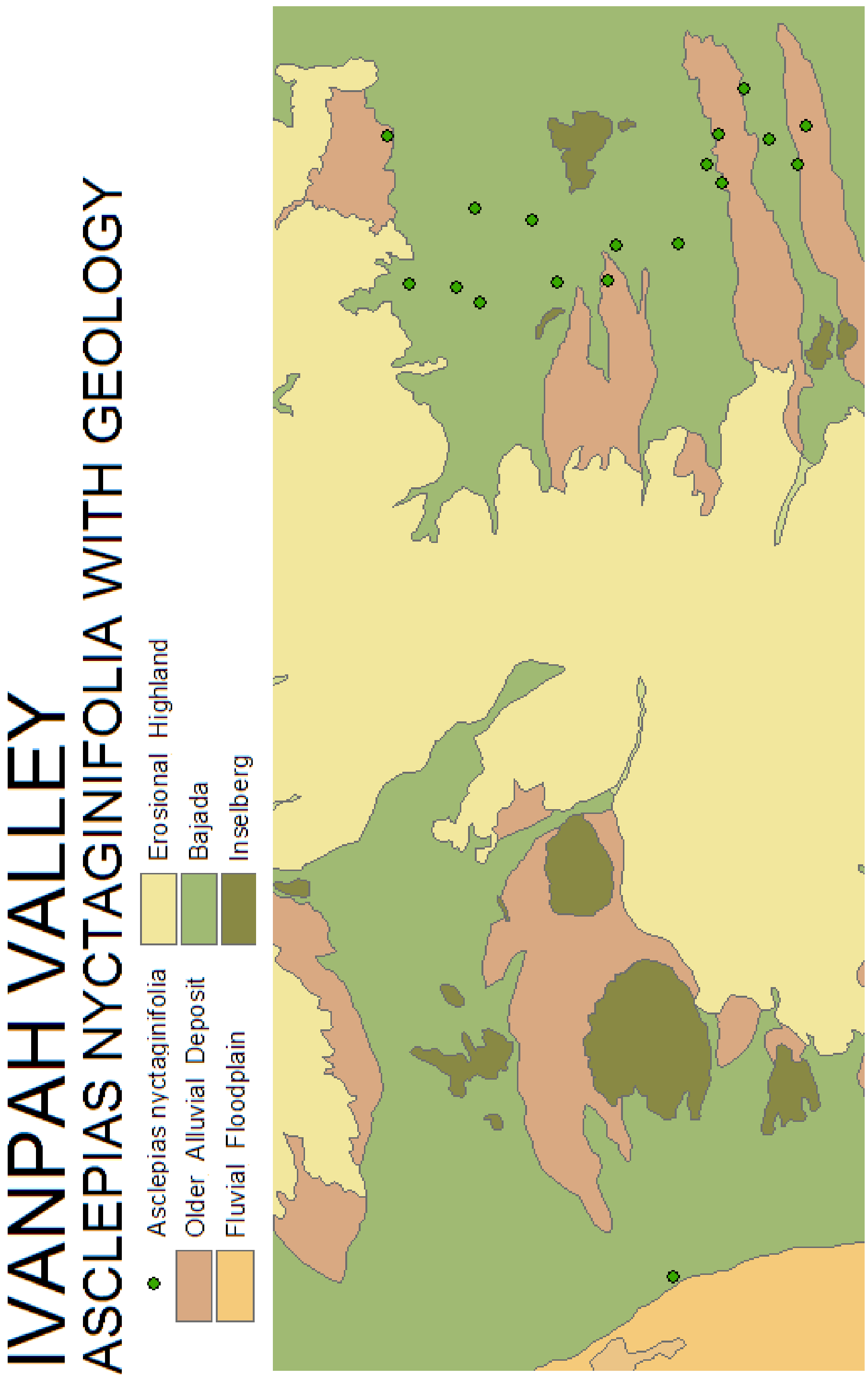

Figure 3. Overlay of CNDDB occurrences of *Asclepias nyctaginifolia* on mapped geology units within the greater Ivanpah Valley and highlands region.

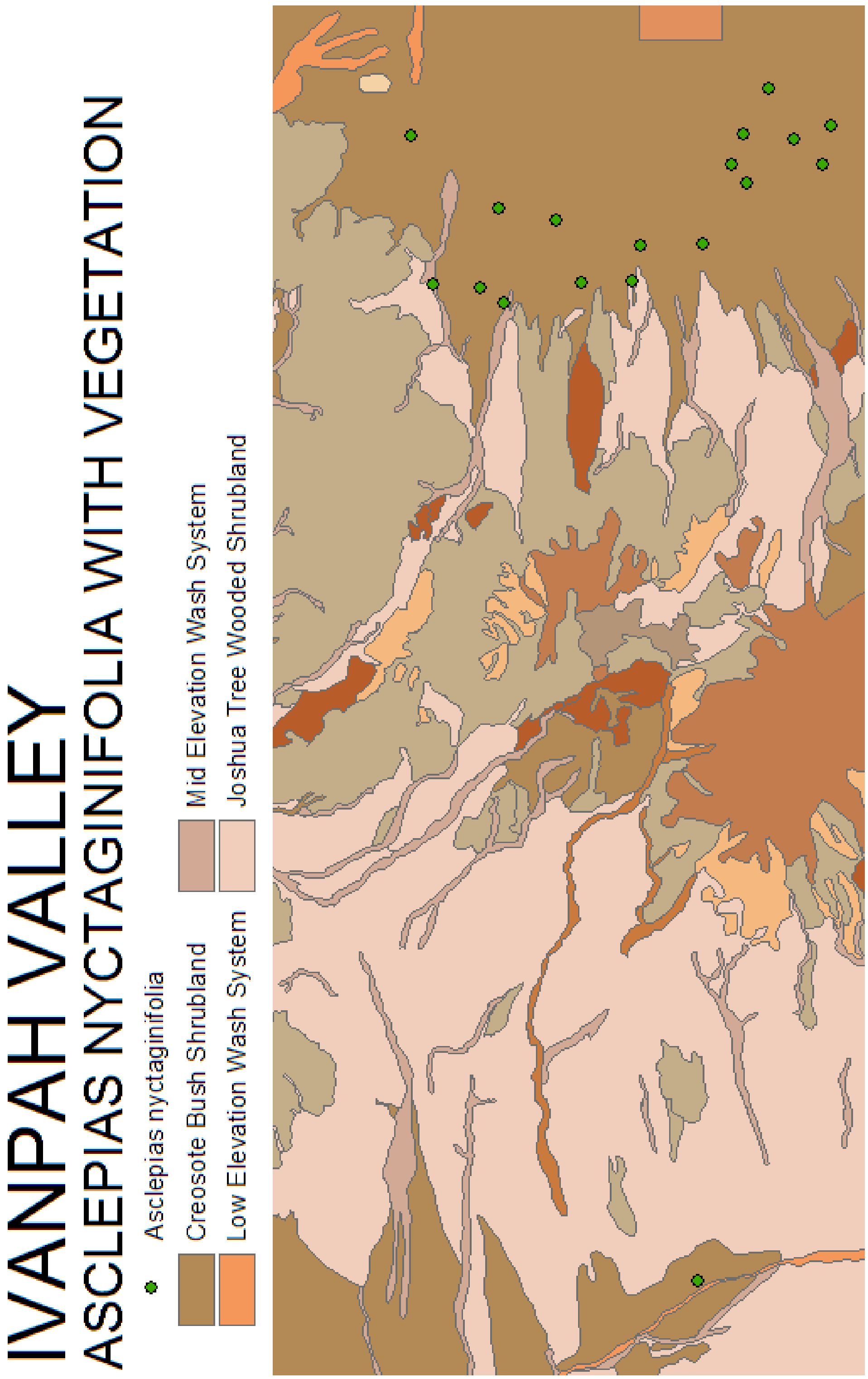

Figure 4. Overlay of CNDDB occurrences of *Asclepias nyctaginifolia* on mapped vegetation units within the greater Ivanpah Valley and highlands region.

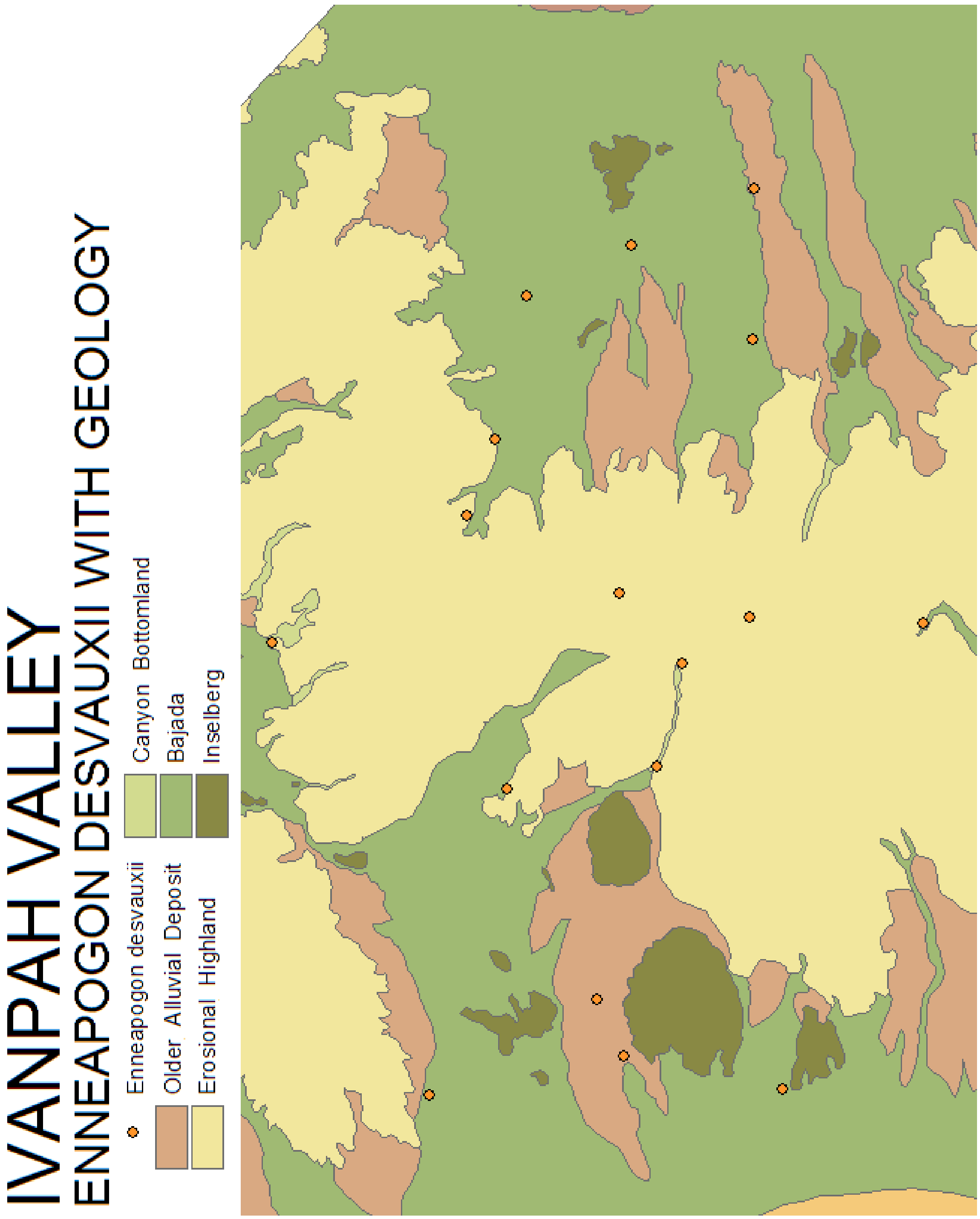

Figure 5. Overlay of CNDDB occurrences of *Enneapogon desvauxii* on mapped geology units within the greater Ivanpah Valley and highlands region.

Figure 6. Overlay of CNDDB occurrences of *Enneapogon desvauxii* on mapped vegetation units within the greater Ivanpah Valley and highlands region.

Resources Cited

CNDDB (California Natural Diversity Database). 2009. RareFind 3.1. Sacramento, CA.

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