



Inventory, Research and Monitoring of Evaluation and Watch List Plants

FINAL REPORT

for work performed by the National Park Service, Lake Mead National Recreation Area during 2008-2010 with funding received from the Clark County Multiple Species Habitat Conservation Plan (Contract reference: 2005-NPS-536-P)

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Agency/Organization: National Park Service-Lake Mead National Recreation Area

Project Number: 2005-NPS-536-P

Project Contact Name and Information: Alice C. Newton, Vegetation Management Specialist

Lake Mead National Recreation Area

601 Nevada Way

Boulder City, NV 89005

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EXECUTIVE SUMMARY:

The goal of “Inventory and Research for Evaluation and Watch Species Project” was to further the knowledge to facilitate conservation, inform Clark County’s conservation management strategies, and to provide more accurate descriptions and locations of *Astragalus mokiacensis* A. Gray (Mokiak milkvetch), *Cirsium virginensis* S.L. Welsh (Virgin River thistle), *Cryptantha hoffmannii* I.M. Johnst. (Hoffman’s cryptantha), *Cryptantha insolita* (J.F. Macbr.) Payson (unusual cat’s-eye), *Dudleya pulverulenta* (Nutt.) Britton & Rose (chalk liveforever), *Enceliopsis argophylla* (D.C. Eaton) A. Nelson (silverleaf sunray), *Eriogonum corymbosum* var. *nilesii* (Las Vegas buckwheat), *Ferocactus cylindraceus* (Engelm.) Orcutt var. *lecontei* (Engelm.) H. Bravo (Leconte’s barrel cactus), *Pediomelum castoreum* (S. Watson) Rydb. (Beaver Dam breadroot), and *Penstemon bicolor* (Brandegge) Clokey & D.D. Keck ssp. *roseus* Clokey & D.D. Keck (rosy two-tone beardtongue). This project increased knowledge concerning these ten evaluation and watch species through inventories and ecological community assessments.

Outcomes of the project included:

- New populations of Virgin River thistle, chalk liveforever, silverleaf sunray and Las Vegas buckwheat were identified during surveys.
- A morphological study found that there is not a significant difference between upper and lower elevation cacti in Lake Mead National Recreation Area; thus, we recommend delisting *Ferocactus cylindraceus* var. *lecontei*.
- It was determined that more intensive management under the proposed Gold Butte National Conservation Area would benefit Mokiak milkvetch, Virgin River thistle, chalk liveforever, barrel cactus, and Las Vegas buckwheat populations.
- No existing or new populations of Hoffman’s cryptantha or unusual cat’s-eye were found. Unusual cat’s-eye may have already been extirpated from Clark County.
- More Las Vegas buckwheat was found on Gold Butte than previously recorded.
- Las Vegas buckwheat is designated as At Risk under Nevada State Law. We recommend that status of Las Vegas buckwheat be changed to Covered Species.
- The largest populations of silverleaf sunray and chalk liveforever occurred on protected federal lands in Lake Mead National Recreation Area and on Gold Butte. We recommend that status of these species be changed to Low Priority Watch Species.
- Few Beaver Dam breadroot were found in Clark County. We recommend that status of Beaver Dam breadroot be changed to Watch List with High Priority.
- Most surveyed populations of rosy two-tone penstemon were extirpated or small. We recommend extensive, county-wide surveys to identify additional populations of the species.

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INTRODUCTION:

DESCRIPTION OF THE PROJECT

The Clark County Multi-Species Habitat Conservation Plan (MSHCP) objectives for the ten evaluation and watch species addressed by this final report [*Astragalus mokiacensis* A. Gray (Mokiak milkvetch), *Cirsium virginensis* S.L. Welsh (Virgin River thistle), *Cryptantha hoffmannii* I.M. Johnst. (Hoffman's cryptantha), *Cryptantha insolita* (J.F. Macbr.) Payson (unusual cat's-eye), *Dudleya pulverulenta* (Nutt.) Britton & Rose (chalk liveforever), *Enceliopsis argophylla* (D.C. Eaton) A. Nelson (silverleaf sunray), *Eriogonum corymbosum* var. *nilesii* (Las Vegas buckwheat), *Ferocactus cylindraceus* (Engelm.) Orcutt var. *lecontei* (Engelm.) H. Bravo (Leconte's barrel cactus), *Pediomelum castoreum* (S. Watson) Rydb. (Beaver Dam breadroot), and *Penstemon bicolor* (Brandeggee) Clokey & D.D. Keck ssp. *roseus* Clokey & D.D. Keck (rosy two-tone beardtongue)] were to gain information about the locations and population sizes of these species and to prioritize these species and their habitats for status re-assessments in future phases of the Clark County MSHCP. Specific goals of the "Inventory and Research for Evaluation and Watch Species Project" were:

- To increase knowledge to facilitate conservation of these evaluation and watch species on federal lands.
- To increase knowledge to inform Clark County's conservation management strategies for these species.
- To provide more accurate descriptions and locations of rare plants to facilitate meeting the MSHCP goal of identifying and prioritizing those species and habitats which may require increased conservation efforts and elevation of status in future phases of the Clark County MSHCP.
- To discover new rare plant populations during field investigations in 20% surveys in habitat where species has no known historical or current occurrences.

This project increased knowledge concerning these ten evaluation and watch species through inventories and ecological community assessments.

MANAGEMENT ACTIONS ADDRESSED

The following MSHCP (RECON, 2000) conservation management actions were addressed by this project (2005-NPS-536-P):

- Conservation Management Action NPS (3) - Cooperate in the identification, development, and implementation of research projects located on Federal lands. Emphasis was placed on research that addressed management concerns and the conservation of Covered and Evaluation Species.
- Conservation Management Action NPS (51) - Assure full and continuing implementation of existing management policies and actions, and monitoring of sensitive habitats and species.

BACKGROUND AND NEED FOR THE PROJECT

In addition to addressing Clark County goals and objectives, this project supported National Park Service (NPS) compliance with federal management guidelines. NPS Management Policies direct managers at Lake Mead National Recreation Area (LMNRA) to survey for, protect and manage state and locally listed species and other native species of special concern (NPS, 2002). These directives are to be achieved by maintaining the species' natural distribution and abundance (NPS, 2002).

The MSHCP lists specific goals for the management of rare plant species which are further outlined in the Low Elevation Rare Plant Conservation Management Strategy (TNC, 2007). The key purposes of the MSHCP are to achieve a balance between 1) long-term conservation and recovery of the diversity of natural habitats and native species of plants and animals, 2) the orderly and beneficial use of land in order to promote the economy, health, well-being, custom and culture of Clark County residents (TNC, 2007), as well as, having no net unmitigated loss or fragmentation of habitat in intensively managed areas and maintain stable or increasing plant populations. In addition, the MSHCP has been designed to provide recovery and conservation benefits to species and ecosystems throughout Clark County. Without baseline information, neither the health nor status of these ten species, nor their habitat can be accurately evaluated.

DESCRIPTION OF THE SPECIES

MOKIAK MILKVETCH

Astragalus mokiensis A. Gray (Mokiak milkvetch) can grow 1-4 dm, and is a purple-flowered vetch that is endemic to Arizona and Nevada, southwestern United States (Figure 1). Mokiak milkvetch is classified as a Special Status Species with the Bureau of Land Management (BLM) (Table 1), and is Globally and State Ranked G2G3Q S1S2 (Table 2). This species is listed as an Evaluation-Medium species under the MSHCP.

A study of the morphology of existing herbarium specimens by J. Andrew Alexander concluded that there are four minor variants of Mokiak milkvetch; additionally Alexander concluded that *Astragalus lentiginosus* var. *trumbullensis* should be considered a synonym of the species (2005). However, var. *trumbullensis* is recognized as an independent variant by the U.S. Department of Agriculture (USDA) Plants Database as revised by John Kartesz (2010). The variant occurring in Clark County is called the "Gold Butte minor variant" and according to Alexander is distinguished by:

“... leaflets that are strigulose adaxially, ranging from strigulose along the midrib to evenly strigulose across the surface, sometimes on the same plant.” (Alexander, 2005).

The largest population of Mokiak milkvetch in North America is located in Gold Butte (Alexander, 2001). Alexander studied specimens collected predominately throughout the Gold Butte area for his morphology study, including: Granite springs, the southwest foothills of Gold Butte, Quail Springs Wash, Mica Spring, Grapevine Spring creek; along with: Twin Springs Wash, the northwest slope of LMNRA Black Mountains, south of Summit Pass, Cataract Wash, Garden Spring and Bonelli Peak (Alexander, 2005).

Isotype specimens of Mokiak milkvetch were collected in Arizona in 1877 by E. Palmer (Herbaria of Princeton University and Herbarium of Columbia College; NY Specimen ID: 5554).

A review of the New York Botanical Garden's (NYBG) virtual specimen library records found documented occurrences of Mokiak milkvetch from Mohave County, Arizona (23 specimens); Washington County, Utah (nine specimens); and Clark County, Nevada (two specimens). Arizona specimens were collected in Mokiak Pass, Virgin Narrows, Parashant "Trail" Canyon, near Griffith Knoll, Bar Ten Ranch, Andrus Canyon, Hendricks Canyon and Hidden Canyon, all within Mohave County. Within Utah, specimens had been collected in Bulldog Canyon and Knolls (1983, 1986), Baird Cove (1987) and Beaverdam Slope (1998) (NYBG, 2010).

A conceptual model depicting the known and unknown environmental requirements and stressors of Mokiak milkvetch was developed (Figure 2).

VIRGIN RIVER THISTLE

Cirsium virginensis S.L. Welsh (Virgin River thistle) was described by Stanley L. Welsh in 1982. While Virgin River thistle is still an accepted taxon as revised by John Kartesz on the USDA Plants Database, it is coming under question (2010). The 2005 *Flora of North America* treated Virgin River thistle as a synonym for *Cirsium mohavense* (Greene) Petr. (Mojave thistle) because the author feels there is no reliable criteria for separating the species. Genetic testing would confirm the issue. Virgin River thistle is listed on the Nevada Natural Heritage Program (NNHP) Sensitive List, is Globally and State Ranked G2S1 (Table 2), and is a U.S. Fish and Wildlife (USFWS) Species of Concern (Table 3).

Virgin River thistle is found in Washington County, Utah, as well as in nearby parts of northern Arizona and Clark County, Nevada. It usually grows near springs and seeps in damp alkaline soil, and has been recorded at elevations of up to 2000 m (Cronquist *et al.*, 1994b) (Figure 3c).

Virgin River thistle is perennial forb with a one or more stems growing up to 2 m high. It can be single or multi-stemmed, with toothed leaves with spines on the teeth (Figure 3). The flowers are lavender, sometimes very pale, and bloom from about May to October. They are usually about 2 cm across. The plant is extremely similar to Mojave thistle. The main differentiating characteristics are that Virgin River thistle is a perennial, spreads by creeping roots, and can be found in Clark County, while Mojave thistle is described as a biennial, without the creeping roots, and in a different range (Cronquist *et al.*, 1994b).

A conceptual model was developed for this project which depicts the known and unknown environmental requirements and stressors of Virgin River thistle (Figure 4).

HOFFMAN'S CRYPTANTHA

Cryptantha hoffmannii I.M. Johnst. (Hoffman's cryptantha) is a rare perennial plant found only in the Mojave Desert in Nevada and California (Calflora, 2010; Kartesz, 1988). In Nevada, it has been recorded in Nye, Esmeralda, and Mineral Counties (Kartesz, 1988). Physiologically, it is very similar to the more common *Cryptantha virginensis* (M.E. Jones) Payson (Virgin River cryptantha) and in some treatments, the two are considered to be the same species (Baldwin, 2002; Cronquist *et al.*, 1994a). The two are differentiated by slight differences in the fruit and

nutlets (Kartesz, 1988). Hoffman's cryptantha grows on dry, rocky or gravelly slopes in volcanic soils. It can be found at about 1500 m to 3000 m, often in pinyon-juniper or other coniferous habitat.

Hoffman's cryptantha is not included in the NNHP's most recent Rare Plant List (2005). A conceptual model was developed for this project which depicts the known and unknown environmental requirements and stressors of Hoffman's cryptantha (Figure 5).

UNUSUAL CAT'S-EYE

Cryptantha insolita (J.F. Macbr.) Payson (unusual cat's-eye) is considered a biennial/perennial herbaceous forb that is endemic to Clark County, Nevada (USDA, 2010). It is Globally and State Ranked GHQ SH (Table 2). This rank indicates that the taxonomic status of unusual cat's-eye is questionable; since there are presently no known populations of unusual cat's-eye this is difficult to verify.

The rare plant is composed of one to two stems emerging from a taproot, and reportedly produces white flowers at some time between April and June. Flowers are eventually replaced by the only positive way to identify the species – its mature nutlets of 3-4 mm long, which are broadly ovate (Arizona Game and Fish Department, 2005a).

Unusual cat's-eye has been reported to establish on "light-colored, alkaline clay flats and rolling hillsides..." between 300-600 m elevation (NatureServe, 2009). Unusual cat's-eye is reportedly associated with vegetation found in "creosote bush scrub" (Arizona Game and Fish Department, 2005a).

There have only been two collections of this species, in 1905 and 1942. Both specimens were collected north of Las Vegas in bajadas (NatureServe, 2009). The habitat for unusual cat's-eye likely no longer exists (Arizona Game and Fish Department, 2005a). Subsequent surveys have thus far been unsuccessful, and it has been suggested that the species is currently extinct (NatureServe, 2009).

A conceptual model was developed for this project which depicts the known and unknown environmental requirements and stressors of unusual cat's-eye (Figure 6).

CHALK LIVEFOREVER

Dudleya pulverulenta (Nutt.) Britton & Rose (chalk liveforever) is a succulent perennial herb. It has a single basal rosette that can be up to 60 cm in diameter (Figure 7). Its flowers grow on a stalk, and are narrow and red, forming tubes of 1.5-2 cm in length. This type of flower is particularly attractive to hummingbirds, and it has been shown that chalk liveforever can be pollinated by hummingbirds (Aigner, 2004; Levin & Mulroy, 1985). The plant is covered in a white, chalky powder, providing its name. It often grows with its root in a rock crevice near wash channels and springs (Figure 7c). It is most often found growing colonially, in a patch containing multiple specimens of chalk liveforever.

Chalk liveforever is listed on the NNHP's Watch List, is Globally and State Ranked G4G5 S3 (Table 2) and is a Watch Species on the Clark County MSHCP species list. Chalk liveforever does not have status on any State Protected Species List.

Chalk liveforever grows in California, Nevada, Arizona, and northwest Mexico at elevations up to 1500 m (Baldwin, 2002). Within LMNRA, it occurs in the southern portion of the park in the Newberry Mountain Range and Hell's Kitchen area (Gold Butte). Elsewhere in southern Nevada, this species is located in the Spring Mountains and in the Gold Butte area (NNHP, 2001a).

A conceptual model was developed for this project which depicts the known and unknown environmental requirements and stressors of chalk liveforever (Figure 8).

SILVERLEAF SUNRAY

Enceliopsis argophylla (D.C. Eaton) A. Nelson (silverleaf sunray) is a perennial forb (Figure 9). It is one of four species in the *Enceliopsis* genus (Sanders & Clark, 1987). Silverleaf sunray is Globally and State Ranked G2G3, S1? (Table 2), and is listed as a Special Status Species with the BLM (Table 1), as a Watch Species for the MSHCP and as a Sensitive Species with the NNHP.

Silverleaf sunrays grow most abundantly the Colorado and Virgin River Valleys, in Nevada and Arizona. The majority of its range is in LMRNA. It has been recorded growing at up to 1250 m (Welsh, 1993), and as low 350 m in Nevada (NNHP, 2001b). It grows primarily on bare or crypto-biotic gypsum soils, in loose or crusted soils (Figure 9c).

Silverleaf sunrays are low growing perennial flowers. They have pale gray-green blade shaped leaves, up to 8 cm wide and 12 cm long, growing in basal clumps up above the older dead growth. The bright orange-yellow are three to six cm wide, growing on stalks. It looks very similar to *Enceliopsis nudicaulis* (A. Gray) A. Nelson (nakedstem sunray), but has wider, winged, shorter petioles, and is found in a different geographic range (Welsh, 1993).

There have been very few previous survey efforts. The last survey was in 1979 (NNHP, 2001b). It has since been mentioned as an associated species during surveys of *Arctomecon californica* Torr. & Frém. (Las Vegas bearpoppy) in and around LMNRA. This inventory will start with that information about where the plant occurs, and expand the knowledge to include more specific information about range and population size.

A conceptual model was developed for this project which depicts the known and unknown environmental requirements and stressors of silverleaf sunray (Figure 10).

LAS VEGAS BUCKWHEAT

Eriogonum corymbosum var. *nilesii* (Las Vegas buckwheat) was designated as a subspecies in 2004 (Reveal). It was previously assigned to *Eriogonum corymbosum* var. *glutinosum*, but was reassigned due to differences in its leaves and distribution. Additionally, genetic analysis supports the designation as a subspecies (Ellis *et al.*, 2009).

Las Vegas buckwheat is a Mojave Desert shrub found primarily in Clark County, Nevada, from the Las Vegas Valley east to Gold Butte, as well as in southern Lincoln County, and possibly in Utah and Arizona (Reveal, 2004). Since the species was designated in 2004, survey efforts to affirm the extent of the range have been ongoing. Las Vegas buckwheat is Globally and State Ranked G5T2 S1S2 (Table 2).

Las Vegas buckwheat is a long-lived shrub, growing up to about 1.2 m high and 2.3 m wide (Figure 11). Its leaves are covered in dense tufts of silvery, cobwebby hair (Figure 11d). It flowers from August to November, with yellow or occasionally white flowers, and with hairs similar to that on the leaves on the flowering branches. It has been found at elevations ranging from 579 m to 1170 m. (NNHP, 2004). It grows in and near gypsic soils (Figure 11c).

A conceptual model was developed for this project which depicts the known and unknown environmental requirements and stressors of Las Vegas buckwheat (Figure 12).

LECONTE'S BARREL CACTUS

Ferocactus cylindraceus (Engelm.) Orcutt var. *lecontei* (Leconte's barrel cactus) (Figure 13), is Salvage Restricted in Arizona and Protected as a Cactus in Nevada. Barrel cactus however, is not included as a Protected Species by the NNHP (accessed 5/18/2010). Leconte's barrel cactus is Globally and State Ranked G5T4?Q (Table 2). This indicates the current taxonomic status of the variety is still questionable. Additionally, rankings throughout the four states in which the barrel cacti ranges (California, Arizona, Nevada and Utah) indicate that the populations within the State of Nevada are the most secure (i.e. considered "Apparently Secure;" NatureServe, 2009). Leconte's barrel cactus also occurs in northern Mexico (Baldwin, 2002).

To date, there are two varieties of barrel cactus under question, var. *cylindraceus*, and var. *lecontei*, which are distinguished by the length of their central spines and seeds and occupy divergent elevation gradients (Baldwin, 2002). It has been stated that var. *lecontei* has 5-7 cm long central spines and 1-2 mm long seeds, whereas var. *cylindraceus* has both longer central spines (7.5-17 cm) and longer seeds (2-3 mm) and occurs at lower elevations (<600 m; Baldwin, 2002). Var. *lecontei* reportedly occurs at elevations greater than 700 m (Baldwin, 2002).

Studies of barrel cactus longevity and population dynamics using repeat photography have indicated population sizes are increasing (128% increase in numbers between 1890 and 1990) and the maximum life span is 55 years (Bowers *et al.*, 1995). Young cacti are frequently associated with nurseplants, most often *Pleuraphis rigida* Thurb. (big galleta grass); in fact, 70% of all found under nurseplants were under big galleta grass (Franco & Nobel, 1989). The benefits for cacti establishing under nurseplants are increased soil N, less extreme soil temperatures, and less available photosynthetically active radiation (Franco & Nobel, 1989). However, as barrel cacti age they must compete with their nurseplants for moisture (Franco & Nobel, 1989).

Barrel cacti germinants only emerge during the wet seasons (in the Mojave this is typically late summer/early fall) of non-drought years (Jordan & Nobel, 1981), with sufficient rains generally only occurring once or twice every 10 years (Arizona Fish and Game, 2005b). Barrel cacti generally flower twice a year, and produce on average 14,000 seeds/year (McIntosh, 2002a).

Increased moisture years result in greater magnitude of flowering (McIntosh, 2002a). Barrel cactus can self pollinate (McIntosh, 2002a).

Cactus height reflects available moisture more than plant age (Jordan & Nobel, 1982). Although cacti height continuously increases, cacti width is limited (McIntosh, 2002b).

Barrel cacti generally establish on igneous or limestone gravel, rock or sand substrates (Arizona Fish and Game, 2005b; Baldwin, 2002); and can grow on flats, hillsides, rocky cliffwalls (NatureServe, 2009) (Figure 13c).

LMNRA has a coarse-scale GIS map of known barrel cactus areas (NPS, *unpublished internal data*). Beyond internal records, Leconte's barrel cactus is documented in Washington County, Utah; Nye, Lincoln and Clark Counties, Nevada; all western and central Arizona counties; and San Bernardino and Riverside Counties in California (USDA, 2010). Thorough surveys of barrel cactus distributions and population sizes which had been generated externally could not be located. A conceptual model was developed for this project which depicts the known and unknown environmental requirements and stressors of Leconte's barrel cactus (Figure 14).

BEAVER DAM BREADROOT

Pediomelum castoreum (S. Watson) Rydb. (Beaver Dam breadroot) is a purple to pink flowered perennial legume with hairs that make its leaves appear silvery (Figure 15). It has the compound leaves common to legumes with 5-6 leaflets (Baldwin, 2002). Beaver Dam breadroots' stiff white hairs clearly distinguish it from the form of its closest counterpart, *Psoraleidium lanceolatum* (lance-leaf scurf pea), which is nearly glabrous and upright growing (Arizona Fish and Game, 2005c). Beaver Dam breadroot is Globally and State Ranked G3 S3 (Table 2) and has been classified as a Sensitive Species with the NNHP, as a Special Status Species with the BLM (Table 1) and as a Watch Species for the MSHCP. In the State of California it is considered "Vulnerable" and in Arizona "Critically Imperiled" (NatureServe, 2009).

Beaver Dam breadroot has been recorded in Nevada at elevations from 390 to 1524 meters (NNHP, 2001c). Beaver Dam breadroot is found in "sand or sandy gravel" (Arizona Game and Fish, 2005c) of open areas and along roadsides (Baldwin, 2002). It flowers between April and June (Arizona Game and Fish, 2005c).

A review of the NYBG's virtual herbarium indicated that most specimens of Beaver Dam breadroot had been collected in Clark County, Nevada, specifically at: Overton Airport Road (1970), 1-2 miles north of the Virgin River on Route 170 (1983), on Lovell Canyon Road in the Spring Mountains (1997), St. Thomas Gap area (1982 & 2005), seven miles west of Mesquite (1983), off Mormon Mesa Road (2004), the south end of the Virgin Mountains (1941) and the south end of Arrow Canyon Mountains (1983). Beaver Dam breadroot has also been collected in Lincoln County, Nevada (2 specimens, 1906; 1 specimen, 2005); Mohave County, Arizona (8 specimens); and San Bernardino County, California (3 specimens) (NYBG, 2010).

A conceptual model was developed for this project which depicts the known and unknown environmental requirements and stressors of Beaver Dam breadroot (Figure 16).

ROSY TWO-TONE BEARDTONGUE

Penstemon bicolor (Brandege) Clokey & D.D. Keck ssp. *roseus* Clokey & D.D. Keck (rosy two-tone beardtongue) is a perennial herb which flowers brilliantly pink between mid-March to mid-May (NNHP, 2001d) (Figure 17). Individuals can reach 15 dm tall (Baldwin, 2002). It is Globally and State Ranked G3?T3Q S3 (Table 2), is classified as a Nevada Special Status Species by the BLM (Table 1), and a Sensitive Species by the USFS (Table 4). The Conservation Status of rosy two-tone beardtongue in both California and Arizona is “Imperiled” (NatureServe, 2009); additionally, it is Salvage Restricted in Arizona (USDA, 2010).

Rosy two-tone beardtongue is not a recognized subspecies in the 2002 Jepson Desert Manual, however the Integrated Taxonomic Information System considers the subspecies “accepted” (accessed 5/19/2010).

Disturbed roadsides, along with washes, rock crevices and other areas that receive more runoff during rain events have been observed to support rosy two-tone beardtongue (NNHP, 2001d) (Figure 17d). The species establishes in “calcareous, carbonate, granitic or volcanic...” substrates and is not thought to depend on increased precipitation to germinate (Smith, 2005). Rosy two-tone beardtongue is associated with “creosote-bursage, blackbrush, and mixed-shrub zones” (NNHP, 2001d).

Rosy two-tone beardtongue can self-pollinate or outcross, which is thought to allow populations to cope with annual fluctuations in the availability of insect pollinators (Smith, 2005). It was first noted in 1916 that *Penstemon bicolor* and *Penstemon palmerii* species hybridize (Smith, 2005).

Natural Heritage records of rosy two-tone beardtongue exist for San Bernadino County, California; Mohave County, Arizona and 49 known occurrences of the species representing an estimated 6049+ individuals in Nye and Clark Counties of Nevada (NatureServe, 2009; NNHP, 2001d). It was reported that surveys had been “extensive and are ongoing” (NNHP, 2001d).

Searches of the NYBG’s virtual herbarium found Isotype specimens were collected in 1938 by I.W. Clokey at Nelson, Clark County, Nevada with “eroded slopes” noted as the species habitat (NY Specimen ID: 91015). In addition, twelve samples of rosy two-tone beardtongue were available, all of which were collected in Clark County (NYBG, 2010).

A conceptual model was developed for this project which depicts the known and unknown environmental requirements and stressors of two-toned rosy beardtongue (Figure 18).

METHODS AND MATERIALS:

For each of the ten watch species, historically reported sites along with 20% additional suitable habitat was surveyed. When a population was located, the area was searched until no more plants were found. Geographical positioning system (GPS) points were taken periodically using a Garmin (model GPS76) and a polygon was created in ArcMap 9.2 to depict the population. If no plants were found, a GPS point was recorded and a polygon created to record absence of the species. Areas outside of known habitat were also searched. Specific data gathered included

assessing the populations for number of individuals, associated plant species, and potential threats to the populations.

MOKIAK MILKVETCH

Location information for Mokiak milkvetch was obtained from Alexander (2001), including the herbariums of Brigham Young University and the University of Nevada Las Vegas (UNLV). Surveys were conducted in March 2008 and May 2009. Historically reported populations were resurveyed at Gold Butte, Devils Cove Road, Fortification Hill, and Black Mountains. An exploratory survey was conducted in the foothills of Indian Hills (Figure 19).

VIRGIN RIVER THISTLE

Virgin River thistle location information was obtained from various herbariums including the UNLV Herbarium, LMNRA Herbarium study collection, and U.S. National Herbarium in New York (USNH). Based on this information, populations were re-located at existing sites and assessed. Surveys were conducted in May 2010. Populations examined in this study were located along Northshore Road at LMNRA and on adjacent BLM lands; specifically at springs/seeps at Rogers Spring, downstream of Rogers Spring, south of Rogers Spring, at Blue Point Spring and on Gold Butte. These were areas where the species had been previously recorded. New areas were surveyed in the same vicinity as the known records, in areas meeting the substrate requirements. (Figures 20 & 21).

HOFFMAN'S CRYPTANTHA

Only unknown habitat was surveyed, since there are no known Hoffman's cryptantha populations existing. Exploratory surveys were conducted at Spirit Mountain, Hamblin Mountain and the Black Mountains. (Figures 22 & 23).

UNUSUAL CAT'S-EYE

There are no known existing populations of unusual cat's-eye. Surveys of unknown habitat were conducted in Sandstone, south of Rogers Spring, Rogers Spring, Fire Wash, Getchal, Red Bluff and Blue Point Spring. (Figure 24).

CHALK LIVEFOREVER

Chalk liveforever location information was obtained from various herbaria including the UNLV Herbarium, LMNRA Herbarium study collection, and USNH. In addition, previous surveys had been conducted in 2001. For this project, surveys for chalk liveforever in historically documented locations were conducted in January 2008 and May 2009 at Gold Butte; January & May 2008, and May & June 2009 in the Newberry Mountains. Exploratory surveys for the species were conducted in June 2009 in Grapevine Canyon, Sacatone Wash, Spirit Mountain and at Pipe Spring. (Figures 25 – 27).

SILVERLEAF SUNRAY

From January to November of 2009, 212 sites were surveyed for silverleaf sunray. Surveys focused on LMNRA and the immediate vicinity, and included extensive surveys along Northshore and Lakeshore Roads in LMNRA along with surveys of BLM's Sunrise Hills, Rainbow Gardens and Lava Butte. Prior records which mentioned silverleaf sunray as an associated species, primarily from past surveys for *Arctomecon californica* and other gypsophyllic species in LMNRA, were used to identify known locations. Unrecorded groups of individuals were located when they were found during surveys of known locations, and incidentally during other activities in suitable habitat. (Figures 28 – 30).

LAS VEGAS BUCKWHEAT

In spring 2010, we surveyed populations of Las Vegas buckwheat that had been detected during 2007 helicopter surveys (conducted jointly by BLM & NPS), as well as new survey areas in the same vicinity. (Figure 31 – 32). The areas delineated during our surveys are as accurate as possible, however, due to time constraints the number of individuals within each population was likely underestimated.

LECONTE'S BARREL CACTUS

Extensive surveys for barrel cactus have not been conducted and fall outside the scope of this project. We did, however, collect data points for barrel cacti in 2009 as they were encountered in the field. (Figures 33 & 34). These barrel cactus populations were located at both lower (<700m) and higher (>700m) elevations. Estimates were not consistently made on how big the populations were due to the vast amount of landscape that would need to be covered to accomplish such a goal.

In addition to collecting data points we utilized plant community data, from a study arranged to span the elevational gradient (230 – 1500 m elevation) of the Newberry Mountains at LMNRA, to describe factors that affect barrel cacti density (NPS, *in-house unpublished data*, 2008). We performed multiple and linear regression analysis on the data.

Morphological analysis was conducted to detect two varieties of barrel cactus which were suspected to occur within LMNRA. Data were gathered for barrel cacti as they were encountered in the field. Ripe fruits, as determined by mature, black-colored seeds, were collected in September 2008 and at the end of July 2009. In 2009, collection was done early in the season, when there were relatively few ripe fruits.

The locations and elevations of cacti included in the morphological study were recorded. Barrel cacti have spines coming from a central point. Each group of spines has a central spine clearly in the middle, coming more directly outward from the plant, while the other spines are spreading along the plant's body. Four center spines were chosen from each cactus, measured, and described by whether they were straight, bent, curved, hooked, or twisted. Measured cactus spines were chosen with some attempt at randomness, but that was impeded because of difficulty reaching the center spine with a measuring device. Spines were measured in place on the cactus, putting a thin ruler at the spine's base (Figure 35).

One fruit was collected from each cactus that had at least one ripe fruit. Fruits were selected based on appearance of ripeness- a larger redder fruit would be selected before a small, green fruit. Fruits were collected using needle nose pliers, dried, and then the length and width were measured and recorded on datasheets. Seeds were measured along the longest dimension available under a stereoscope to the nearest 0.1 mm. Barrel cacti data were separated into “high” and “low” groups at 700 m elevation. All but three cacti were collected from the low end of the range of var. *lecontii*, or the high end of the range of var. *cylindraceus*, about 500-850 m. Unless the elevation was an exceptionally strong feature dividing the two species, one would expect some overlap in the ranges.

A Student’s t-test for parametric data was applied.

BEAVER DAM BREADROOT

Beaver Dam breadroot location information was obtained from various herbaria including the UNLV Herbarium, LMNRA Herbarium study collection, and USNH. The two sites where it was found in this study are the Virgin River dunes by the Virgin River, and Sandy Point in Arizona.

Exploratory surveys were conducted at Delmar Butte, Temple Mesa, Jawbone, Middle Point, Sandy Cove, Devils Cove, Lime Cove, Valley of Fire and St. Thomas Road. Historically reported areas that were surveyed were Sandy Point (April 2010), Glory Hole and Lime Cove (April 2009), Ebony Cove and Sandy Cove (March 2009). (Figure 36).

ROSY TWO-TONE BEARDTONGUE

Location information was obtained from various herbaria including the UNLV Herbarium, LMNRA Herbarium study collection, and USNH. Surveys were conducted in known and potential habitat in and around Henderson, Bootleg Canyon, Boulder City, and Nelson. (Figures 37 & 38).

RESULTS:

MOKIAK MILKVETCH

Thirty-two populations of Mokiak milkvetch were recorded during surveys. Population sizes ranged from one to hundreds of individuals. Of the 29 populations with exact numbers recorded, the average population size of Mokiak milkvetch was ~15 individuals.

The Gold Butte populations generally grew in granite rock and gravel areas, usually in the gravel rather than out of the rock. Some of the soil associations that Mokiak milkvetch occurred on were: Guardian-Sunrock-Badland, Valatier-Goldbutte, Goldbutte-Nolena and Nolena-Nipton (NRCS, 2010).

Soil association	Estimated number of individuals
Guardian-Sunrock-Badland	1
Valatier-Goldbutte	Many
Goldbutte-Nolena	Many
Nolena-Nipton	Many

Some of the potential Mokiak milkvetch habitat was burned in recent years. Of the populations found in burned areas, greater numbers grew in less severely burned areas where some shrubbery had survived than in the more severely burned parts where no shrubs or trees survived (K. Maloof, *pers. obs.*). There were, however, a few plants found in the severely burned habitat. No new populations were detected during our survey efforts.

Perennial species we found in association with Mokiak milkvetch populations included:

Scientific name	Common name
<i>Acacia greggii</i> A. Gray	catclaw acacia
<i>Ambrosia eriocentra</i> (A. Gray) Payne	woolly fruit bur ragweed
<i>Baileya multiradiata</i> Harv. & A. Gray ex A. Gray	desert marigold
<i>Bebbia juncea</i> (Benth.) Greene	sweetbush
<i>Chrysothamnus pulchellus</i> (A. Gray) Greene	southwestern rabbitbrush
<i>Coleogyne ramosissima</i> Torr.	blackbrush
<i>Cylindropuntia echinocarpa</i> (Engelm. & Bigelow) F.M. Knuth	Wiggins' cholla
<i>Encelia virginensis</i> A. Nelson	Virgin River brittlebush
<i>Ericameria laricifolia</i> (A. Gray) Shinnars	turpentine bush
<i>Eriogonum fasciculatum</i> Benth.	Eastern Mojave buckwheat
<i>Hymenolcea salsola</i> Torr. & A. Gray	burrobush
<i>Larrea tridentata</i> (DC.) Coville	creosote bush
<i>Lotus rigidus</i> (Benth.) Greene	shrubby deervetch
<i>Mirabilis multiflora</i> (Torr.) A. Gray	Colorado four o'clock
<i>Prunus fasciculata</i> (Torr.) A. Gray	desert almond
<i>Psoralea arborescens</i> (Torr. ex A. Gray) Barneby	Mojave indigobush
<i>Salazaria mexicana</i> Torr.	Mexican bladdersage
<i>Sphaeralcea ambigua</i> A. Gray	desert globemallow
<i>Stephanomeria pauciflora</i> (Torr.) A. Nelson	brownplume wirelettuce
<i>Thamnosma montana</i> Torr. & Frém.	turpentinebroom
<i>Viguiera parishii</i> Greene	Parish's goldeneye
<i>Yucca baccata</i> Torr.	banana yucca
<i>Yucca schidigera</i> Roez. ex Ortgies	Mojave yucca

Figure 19 shows known locations plus additional areas outside of known habitat that were surveyed.

VIRGIN RIVER THISTLE

Two new populations of Virgin River thistle were identified during surveys. One was downstream from Rogers Spring on the north bank with an estimated 250 individuals; the other was on the south bank and was estimated to be composed of ~550 individuals. Six additional populations that had been historically reported were resurveyed, population sizes ranged from 29 to an estimated 1550 individuals (Figures 20 & 21).

Virgin River thistle grows mainly at a level just beyond the water line, where roots are within or adjacent to very wet soil, and would flood with very little rise in the water level (K. Maloof, *pers. obs.*). No plants were observed growing with rosettes or stems under water.

Most sites where Virgin River thistle was found had open water near the plants. Gold Butte had relatively little open water, but the soil was very damp.

Perennial species we found in association with Virgin River thistle included:

Scientific name	Common name
<i>Anemopsis californica</i> (Nutt.) Hook. & Arn.	yerba mansa
<i>Cladium californicum</i> (S. Watson) O'Neill	sawgrass
<i>Distichlis spicata</i> (L.) Greene	saltgrass
<i>Isocoma acradenia</i> (Greene) Greene	alkali goldenbush
<i>Pluchea sericea</i> (Nutt.) Coville	arrowweed
<i>Typha domingensis</i> Pers.	southern cattail

The invasive, *Tamarix ramosissima* Ledeb. (saltcedar) was also observed in habitat supporting Virgin River thistle.

Figures 20 & 21 show all existing locations for this species plus additional survey locations where no plants were found.

HOFFMAN’S CRYPTANTHA

No populations of Hoffman’s cryptantha were found during the current survey effort. (Figures 22 & 23).

UNUSUAL CAT’S-EYE

No new populations of unusual cat’s-eye were found during the current inventory effort. Development may have already extirpated the species. (Figure 24).

CHALK LIVEFOREVER

Several new populations of chalk liveforever were recorded during our inventory effort. A total of 167 individuals were recorded during surveys in the Newberry Mountains.

Populations of chalk liveforever occur colonially in crevices of exposed granite bedrock throughout higher elevations of the Newberry Mountains, NPS and BLM (C. Roberts, *pers. obs.*). Chalk liveforever was frequently recorded as occurring in granite outcroppings along drainages/or crevices in rocks and on north facing slopes. While five of our records reported chalk liveforever occurring on northfacing slopes, one record reported it growing on a south-facing slope. Sites chalk liveforever occurred on were composed of Boxspring-Zeheme-Rockoutcrop, Goldbutte-Nolena, Cetrepas-Nolena-Rockoutcrop, Seanna-Goldroad-Rockoutcrop, Fillaree-Seanna and Nolena-Rockoutcrop soil associations (NRCS, 2010).

Soil association	Estimated number of individuals
Boxspring-Zeheme-Rockoutcrop	4
Goldbutte-Nolena	Many
Cetrepas-Nolena-Rockoutcrop	Many
Seanna-Goldroad-Rockoutcrop	Many
Fillaree-Seanna	Many
Nolena-Rockoutcrop	Many

We documented chalk liveforever populations on the base of the north side of Spirit Mountain, along Christmas Tree Pass Road, off of Bridge Canyon Road, and in Upper Bridge Canyon.

Perennial plant species we found in association with chalk liveforever were:

Scientific name	Common name
<i>Achnatherum speciosum</i> (Trin. & Rupr.) Barkworth	desert needlegrass
<i>Brickellia arguta</i> B.L. Rob.	pungent brickellbush
<i>Cirsium neomexicanum</i> A. Gray	New Mexico thistle
<i>Coleogyne ramosissima</i> Torr.	blackbrush
<i>Ericameria linearifolia</i> (DC.) Urbatsch & Wussow	narrowleaf goldenbush
<i>Eriogonum fasciculatum</i> Benth.	Eastern Mojave buckwheat
<i>Eriogonum wrightii</i> Torr. ex Benth.	bastardsage
<i>Juniperus californica</i> Carrière	California juniper
<i>Keckiella antirrhinoides</i> (Benth.) Straw	snapdragon penstemon
<i>Lotus rigidus</i> (Benth.) Greene	shrubby deervetch
<i>Nolina bigelovii</i> (Torr.) S. Watson	Bigelow's nolina
<i>Pinus monophylla</i> Torr. & Frém.	singleleaf pinyon
<i>Rhamnus ilicifolia</i> Kellogg	hollyleaf redberry
<i>Thamnosma montana</i> Torr. & Frém.	turpentine-broom
<i>Viguiera parishii</i> Greene	Parish's goldeneye

Figures 25 - 27 show locations where chalk liveforever occurred plus additional areas we surveyed.

SILVERLEAF SUNRAY

Silverleaf sunrays were common along disturbed roadsides in areas near to established populations, especially along Northshore Road where the road had been repaved in the last few years (Figure 9c). In fact, between 20,000 and 30,000 silverleaf sunrays were newly documented in over 200 sites along Northshore Road and Lakeshore Drive in LMNRA. The plant was nearly ubiquitous along Northshore Road, with populations observed at least every few miles from a mile south of the Valley of Fire turnoff stretching to the northernmost mile of Lakeshore Road. The largest group of silverleaf sunray sites was in the Echo Wash and Bitter Springs area of LMNRA. Smaller populations of silverleaf sunray were documented on Gold Butte (BLM), Kingman Wash and in the Bonelli Bay and Temple Bar area.

The largest populations were growing on gypsum soils with thick biotic crusts, often in the same areas as Las Vegas bearpoppy, however silverleaf sunray was also common in gypsic areas with

thin or no biotic crusts (K. Maloof, *pers. obs.*). Silverleaf sunray was never encountered on rocky areas.

Perennial plant species we found in association with silverleaf sunray were:

Scientific name	Common name
<i>Acacia greggii</i> A. Gray	catclaw acacia
<i>Allenrolfea occidentalis</i> (S. Watson) Kuntze	iodinebush
<i>Ambrosia dumosa</i> (A. Gray) Payne	burrobush
<i>Amphipappus fremontii</i> Torr. & A. Gray ex A. Gray	Fremont's chaffbush
<i>Anulocaulis leiosolenus</i> (Torr.) Standl.	ringstem
<i>Arctomecon californica</i> Torr. & Frém.	Las Vegas bearpoppy
<i>Argemone munita</i> Durand & Hilg.	flatbud pricklypoppy
<i>Asclepias subulata</i> Decne.	rush milkweed
<i>Astragalus preussii</i> A. Gray	Preuss' milkvetch
<i>Atriplex canescens</i> (Pursh) Nutt.	fourwing saltbush
<i>Atriplex confertifolia</i> (Torr. & Frém.) S. Watson	shadscale saltbush
<i>Atriplex hymenelytra</i> (Torr.) S. Watson	desert holly
<i>Bebbia juncea</i> (Benth.) Greene	sweetbush
<i>Cylindropuntia echinocarpa</i> (Engelm. & Bigelow) F.M. Knuth	Wiggins' cholla
<i>Distichlis spicata</i> (L.) Greene	saltgrass
<i>Encelia farinosa</i> A. Gray ex Torr.	brittlebush
<i>Ephedra torreyana</i> S. Watson	Torrey's jointfir
<i>Eriogonum inflatum</i> Torr. & Frém.	desert trumpet
<i>Eucnide urens</i> (Parry ex A. Gray) Parry	desert stingbush
<i>Ferocactus cylindraceus</i> (Engelm.) Orcutt	barrel cactus
<i>Hymenolcea salsola</i> Torr. & A. Gray	burrobush
<i>Isocoma acradenia</i> (Greene) Greene	alkali goldenbush
<i>Krameria erecta</i> Willd. Ex Schult.	littleleaf ratany
<i>Larrea tridentata</i> (DC.) Coville	creosote bush
<i>Lepidium fremontii</i> S. Watson	desert pepperweed
<i>Lycium andersonii</i> A. Gray	water jacket
<i>Lycium pallidum</i> Miers	pale desert-thorn
<i>Opuntia basilaris</i> Engelm. & Bigelow	beavertail pricklypear
<i>Petalonyx parryi</i> A. Gray	Parry's sandpaper plant
<i>Peucephyllum schottii</i> A. Gray	Schott's pygmycedar
<i>Physalis crassifolia</i> Benth.	yellow nightshade groundcherry
<i>Pleuraphis rigida</i> Thurb.	big galleta
<i>Prosopis glandulosa</i> Torr.	honey mesquite
<i>Psoralea fremontii</i> (Torr. ex A. Gray) Barneby	Fremont's dalea
<i>Salazaria mexicana</i> Torr.	Mexican bladdersage
<i>Sphaeralcea ambigua</i> A. Gray	desert globemallow
<i>Sporobolus airoides</i> (Torr.) Torr.	alkali sacaton
<i>Stephanomeria pauciflora</i> (Torr.) A. Nelson	brownplume wirelettuce

<i>Tidestromia oblongifolia</i> (S. Watson) Standl.	Arizona honeysweet
<i>Tiquilia latior</i> (I.M. Johnst.) A.T. Richardson	matted crinklemat
<i>Xylorhiza tortifolia</i> (Torr. & A. Gray) Greene	Mojave woodyaster
<i>Yucca elata</i> (Engelm.) Engelm.	soaptree yucca

Figures 28 – 30 indicate previously known and additional areas we surveyed for silverleaf sunray.

LAS VEGAS BUCKWHEAT

Populations of Las Vegas buckwheat were noted to occur within distinctive narrow bands of exposed soils (Figure 39). Although Las Vegas buckwheat was only observed growing in gypsic soils, it did not grow in gypsic areas with thick biotic crust, even when individuals grew in the immediate vicinity of that soil type. Gold Butte populations occurred at high elevations associated with blackbrush communities. At Bill’s Spring on Gold Butte, Las Vegas buckwheat grew in a patch of gypsic soil surrounded by granite soils. The boundary could be seen by a change in soil color (K. Maloof, *pers. obs.*).

The largest population of Las Vegas buckwheat we observed occurred on a Upperline-Weiser-Whitebasin soil association, other soil associations the species established on were: Boxspring-Zeheme-Rockoutcrop, Zeheme-Rockoutcrop and Valatier-Goldbutte (NRCS, 2010).

Soil association	Estimated number of individuals
Boxspring-Zeheme-Rockoutcrop	420
Zeheme-Rockoutcrop	450, 370
Valatier-Goldbutte	221
Upperline-Weiser-Whitebasin	2,350

Perennial plant species found in association with Las Vegas buckwheat were:

Scientific name	Common name
<i>Ambrosia dumosa</i> (A. Gray) Payne	burrobush
<i>Atriplex confertifolia</i> (Torr. & Frém.) S. Watson	shadscale saltbush
<i>Bebbia juncea</i> (Benth.) Greene	sweetbush
<i>Coleogyne ramosissima</i> Torr.	blackbrush
<i>Enceliopsis argophylla</i> (D.C. Eaton) A. Nelson	silverleaf sunray
<i>Ephedra torreyana</i> S. Watson	Torrey’s jointfir
<i>Eriogonum inflatum</i> Torr. & Frém.	desert trumpet
<i>Gutierrezia sarothrae</i> (Pursh) Britton & Rusby	broom snakeweed
<i>Parthenium incanum</i> Kunth	mariola
<i>Penstemon palmeri</i> A. Gray	Palmer's penstemon
<i>Penstemon utahensis</i> Eastw.	Utah penstemon
<i>Pleuraphis rigida</i> Thurb.	big galleta
<i>Prunus fasciculata</i> (Torr.) A. Gray	desert almond
<i>Psorothamnus arborescens</i> (Torr. ex A. Gray) Barneby	Mojave indigobush
<i>Psorothamnus fremontii</i> (Torr. ex A. Gray) Barneby	Fremont’s dalea
<i>Salix gooddingii</i> C.R. Ball	Goodding's willow

<i>Sphaeralcea ambigua</i> A. Gray	desert globemallow
<i>Tiquilia latior</i> (I.M. Johnst.) A.T. Richardson	matted crinklemat
<i>Xylorhiza tortifolia</i> (Torr. & A. Gray) Greene	Mojave woodyaster
<i>Yucca baccata</i> Torr.	banana yucca
<i>Yucca brevifolia</i> Engelm.	Joshua tree

One new population of Las Vegas buckwheat was detected during surveys. In addition, while revisiting previously documented sites, the area occupied by a population at Gold Butte was expanded. Figures 31 & 32 show previously known locations of Las Vegas buckwheat in addition to areas we surveyed from the ground.

LECONTE'S BARREL CACTUS

Barrel cactus populations have been documented in a wide range of life-zones including: higher elevation pinyon-juniper woodlands, mid-elevation mixed shrub, and low elevation creosote-burrobush communities. We recorded populations of barrel cactus at: Blue Point, Gale Hills, Gold Butte, in the Meadview area, Bitter Springs, in the River Mountains, Sunrise Hills and Valley of Fire. These populations occurred on cliffs, on flats, and on limestone outcrops (D. Bangle, *pers. obs.*).

Figures 33 & 34 show previously documented locations of barrel cactus in addition to exploratory surveys we conducted from the ground.

In the study conducted in the Newberry Mountains at LMNRA, we observed that half of the 116 sites sampled supported populations of barrel cactus (NPS, *in-house unpublished data*, 2008). Additionally, our multiple and linear regression analysis indicated that of the ten environmental variables used, elevation was the only significant predictor for barrel cacti density. Barrel cacti density increases with elevation ($p=0.0026$).

Our barrel cacti morphology study found that individuals at both high and lower elevations tended to have a large variety in the spine shapes, with curved, hooked, bent, and straight spines all occurring on most specimens. Most or all of the cacti were in large groups of individuals, sometimes stretching both for miles along the roadside and long distances away from the road.

There was no significant difference observed between mean sizes of seeds, fruit or spines (Table 5). Furthermore, linear regression analysis was performed with seed, fruit and spine measurements and elevation. None of these measurements were significantly correlated with elevation. Based on the data collected we determined that the morphological distinction between variations of barrel cacti does not exist within LMNRA.

BEAVER DAM BREADROOT

During surveys in early 2009, it was estimated that 150 individuals occurred at the historically recorded population at Sandy Point and 200 at the Virgin River Dunes. Fourteen individuals were documented at Sandy Point in April 2010, however these were incidental records and should not be considered evidence of an overall population decline at Sandy Point.

Beaver Dam breadroot was found growing on active sand dunes. It was mostly found on dunes where the sand was moderate to very loose, although it did not appear on the dunes that shift so much that they were almost bare. No new populations were located during exploratory survey efforts.

Perennial plant species found in association with Beaver Dam breadroot were:

Scientific name	Common name
<i>Achnatherum hymenoides</i> (Roem. & Schult.) Barkworth	Indian ricegrass
<i>Ambrosia dumosa</i> (A. Gray) Payne	burrobush
<i>Larrea tridentata</i> (DC.) Coville	creosote
<i>Pleuraphis rigida</i> Thurb.	big galleta
<i>Sphaeralcea ambigua</i> A. Gray	desert globemallow

Figure 36 shows known locations plus additional areas outside of known habitat that were surveyed.

ROSY TWO-TONE BEARDTONGUE

In May 2009, populations of rosy two-tone beardtongue were surveyed in the Nelson area and Dutchman Pass. It was estimated that 190 individuals composed the population surveyed in Nelson.

In addition, populations were noted in the Devils Cove area of Gold Butte (March 2008), in the River Mountains (August 2008), Callville Wash North (June 2008), Hidden Valley (February 2008), Bootleg Canyon (April 2009) and in Henderson (May 2009).

Rosy two-tone beardtongue grew mostly in granite soils, especially gravelly roadsides and washes. The sites surveyed were in and near Henderson, Boulder City, and Nelson. All the individuals in the Nelson area and in Henderson were in washes or on gravel roadsides, while the Boulder City population was almost extinct, and grew by a dirt road. While most individuals were growing in gravel, a few along the road to Nelson were growing out of granite rock faces. Soil associations rosy two-tone beardtongue occurred on included: Nipton-Haleburu-Rockoutcrop, Sunrock-Haleburu-Rockoutcrop, Arizo, Tonopah-Arizo and Seanna-Goldroad-Rockoutcrop (NRCS, 2010).

Soil association	Estimated number of individuals
Nipton-Haleburu-Rockoutcrop	<10
Sunrock-Haleburu-Rockoutcrop	<10
Arizo	<10
Tonopah-Arizo	<10
Seanna-Goldroad-Rockoutcrop	<10

Perennial plant species found in association with rosy two-tone beardtongue were:

<i>Scientific name</i>	<i>Common name</i>
<i>Acacia greggii</i> A. Gray	catclaw acacia
<i>Ambrosia dumosa</i> (A. Gray) Payne	burrobush
<i>Bebbia juncea</i> (Benth.) Greene	sweetbush
<i>Chilopsis linearis</i> (Cav.) Sweet	desert willow
<i>Eriogonum inflatum</i> Torr. & Frém.	desert trumpet
<i>Eriogonum fasciculatum</i> Benth.	Eastern Mojave buckwheat
<i>Krameria erecta</i> Willd. Ex Schult.	littleleaf ratany
<i>Larrea tridentata</i> (DC.) Coville	creosote bush
<i>Nicotiana obtusifolia</i> M. Martens & Galeotti	desert tobacco
<i>Stephanomeria pauciflora</i> (Torr.) A. Nelson	brownplume wirelettuce

No new populations were located from the current inventory effort. Figure 37 and 38 show known locations plus additional areas outside of known habitat that were surveyed.

DISCUSSION:

The index for success for “Inventory, Research and Monitoring of Evaluation and Watch List Plants” was increased knowledge of locations, numbers and threats to ten plant species within LMNRA. Assessments, along with survey outcomes, would help inform management actions for these species. The survey efforts were successful in documenting several new locations and determining the present status of known rare plant populations in LMNRA and surrounding BLM lands. Project products included: detailed maps of distributions and a GIS database of population characteristics including: number of individuals, associated species and habitat conditions.

MOKIAK MILKVETCH

POPULATION STATUS

Mokiak milkvetch was found in areas outside of the area previously surveyed, as well as in the known habitat. Although the range was expanded, relatively few individuals were found. Much of the known habitat and survey areas had been burned in the 2005 Fork and Tramp fires on Gold Butte. While the plant was found in the burned areas, the population may have been damaged by the fire. However, the expanded range shows that either the plant’s range had been underestimated before, or that it has dispersed into new areas. A new, more intensive survey for this species might expand the range further, and give a clearer estimate of how many individuals occupy that range.

THREATS

The main threat to Mokiak milkvetch is exotic annual grasses and the impacts of exotic grasses on system ecology. Clark County, Nevada’s previously documented populations of Mokiak milkvetch predominately occur in the Gold Butte area (BLM) which has experienced increased wildfire in recent decades. These wildfires are a result of high densities of exotic annual grasses

such as *Bromus* L. (brome grasses), which after senescence create stands of fire fuel. Some of the Mokiak milkvetch observed occurred on previously burned areas, where non-native and invasive grasses and weeds predominate vegetation, increasing the likelihood of successive fires. In areas with heavy burn scars, and few remaining woody plants, single Mokiak milkvetch individuals were observed. On the other hand, in areas that still had standing charred Joshua trees and other standing woody vegetation (and presumably less intense fires), populations of multiple Mokiak milkvetch were observed. It is unknown exactly what the effects of fire are on Mokiak milkvetch. Along with higher frequencies of fire, it is possible that exotic grasses may compete with Mokiak milkvetch for resources.

We hypothesize that disturbance by recreational OHV use may also pose a threat to Mokiak milkvetch populations. Many Mokiak milkvetch individuals we observed were fairly near roads, (K. Maloof, *pers. obs.*), and OHV use is likely to increase in the Gold Butte area (Alexander, 2001).

VIRGIN RIVER THISTLE

POPULATION STATUS

Virgin River thistle was fairly common at springs examined within its range. At all springs visited, there were numerous rosettes as well as growing stalks, implying good recruitment. Because Virgin River thistle tends to grow in less densely vegetated areas, disturbances which clear vegetation may benefit this species. Numerous stalks were seen growing in an area cleared by a recent fire at Rogers Spring, and one of the largest populations observed was at Blue Point Spring in an area that had been recently cleared for a separate study (Newton *et al.*, 2010).

THREATS

Possible threats to Virgin River thistle populations are from non-native ungulates, encroachment by saltcedar, alteration of hydrology, and disturbance by recreationalists. Trespass cattle and evidence of cattle damage are frequently observed in the northern portion of LMNRA (A. Newton, *pers. comm.*). Cattle and burros can pose threats to Virgin River thistle from possible herbivory, alteration of hydrology and trampling. Virgin River thistle populations may be impacted if burros and cattle remain free to roam the northern portions of LMNRA.

Saltcedar was present at several springs that support Virgin River thistle. It is unknown how saltcedar populations affect recruitment and establishment of Virgin River thistle.

Alteration of hydrology is a serious threat to populations of Virgin River thistle, even in otherwise protected habitats. Saltcedar and other non-native vegetation can alter the hydrology of a spring, decreasing the amount of water available for other plants. Additionally, as most areas surveyed are perennial spring and seep habitats, it is unclear if future groundwater development in the state of Nevada has potential to alter Virgin River thistle habitat.

Rogers and Blue Point Springs are relatively high use areas within LMNRA, with picnic tables and parking areas. The Virgin River thistle may be trampled by visitors or misidentified as a nonnative thistle and pulled (K. Maloof, *pers. comm.*). Additionally, there were signs of OHV use observed near the Gold Butte population. The spring was fenced off, and OHV tracks were

on the far side of the fence, however, cattle prints could be found on both sides of the fence (K. Maloof, *pers. obs.*).

HOFFMAN'S CRYPTANTHA

POPULATION STATUS

Hoffman's cryptantha was not found and may not be present in Clark County.

THREATS

There are currently no existing populations of Hoffman's cryptantha documented in Clark County. Since the species occurs in upper elevation pinyon-juniper habitats, threats may be fire or recreational use. However, without observing existing populations of Hoffman's cryptantha threats to the species cannot be confidently identified.

UNUSUAL CAT'S-EYE

POPULATION STATUS

Unusual cat's-eye may already be extirpated due to development in the Las Vegas Valley.

THREATS

There are currently no existing populations documented of unusual cat's-eye. If the species has not already been extirpated, urban development of areas containing undiscovered populations is the main threat to the species.

CHALK LIVEFOREVER

POPULATION STATUS

Populations of chalk liveforever occur colonially in crevices of exposed granite bedrock throughout higher elevations of the Newberry Mountains and on Gold Butte on NPS and BLM land. While areas where the species is found are limited to Sonoran vegetation incursions, the plant is doing well within its range. Pockets appear healthy, with individuals flowering and seeding over the last couple of years. (C. Roberts, *pers. obs.*). The rocky nature of this species' habitat makes extensive surveying difficult because access can involve extensive hiking and scrambling over difficult mountainous terrain.

THREATS

The range of chalk liveforever is very limited within Clark County and restricted to regions containing Sonoran desert associated plant community incursions along the Colorado River.

Populations are at risk of hobbyist collections, fire and, depending upon BLM decisions, development (roads and mines on the BLM portion of the Newberry Mountains). The populations occurring in the Newberry Mountains are protected by nature of being in LMNRA, as is a large part of the Gold Butte population.

As evidenced by their name, liveforevers are considered easy to establish and low-maintenance plants, making them a popular ornamental to include in xeriscaped landscapes. Liveforevers may be purchased by homeowners throughout the U.S., and are reportedly easy to transplant because of their simple caudex stem.

Populations of chalk liveforever which occur in the Bridge Canyon area may be susceptible to fire. Invasive annual grasses and saltcedar grow densely in portions of Bridge Canyon and provide fuels for fire. It is unknown how chalk liveforever populations would respond to fire.

SILVERLEAF SUNRAY

POPULATION STATUS

Silverleaf sunray is doing very well within LMNRA in the vicinity of Northshore Road. A number of the plants observed were seedlings or juveniles, and the range expansion to below the high water mark at Government Wash and Stewart's Point and along the newly reconstructed portions of Northshore Road imply a healthy population. Silverleaf sunray populations in Arizona also appear to be prospering. Although no seedlings were observed, expansions of the Kingman Wash population to below the high water line confirm that recruitment is occurring.

The Gold Butte population of silverleaf sunray was the smallest. All but one of the groups of individuals observed at Gold Butte were very restricted. In some cases, a known occurrence was no longer present, but unrecorded occurrences were observed nearby. The smaller populations with few flowers may simply be recruited from the seed dispersal of larger populations, rather than being self-sustaining.

Many of the sites where few or no silverleaf sunrays were found were areas with relatively little gypsic soil or crust. It is possible that although silverleaf sunrays can grow in such areas, in these areas with minimal gypsic soil it is less likely for viable, long-term populations to form.

THREATS

Threats to silverleaf sunray are non-native ungulates and human recreational uses (such as OHV and hiking). Some herbivory of flower heads and trampling has been observed, however, as long as cattle and burro populations are maintained at current levels, or populations are reduced, non-native ungulates are not considered a significant threat to silverleaf sunray populations.

Many silverleaf sunray populations are near established roads, and OHV tracks can be seen running through habitats in some places. In addition, the large, attractive flowers may be picked from plants growing near common gathering places.

LAS VEGAS BUCKWHEAT

POPULATION STATUS

All populations of Las Vegas buckwheat that were observed included individuals of a variety of sizes, although the range of sizes varied between sites. The NNHP Rare Plant Fact Sheet for Las Vegas buckwheat specifies the habitat as "in washes and drainages, or in areas of generally low

relief” (2004). However, we found plants growing on steep slopes on Gold Butte. The individuals at a flat area near Bill’s Spring on Gold Butte tended to be remarkably larger than the individuals we observed growing on the steep, bare slopes within a few miles. The population near Bill’s Spring may have access to underground water, enabling exceptional growth. Populations of Las Vegas buckwheat on Gold Butte occurred within limited patches of exposed soils or on gypsic soils. Additional populations of Las Vegas buckwheat probably exist on Gold Butte within the same soil types. It is likely that the size of sub-populations will not change rapidly from year to year, because Las Vegas buckwheat is a long-lived shrub with low recruitment.

The Gold Butte Las Vegas buckwheat population is at the uppermost known elevation limit and the westernmost known geographical limit. Genetic analysis suggests that Las Vegas buckwheat populations become less distinct from the species’ closest relative, *Eriogonum corymbosum* Benth. var. *aureum* (M.E. Jones) Reveal (crispleaf buckwheat), as one moves further west from the Las Vegas Valley (Ellis & Wolf, 2009).

The largest population of Las Vegas buckwheat we surveyed lies in the Muddy Mountains, near Lovell Wash on BLM and NPS land. This population is in the designated Muddy Mountain Wilderness Area, and receives additional protection under NPS management. We observed that this population occupied more habitat heterogeneity than other Las Vegas buckwheat populations we had documented. While the population’s densest group of individuals was on a flat area with a thin soil crust, many more individuals also grew on surrounding hills and washes.

THREATS

Development is a major threat to Las Vegas buckwheat populations in the Las Vegas Valley. The Lovell Wash population is healthy, in a designated wilderness area, and removed from any recreational land use.

Gold Butte populations are vulnerable to illegal cattle grazing, fire and OHV use. Some of the Las Vegas buckwheat populations in Gold Butte are near springs, all of which had signs of cattle nearby. This indicates these populations are susceptible to herbivory, trampling and an alteration in hydrology. Another Las Vegas buckwheat population was adjacent to a recently burned area. The recovering area is now covered in cheatgrass, creating the potential for subsequent fire (Figure 40). An additional population surveyed had an illegal OHV road bisecting the habitat, causing compacted substrate and the potential that individuals could be crushed (Figure 41).

LECONTE’S BARREL CACTUS

POPULATIONS STATUS

Barrel cactus populations were extremely numerous and extensive within and immediately surrounding LMRNA, so much so that the typical survey protocol used for this project was impractical for barrel cactus. While we did not estimate population sizes for this project, other data indicate that over the last 30 years, the barrel cactus population has increased in the Newberry Mountains (NPS, *in-house unpublished data*, 2008).

THREATS

Current threats to barrel cactus populations include development, loss of nurse plants and poaching. The Hoover Dam Bypass was constructed through barrel cactus habitat. In addition, research has shown barrel cacti tend to establish under big galleta grass (Franco & Nobel, 1989). If numbers of big galleta grass or other perennial natives are significantly reduced due to illegal grazing this could diminish barrel cacti establishment. Barrel cacti are valuable in the landscaping trade and are susceptible to poaching. There have been documented incidents of poaching at LMNRA, however, the cacti tend to grow in remote areas making poaching difficult to prevent (A. Newton, *pers. comm.*).

BEAVER DAM BREADROOT

POPULATION STATUS

Beaver Dam breadroot has a very limited range in eastern Clark County, with only one of the two populations found occurring in Nevada. Because the sand dune habitat where this species occurs is not common, and supports two additional rare species, *Eriogonum viscidulum* J.T. Howell (sticky buckwheat) and *Astragalus geyeri* A. Gray (Geyer's milkvetch), the potential habitat within LMNRA was examined more closely than more common habitat types, and it is very unlikely that any significant populations have been overlooked. Because this plant is an annual, there can be huge variation from year to year, making it difficult to assess the population status without longer term and more focused study than this survey permitted.

THREATS

The main threats observed during surveys for Beaver Dam breadroot were cattle grazing, habitat conversion, and possibly recreational use. Active cattle grazing was observed on the Virgin River Dunes in potential Beaver Dam breadroot habitat, in addition, signs of cattle were widespread at South Cove which is very near to Sandy Point where Beaver Dam breadroot occurs. Cattle create the risk of trampling and herbivory to Beaver Dam breadroot populations; this potential poses a serious threat because of the specie's very limited population range.

Brassica tournefortii Gouan (Sahara mustard) is prevalent on sandy soils and is abundant at Beaver Dam breadroot sites. This plant may compete with Beaver Dam breadroot for resources, or if densely established, could alter sand dune habitat by stabilizing the substrate. *Malcolmia africana* (African malcolmia) is another invasive annual that was seen growing in the vicinity of the Virgin River Dunes and may have the potential to convert dune habitat.

Sand dunes where Beaver Dam breadroot occurs are sometimes targeted by OHV enthusiasts, creating a potential threat to the species. Boaters use Sandy Point recreationally, and the Virgin River Dunes are accessible to the public by 4-wheel drive. The increased recreational use of areas supporting Beaver Dam breadroot may lead to individuals being trampled and an elevated rate of exotic introduction to these areas.

ROSY TWO-TONE BEARDTONGUE

POPULATION STATUS

Rosy two-tone beardtongue grows on roadsides and in washes, thus, it is very vulnerable to vehicles pulling off the road or driving off road. Several historical populations are in Henderson or Boulder City in areas with high use. Apart from the Nelson road population, known populations in the eastern part of Clark County are either reduced to a very small number of individuals, or are extinct.

THREATS

In the areas we surveyed within the Las Vegas Valley, rosy two-tone beardtongue is under threat from development and heavy recreational use by OHV. We found several historical populations are in high use areas of Henderson or Boulder City. One population was extirpated during development. Other populations in Henderson and Boulder City are threatened by development or, if located on protected lands, susceptible to destruction due to an increase in the recreational use of the habitat surrounding established neighborhoods. Rosy two-tone beardtongue often grows on roadsides (many of which are moderately to heavily-used) and in washes, thus, the species is vulnerable to vehicles driving on the road shoulder and OHV use.

Behind development, hybridization is a great threat to rosy two-tone beardtongue (Smith, 2005). Penstemon hybridization, and specifically hybridization between Palmer's penstemon and rosy two-tone beardtongue, has been documented for many years (Smith, 2005). Based on MS thesis research conducted by Gina Glenne at Utah State University, both the intentional introduction of Palmer's penstemon during restoration activities and the natural establishment of Palmer's penstemon near rosy two-tone beardtongue populations can threaten the species by polluting the genetic integrity of the population (Smith, 2005).

CONCLUSION:

"Inventory and Research for Evaluation and Watch Species Project" goals were accomplished through surveys and ecological community assessments conducted within LMNRA and surrounding BLM land inside Clark County, Nevada. Impressions of population status were generally positive for three species. This led to recommendations to delist Leconte's barrel cactus, and diminish the MSHCP monitoring status of silverleaf sunray and chalk liveforever to Watch Species of Low Priority. Unfavorable population conditions were encountered for Las Vegas buckwheat and Beaver Dam breadroot, guiding recommendations to elevate Las Vegas buckwheat's MSHCP listing from Watch Species to Covered Species and Beaver Dam breadroot's status to Watch List with High Priority. It was recommended that Mokiak milkvetch and Virgin River thistle's current status be maintained. More surveys are necessary before rosy two-tone beardtongue's status can be effectively assessed. Neither Hoffman's cryptantha nor unusual cat's-eye were encountered during our surveys.

During surveys and community assessments topics where more research is needed were identified in addition to the information gathered to assess the current status and prioritization of the ten Watch and Evaluation Species.

Future research objectives include:

- Determine how to reduce the presence non-native grasses and improve wildfire prevention strategies in the Gold Butte area.
- Conduct taxonomic studies to determine whether Virgin River thistle is significantly different from Mojave thistle.
- Determine environmental parameters that define the limited range of silverleaf sunray.
- Conduct genetic analysis to establish Gold Butte Las Vegas buckwheat's relatedness to the core Las Vegas Valley population.
- Describe dune dynamics and clarify actual threats to this system (OHV, invasive plant species).
- Determine best management practices for exotic annuals threatening stabilization of dune habitat.

Future survey objectives include:

- Complete Virgin River thistle surveys focusing on riverside terraces of the Virgin and Muddy Rivers.
- Conduct rosy two-tone beardtongue surveys throughout the entire county, as well as in remote areas in eastern Clark County.
- Survey the extent of Palmer's penstemon to determine the magnitude of the species' threat on rosy two-tone beardtongue.
- Improve distribution models by compilation and comparison of soil types at known locations of Mokiak milkvetch.
- Survey and repair cattle exclosures at Bill's Spring and Granite Spring biannually (Virgin River thistle).
- Expand Las Vegas buckwheat ground surveys to include steeper, rougher terrain on Gold Butte.
- Conduct exhaustive surveys of suitable sandy habitat for Beaver Dam breadroot.

Future monitoring objectives include:

- Develop and implement an annual monitoring plan for Mokiak milkvetch to track population dynamics and responses to fire.
- Monitor the genetic composition of rosy two-tone beardtongue populations to identify genetic swamping.

RECOMMENDATIONS:

MOKIAK MILKVETCH

PRIORITIZATION AND REASSESSMENT

Mokiak milkvetch populations are generally small and in Clark County, the species occurs primarily on Gold Butte. The majority of the Gold Butte population in Nevada is on BLM administered lands with the remainder occurring on protected NPS lands. For these reasons we recommend maintaining current Protective Status with BLM as a Special Status Species, NNHP Status as a Sensitive Species and MSHCP listing of Evaluation Species with Medium Priority.

LONG TERM CONSERVATION AND RECOMMENDATIONS

The area burned by the Tramp and Fork fires on Gold Butte in 2005 covered almost all known sub-populations of Mokiak milkvetch on Gold Butte, but the exact effects of the fire are uncertain. To determine how the species is responding to the blazes, we recommend further monitoring. Annual monitoring of Mokiak milkvetch using a controlled methodology would improve the understanding of population dynamics, and provide more adequate information to reassess listing. A compilation and comparison of soil types at known locations would also improve distribution models and assist with identifying additional survey locations.

Recreational OHV activity was observed near several sub-populations. Access to these roads should be blocked. Additionally, more thorough patrolling of Gold Butte would decrease illegal OHV use. We also recommend the current moratorium on new mining leases afforded by the designation of BLM Area of Critical Environmental Concern (ACEC) for Gold Butte be maintained.

Feral and/or trespass cattle are known to occupy Gold Butte. Ownership and legality of cattle presence should be addressed. Cattle should be removed from the biologically sensitive Gold Butte area pursuant to BLM's adherence to the Federal Endangered Species Act (ESA) and Listed Desert Tortoise Habitat in that area.

Finally, the Mokiak milkvetch population on Gold Butte would benefit from the enhanced protection imbued by the designation of Gold Butte as a National Conservation Area.

VIRGIN RIVER THISTLE

PRIORITIZATION AND REASSESSMENT

In Clark County, the majority of known and surveyed locations of Virgin River thistle occur within LMNRA in Intensely Managed Areas. Virgin River thistle has NPS Priority 1 status in LMNRA due to the NNHP Sensitive Species listing and the USFWS classification as Species of Concern. All populations surveyed appear healthy with numerous individuals. For these reasons we recommend maintaining the species' current status with MSHCP as an Evaluation Species with Low Priority.

Riverside terraces of the Virgin and Muddy Rivers in Clark County represent an under-surveyed portion of Virgin River thistle habitat and should be the focus of future survey efforts.

LONG TERM CONSERVATION AND RECOMMENDATIONS

Because non-native species can threaten Virgin River thistle through both direct competition and indirectly through changing local hydrology, we recommend an aggressive early detection rapid response weed management program focused on Virgin River thistle locations.

Herbivory has not been observed on Virgin River thistle. However these streamside habitats are utilized heavily by burros and cattle. The Gold Butte Virgin River thistle population is associated with highly palatable grass species and is currently enclosed from livestock. We recommend biannual survey and repair on this fence to ensure Virgin River thistles remain protected.

Recent management efforts for the relict leopard frog included burning and alteration of habitat shared with Virgin River thistle (Newton *et al.*, 2010). These management actions included the collection of baseline data and subsequent monitoring of all vegetation. We recommend this data be utilized to detect whether there are adverse effects to Virgin River thistle.

Finally, the Virgin River thistle population on Gold Butte would benefit from the enhanced protection provided by the designation of Gold Butte as a National Conservation Area.

HOFFMAN'S CRYPTANTHA

PRIORITIZATION AND REASSESSMENT

Until Hoffman's cryptantha populations are detected in Clark County, we recommend that this species either remain on the MSHCP Watch List or be reassessed for removal from MSHCP Covered Species.

LONG TERM CONSERVATION AND RECOMMENDATIONS

We recommend that surveys for this species continue, but that they are considered a low priority until this species is proven extant in Clark County.

UNUSUAL CAT'S-EYE

PRIORITIZATION AND REASSESSMENT

Until unusual cat's-eye is found, warranting more intensive protective status, we recommend that this species remain on the MSHCP Watch List.

LONG TERM CONSERVATION AND RECOMMENDATIONS

We recommend that surveys continue, but that surveys are considered a low priority unless the species is proven extant.

CHALK LIVEFOREVER

PRIORITIZATION AND REASSESSMENT

Chalk liveforever has a localized distribution in Clark County but is not considered uncommon in other parts of the natural range of this species. The species occurrence and associated habitat in Clark County is within NPS and BLM ACEC lands currently not subject to development. For these reasons we recommend maintaining status with MSHCP and NNHP as a Watch List Species.

LONG TERM CONSERVATION AND RECOMMENDATIONS

Chalk liveforever is a popular plant among cactus and succulent collectors, so easily accessible populations are vulnerable to poaching. We recommend thorough and frequent patrolling of the Newberry Mountains and Gold Butte. The chalk liveforever population on Gold Butte would benefit from the enhanced protection imbued by the designation of Gold Butte as a National Conservation Area. We also recommend that the current designation of BLM ACEC for Gold Butte and the BLM portion of the Newberry Mountains be maintained to protect the areas from new mining development.

Because the population ranges are already on protected land and are healthy, we recommend that monitoring and conservation efforts focus on known locations, but that chalk liveforever be considered a Low Priority Watch Species.

SILVERLEAF SUNRAY

PRIORITIZATION AND REASSESSMENT

Most silverleaf sunray populations surveyed occurred within protected NPS lands. Limited disturbance does not appear to adversely affect the species. Actually, silverleaf sunray has been observed as one of the first species to colonize newly built road sides (J. Craig, *pers. obs.*). The minimal development occurring within NPS and BLM property ensures protection of the species. For these reasons, we recommend maintaining BLM designation of Sensitive Species, NNHP Sensitive Species Status and MSHCP listing of Watch Species. We also recommend that population monitoring for this Watch List Species be designated Low Priority.

LONG TERM CONSERVATION AND RECOMMENDATIONS

Recreational OHV activity is the greatest threat silverleaf sunray populations on BLM lands. We recommend that access to illegal roads on silverleaf sunray habitat be blocked and efforts to effectively patrol BLM lands to prevent illegal OHV activity be maintained.

Further research is needed to better understand environmental parameters that define the limited range of this species.

LAS VEGAS BUCKWHEAT

PRIORITIZATION AND REASSESSMENT

This project has described one new sub-population of Las Vegas buckwheat and expanded another. These new and expanded sub-populations do not represent a change in the overall threat of extinction or urgent need for conservation actions for Las Vegas buckwheat. Las Vegas buckwheat was reclassified as a Candidate Species Priority Level 6 with the USFWS immediately prior to project implementation in 2008. This listing is concurrent with BLM designation of Las Vegas buckwheat as a Nevada Special Status Species. We support the need for these designations based on data collected from known occurrences, as well as newly described occurrences and associated observations. Further, we recommend that the federal designations be matched by both a Nevada State listing as a Species Threatened with Extinction

under NRS 527.260 and elevation of the MSHCP designation from a Watch Species to a Covered Species.

LONG TERM CONSERVATION AND RECOMMENDATIONS

This project has identified and described one new sub-population of Las Vegas buckwheat near previously known Gold Butte locations, and expanded another. Ground surveys should be expanded in the Gold Butte area to include steeper, rougher terrain and soil types other than gypsum, such as clay beds and high boron shale (Meyer, 1986).

Existing genetic analyses on Las Vegas buckwheat does not include any samples collected further west than White Basin in the Muddy Mountains (Ellis & Wolf, 2009). We recommend further genetic analysis to include the Gold Butte population since it is the easternmost known population. These analyses would indicate Las Vegas buckwheat's relatedness to the core Las Vegas Valley population, which is the population most severely threatened by development. This would allow conservation efforts to focus on those populations most closely related to the threatened populations.

Invasive weeds, particularly brome grass, and the subsequent threat of fire is the most imminent danger to the Gold Butte population. We suggest continued research into fire reduction in habitats dominated by invasive brome grass and the creation of a fire reduction plan for Gold Butte.

An illegal road bisected the Las Vegas buckwheat site at Bill's Spring. Protective-measures restoration should be implemented to close access to that road and any others that transect Las Vegas buckwheat sub-populations. Continued effort to more effectively patrol Gold Butte from illegal OHV activity is also recommended. We recommend that the current moratorium on new mining leases afforded by the designation of BLM ACEC for Gold Butte be maintained.

Feral and or trespass cattle are known to occupy Gold Butte. Ownership and legality of cattle presence should be addressed. Cattle should be removed from the biologically sensitive Gold Butte area pursuant to BLM's adherence to the ESA and Listed Desert Tortoise Habitat. Las Vegas buckwheat sites on Gold Butte which are associated springs were observed to be heavily used by cattle drinking the surface water. Until cattle issues are resolved, cattle-exclusion fences should be built around Granite Spring and Bill's Spring to prevent Las Vegas buckwheat habitat degradation.

Finally, the Las Vegas buckwheat population on Gold Butte would benefit from the enhanced protection given if Gold Butte is designated as a National Conservation Area.

LECONTE'S BARREL CACTUS

PRIORITIZATION AND REASSESSMENT

Barrel cacti occur in large numbers throughout Clark County. Analysis of morphological characteristics did not reveal the presence of ssp. *lecontei* in eastern Clark County. We recommend that Leconte's barrel cactus be reassessed and removed from MSHCP Covered Species Status because barrel cacti occur in large numbers throughout the project area and if, as

our analysis suggests, the two cactus species are in fact a single species, there is no reason to continue listing the subspecies.

LONG TERM CONSERVATION AND RECOMMENDATIONS

We believe the State of Nevada's cactus salvage restriction under NRS 527.060 is sufficient for the protection of this species.

BEAVER DAM BREADROOT

PRIORITIZATION AND REASSESSMENT

Populations of Beaver Dam breadroot are extremely localized, contain low numbers of individuals, and are dependent upon ephemeral aeolian dune dynamics. We recommend exhaustive surveys of suitable sandy habitat and subsequent reassessment toward Elevated Listing Status among agencies. The MSHCP Watch List Status should be modified to Watch List with High Priority. Most sub-populations surveyed occur within NPS lands where the species has NPS Priority LAME-P1 protection due to the NNHP listing of Sensitive Species. Similarly, sub-populations are protected as Special Status Species on BLM lands along the Virgin River.

LONG TERM CONSERVATION AND RECOMMENDATIONS

We recommend surveys for this short-lived herbaceous perennial be conducted annually to monitor population dynamics and reassess listing.

Physical properties that drive aeolian dune development and movement may be altered due to dune stabilizing invasive species such as Sahara mustard or African mustard, as well as inundation by lake water of sandy riverbeds which contribute greatly to wind borne sand particles. We recommend cooperative research with the Natural Resource Conservation Service (Las Vegas) to describe these dune dynamics and potential threats to this system.

Sand dunes are often the focus of recreational OHV activity. This activity could potentially jeopardize the integrity of dunes specifically on the BLM portion of the Virgin River Valley Dunes Complex. Protective-measures restoration should be implemented to close access to illegal roads. Continued effort to more effectively patrol these BLM lands from illegal OHV activity is also recommended.

Cattle were observed within both the BLM and NPS portions of Virgin River Dunes habitat. Ownership and legality of cattle presence should be addressed. Cattle should be removed from the biologically sensitive Virgin River Area pursuant to BLM's adherence to the ESA and Listed Desert Tortoise Habitat.

Sahara mustard and Mediterranean grass are observed to be particularly abundant on sandy soils in the Virgin River Dunes Complex. These species represent the greatest potential threat to Beaver Dam breadroot through processes of dune stabilization and competition for resources. Other invasive plants such as *Salsola* L. (Russian thistle) are present on these dunes and present a lesser degree of imminent threat. After research of contemporary control methods, we

recommend trials to remove these species on dunes not currently occupied by Beaver Dam breadroot in order to minimize potential impact to extant sub-populations.

ROSY TWO-TONE BEARDTONGUE

PRIORITIZATION AND REASSESSMENT

Rosy two-tone beardtongue was very rare in eastern Clark County. Apart from the Nelson road populations we surveyed, populations were either reduced to a very small number of individuals, or were extinct. Rosy two-tone beardtongue may need elevated protective status after more extensive surveys are completed.

LONG TERM CONSERVATION AND RECOMMENDATIONS

Rosy two-tone beardtongue is known to hybridize with Palmer's penstemon, which is often introduced in roadside seed mixes (Smith, 2005). Eliminating the use of Palmer's penstemon in roadside mixtures would limit the interaction between the plants, and minimize interbreeding. Efforts should be made to determine the extent of Palmer's penstemon populations adjacent to rosy two-tone beardtongue, whether there is a presence of hybridization within existing rosy two-tone beardtongue populations and which measures could prevent future hybridization.

We recommend that surveys for rosy two-tone beardtongue be conducted regularly every one to two years. Since the species is distributed somewhat evenly across the Clark County, future surveys should include the entire county, as well as remote areas in eastern Clark County in addition to our surveys (NNHP, 2001e).

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LITERATURE CITED:

- Aigner, P.A. 2004. Floral specialization without trade-offs: Optimal corolla flare in contrasting pollination environments. *Ecology* 85(9):2560-2569.
- Alexander, J.A. 2005. The taxonomic status of *Astragalus mokiacensis* (Fabaceae), a species endemic to southwestern United States. *Brittonia* 57:320-333.
- Alexander, J. A. 2001. Population assessment of *Astragalus mokiacensis*, *Astragalus amphioxys* var. *musimonum* and *Astragalus funereus* in Nevada, California, and Arizona. Unpubl. manuscript on file 2005. ALEXANDER: ASTRAGALUS MOKIACENSIS 333 at the Las Vegas District Office of the Bureau of Land Management. 41 pp.
- Arizona Game and Fish Department. 2005a. *Cryptantha insolita*. Unpublished abstract compiled and edited by the Heritage Data Management System, Arizona Game and Fish Department, Phoenix, AZ. 4 pp.
- Arizona Game and Fish Department. 2005b. *Ferocactus cylindraceus* var. *cylindraceus*. Unpublished abstract compiled and edited by the Heritage Data Management System, Arizona Game and Fish Department, Phoenix, AZ. 5 pp.
- Arizona Game and Fish Department. 2005c. *Pediomelum castoreum* Rydb. Unpublished abstract compiled and edited by the Heritage Data Management System, Arizona Game and Fish Department, Phoenix, AZ. 4 pp.
- Baldwin (ed.) 2002. *The Jepson Desert Manual: vascular plants of southeastern California*. Berkeley and Los Angeles, CA. University of California Press. 624 pp.
- Bowers, Janice E., Webb, Robert H. and Rondeau, Renee J. 1995. Longevity, recruitment and mortality of desert plants in Grand Canyon, Arizona, USA. *Journal of Vegetation Science* 6:551-564.
- Calflora: Information on California plants for education, research and conservation. 2010. Web application. Berkeley, California: The Calflora Database [a non-profit organization]. Website. <http://www.calflora.org/>. Accessed May 19, 2010.
- Cronquist, A., N.H. Holmgren, and J.L. Reveal. 1994a. *Intermountain Flora* Vol. 4. New York Botanical Garden Press.
- Cronquist, A., N.H. Holmgren, and J.L. Reveal. 1994b. *Intermountain Flora* Vol. 5. New York Botanical Garden Press.
- Ellis, M.W., J.M. Roper, R. Gainer, J.P. Der, P.G.Wolf. 2009. "The Taxonomic designation of *Eriogonum corymbosum* var. *nilesii* (Polygonaceae) is supported by AFLP and cpDNA analyses." *Systematic Botany* 34(4):693-704.

- Flora of North America*. 2008. vol. 19. Oxford University Press. Franco, A. C. and P. S. Nobel. 1989. Effect of nurse plants on the microhabitat and growth of cacti. *Journal of Ecology* 77:870-886.
- Integrated Taxonomic Information System. 2009. Website. www.itis.gov. Accessed May 20, 2010.
- Isotype of: *Astragalus mokiacensis* Gray in Proc. Amer. Acad. 13: 367. 1878. (**NY Specimen ID: 5554**).
- Jordan, P.W. and P.S. Nobel. 1981. Seedling establishment of *Ferocactus acanthodes* in relation to drought. *Ecology* 62(4):901-906.
- Jordan, Peter W. and Park S. Nobel. 1982. Height distributions of two species of cacti in relation to rainfall, seedling establishment, and growth. *Botanical Gazette* 143(4):511-517.
- Kartesz, J.T. 1988. *A flora of Nevada*. Ph.D. Dissertation. University of Nevada, Reno.
- Levin, G. A., and T. W. Mulroy. 1985. Floral morphology, nectar production, and breeding systems in *Dudleya* subgenus *Dudleya* (Crassulaceae). *Transactions of the San Diego Society of Natural History* 21:57-70.
- McIntosh, M.E. 2002a. Flowering phenology and reproductive output in two sister species of *Ferocactus* (Cactaceae). *Plant Ecology* 159:1-13.
- McIntosh, M.E. 2002b. Plant size, breeding system, and limits to reproductive success in two sister species of *Ferocactus* (Cactaceae). *Plant Ecology* 162:273-288.
- Meyer, S. 1986. The ecology of gypsophile endemism in the eastern Mojave Desert. *Ecology* 67(5):1303-1313.
- The National Park Service. 2002. The Lake Mead National Recreation Area Lake Management Plan and Final Environmental Impact Statement. Lake Mead National Recreation Area, Boulder City, Nevada.
- [NRCS] Natural Resources Conservation Service. 2010. Soil Data Mart. Website. <http://soildatamart.nrcs.usda.gov/Default.aspx>. Accessed May 21, 2010.
- NatureServe. 2009. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Website. <http://www.natureserve.org/explorer>. Accessed May 18, 2010.
- The Nature Conservancy. 2007. A Conservation Management Strategy for nine low elevation rare plants in Clark County, Nevada. Nevada Field Office Reno, NV. TNC 2007.
- Nevada Natural Heritage Program. Symbol and Data Definitions. Website. <http://heritage.nv.gov/keycodes.htm#state>. Accessed May 20, 2010.

- [NNHP] Nevada Natural Heritage Program. 2001a. *Dudleya pulverulenta*. Nevada Rare Plant Atlas. Website. <http://heritage.nv.gov/atlas/maps/dudlepulve.html>. Accessed May 19, 2010.
- [NNHP] Nevada Natural Heritage Program. 2001b. *Enceliopsis argophylla* (D.C. Eaton) A. Nelson. Rare plant fact sheet. Compiled June 25, 2001.
- [NNHP] Nevada Natural Heritage Program. 2001c. *Pediomelum castoreum* (S. Watson) Rydberg. Rare Plant Fact Sheet. Compiled June 25, 2001.
- [NNHP] Nevada Natural Heritage Program. 2001d. *Penstemon bicolor* (Brandege) Clokey & Keck ssp. *roseus* Clokey & Keck. Rare plant fact sheet. Compiled June 25, 2001.
- [NNHP] Nevada Natural Heritage Program. 2001e. *Penstemon bicolor* ssp. *roseus*. Nevada Rare Plant Atlas. Accessed at <http://heritage.nv.gov/atlas/maps/penstbicolroseu.html>. Accessed May 21, 2010.
- [NNHP] Nevada Natural Heritage Program. 2004. *Eriogonum corymbosum* Bentham var. (unnamed) Reveal. Rare plant fact sheet.
- [NNHP] Nevada Natural Heritage Program. 2005. *Detailed rare plant and lichen list*. Website. <http://heritage.nv.gov/plantsml.htm>. Accessed May 18, 2010.
- Newton, A.C., S.R. Abella, J.E. Craig. 2010. The Interagency Weed Sentry Report. *Unpublished Project Report 2008-2009 for Clark County, Nevada and the Multiple Species Habitat Conservation Plan*. Boulder City, Nevada.
- [NYBG] New York Botanical Garden. 2010. C.V. Starr Virtual Herbarium: Website. <http://sciweb.nybg.org/science2/VirtualHerbarium.asp>. Accessed May 18, 2010.
- [RECON] Regional Environmental Consultants, Inc. 2000. Final Clark County Nevada Multiple Species Habitat Conservation Plan and Environmental Impact Statement. Prepared for Clark County Administrative Services. 550 pp. plus appendices.
- Reveal, J.L. 2004. New Entities in *Eriogonum* (Polygonaceae: Eriogonoideae) *Phytologia* 86: 121-159.
- Sanders, D.L. and C. Clark. 1987. Comparative morphology of the capitulum of *Enceliopsis* (Asteraceae: Heliantheae). *American Journal of Botany* 74(7):1072-1086.
- Smith, F. 2005. Current knowledge and conservation status of *Penstemon bicolor* (Brandege) Clokey & Keck (Plantaginaceae), the two-tone beardtongue. Unpublished status report prepared for Nevada Power Company and U.S. Fish and Wildlife Service, Nevada State Office. Website. heritage.nv.gov/reports/pebitext.pdf. Accessed May 17, 2010.
- USDA, NRCS. 2010. The PLANTS Database. National Plant Data Center, Baton Rouge, LA 70874-4490 USA. Website. <http://plants.usda.gov>. Accessed May 18, 2010.

Welsh, S.L., N.D. Atwood, S. Goodrich, L.C. Higgins, 1993. *A Utah Flora*. Second edition, revised. Print Services, Brigham Young University. Provo Utah. Pp 986.