Lake Mead National Recreation Area Vegetation Monitoring and Management: Final Close-Out Report, Time Period: October 1, 2005 to September 30, 2006

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EXECUTIVE SUMMARY

The National Park Service (NPS) at Lake Mead National Recreation Area (LAME) entered into a cooperative agreement with the University of Nevada, Las Vegas (UNLV) to accomplish vegetation monitoring and management activities. This report summarizes activities that took place by UNLV under this task agreement between October 1, 2005, and September 30, 2006. The activities included:

A. Weed Sentry mapping and treating incipient populations of exotic invasive plants throughout Clark County, including along shorelines of Lakes Mead and Mohave;

B. Monitoring of targeted rare native plant species;

C. Sahara mustard research; and

D. Providing technical assistance upon request to the NPS vegetation manager.

In addition, work set forth in the task agreement has been exceeded by conducting supplemental monitoring and research activities that support the broad activities of the task agreement (stated above). This “value added” monitoring and research included such activities as initiating scientific literature reviews and surveys to enhance rare plant monitoring and management in Clark County, and assessing the feasibility of determining reference conditions for ecological restoration. All activities performed under this task agreement are summarized below:

- The Weed Sentry program surveyed more than 1,400 miles of federal lands in Clark County for invasive, exotic plant species.
- Weed Sentry also removed more than 250,000 individual invasive plants from federal lands. These removals represent pro-active efforts that may have forestalled large infestations difficult and costly to eradicate.
- Monitoring was conducted for targeted rare plant species and was presented in several reports submitted to Clark County and the National Park Service.
- Species-status reports, including summaries of known locations from herbarium records, were prepared for 11 rare native species. Synthesizing known locations of the species is a critical first step in developing a habitat map for the species in Clark County.
- UNLV provided technical assistance to the LAME vegetation manager for designing a study of restoration effects on illegal off-road vehicle activity and for monitoring succession on a pipeline right-of-way.
- A survey and literature synthesis was initiated for rare plant monitoring protocols and linking monitoring data with management decisions. An assessment of the feasibility of using phytoliths (plant fossils) as a reference for ecological restoration activities and weed management at LAME was initiated. Both assessments are ongoing, and the information will be delivered to park managers early in the next task agreement.
- All data from the activities of this task agreement have been delivered to the National Park Service electronically, or will be delivered during the next task agreement for ongoing projects.

**PROGRAM ACTIVITIES**

The task agreement was awarded to UNLV on October 1, 2005. Activities that took place between October 1, 2005, and September 30, 2006, are summarized by program category.

**Invasive Plant Monitoring and Management (Weed Sentry Program)**

Research assistants in the Weed Sentry Program are tasked with mapping and treating incipient populations of exotic species on targeted federal lands throughout Clark County. Surveying activities for invasive species that took place from October 1, 2005, to September 30, 2006, are divided into sections by federal agency, and are summarized in Table 1. More than 1,400 miles and 10,000 acres were surveyed for exotic, invasive species during this period. This effort was clearly an interagency effort, with at least 50 miles being surveyed on lands of each of the four federal agencies – NPS, Bureau of Land Management (BLM), U.S. Forest Service (USFS), and U.S. Fish and Wildlife Service refuge (USFWS). The Weed Sentry Program also submits trip reports to federal managers that show maps of where exotic species occur, estimate which species are likely to be most problematic, and provides recommendations for treatment. These trip reports were sent to managers shortly after a given area was surveyed to provide timely, up-to-date information.

**Table 1. Summary of miles and acres surveyed, Weed Sentry Program, October 1, 2005-September 30, 2006, by federal agency.**

<table>
<thead>
<tr>
<th>Agency</th>
<th>Miles</th>
<th>Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Park Service</td>
<td>638</td>
<td>4423</td>
</tr>
<tr>
<td>Bureau of Land Management</td>
<td>621</td>
<td>5068</td>
</tr>
<tr>
<td>Forest Service</td>
<td>118</td>
<td>901</td>
</tr>
<tr>
<td>Fish and Wildlife Service</td>
<td>50</td>
<td>399</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1,427</td>
<td>10,792</td>
</tr>
</tbody>
</table>
A. Locations Surveyed: National Park Service

Surveys on land managed by the NPS occurred in the following locations: Lakes Mead and Mohave shorelines, approved roads along the Northshore of the Overton Arm, approved roads around Gold Butte, approved roads south of Hoover Dam, approved roads surrounding Temple Bar, and approved roads south of Willow Beach in both Arizona and Nevada.

B. Locations Surveyed: Bureau of Land Management

Surveys on BLM holdings were widely distributed and included the Gold Butte area, Frenchman Mountain area, roads surrounding rare plant sites near Jean, roads in Eldorado Valley south of Boulder City, roads east and south of Searchlight, Sandy Valley, Goodsprings out to Pahrump, and the dry lake by Ute.

C. Locations Surveyed: Forest Service

Areas surveyed on USFS lands included the Mt. Stirling area, approved roads on the west side of the Spring Mountains, and high-use trails on the east side of the Spring Mountains.

D. Locations Surveyed: Fish and Wildlife Service

On the Desert Range National Wildlife Refuge, Gass Peak Road out to North Las Vegas and Mormon Well Road were surveyed.

E. Small Incipient Population Treatment

In addition to surveying, the Weed Sentry staff are tasked with treating upon discovery (often hand pulling) small, incipient populations of invasive plants. This represents a pro-active effort to remove invasive species before they become larger infestations and, therefore, increasingly costly and difficult to eradicate. During the term of the task agreement, a total of 254,744 individual invasive plants were removed by Weed Sentry staff from federal lands in Clark County. These removals are summarized by agency lands in Tables 2-5.

Table 2. Number of individual invasive plants removed, Weed Sentry Program, October 1, 2005-September 30, 2006, National Park Service lands.

<table>
<thead>
<tr>
<th>Species</th>
<th>Number of Plants Treated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alhagi pseudalhagi</td>
<td>17</td>
</tr>
<tr>
<td>Brassica tournefortii</td>
<td>24,1057</td>
</tr>
<tr>
<td>Centaurea melitensis</td>
<td>1147</td>
</tr>
<tr>
<td>Hirschfeldia incana</td>
<td>43</td>
</tr>
<tr>
<td>Lepidium latifolium</td>
<td>671</td>
</tr>
<tr>
<td>Nerium oleander</td>
<td>23</td>
</tr>
<tr>
<td>Nicotiana glauca</td>
<td>99</td>
</tr>
<tr>
<td>Malcomia africana</td>
<td>1,021</td>
</tr>
<tr>
<td>Marrubium vulgare</td>
<td>11</td>
</tr>
<tr>
<td>Parkinsonia aculeata</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Species</th>
<th>Number of Plants Treated</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Pennisetum setaceum</em></td>
<td>239</td>
</tr>
<tr>
<td><em>Sisymbrium altissimum</em></td>
<td>83</td>
</tr>
<tr>
<td><em>Sisymbrium irio</em></td>
<td>998</td>
</tr>
<tr>
<td><em>Sisymbrium orientale</em></td>
<td>282</td>
</tr>
<tr>
<td><em>Sonchus oleraceus</em></td>
<td>13</td>
</tr>
<tr>
<td><em>Tamarix ramosissima</em></td>
<td>5179</td>
</tr>
<tr>
<td><em>Washingtonia filifera</em></td>
<td>9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>250,896</strong></td>
</tr>
</tbody>
</table>

Table 4. Number of individual invasive plants removed, Weed Sentry Program. October 1, 2005-September 30, 2006, on Forest Service land.

<table>
<thead>
<tr>
<th>Species</th>
<th>Number of Plants Treated</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Brassica tournefortii</em></td>
<td>1,749</td>
</tr>
<tr>
<td><em>Centaurea melitensis</em></td>
<td>662</td>
</tr>
<tr>
<td><em>Hordeum murinum</em></td>
<td>2</td>
</tr>
<tr>
<td><em>Malcomia africana</em></td>
<td>45</td>
</tr>
<tr>
<td><em>Marrubium vulgare</em></td>
<td>1</td>
</tr>
<tr>
<td><em>Peganum harmala</em></td>
<td>272</td>
</tr>
<tr>
<td><em>Sisymbrium irio</em></td>
<td>81</td>
</tr>
<tr>
<td><em>Sisymbrium altissimum</em></td>
<td>76</td>
</tr>
<tr>
<td><em>Sisymbrium orientale</em></td>
<td>54</td>
</tr>
<tr>
<td><em>Tamarix ramosissima</em></td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2,943</strong></td>
</tr>
</tbody>
</table>

Table 5. Number of individual invasive plants removed, Weed Sentry Program, October 1, 2005-September 30, 2006, Fish and Wildlife Service land.

<table>
<thead>
<tr>
<th>Species</th>
<th>Number of Plants Treated</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Arundo donax</em></td>
<td>1</td>
</tr>
<tr>
<td><em>Bromus tectorum</em></td>
<td>128</td>
</tr>
<tr>
<td><em>Chorispora tenella</em></td>
<td>17</td>
</tr>
<tr>
<td><em>Descurania sophia</em></td>
<td>124</td>
</tr>
<tr>
<td><em>Sisymbrium altissimum</em></td>
<td>149</td>
</tr>
<tr>
<td><em>Taraxacum officinale</em></td>
<td>227</td>
</tr>
<tr>
<td><em>Tragopogon dubius</em></td>
<td>1</td>
</tr>
<tr>
<td><em>Verbascum thapsus</em></td>
<td>83</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>730</strong></td>
</tr>
</tbody>
</table>
The following map (Fig. 1) shows the general locations of where Weed Sentry activities occurred in Clark County.

**Fig. 1.** Locations of Weed Sentry surveys in Clark County, October 1, 2005-September 30, 2006. The tracklog represents GPS routes of surveys along roads and trails.
F. Additional Monitoring and Research Activities Supporting Exotic Species Management

In August 2006, a rapid monitoring activity was begun to assess seed bank densities in the soil of the invasive species Sahara mustard. Seed banks are key to both monitoring and management for short-lived (aboveground) species such as Sahara mustard. The monitoring activity included estimating densities and distributions of seeds of this invasive species, and is ongoing. In addition, research assistants in the Weed Sentry Program are overlaying GIS data layers of invasive species distributions with the freshly completed Clark County soil survey. The purpose of this activity is to look for patterns and assess the ability to predict potential infestation locations using the soil survey. If patterns exist, this could greatly improve the efficiency of exotic species surveying in Clark County.

G. Trip Reports and Final Report

Many of the activities in the Weed Sentry Program have been detailed in trip reports sent to federal managers and in another stand-alone final report submitted to Clark County Multiple Species Habitat Conservation Plan (MSHCP) and the NPS during the period October 1, 2005, to September 30, 2006 (as specific deliverables). The citation for the report is:

Hoines, J. 2006. Weed Sentry program for Clark County, Nevada and the Multiple Species Habitat Conservation Plan from the National Park Service, Lake Mead National Recreation Area, Boulder City, NV. 35 pp.

The above report provided maps of where Weed Sentry survey activities took place through 2005, documented field methods used for surveying, outlined the database procedures for storing the data produced, included the raw field data, and provided a report on the use of interns within the program (as an appendix).

**Rare Plant Monitoring**

UNLV was tasked with conducting monitoring of targeted rare plant species, including species along shorelines of Lakes Mead and Mohave. These species included covered and watch/evaluation listed species.

A. Monitoring and Mapping of Shoreline Populations of Rare Plants

Surveys for two MSHCP-covered species (*Eriogonum viscidulum* and *Astragalus geyeri* var. *triquetrum*) within LAME during the 2006 field season were completed. Assessments of methodology for monitoring these species are ongoing.

B. Monitoring and Mapping of Populations of Other Rare Plants

Data previously collected on Las Vegas bearpoppy (*Arctomecon californica*) were evaluated and summarized in association with a required final report (Bangle 2006, full citation at the end of this section). Field surveys for Las Vegas bearpoppy did not occur this year, following recommendations from the NPS, as data from previous years were unable to be obtained from
personnel previously tasked with monitoring bearpoppy. New monitoring approaches are under consideration. Weather data monitoring at eight bearpoppy transect sites continued with data downloads every month. The weather station at the Sunrise Hills poppy site was removed in July 2006 because the site became increasingly difficult to access (construction and road closures); the Sunrise Hills rain gauge was used to replace a damaged unit at another location. Consultation with a LAME data manager occurred to discuss creating a database for all Las Vegas bearpoppy transect weather station data, and its creation is underway. Weather data collected through 2005 was included in the final bearpoppy report.

Conceptual models were prepared for four MSHCP covered species. Survey and mapping of ringstem (*Anulocaulis leiosolenus var. leiosolenus*) was continued within LAME. Species and distribution information for Lancaster milkvetch (*Astragalus preussii var. laxiflorus*), Beaver Dam breadroot (*Pediomelum castoreum*), Mokiak milkvetch (*Astragalus mokiacensis*), Barrel cactus (*Ferocactus cylindraceus*), unusual catseye (*Cryptantha insolita*), Hoffman’s Cryptantha (*Cryptantha hoffmannii*), and chalk live-forever (*Dudleya pulverulenta*) have been completed, and distribution maps are being made for use in creating habitat maps for each species.

C. Rare Plant Monitoring Data Summaries

Synthesizing known locations and what is known about rare plant species is a first step in creating habitat maps and, later, monitoring protocols for the species. A new CESU task agreement for the period October 1, 2006, to September 30, 2008, stipulates the creation of a habitat map and monitoring protocol for targeted rare species. This is a major undertaking, and work toward these objectives was initiated during the period covered in this report. This work has produced status reports for eight covered/watch/evaluation species that list historical and present plant locations (based on herbarium records) and synthesize what is known about the life histories of the species. Status reports for three other species are in preparation. Citations for the reports are listed at the end of the Rare Plant Monitoring section. In addition, literature searches were conducted throughout the year and remain ongoing in areas of seed longevity, seed germination, rare plant monitoring protocols, plant species habitat maps, and gypsum endemism. Research on several of the listed MSHCP-watch species is ongoing and has included: interviews with professional botanists, internet and herbaria searches, and UNLV library searches for use in compiling species assessment and distribution reports. This work is expected to support the development of up-to-date distributional maps and monitoring protocols for targeted rare species.

Additionally, Clark County soil data provided by the NRCS will be evaluated in areas where known and potential locations of rare plants exist within LAME (Clark County portion). A watch species distribution map of known and potential locations has been created and includes the following species: *Pediomelum castoreum, Astragalus preussii var. laxiflorus, and Astragalus mokiacensis*. Portions of the known distribution of *Ferocactus cylindraceus* (areas associated with GPS coordinates) are included, but not complete.
D. Aquatic Plant Monitoring

No activities associated with aquatic plant monitoring were conducted by UNLV employees this year, although the Weed Sentry research assistants surveyed for surface visible aquatic weeds during shoreline activities.

E. UNLV Intern for Rare Plants

A UNLV undergraduate student interned with the botany program at LAME for 6 months. The job requirements included: assisting with research projects, weed removals, herbarium work (specimen pressing, mounting, accessioning, and data entry), and weather station monitoring.

F. Herbarium

Throughout the past year, 31 plant specimens were processed into the herbarium and information entered into a database. Plants were keyed on a regular basis for all vegetation programs including: Exotic Plant Management Team, Weed Sentry, Nursery, and Botany. Approximately 35 plants were identified and pressed for the Wildlife Division for use in wildlife research projects. Botanical assistance for wildlife projects will continue as needed.

G. Conservation Planning and Monitoring Technical Assistance for Rare Plants

Meetings with Jan Nachlinger of The Nature Conservancy took place this year to discuss a conservation management strategy (currently in preparation) aimed at threats to rare species within the park and strategies for mitigation.

Phone and email correspondence with BLM botanist Christina Lund and BLM weed coordinator Everett Bartz occurred as needed to discuss rare plant monitoring of MSHCP-covered species and weed related issues.

UNLV research assistants attended the following workshop for the purpose of increasing knowledge of current research in the area of revegetation in the Mojave Desert:


H. Other Stand-Alone Rare Plant Reports

Many rare plant monitoring activities for the period of this task agreement are detailed in other stand-alone reports. This section cites those reports and summarizes their contents.

This report summarized previous and current survey information on the following plant species: *Anulocalvis leiosolenus* var. *leiosolenus*, *Astragalus preussii* var. *laxiflorus*, *Eriogonum corymbosum* var. *nilesii*, and *Pediomelum castoreum*. Data presented included counts of plants at targeted monitoring sites.


The report provided a compilation of plant counts at various sites in Lake Mead National Recreation area and a summary of monitoring activities to date.


This report documented nine years (1997-2005) of monitoring data for sticky buckwheat within LAME, presented a summary of estimated emerging threats (e.g., exotic species) to buckwheat populations, and provided some recommendations for management.


The report summarized eight years of monitoring data for Las Vegas bearpoppy as well as weather data collected from weather stations at monitoring sites. Unfortunately, some important long-term data have been unable to be gleaned from previous personnel who monitored the species.

The following species status reports, prepared by D. Bangle, are in a final form (also included on the CD with other reports accompanying this document) or are in progress. These reports summarize known locations of the species compiled from herbarium records and other information sources, and include basic life-history data on the species. The reports are a critical precursor to the development of up-to-date habitat maps and monitoring protocols for the species.

- Assessment and Distribution of *Pediomelum castoreum* (Beaver Dam Breadroot)
- Assessment and Distribution of *Astragalus preussii* var. *laxiflorus* (Lancaster milkvetch)
- Assessment and Distribution of *Astragalus mokiacensis*
- Assessment and Distribution of *Ferocactus cylindraceus* (barrel cactus)
- Assessment of *Cryptantha hoffmannii* (Hoffman’s Cryptantha) and *Cryptantha insolita* (Unusual catseye), and *Cirsium virginensis* (Virgin thistle)
Assessment and Distribution of *Dudleya pulverulenta* (Chalk live forever)
Assessment and Distribution of *Enceliopsis argophylla* (Sunray) [in progress]
Assessment and Distribution of *Eriogonum corymbosum* var. *nilesii* [in progress]
Assessment and Distribution of *Penstemon bicolor* ssp. *Bicolor* [in progress]

**Sahara Mustard Research**

Experiments on the germination and pollination ecology of the invasive species *Brassica tournefortii* (Sahara mustard) are ongoing. Data are being evaluated on completed experiments and additional experiments will begin upon arrival of a seed germination chamber (on order). The experiments are described and called for in a MSHCP proposal – MSHCP 2005-NPS-532-P; Threats, research, and monitoring on the invasive species Sahara mustard (*Brassica tournefortii*). Proposal submitted to the Clark County Multiple Species Habitat Conservation Plan, primary contact from the National Park Service, Lake Mead National Recreation Area.

In addition, a PowerPoint presentation covering general information about Sahara mustard was delivered to the Community Organization of Meadview, in Meadview, Arizona, on April 7, 2006.

**Technical Assistance**

A major benefit of land management agencies partnering with a university under a cooperative agreement is that university scientists are available to provide technical assistance to land managers for projects of mutual interest. During the last five months of this task agreement, two NPS projects benefited from technical assistance, at the request of the LAME vegetation manager:

A. Monitoring Illegal Ground Disturbance from Off-Road Vehicles

UNLV provided suggestions for study design and statistical analysis for an assessment of the effects of restoration activities (e.g., raking tire tracks) on subsequent illegal off-road vehicle use. In addition, a meeting was set up with the UNLV Civil Engineering Department to discuss the potential for improving the efficiency of traffic counters used at LAME. This NPS project is detailed in a MSHCP-funded proposal (MSHCP 2005-NPS-526-P. Monitoring of illegal ground disturbance in response to management actions. Proposal submitted to the Clark County Multiple Species Habitat Conservation Plan, primary contact from the National Park Service, Lake Mead National Recreation Area).

B. Monitoring Vegetation Succession on a Water Pipeline

The NPS is interested in monitoring vegetation changes after various restoration treatments eight years following the revegetation of a water pipeline right-of-way at LAME. At the request of the LAME vegetation manager, UNLV established nine monitoring field plots in August 2006 in the area of interest and sampled vegetation and soil indicators on the plots. The plots were marked and geospatially referenced by GPS for potential resampling in the future. Vegetation and soil
data are currently being analyzed, and will be delivered to the LAME vegetation manager early in a task agreement beginning October 1, 2006.

**Other Monitoring and Research Activities**

UNLV also initiated several additional activities that are expected to enhance the program areas of exotic species management/restoration and rare plant monitoring. The following projects were initiated and ongoing, with information produced from these projects to be delivered to the NPS within another CESU task agreement:

A. Rare Plant Information Needs and Monitoring Synthesis

UNLV has been tasked with developing monitoring protocols for targeted rare plant species. A survey was initiated to synthesize information on what activities are being undertaken by public and a private agency (specifically, The Nature Conservancy) to monitor rare plant populations in Nevada and Arizona. This survey will be useful for generating efficient monitoring protocols for species in Clark County that may be widely acceptable to all agencies concerned. In addition, a literature review is ongoing to assess the link between monitoring data and management actions for rare species. Monitoring data that does not translate to effective management decisions has little applicability and is a waste of resources to collect. The intent of the synthesis is to guide the collection of monitoring data that is appropriate for making management decisions.

B. Ecological Restoration References Technical Assistance

The LAME vegetation manager is interested in ecological restoration at selected areas in LAME. A first step in ecological restoration consists of at least generally defining the target reference condition to restore. Without this target, it is difficult to do restoration and monitor whether it has been successful. While not necessarily representing what should be restored, past pre-degradation ecosystems do provide valuable references for restoration. An assessment is underway to evaluate the feasibility of using phytolith (plant fossil) analysis to estimate past plant species composition as a reference for restoration activities at LAME. This assessment may greatly enhance the efficiency of restoration and allow park managers to assess what may be feasible to accomplish with restoration activities. This assessment will be presented to park managers upon completion early within another CESU task agreement.

**Miscellaneous Activities**

A. Close-out Reports for Clark County MSHCP

As part of this task agreement, UNLV assisted the NPS with writing a close-out report associated with funding from the Clark County MSHCP. The specific citation follows:

B. Meeting Key Southern Nevada Scientists and Agency Representatives

Upon arriving in the position in April 2006, the UNLV project manager for the vegetation program (S.R. Abella) has met with numerous individuals in southern Nevada to try to develop interagency partnerships and collaborations for rare plant monitoring and exotic species management. These meetings were with individuals from the BLM, USFS, U.S. Geological Survey, and the Clark County NRCS soil scientist. Some of these meetings were fruitful in terms of having individuals eager to collaborate, while others were not, which is to be expected. A particularly fruitful and ongoing collaboration has been with the Clark County soil scientist (D. J. Merkler), who has already collaborated on a soil phytolith assessment and in providing Clark County soil survey data in support of vegetation management efforts.

C. Southern Nevada Science Strategy Workshop

The UNLV project manager participated in the Invasive Species section of an August 2006 workshop at Desert Research Institute to prioritize science and research activities in southern Nevada. The two-day workshop was held as part of a SNPLMA Conservation Initiative to create an interagency Science and Research Strategy for Southern Nevada.

D. Northern Arizona University, Ecological Restoration Institute Research Collaboration

Vegetation program manager Scott Abella traveled to Flagstaff, Arizona, in September 2006 to visit sites of long-term restoration and monitoring research he had previously initiated. The purpose of this trip was to evaluate the potential for similar monitoring and research activities with LAME. The knowledge of what has and has not worked previously in other areas will provide for efficiencies when conducting similar activities within LAME.

E. Scholarly Activity

Summarized below is scholarly activity performed by Dr. Scott Abella in the past five months. The work in these articles was not funded or conducted under this task agreement, but final proof checking and publication of the articles was performed during the term of the task agreement. Several of the articles, such as seed bank research and ecological restoration, report information that is directly transferable to activities in the current and future task agreement:


