Final Project Report

Desert Pocket Mouse Surveys
Clark County, Nevada

Prepared For:

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ABBREVIATIONS

BCCE	Boulder City Conservation Easement
BLM	Bureau of Land Management
DCP	Desert Conservation Program
MSHCP	Multiple Species Habitat Conservation Plan
NDOW	Nevada Department of Wildlife
NDCNR	Nevada Department of Conservation and Natural Resources
NDNH	Nevada Division of Natural Heritage
SMA	Special Management Area
UNR	University of Nevada, Reno

EXECUTIVE SUMMARY

Chaetodipus penicillatus (desert pocket mouse) has been recommended for designation as a "Covered Species" in the proposed amendment to the Clark County Multiple Species Habitat Conservation Plan (MSHCP). The Clark County Desert Conservation Program (DCP) commissioned development of a habitat suitability model for the species to provide resource managers a tool for developing conservation goals and management strategies for the species. These models are extremely useful tools, but their effectiveness is tied directly to the number of confirmed observations of the particular species. Given relatively few confirmed observations of this species exist in southern Nevada, the resulting model and outputs must be used with caution.

DCP contracted BEC Environmental, Inc. (BEC) to implement a survey of *C. penicillatus* throughout the County to (1) develop a better understanding of the distribution of the species throughout the County, and (2) improve the predictability of the current habitat suitability model by confirming occupancy of the species in targeted areas.

BEC developed and implemented a project to survey areas throughout the County to determine the presence or absence of this species in ten targeted areas. These included areas proposed as MSHCP Amendment Impact Areas (high potential for development) and areas proposed as MSHCP Amendment Reserve System Areas, including existing reserve properties and proposed Special Management Areas (SMAs) (to be managed for conservation of multiple species). Sampling also occurred outside these areas to include locations predicted by the habitat suitability model to be suitable for the species. The survey was expanded to include an 11th target area, the Wetlands Park, to incorporate another conservation area with suitable habitat. Thirty-five trapping sites composed of three transects of twenty trap stations were allocated among the 11 target areas.

C. penicillatus is not abundant in southern Nevada and all confirmed observations of the species are within the Colorado River watershed. The low number of observations weakens the suitability model generated for the species. The physical similarities of this species to the more abundant and widespread *C. formosus* (long-tailed pocket mouse) results in misidentification of captured specimens if only observed and not evaluated morphologically, further weakening model effectiveness. Additionally, habitat preferences for *C. penicillatus* have not been well-studied, providing another level of difficulty in developing effective conservation measures for the species. One last factor potentially affecting the conservation and management of this species is the fact two subspecies are present in Clark County (*C. p. sobrinus* and *C. p. penicillatus*) and the boundary between these group along the Colorado River is unknown.

A total of 87 *C. penicillatus* individuals were captured during the study. *C. penicillatus* was found to be occupying five trapping sites in two areas with existing or proposed conservation goals, including the proposed SMA in Moapa and in the existing Wetlands Park. *C. penicillatus* was found to occupy eight sites within three areas identified as proposed MSHCP Impact Areas, including Laughlin, Moapa, and Urban Las Vegas. These findings expand upon 2020 surveys results where the species was found within the Riparian Reserve System parcels. *C. penicillatus* was found to be closely associated with the Colorado River watershed in areas with loose, sandy substrates and relatively dense shrub layers of varied species with some shrub interspace.

New objectives were identified as a result of this survey, including:

- **Conduct Robust Habitat Analysis Studies.** As stated in this report, the literature is not clear in characterizing the habitat of the *C. penicillatus*. Miccone (2003) and Herndon (2004) included habitat as a portion of their studies at the Springs Preserve and in the Las Vegas Wash,

respectively, and we recommend a future study that focuses specifically on this endeavor but at a larger scale.

- **Expand Current Study Beyond BLM and County- managed Lands**. Coordinate with other land managers within the County to identify habitats within their jurisdiction, primarily within the greater Colorado River watershed, for surveys to identify additional populations.
- **Confirm Boundary Between *C. p. sobrinus* and *C. p. penicillatus*.** Conduct sampling along the lower Colorado River between Boulder City and Laughlin to identify habitat and populations throughout the area, and identify potential barriers between subspecies.
- **Evaluate Interconnectedness Within *C. p. sobrinus* and Among Clark County Subspecies.** Ensuring connectivity among the *C. p. sobrinus* Moapa, Virgin River, Las Vegas, and Laughlin populations within the Colorado River watershed is important for the long-term conservation of the subspecies. Given that even the most thorough attempts at sampling a species' distribution will result in incomplete data; a genetic analysis will identify routes of geneflow and by extension, connectivity.

1 INTRODUCTION

1.1 Project Background and Need

Chaetodipus penicillatus (desert pocket mouse) has been recommended for designation as a "Covered Species" in the proposed amendment to the Clark County Multiple Species Habitat Conservation Plan (MSHCP). Understanding of the range, distribution, abundance, habitat preference, and population status of the species in Nevada is based on relatively few documented occurrences of the species, of which some include vague location information and others with unverified species identification. Limited information makes developing conservation goals and management decisions a challenge.

The Clark County Desert Conservation Program (DCP) commissioned development of habitat suitability models for species proposed to be included as Covered Species in the MSHCP. Resource managers use output from such models in many ways, including locating previously unknown populations of a species, assessing abundance/rarity of habitat, identifying potential conservation areas, and many others. However, resource managers must have some degree of certainty in the output of such models. Model certainty is based in part on the number of confirmed species observations used to build and train the models. The limited number of confirmed observations of the species has resulted in a model with a high level of uncertainty, and incorrect identification of suitable habitat based on known species ecology and field observations.

1.2 Project Goals

The primary goals of this project were to (1) develop a better understanding of the desert pocket mouse distribution throughout Clark County, and (2) improve the predictability of the current habitat suitability models by confirming occupancy of the species in targeted areas.

1.3 Project Description

Priority target areas for the project were identified by DCP and included those proposed as MSHCP Amendment Impact Areas and the proposed MSHCP Amendment Reserve System (including existing reserve properties and proposed Special Management Areas) (**Appendix 1 – Map Figures, Figure 1 – DCP Target Areas**). Impact Areas likely would be lost to development, and Special Management Areas would be managed for conservation purposes. Understanding occupancy of the species in these areas provides valuable information for species management and conservation.

To further address the project goals and provide additional data for habitat model refinement, areas outside of those identified by the DCP were included where predicted suitability was inconsistent with the observed habitat, or in areas where recorded species observations included unverifiable identification or location information.

Previous studies in Nevada have shown the species is found only within the Colorado River watershed; therefore, the project focused primarily within that watershed, but also included areas outside the watershed to confirm unverified observations of the species and to sample additional areas modeled as highly suitable habitat. Confirming presence of this species outside of the Colorado River Basin would significantly alter understanding of the species.

Within the targeted areas, priority trapping sites were identified as those where previous trapping or observations documented unverifiable or otherwise uncertain species identification, areas mapped as "optimal or suitable" habitat by the model, or areas observed by the BEC Team mammalogists to have appropriate habitat for the species but no recorded occupancy data. Areas with suitable habitat and verifiable occupancy data for the species were not prioritized for trapping to minimize redundancy.

Trapping efforts were conducted on lands managed by the Bureau of Land Management (BLM) or Clark County. Lands managed by other entities and BLM lands designated as Wilderness Study Areas, Wilderness Areas, and National Conservation Areas were excluded from consideration for this project due to timeframes required for obtaining permits and the seasonality of the surveys, but may be considered in future studies if necessary.

2 METHODS AND MATERIALS

2.1 BEC Project Team

The BEC Team conducting this survey included several individuals in various roles. Dr. Sean Neiswenter was the senior mammalogist for the project, providing technical guidance and oversight of the project. Dr. Neiswenter utilized his understanding of range, distribution, habitat requirements, taxonomic status, and morphology of this and associated species to assist in development of a technically sound plan, oversee implementation of field surveys in accordance with standards for animal welfare, and ensure specimens captured were correctly identified. Danielle Viglione was the assistant mammalogist supporting Dr. Neiswenter by developing the survey plan, implementing the field surveys, conducting the trapping and specimen preparation, collecting and managing the data, coordinating the field effort, and supporting development of the report. Danny Rakestraw was the project manager, providing general oversight of the project, land management agency coordination, quality control and technical reviews, and report development support. This team previously completed two small mammal projects for the DCP: the "Desert Upland Small Mammal Surveys II" (BEC Environmental, Inc., 2019) conducted within the bounds of the Boulder City Conservation Easement (BCCE) in 2019 and the "Riparian Small Mammal Surveys" (BEC Environmental, Inc., 2020) conducted within the bounds of the Riparian Reserve System in 2020.

2.2 Existing Data Resources and Limitations

BEC Team mammalogists obtained available data on documented observations of this species throughout Nevada to understand status of our knowledge of the species distribution and to confirm the validity of the observations. Data available for use in the development of the model were obtained from DCP, but most records did not include information needed to validate species identification or location. Additionally, observation data were also obtained from the Nevada Department of Conservation and Natural Resources' (NDCNR) Division of Natural Heritage (NDNH), which included some overlap with the data provided by DCP (Nevada Division of Natural Heritage, 2021). The observation data obtained from the NDNH included information such as year of observation, visual/incidental observation versus specimens taken and confirmed, name of observer, and location data.

The BEC Team also reviewed other literature which provided information regarding observations and captures, or otherwise documented the presence of the species in a particular area (Hall, 1946) (Micone, 2002) (Herndon, 2004) (Jezkova, 2009). These sources were reviewed to evaluate the potential accuracy of the location and species identification. Observations that did not include capture and preparation of the specimen or collection of a tissue sample to confirm species identification based on internal morphological characteristics or genetics were deemed as unconfirmed due to the difficulty in species identification without these procedures. The BEC Team also evaluated the validity and potential accuracy of the location information for the observation to the extent possible based on available information within the reviewed literature.

2.3 Target Area Identification

Based on the goals of the project, the BEC Team reviewed geospatial data provided by the DCP, the BLM, and other sources, to identify proposed Target Areas within which Trapping Sites could be distributed/allocated. Target Areas are relatively large, geographically distinct, or isolated areas that meet one or more of various criteria given the multiple goals of the project. Generally, Target Areas met one or more of the following criteria:

- Areas within the proposed MSHCP Amendment Reserve System and Amendment Impact Areas with potential habitat based on evaluation of aerial imagery or modeled as Optimal, Suitable, or Marginal habitat by the DCP Habitat Suitability Model (Nussear, 2020).
- Areas on BLM- or County-managed lands within the Colorado River watershed and areas in adjacent, closed basins with previous records of the species.
- Other areas modeled as Optimal, Suitable, or Marginal for the species by the DCP Habitat Suitability Model (Nussear, 2020).
- Areas where the evaluation of aerial imagery and familiarity with the area indicate the potential presence of suitable habitat for the species but did not fall within the other criteria.

Based on this initial review, BEC mammalogists identified ten general Target Areas (**Appendix 1, Figure 2 – Project Target Areas)**. As the project progressed, the BEC Team and DCP agreed reallocating some survey efforts to the Wetlands Park (an eleventh Target Area) was warranted as discussed below.

2.4 Trapping Site Allocation and Selection

The BEC Team reviewed each of the Target Areas and determined 35 Trapping Sites distributed among the Target Areas would be adequate for an initial evaluation based on the amount and quality of habitat mapped as available, amount and certainty of previous occupancy data, and guidance provided by the DCP. The distribution of sample sites is shown in **Table 1: Target and Final Site Distribution per Area**.

The specific location of each Trapping Site and the placement of three transects within the site were then determined during reviews of aerial imagery and reconnaissance of the area based on the following criteria:

- Available access to the site from existing, approved roads and on foot.
- Minimal sign of recent human activity to minimize chance of vandalism or theft of traps.
- Areas predicted by the DCP Habitat Suitability Model to have the highest suitability for the species.
- Areas with recorded observations of unverified or questionable species identification.

Presence of habitat considered preferred or suitable for the species was based on field observations and judgement of the mammalogists using the described range of habitats documented as used by the species.

Throughout the project, the team adjusted the number of sites distributed among the Target Areas based on the amount or condition of habitat observed during reconnaissance of the areas. Due to lack of habitat or confirmed species observations in the Jean/Ivanpah area, two sites from this area were re-allocated to Jean Lake to target areas with recorded species observations. Due to lack of habitat and extensive surveying performed under a previous DCP project (BEC Environmental, Inc., 2019), three sites from the BCCE were re-allocated to the Wetlands Park. The Wetlands Park was not initially a Target Area due to not being within the proposed MSHCP Amendment Reserve System or Amendment Impact Areas; however, the habitat was extremely suitable and previous reports stated the species was captured in the park, but specimens were not collected to confirm identification. The initial and final trapping site

distribution are summarized in **Table 1: Target and Final Site Distribution per Area** and shown in **Appendix 1, Figure 3a – Trapping Sites within North Target Areas** and **Figure 3b – Trapping Sites within South Target Areas**.

Table 1: Target and Final Site Distribution per Area

Target Areas	Initial Target Number of Trapping Sites per Area	Final Number of Trapping Sites per Area
Apex/North Las Vegas	5	5
Boulder City Conservation Easement*	4	1
Jean/Ivanpah*	4	2
Jean Lake *	2	4
Laughlin	3	3
Moapa	7	7
North of Lake Mead	2	2
Sloan	2	2
South of Henderson	2	2
Urban Las Vegas	4	4
Wetlands Park*	0	3
Total	***35***	***35***

*Indicates change in number of sites from the number initially planned in the Work Plan.

2.5 Field Methods

BEC mammalogists conducted reconnaissance of the Target Areas and initially identified trapping sites to confirm the previous assessment of the site location would accomplish the project goals and meet the above criteria, and to determine the time required to access the sites to plan sufficient time to set and collect traps without putting animals at risk from heat.

Not more than two hours before sunset on the evening of trap setting, the mammalogists designated the starting points and direction of each transect in a designated site(s). Twenty trap stations of two traps each were laid per transect; each designated site was allocated three transects. Each station was approximately ten meters apart, but the distance was adjusted as needed based on terrain and vegetation. When the location of each station was identified, the mammalogists baited and set the traps.

The following morning, shortly after sunrise, the mammalogists began checking all traps set the previous night. Site, transect, and specimen data were collected and recorded using a custom-built Fulcrum (commercial data collection and form building application) application on a Trimble TDC600 handheld GPS unit. Data collected included GPS coordinates, habitat description, and representative habitat photos. For traps containing an animal, mammalogists observed and documented the species and condition of the animal, took a representative photo, recorded the location of the trap, and either released the animal or collected it as a voucher specimen if needed (see Section 2.6). After the last trap was checked, mammalogists measured and recorded temperatures. Data were reviewed within the Fulcrum application prior to departing the trapping site to confirm all data were captured, locations were mapped correctly, and photos were saved.

2.6 Collecting Voucher Specimens

Correct taxonomic identification of the species and confirmed differentiation of the species from *Chaetodipus formosus* (long-tailed pocket mouse) is critical when developing habitat suitability models and establishing conservation goals, given *C. formosus* is found throughout the region in varied habitat and *C. penicillatus* is found in unique habitats in declining abundance. Misidentification of the two

similar species would bias habitat models, assessments of population trends, and other management and conservation tools.

The most effective method for establishing a reliable and permanent species record is via the collection and accession of specimens of species captured during a project. Additionally, evaluation of morphological characteristics of the skull is the most reliable method to confidently differentiate *C. penicillatus* from *C. formosus* and confirm the field mammalogists preliminary designations. During the project, representative specimens of *Chaetodipus* sp. captured at each site were collected, their species identity confirmed by morphological measurements, and the specimens were prepared to be submitted to the Angelo State Natural History Collection in accordance with standard specimen preparation protocol. Several specimens of additional species captured during the survey were collected for future reference and in support of scientific record in accordance with Dr. Neiswenter's Nevada Department of Wildlife (NDOW) scientific collection permit and the Work Plan developed for the project (Project No. 2017-BEC-1782A; Deliverable No. 04 - Permits).

3 RESULTS AND EVIDENCE OF THE RESULTS

3.1 Trapping Results

During this project, 4,160 trap-nights were successfully completed on 104 transects within the 35 trapping sites across the 11 Target Areas included in **Table 1**. During this effort, 729 individual small mammals were captured representing 13 different species. In addition, two birds, two lizards, one cottontail, and one scorpion were captured in the traps. Unfortunately,125 trap-nights were lost due to closed traps from investigation/molestation by rodents or other animals, weather, theft, and other unknown causes. Ten of the trapped animals were found dead within the traps due to injuries (existing or sustained in trap), ants, and other unknown causes. A table summarizing number of each species caught within each trapping site is included in **Appendix 2**, and representative photos of each species captured are included in **Appendix 3**.

In support of the primary goal of the project, 87 individual *C. penicillatus* were captured, identified, and recorded on 13 of the 35 trapping sites, within 4 of the 11 Target Areas trapped (**Table 2: Target Areas with Positive Captures of *C. penicillatus***). **Appendix 1, Figure 4 – Survey Results** shows the distribution of the successful captures throughout the project area and locations in which the species was not captured along with the results of the 2020 Riparian Rodents Survey conducted in the Riparian Reserve Units (BEC Environmental, Inc., 2020).

3.2 Trapping Site Habitat Descriptions

Brief habitat descriptions and photos were collected for each Trapping Site and each transect. This information is included in the data set provided to the DCP as a deliverable for this project. To provide the readers an indication of the habitat observed in each area, and to support the discussion below, a general description of habitat observed at each trapping site within the target areas is included in **Appendix 4**.

Table 2: Target Areas with Positive Captures of *C. penicillatus*

Target Area, Site Number	Number of *C. penicillatus* Captured	Land Management Type
Laughlin, 1	4	Proposed Impact Area
Laughlin, 2	8	Proposed Impact Area
Laughlin, 3	8	Proposed Impact Area
Moapa, 1	17	Proposed Impact Area
Moapa, 3	2	Proposed Special Management Area
Moapa, 4	3	Proposed Impact Area
Moapa, 5	10	Proposed Impact Area
Moapa, 6	4	Proposed Impact Area
Moapa, 7	12	Proposed Special Management Area
Urban Las Vegas, 4	1	Proposed Impact Area
Wetlands Park, 1	10	Reserve System
Wetlands Park, 2	4	Reserve System
Wetlands Park, 3	4	Reserve System
Total	***87***	

4 EVALUATION/DISCUSSION OF RESULTS

During development and implementation of this project, the team reviewed data collected and documents developed in support of the MSHCP, data and documents developed as part of the Lower Colorado River Multiple Species Conservation Plan, and peer-reviewed literature from throughout the range of the species. In comparing the information from these sources and the results of this project, numerous discussion topics arose. Below are several of the topics more pertinent to the purpose of this project, as well as to the conservation of the species.

4.1 Preferred/Occupied Habitat Characteristics

One of the primary goals of this project was to provide additional information to enhance habitat suitability models developed for the MSHCP for the species. The current models are not intended to predict locations of the microhabitat preferred or utilized by the species; the models use habitat and surrogate data at a scale too large to capture such fine scale characteristics due to the size of the area covered and the number of species addressed (Nussear, 2020). Regardless, a discussion on the habitat preferences or requirements of the species and observations from this survey seem appropriate.

In reviewing published documents (journal articles, governmental reports, species accounts, etc.), the general consensus seems to be the species is found in areas with "sandy or alluvial soils with sparse or scattered shrubs, associated with creosote bush or mesquite." Some descriptions include or replace mesquite with salt bush (Hoffmeister, 1986). In most cases, these statements are followed by multiple acknowledgements that the species has been captured in or adjacent to dense stands or thickets of various species, including arrowweed, mesquite, tamarisk, and some grasses where they also have a shrub canopy (Mantooth, 2005). The generalization followed by the multiple exceptions warrants an explanation or clarification of some sort. It is unclear if the original authors of this statement were documenting that observations/captures of the species were typically in open, sparsely vegetated areas and the noted exceptions were truly exceptions, or if the authors were describing the general creosote bush (or mesquite) community where shrub density is low, and the microhabitats the species prefer, are the more densely vegetated areas where they were trapped.

Some documents providing a more detailed discussion of habitat associated with verified captures of the species indicate the species utilizes washes or floodways with tall shrub cover compared to adjacent uplands, with or without herbaceous groundcover (Hall, 1946) (Micone, 2002) (Herndon, 2004) (Lower Colorado River Multi-Species Conservation Program., 2016). Associated vegetative species included arrowweed, quailbush, saltbush, tamarisk, and some grasses. One factor mentioned consistently related to habitat was the need for loose, sandy, or silty soil that is friable and not compacted to support development of burrows.

During this study, mammalogists surveyed washes and other features with silty, fine sand, coarse sand, and small gravel substrates which possessed a range of densities and species of herbaceous and shrub species. This range of habitats was included to represent the stated breadth of habitat preferences described in the literature and accomplished several objectives:

- Provide future modeling efforts a more robust dataset to use, particularly if such models utilize negative data and are able to include microhabitat characteristics.
- Support an effort to narrow down the habitat characteristics where species may be found in Nevada, supporting future conservation goals.
- Maximize the number of captures of the species.
- Reduce the potential bias of the mammalogist from targeting preconceived characteristics of habitat based on previous experience.

During this study, *C. penicillatus* was found consistently in sandy or silty lowlands, floodplains, or shorelines associated with permanent or ephemeral but regular water sources (river, stream, spring, reservoir, or wash) which supported moderate to dense shrubs, including quailbush, tamarisk, and arrowweed with some shrub interspace, sometimes associated with mesquite, acacia, willow, tamarisk, or cottonwood overstory, and other times with no canopy layer. The areas with the largest number of captures occurred in washes and floodways with sandy soils and dense shrub layers over approximately two feet high, typically with some shrub interspace for foraging. These results are consistent with literature the microhabitats used by the species and a previous study within the Riparian Reserve System (BEC Environmental, Inc., 2020). The species was not captured in areas with sparse vegetation and/or gravelly to rocky soils. In these areas, if a *Chaetodipus* was captured, it was consistently *C. formosus*. Likewise, the species was not captured during the previous surveys in the BCCE, which possessed the soils and some areas of moderately dense shrubs, but no water sources to support the densities seemingly required for the species (BEC Environmental, Inc., 2019).

4.2 Impact Areas and Conservation Areas

Eight sites within proposed MSHCP Impact Areas included in this study were found to be occupied by the species, including Laughlin, Moapa, and Urban Las Vegas (**Table 2**). All these areas possessed habitat mammalogists considered suitable for the species, with sandy soils and significant stands of shrubs and other vegetation (**Appendix 4**). If these areas are developed at some time in the future, this habitat and the populations in the area will likely be lost.

Two sites within proposed MSHCP Special Management Areas (SMAs) (both in Moapa) and three sites within the Wetlands Park were found to be occupied by the species; these areas also contained the most potential habitat and the greatest number of species observed. While Moapa was the largest SMA with potential for future conservation, most of these parcels include only small slivers of the wash/riparian habitat used by the species, with the remainder of the areas being Mojave desert uplands. The Wetlands Park is dedicated to conservation and education, so these populations here are likely already fully protected.

MSHCP Reserve System properties were surveyed during previous studies. The existing BCCE was trapped in 2019 and once for this study; the target species was not captured, but the objective of the 2019 study was a general inventory of small mammals, and *C. penicillatus* specifically was not targeted. However, habitat consistent with requirements for the species were not observed within the bounds of the easement (BEC Environmental, Inc., 2019). The Riparian Reserve System was surveyed in 2020 (BEC Environmental, Inc., 2020) and the species was captured throughout many of the parcels (**Table 3: Captures of *C. penicillatus* from the 2020 Riparian Rodent Survey**).

Table 3: Captures of *C. penicillatus* from the 2020 Riparian Rodent Survey

Riparian Reserve Unit Name	Number of *C. penicillatus* Captured
Muddy River	4
Mormon Mesa	1
Bunkerville West	3
Bunkerville East	8
Mesquite West	0
Riverside	11
Total	***27***

Based on these results, the species would be impacted by the loss of occupied habitat associated with the development of the proposed MSHCP Impact Areas, and some habitat will be protected within the Riparian Reserve System, the Wetlands Park, and several of the proposed SMAs. This survey did not include potential habitat within the Lake Mead National Recreation Area, Floyd Lamb Park at Tule Springs, or the Fossil Beds National Monument, all of which may provide habitat for this species and are currently managed for conservation.

4.3 Previously Documented Species Observations

As discussed above, biologists reviewed previously documented observations of the species to help prioritize areas for distribution of the limited sampling effort. Part of that review included an assessment of the validity/credibility/confirmability of the species identification and accuracy or precision of the location descriptions. Existing data points for the species were obtained by the BEC Team from the NDNH. Many of these data points corresponded with data provided by the DCP as those evaluated and possibly utilized in development of the habitat suitability model.

Although many of the data points referenced existing, verifiable voucher specimens (and presumably verified taxonomy), some localities consisted of data points with no reference to voucher specimens or other means of confirming correct species identification. In other cases, the points are simply listed as observations with no additional information. Data points near Sloan, South Henderson, North Las Vegas, and the southwest portion of urban Las Vegas were all noted to be "observations."

Additionally, a grouping of data points in the Jean Lake area indicated specimens identified as *C. penicillatus* were captured and collected by a project conducted by professors and students from the University of Nevada, Reno (UNR). The BEC Team could not locate the repository for these vouchers to confirm positive identification. If these specimens were correctly identified as *C. penicillatus* this would mark a departure from the general understanding of the preferred habitat for the species and know its distribution in Nevada outside of Colorado River watershed. This location was trapped during this project due to this potential significance, but habitat indicative of the species was not observed and no *C. penicillatus* were captured. Also, while other species were captured in the Jean Lake area, no *C. formosus* were captured despite the habitat observed being suitable for that associated with *C. formosus* and could have resulted in potential misidentification of the species during the UNR study, despite the trapping results from the current survey.

Correct identification of species observations used in developing habitat suitability models and conservation and management planning in general is required when the status and habitat preferences of the associated species do not vary greatly. *C. penicillatus* and *C. formosus* are very difficult to differentiate with a live specimen and occupy microhabitats immediately adjacent to each other, providing an ideal opportunity for misidentification of the species. Additionally, *C. formosus* will occupy *C. penicillatus* microhabitat when that species is not present, increasing the potential for misidentification if habitat is factored in.

The variability in pelage coloration (one of the identifying features) amongst individuals of the same species is high and can be dependent on substrate in the area (Hall, 1946). Even to a trained mammalogist, a visual observation of the species without careful examination or comparison to other individuals in the area can make identification between *C. penicillatus* and *C. formosus* challenging. In instances where external characteristics are intermediate or indistinct, the only way to confirm species identity is to measure cranial features of the specimen. Even with specimens collected, without documentation of species confirmation, or the ability to locate the voucher repository to obtain this information, the validity of the species identity should be considered unconfirmed and used with caution.

4.4 Challenges with Habitat Suitability Models

Because of the limited number of data points available for this species, it is likely any of the unverifiable points from existing studies could have skewed the habitat model to indicate the species is present in areas it likely is not.

The most heavily contributing input variables used in the DCP model (Nussear, 2020) to describe suitable habitat and predict the species presence were climate related metrics: extreme maximum temperature, average maximum temperatures, winter precipitation, and average minimum temperature. Although these characteristics may accurately reflect the characteristics of preferred *C. penicillatus* habitat, they may not be limiting enough factors to pinpoint the microhabitats preferred by the species. *C. penicillatus* is most often associated with dense, brushy, vegetative cover in locations with sandy or silty soils near sources of water and associated with riparian habitat. This habitat type is frequently immediately adjacent to the much more broadly distributed Mojave desert scrub habitat. These two habitat types are not distinguishable based on climate characteristics alone; therefore, the model appears to have incorrectly mapped a large amount of Mojave desert scrub ecosystem within the County (382,508 hectares) as highly suitable for the species due to its proximity, scale, and shared climate characteristics between the adjacent ecosystems.

A species with such specific microhabitat requirements will likely require a model considering factors such as soil type, vegetation cover density, and proximity to water and be mapped with a small pixel size. Having more consistent and well-documented data on species habitat requirements as well as a higher number of verified species occurrence data points would likely lead to a more refined and precise model of habitat suitability for the species.

4.5 Species, Subspecies, and Conservation

Several subspecies of *C. penicillatus* have been identified and are currently recognized, including *C. p. sobrinus* which is located exclusively within the Colorado River watershed in Nevada and possibly in southwestern Utah and northwestern Arizona. The southern range of this subspecies is unconfirmed but is somewhere between Boulder City or possibly Searchlight and Laughlin. Jezkova et al (Jezkova, 2009) supports the validity of this separation, and further states *C. p. sobrinus* is likely more closely related to *C. p. stephensi* in the Death Valley area than to *C. p. penicillatus*. This current study did not attempt to differentiate or address the *C. p. sobrinus* versus *C. p. penicillatus* taxonomic questions or any associated conservation issues. However, given the available literature, it appears these subspecies have similar

habitat preferences or requirements, therefore habitat suitability modeling may not be affected by the lack of differentiating between subspecies, therefore conservation and management decisions made for one would benefit the other. However, if the *C. p. sobrinus* is the taxonomic level included as a covered species in the amended MSHCP, understanding the location of separation for these subspecies may be valuable regarding utilization of conservation resources.

5 CONCLUSIONS

The following notable conclusions have been developed based on the results of this survey.

- *C. penicillatus* was found to be occupying five trapping sites in two areas with existing or proposed conservation goals, including proposed SMAs in Moapa and the Wetlands Park. These findings expand upon 2020 surveys results (BEC Environmental, Inc., 2020) where the species was found within the Riparian Reserve System parcels.
- *C. penicillatus* was found to occupy eight sites within three areas identified as proposed MSHCP Impact Areas, including Laughlin, Moapa, and Urban Las Vegas.
- *C. penicillatus* appears to be closely associated with the Colorado River watershed in areas with loose, sandy substrates and relatively dense shrub layers of varied species with some shrub interspace.
- Unconfirmed identification of the species, particularly differentiating it from the more generalist *C. formosus*, may have a significant impact on the habitat suitability modeling and its ability to predict where the species may occur presently and where it may occur with climatic changes.

6 RECOMMENDATIONS AND NEW OBJECTIVES

6.1 Recommendations

The following are recommendations the BEC Team identified for the DCP to consider as conservation and management planning associated with this species moves forward.

Use unconfirmed species observations cautiously. Species identification remains questionable for some of the localities we presume were used in the habitat suitability models. Specifically, we were unable to find any areas in or around Jean Lake with habitat characteristics similar to *C. penicillatus* habitat observed elsewhere in this study or in the literature, and we were unable to locate voucher specimen to confirm species identification. These localities are unusual based on geography and habitat, and we believe unlikely to support *C. penicillatus*. It is possible the original specimens were misidentified *C. formosus*; however, without a voucher specimen this will remain unknown. We recommend not using observations in the Jean or Jean Lake area when building models or other conservation planning until the voucher specimens can be located and identification verified.

Temper reliance on the Habitat Suitability Model for this species for conservation decisions until it is updated with new observations. While habitat suitability and species distribution models can be effective in identifying general areas with likely occurrences, they do not identify where a species actually occurs or whether or not the habitat that the species requires is in that area. This disconnect is exacerbated when such modeling is attempted using large-scale climatic or landscape-scale topography variables for a species with such a narrow microhabitat niche. We found several examples of discrepancies between what the model predicted as high suitability of habitat or probability of presence of the species and what we qualitatively know of its habitat preferences. For example, barren areas of rocky substrate desert were on several occasions identified as highest suitability; however, we know from experience and a review of the literature that this species is found in sandy substrates with bushy vegetative cover. Such models may improve over time with the

addition of a large number of observed locations with confirmed identification, but our recommendation is to proceed with caution in utilizing the current models for making conservation decisions.

6.2 New Objectives

The following items are potential new objectives for the DCP to consider in furthering the understanding of this species and possibly the subspecies present within the County, and develop additional tools and conservation objectives to be addressed in the MSHCP.

Conduct Robust Habitat Analysis Studies. As stated in this report, the literature is not clear in quantifying the habitat of the *C. penicillatus.* Miccone (2003) and Herndon (2004) included habitat as a portion of their studies at the Springs Preserve and in the Las Vegas Wash, and we recommend a future study that focuses specifically on this endeavor but at a larger scale. Identifying not only the specific habitat preferences of the species but also population density among different areas and habitats would aid modeling attempts by providing more useful dependent variables than just climate variables for the model. Such information also would provide baseline density estimates for monitoring status and trends in the populations.

Expand Current Study Beyond BLM and County- managed Lands. Coordinate with other land managers within the County to identify habitats within their jurisdiction, primarily within the greater Colorado River watershed, for surveys to identify additional populations. Potential areas for subsequent surveys include Lake Mead National Recreation Area, Floyd Lamb Park at Tule Springs, Fossil Beds National Monument, the springs at the Desert Wildlife Range Corn Creek Station, and Overton Wildlife Management Area.

Confirm Boundary Between *C. p. sobrinus* and *C. p. Penicillatus*. Conduct sampling along the lower Colorado River between Boulder City and Laughlin to identify habitat and populations throughout the area, and identify potential barriers between subspecies. Close attention should be paid to the discrepancy among authorities in terms of where the subspecies boundary or boundaries are likely to occur.

Evaluate Interconnectedness Within *C. p. sobrinus* and Among Clark County Subspecies. Ensuring connectivity among the *C. p. sobrinus* Moapa, Virgin River, Las Vegas, and Laughlin populations within the Colorado River watershed is important for the long-term conservation of the subspecies. Given that even the most thorough attempts at sampling a species' distribution will result in incomplete data; a genetic analysis will identify routes of geneflow and by extension, connectivity.

Genomic markers such as restriction site-associated DNA sequencing (RADseq) could be used to identify geneflow among populations within and among the subspecies, establishing subspecies boundaries. The exact distribution of *C. p. sobrinus* is not well understood given uncertainties in the southern limits of its described distribution. No definitive boundary has been identified that would limit introgression among other subspecies of *C. penicillatus* (e.g., *penicillatus* to the south and *stephensi* to the northwest). More accurate taxonomic information will help alleviate the uncertainty in geographic distribution leading to better model design by including only the appropriate subspecies. Other outcomes of this analysis will be a clear understanding of gene flow among the populations within *C. p. sobrinus* throughout its current distribution, which is becoming increasingly sparse and fragmented.

7 LITERATURE CITED

BEC Environmental, Inc. (2019). Desert Upland Small Mammal Surveys II. Boulder City Conservation Easement, Eldorado Valley, Nevada.Final Project Report Prepared for Desert Conservation Program, Clark County Department of Air Quality, Nevada.

BEC Environmental, Inc. (2020). Small Mammal Surveys of the Riperian Reserve Units Muddy River and Virgin River, Clark County, Nevada. Final Project Report Prepared for Desert Conservation Program, Clark County Department of Air Quality, Nevada.

Hall, E. (1946). *Mammals of Nevada.* Reno: University of Nevada Press.

Herndon, C. (2004). *Vegetation characteristics associated with small mammal populations in the Las Vegas Wash.* Retrieved from UNLV Theses, Dissertations, Professional Papers, and Capstones: http://dx.doi.org/10.34917/1439419

Hoffmeister, D. (1986). *Mammals of Arizona.* Tucson: University of Arizona Press.

Jezkova, T. J. (2009). Pleistocene Impacts on the Phylogeography of the Desert Pocket Mouse (Chaetodipus penicillatus). *Journal of Mammalogy*, 90(2):306-320.

Lower Colorado River Multi-Species Conservation Program. (2016). *Species Accounts for the Lower Colorado River Multi-Species Conservation Program.* Retrieved from http://www.lcrmscp.gov

Mantooth, S. B. (2005). Chaetodipus penicillatus. *Mammalian Species*, 767: 1-7.

Micone, K. D. (2002). *Demographics and ecology of an isolated population of a desert pocket mouse, Chaetodipus penicillatus sobrinus, in the Las Vegas Valley, Nevada*. University of Nevada Las Vegas.

Nevada Division of Natural Heritage. (2021). Letter Response to Data Request for Occurances of the Desert Pocket Mouse. Letter received February 4, 2021, from Eric Miskow, Biologist/Data Manager.

Nussear, K. E. (2020). *Covered Species Analysis Support - Final Report for 2013-UNR-1460E. Submitted to Clark Couny Desert Conservation Program.* Reno: University of Nevada.

APPENDIX 1

Map Figures

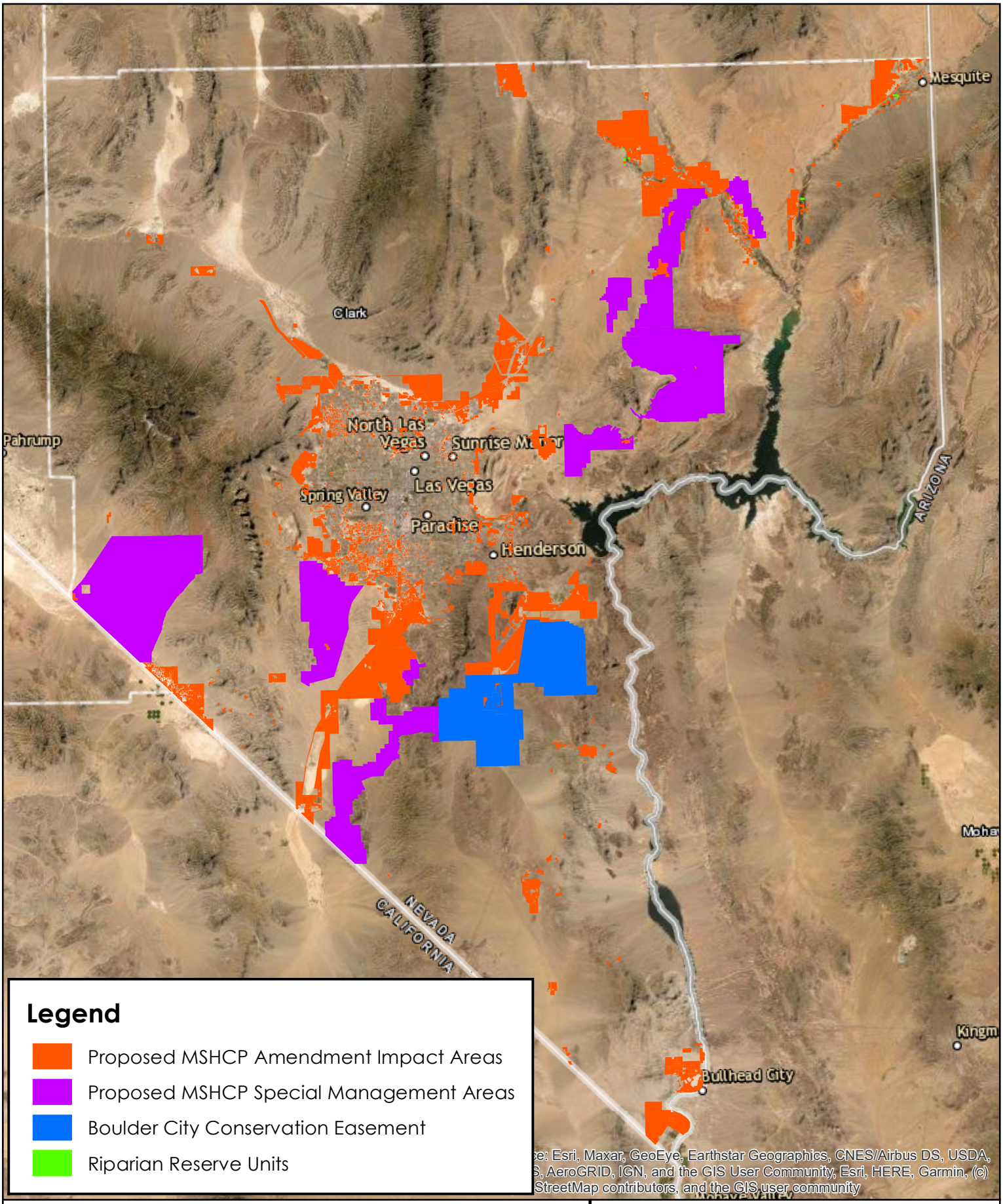

Figure 1 - DCP Target Areas

Priority Study Areas Targeted by DCP for the Project.

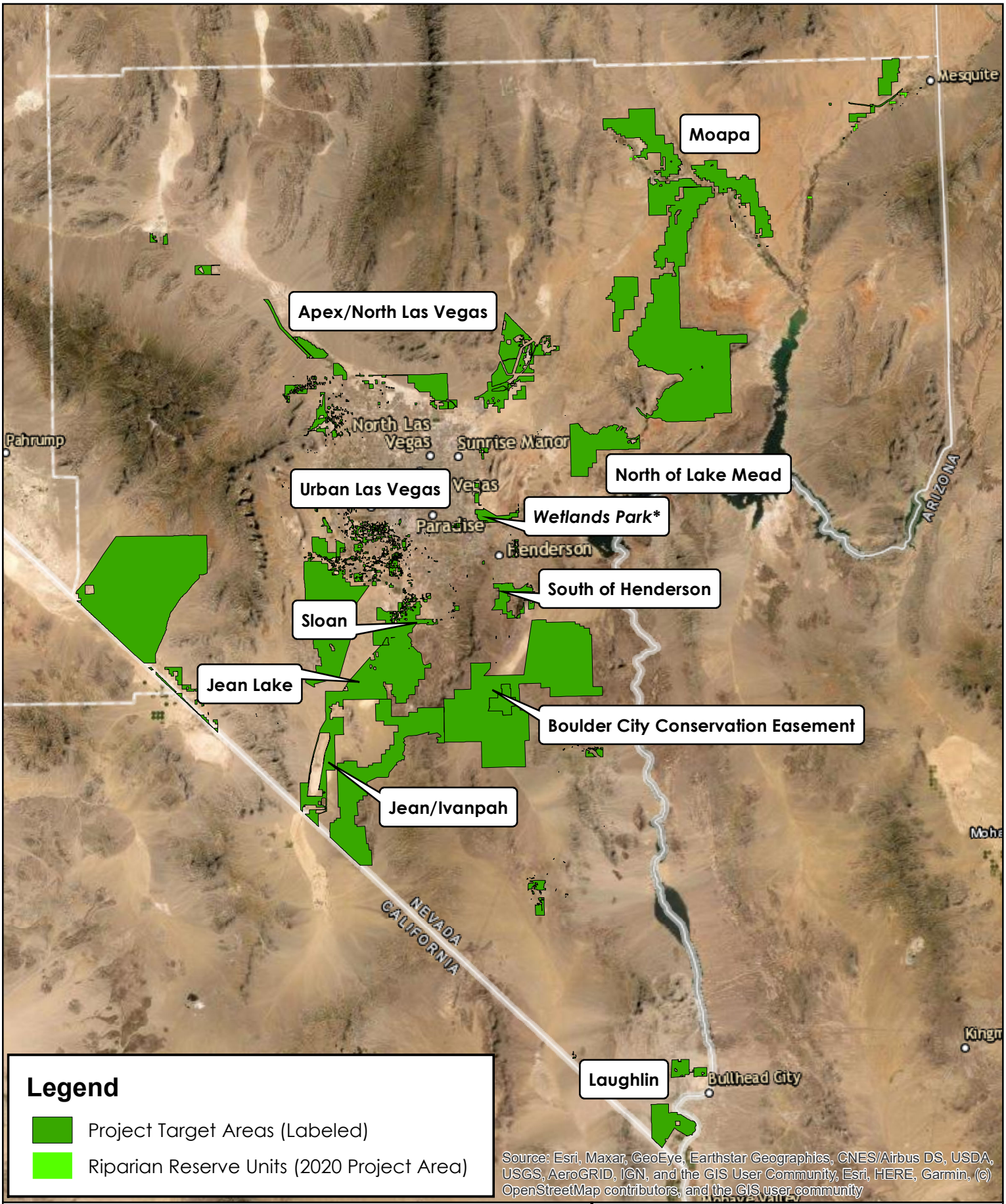

Figure 2 - Project Target Areas

Project Target Areas (general locations labeled) selected from the DCP Project Area and Riparian Reserve Units. *Wetlands Park was Later Added as an 11th Target Area.

N

Miles

0 5 10 20 30

bec environmental, inc.
Environmental Services

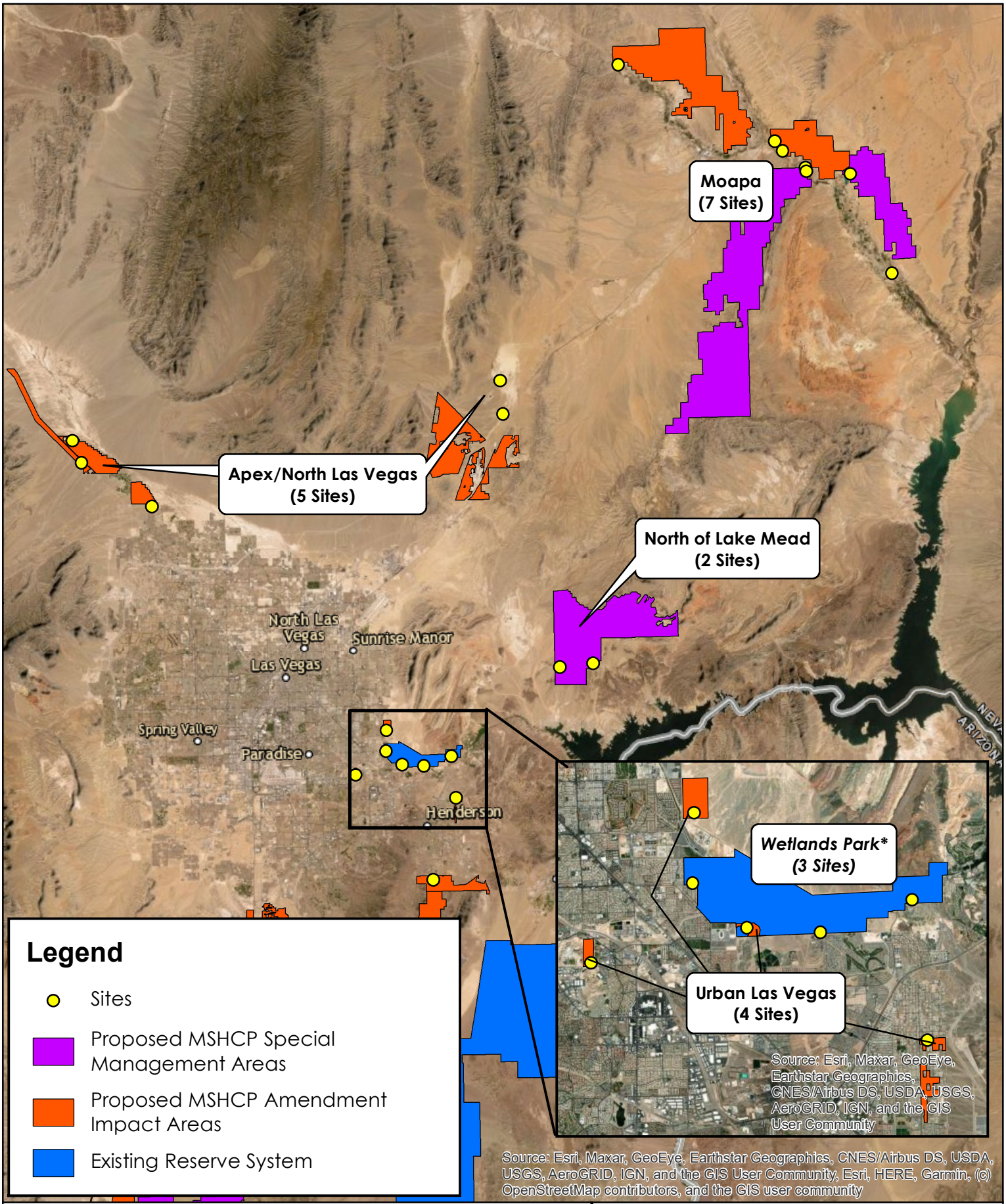

Figure 3a - Trapping Sites within North Target Areas

Trapping Sites selected and distributed across the Target Areas in the Northern portion of the County.

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bec environmental, inc.
Environmental Services

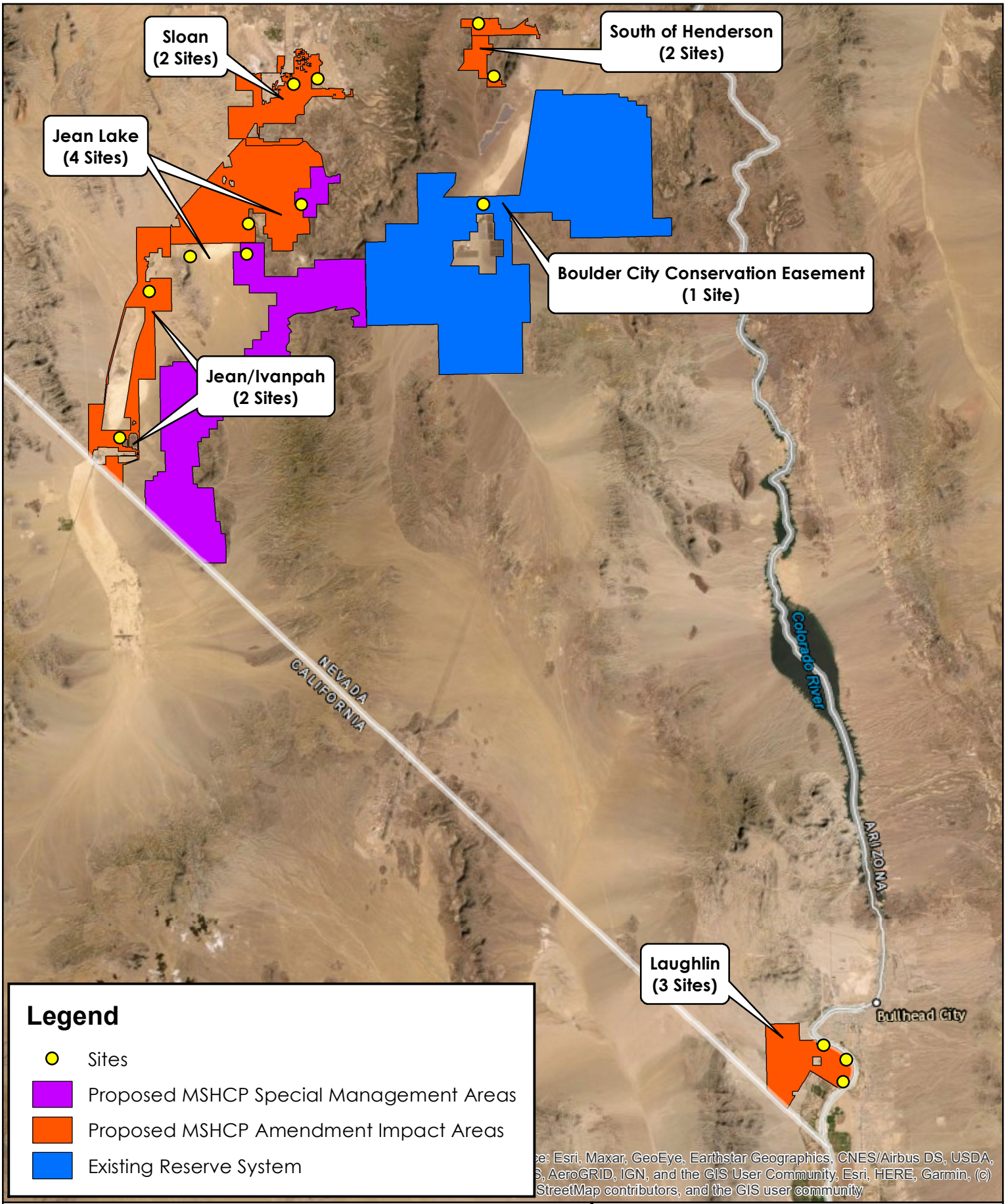

Figure 3b - Trapping Sites within South Target Areas

Trapping Sites selected and distributed across the Target Areas in the Southern portion of the County.

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bec environmental, inc.
Environmental Services

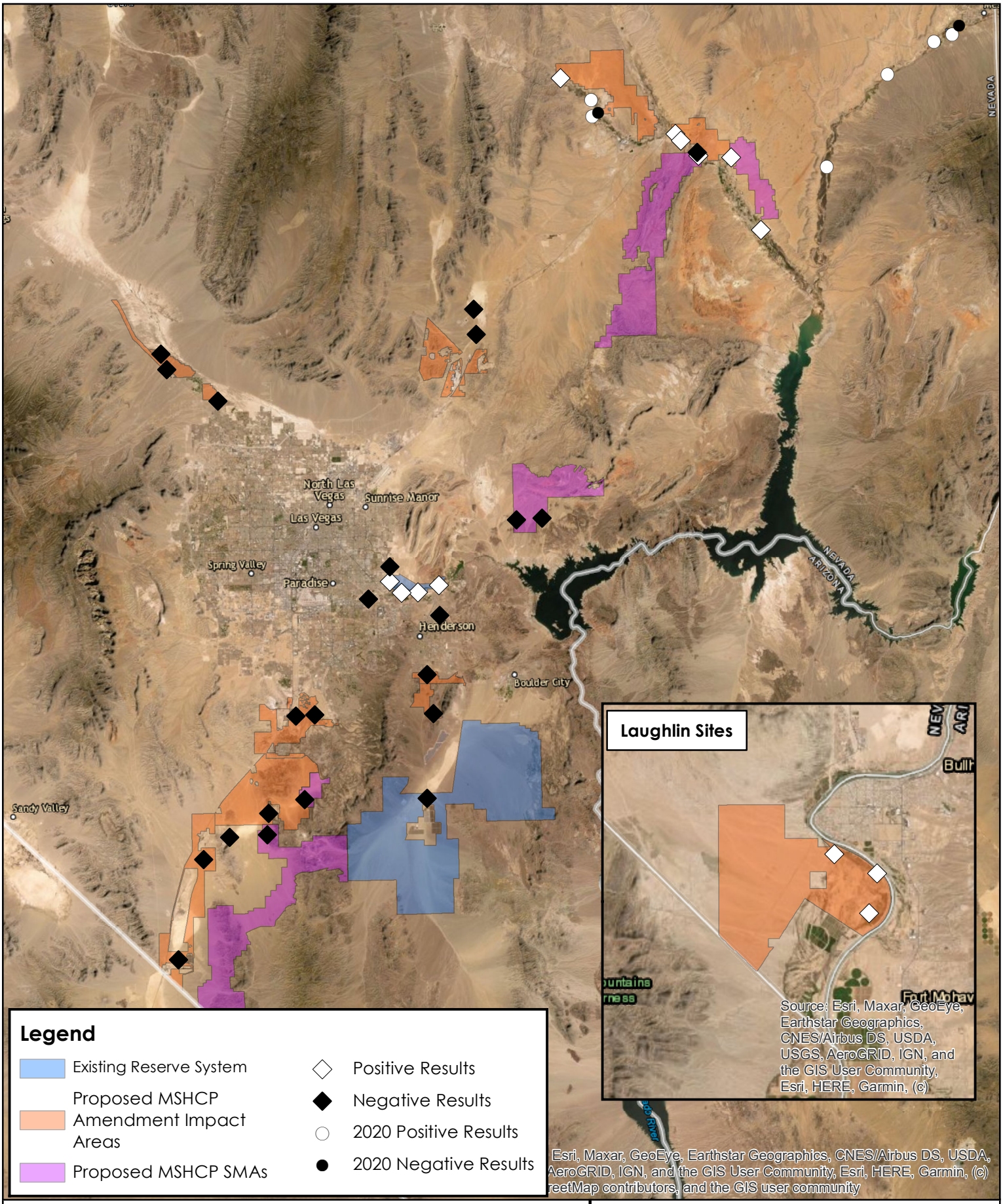


Figure 4 - Survey Results

Positive results indicate locations in which *Chaetodipus penicillatus* was captured in this study and in the 2020 Riparian Rodent Survey conducted by BEC.

N

Miles

0 3.5 7 14 21

bec environmental, inc.
Environmental Services

APPENDIX 2

Species Summary per Target Area

Trapping Sites within Target Areas	SPECIES*													
	AMLE	CHFO	CHPE	DIDE	DIME	MUMU	NELE	ONTO	PEER	PELO	RARA	REME	XETE	TOTAL
Apex/North Las Vegas	**7**	**1**	**-**	**-**	**24**	**1**	**2**	**-**	**6**	**-**	**-**	**-**	**-**	**41**
Apex/North Las Vegas, 1	1	-	-	-	5	-	-	-	1	-	-	-	-	7
Apex/North Las Vegas, 2	1	-	-	-	1	-	1	-	-	-	-	-	-	3
Apex/North Las Vegas, 3	-	-	-	-	1	1	1	-	5	-	-	-	-	8
Apex/North Las Vegas, 4	1	1	-	-	7	-	-	-	-	-	-	-	-	9
Apex/North Las Vegas, 5	4	-	-	-	10	-	-	-	-	-	-	-	-	14
Boulder City Conservation Easement	**1**	**1**	**-**	**-**	**6**	**-**	**1**	**-**	**-**	**6**	**-**	**-**	**-**	**15**
Boulder City Conservation Easement, 1	1	1	-	-	6	-	1	-	-	6	-	-	-	15
Ivanpah/Jean	**2**	**-**	**-**	**2**	**22**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**27**
Ivanpah/Jean, 1	2	-	-	2	17	-	-	-	-	-	-	-	-	21
Ivanpah/Jean, 2	-	-	-	-	5	-	-	-	-	1	-	-	-	6
Jean Lake	**3**	**-**	**-**	**5**	**45**	**-**	**1**	**-**	**1**	**2**	**-**	**-**	**1**	**58**
Jean Lake, 1	-	-	-	2	9	-	-	-	-	1	-	-	-	12
Jean Lake, 2	-	-	-	1	18	-	-	-	-	1	-	-	1	21
Jean Lake, 3	3	-	-	-	10	-	1	-	-	-	-	-	-	14
Jean Lake, 4	-	-	-	2	8	-	-	-	1	-	-	-	-	11
Laughlin	**-**	**-**	**20**	**-**	**40**	**-**	**1**	**-**	**37**	**-**	**-**	**-**	**-**	**98**
Laughlin, 1	-	-	4	-	12	-	-	-	6	-	-	-	-	22
Laughlin, 2	-	-	8	-	25	-	-	-	8	-	-	-	-	41
Laughlin, 3	-	-	8	-	3	-	1	-	23	-	-	-	-	35
Moapa	**1**	**1**	**48**	**-**	**43**	**1**	**12**	**1**	**102**	**-**	**-**	**2**	**-**	**211**
Moapa, 1	-	-	17	-	18	-	2	-	9	-	-	-	-	46
Moapa, 2	1	-	-	-	4	-	-	-	16	-	-	-	-	21
Moapa, 3	-	-	2	-	13	-	1	-	18	-	-	-	-	34
Moapa, 4	-	-	3	-	-	-	1	-	13	-	-	2	-	19
Moapa, 5	-	1	10	-	1	1	1	1	11	-	-	-	-	26
Moapa, 6	-	-	4	-	2	-	4	-	28	-	-	-	-	38
Moapa, 7	-	-	12	-	5	-	3	-	7	-	-	-	-	27
North of Lake Mead	**1**	**23**	**-**	**-**	**14**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**38**
North of Lake Mead, 1	1	7	-	-	11	-	-	-	-	-	-	-	-	19
North of Lake Mead, 2	-	16	-	-	3	-	-	-	-	-	-	-	-	19
Sloan	**15**	**7**	**-**	**-**	**13**	**-**	**5**	**-**	**3**	**-**	**-**	**-**	**-**	**43**
Sloan, 1	11	1	-	-	5	-	-	-	-	-	-	-	-	17
Sloan, 2	4	6	-	-	8	-	5	-	3	-	-	-	-	26

Trapping Sites within Target Areas	SPECIES*													
	AMLE	CHFO	CHPE	DIDE	DIME	MUMU	NELE	ONTO	PEER	PELO	RARA	REME	XETE	TOTAL
South of Henderson	**11**	**49**	**-**	**-**	**2**	**-**	**4**	**-**	**10**	**-**	**-**	**-**	**-**	**76**
South of Henderson, 1	10	17	-	-	-	-	3	-	6	-	-	-	-	36
South of Henderson, 2	1	32	-	-	2	-	1	-	4	-	-	-	-	40
Urban Las Vegas	**-**	**9**	**1**	**-**	**19**	**-**	**1**	**-**	**12**	**-**	**-**	**-**	**1**	**43**
Urban Las Vegas, 1	-	2	-	-	5	-	-	-	-	-	-	-	1	8
Urban Las Vegas, 2	-	7	-	-	5	-	-	-	-	-	-	-	-	12
Urban Las Vegas, 3	-	-	-	-	-	-	-	-	5	-	-	-	-	5
Urban Las Vegas, 4	-	-	1	-	9	-	1	-	7	-	-	-	-	18
Wetlands Park	**-**	**-**	**18**	**-**	**13**	**8**	**20**	**-**	**19**	**-**	**1**	**-**	**-**	**79**
Wetlands Park, 1	-	-	10	-	9	1	5	-	7	-	-	-	-	32
Wetlands Park, 2	-	-	4	-	-	7	3	-	1	-	1	-	-	16
Wetlands Park, 3	-	-	4	-	4	-	12	-	11	-	-	-	-	31
TOTAL	**41**	**91**	**87**	**7**	**241**	**10**	**47**	**1**	**190**	**9**	**1**	**2**	**2**	**729**

*Species Abbreviations

AMLE	*Ammospermophilus leucurus*	White-tailed antelope ground squirrel
CHFO	*Chaetodipus formosus*	Long-tailed pocket mouse
CHPE	*Chaetodipus penicillatus*	Desert pocket mouse
DIDE	*Dipodomys deserti*	Desert kangaroo rat
DIME	*Dipodomys merriami*	Merriam's kangaroo rat
MUMU	*Mus musculus*	House Mouse
NELE	*Neotoma lepida*	Desert woodrat
ONTO	*Onychomys torridus*	Southern grasshopper mouse
PEER	*Peromyscus eremicus*	Cactus mouse
PELO	*Perognathus longimembris*	Little pocket mouse
RARA	*Rattus rattus*	Roof rat
REME	*Reithrodontomys megalotis*	Western harvest mouse
XETE	*Xerospermophilus tereticaudus*	Round-tailed ground squirrel

APPENDIX 3

Species Photo Log

Photo 1

Chaetodipus penicillatus

Photo 2

Chaetodipus penicillatus

Photo 3

Chaetodipus penicillatus

Photo 4

Chaetodipus penicillatus

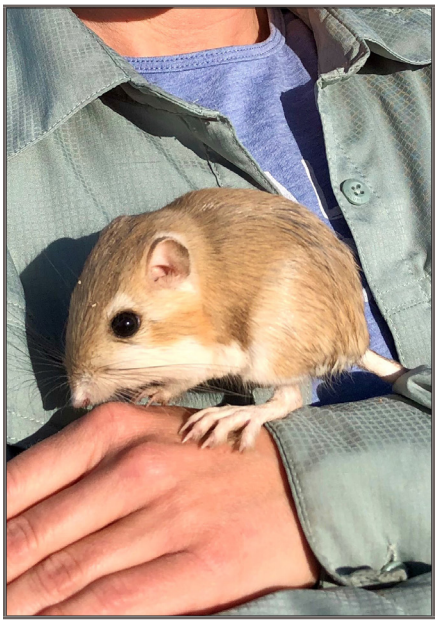
Photo 5

Ammospermophilus leucurus

Photo 6

Chaetodipus formosus

Photo 7



Dipodomys deserti

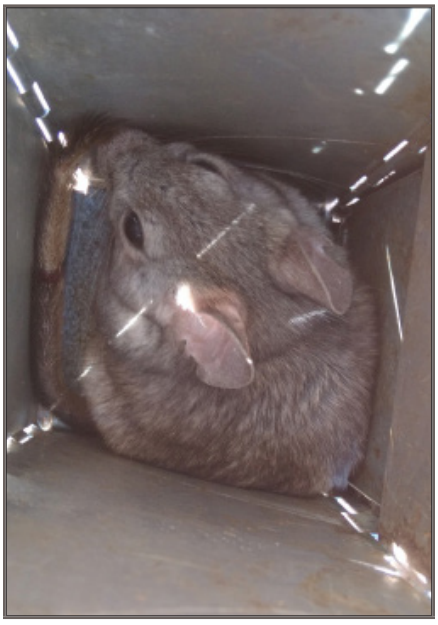
Photo 8

Dipodomys merriami

Photo 9

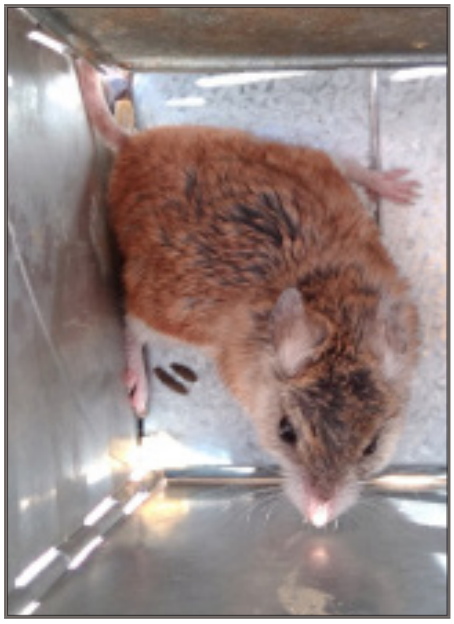
Mus musculus

Photo 10



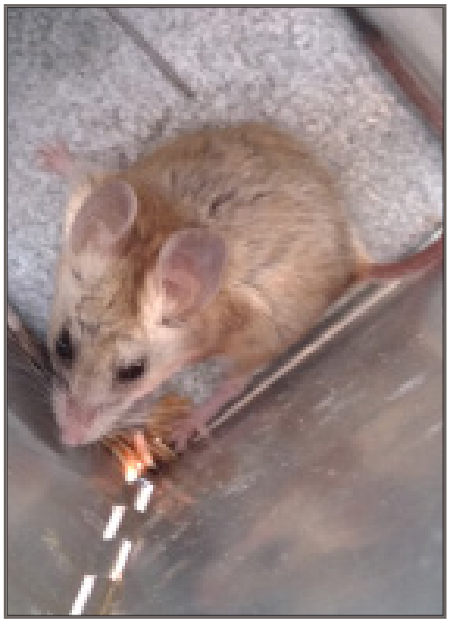
Neotoma lepida

Photo 11



Onychomys torridus

Photo 12

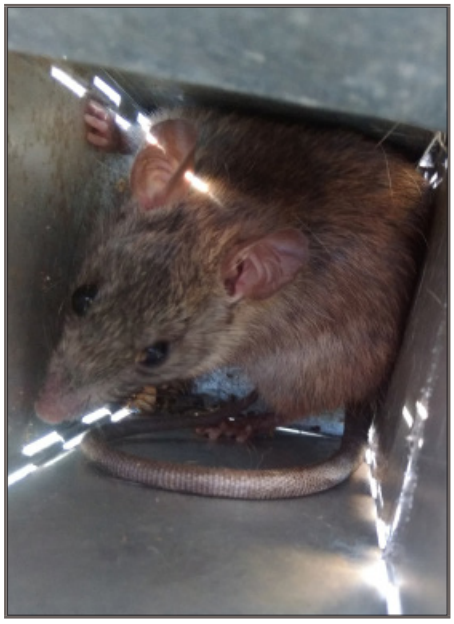


Peromyscus eremicus

Photo 13

Perognathus longimembris

Photo 14



Rattus rattus

Photo 15

Reithrodontomys megalotis

Photo 16

Xerospermophilus tereticaudus

APPENDIX 4

Habitat Descriptions of Trapping Sites

Target Area/ Trapping Site	Habitat Description of Trapping Site (and transects when habitat varied)
***C. penicillatus* Species Absent**	
Apex/North Las Vegas 1	Desert scrub interspersed with small desert washes. Sparse to medium density vegetation. Compacted sand and large gravel with sandy wash bottoms. Transects mostly targeted available washes.
Apex/North Las Vegas 2	Desert scrub interspersed with small desert washes. Sparse to medium density vegetation. Compacted sand and large gravel in uplands, gravel wash bottoms with sandy banks. Transects mostly targeted available washes.
Apex/North Las Vegas 3	Varied. Dry lakebed with islands of vegetation associated with seeps/springs. Islands composed of sparse desert scrub and others of stands of trees with dense herbaceous layer of grasses and no and no shrub layer. Compacted silt and sand. Transects mostly targeted dense vegetation.
Apex/North Las Vegas 4	Desert scrub interspersed with small desert washes. Sparsely vegetated. Rocky with compacted sand and gravel uplands, compacted sand, and rocky wash bottoms. Transects mostly targeted available washes.
Apex/North Las Vegas 5	Desert scrub interspersed with small desert washes. Sparsely vegetated. Rocky with compacted sand and gravel uplands, compacted sand, and rocky wash bottoms. Transects mostly targeted available washes.
Boulder City Conservation Easement 1	Varied. Drainage features along dirt road and within valley bottom. Medium to dense vegetation ranging from mostly shrubs to mostly shrubs and grasses. Sandy and compact sand. Transects targeted vegetation.
Jean/Ivanpah 1	Desert scrub interspersed with small desert washes. Sparse to medium density vegetation. Windblown sand and sandy wash bottoms. Transects mostly targeted available washes.
Jean/Ivanpah 2	Desert scrub interspersed with small desert washes. Sparse to medium density vegetation. Windblown sand and sandy wash bottoms. Transects mostly targeted available washes.
Jean Lake 1	Valley bottom. Sparsely vegetated with patches of grasses/forbs with no other vegetation. Sandy with small rocks. Transects spread across open area.
Jean Lake 2	Valley bottom/desert scrub. Sparsely vegetated with patches of small shrubs. Sandy with small rocks. Transects spread across area.
Jean Lake 3	Desert scrub/rocky foothills interspersed with small to medium desert washes. Sparsely vegetated. Gravel and rocky substrate in uplands; wash bottoms predominantly gravel/rock. Transects mostly targeted available washes.
Jean Lake 4	Varied. Valley bottom. Sparsely vegetated, to patches of grasses/forbs with no other vegetation, to sandy/rocky foothills with sparse vegetation, mostly small shrubs. Sandy with small rocks. Transects spread across open area.
Moapa 2	Varied. Foothills and riparian woodland/riverbank/floodplain with water. Very dense vegetation including areas with thick shrubs and herbaceous layer with no interspace, to dense grass layer farther from water's edge, to moderate vegetation density with some interspace, and uplands with desert scrub. Compacted sand and moist soils, with rock and gravel in foothills. Transects targeted dense vegetation and access to open ground.

Target Area/ Trapping Site	Habitat Description of Trapping Site (and transects when habitat varied)
North of Lake Mead 1	Desert foothills with large wash systems. Sparse to medium density vegetation. Gravel and rock with small patches of sand in upland. Wash bottoms predominantly gravel/rock. Transects mostly targeted available washes.
North of Lake Mead 2	Desert foothills with very large wash systems. Sparse to medium density vegetation. Gravel and rock with small patches of sand in upland. Wash bottoms predominantly gravel/rock. Transects mostly targeted available washes.
Sloan 1	Desert scrub/rocky foothills interspersed with small to medium desert washes. Sparsely vegetated desert scrub. Gravel and rock upland substrate. Wash bottoms predominantly gravel/rock with small patches of sand. Transects mostly targeted available washes, especially those with larger percentage of sand.
Sloan 2	Desert scrub/rocky foothills interspersed with small to medium desert washes. Sparsely vegetated with desert scrub. Gravel and rock upland substrate. Wash bottoms predominantly gravel/rock with small patches of sand. Transects mostly targeted available washes, especially those with larger percentage of sand.
South of Henderson 1	Desert scrub/rocky foothills interspersed with small to medium desert washes. Sparsely vegetated. Gravel and rock substrate throughout. Transects mostly targeted available washes.
South of Henderson 2	Desert scrub/rocky foothills interspersed with small to medium desert washes. Sparsely vegetated. Gravel and rock substrate throughout, including wash bottoms. Transects mostly targeted available washes.
Urban Las Vegas 1	Desert scrub upland interspersed with small desert washes. Sparsely vegetated. Compacted sand and large gravel with sandy wash bottoms. Transects mostly targeted available washes.
Urban Las Vegas 2	Desert scrub upland interspersed with small desert washes. Sparsely vegetated. Gravel and rock substate in uplands and wash bottoms. Transects mostly targeted available washes.
Urban Las Vegas 3	Mesa edge. Dense vegetation with thick shrub layer and canopy. Compacted sand to rocky substrate throughout. Small stream with salt deposit layer on soils. Transects mostly targeted dense vegetation.
***C. penicillatus* Species Present**	
Laughlin 1	Floodplain. Moderate to dense vegetation of brush and thickets. Soft sand. Appeared to have been recently affected by fire. Transects targeted vegetation.
Laughlin 2	Floodplain. Moderate to dense vegetation of mostly brush and thickets with some overstory. Soft sand. Transects targeted vegetation.
Laughlin 3	Floodplain. Mostly dense vegetation of mostly brush and thickets with some overstory. Soft sand. Transects targeted vegetation.
Moapa 1	Sandy wash system. Dense vegetation of mostly brush with some grasses and overstory. Sandy wash bottoms and edges with some rocks and gravel. Transects targeted wash and vegetation along wash.
Moapa 3	Floodplain. Dense vegetation of mostly brush. Minimal overstory or herbaceous layer. Sandy soil.
Moapa 4	Floodplain/drainage area. Moderate to dense vegetation of mostly brush, minimal groundcover, and some canopy. Sandy soils. Transects targeted areas of vegetation.

Target Area/ Trapping Site	Habitat Description of Trapping Site (and transects when habitat varied)
Moapa 5	Floodplain/adjacent to agriculture field and desert scrub foothills. Moderate to dense vegetation of mostly brush with minimal groundcover and some canopy. Sandy soils, some rocky outcrops. Transects targeted areas of vegetation.
Moapa 6	Floodplain/adjacent to river channel. Dense vegetation of mostly brush with tamarisk cuttings on ground. Sandy soils. Transects targeted areas of vegetation.
Moapa 7	Floodplain/adjacent to reservoir. Moderate to dense vegetation of mostly brush with some canopy and herbaceous groundcover. Sandy soils. Transects targeted areas of vegetation.
Urban Las Vegas 4	Floodplain. Moderate vegetation of mostly brush thicket. Sandy soils. Transects targeted areas of vegetation.
Wetlands Park 1	Floodplain/adjacent to wetlands. Moderate to dense vegetation of mostly brush with some canopy layer and minimal groundcover. Sandy with some gravel. Transects targeted areas of vegetation.
Wetlands Park 2	Floodplain/adjacent to wetlands. Moderate to dense vegetation of brushy thicket and open canopy layer with minimal groundcover. Sandy with some gravel. Transects targeted areas of vegetation.
Wetlands Park 3	Varied. Foothills and banks adjacent to wetlands. Moderate to dense vegetation of brushy thicket and open canopy layer with minimal groundcover, to desert scrub in upland. Rocky foothills to sandy with some gravel and rock. Transects targeted areas of vegetation.