

Final Project Report

Desert Upland Small Mammal Surveys II

Boulder City Conservation Easement Eldorado Valley, Nevada

Prepared For:

*Desert Conservation Program
Clark County Department of Air Quality
Stefanie Ferrazzano
4701 West Russell Road, Suite 200
Las Vegas, Nevada 89118*

Prepared By:

*BEC Environmental, Inc.
7241 West Sahara Avenue, Suite 120
Las Vegas, Nevada 89117
(702)304-9830
www.becnv.com*

Project No. 2017-BEC-1730M

Date July 19, 2019



Table of Contents

ACRONYMS..... III

EXECUTIVE SUMMARY..... 1

1 INTRODUCTION 2

1.1 Background and Need for the Project 2

1.2 Project Description, Goals and Objectives..... 2

2 METHODS AND MATERIALS..... 3

2.1 Survey Planning Activities..... 3

2.2 Survey Activities..... 5

2.3 Post-Survey Activities 6

3 RESULTS AND EVIDENCE OF RESULTS..... 6

3.1 Objectives Completed 6

3.2 Species and Habitat Focused Survey Efforts..... 7

3.2.1 Mojave Desert Scrub 7

3.2.2 Deep Sand/Wind-Blown Sand..... 8

3.2.3 Water Treatment Outfall..... 9

3.2.4 Foothills & Rocky Outcrops..... 9

Western Basaltic Foothills 9

Eastern Basaltic Foothills..... 10

Granite Foothills 10

Mixed Foothills 10

Andesite Foothills..... 10

Results for the Foothills..... 11

3.2.5 Desert Wash Systems..... 11

Creosote-Acacia Wash System..... 11

Cholla-Creosote Wash System 11

Wide Wash System..... 11

Results for Wash Systems 12

3.2.6 Salt Desert Scrub/Fenceline Disturbance 12

3.3 Trapping Results 12

4 EVALUATION/DISCUSSION OF RESULTS 14

4.1 Evaluation of 2018 Results..... 14

4.2 Evaluation of 2019 Results..... 14

4.2.1 Species Captured..... 14
 4.2.2 Species Not Captured..... 15
 4.3 Covered/Evaluation Species 16
 4.3.1 *Dipodomys deserti* (Desert Kangaroo Rat)..... 16
 4.3.2 *Chaetodipus penicillatus* (Desert Pocket Mouse) 16
 5 CONCLUSION 17
 6 RECOMMENDATIONS 18
 6.1 Small Mammal Population Ecology Studies and Monitoring Program..... 18
 6.2 *Dipodomys* Studies 18
 REFERENCES..... 19

List of Figures

Figure 1: Preliminary map of habitat targeted for trapping within the BCCE..... 3
 Figure 2: Map showing general locations of the 2018 and 2019 survey transects. 7

List of Tables

Table 1: Small Mammal Species Expected to Occur within the BCCE 4
 Table 2: Trapping Results by Species and Habitat 13

List of Appendices

- APPENDIX A – Species Photo Log
- APPENDIX B – Detailed Trapping Results per Transect

ACRONYMS

BCCE	Boulder City Conservation Easement
DCP	Desert Conservation Program
ESA	Endangered Species Act
MSHCP	Multiple Species Habitat Conservation Plan
UTM	Universal Transverse Mercator

EXECUTIVE SUMMARY

The Multiple Species Habitat Conservation Plan (MSHCP) and the Boulder City Conservation Easement (BCCE) Management Plan require adaptive management and monitoring of resources throughout the permitted areas. Given their role in the ecosystem, small mammals, as well as birds and bats, were identified as species for which monitoring may be appropriate, and for which initial surveys should be implemented. As part of that objective, an initial survey was conducted in 2018 to begin assessing the small mammal community in the BCCE; a 2019 survey was conducted to update and augment the data collected under the initial survey. The 2018 survey identified transect locations randomly, resulting in sample sites primarily within the Mojave Desert scrub habitat, which composes most of the BCCE.

Rather than duplicating the previous effort, the 2019 survey focused on sampling isolated or unique habitats throughout the BCCE, in addition to collecting data within the more common habitat. Prior to conducting the surveys, potential habitats were identified using available habitat maps, topographic maps, aerial photography, and the biologists' prior experience in the area and expertise related to small mammals. During the surveys, biologists confirmed the presence and characteristics of these habitats, and sought other unique areas to sample.

Biologists conducted 16 single-night trap events, during which 58 transects of 10 to 30 trap stations, with two traps per station, were set. A total of 2,240 trap nights between March 27 and May 30, 2019, were conducted. Between three and five transects were set within each of six habitat types at 14 locations within the BCCE.

Fourteen species of small mammals had been identified as likely or potentially present within the BCCE based on geographic range, distribution, prior trapping records, habitat requirements, and habitat expected to be present within the BCCE according to available literature and previous studies. Two of these species are listed in the MSHCP as Evaluation Species: *Chaetodipus penicillatus* (desert pocket mouse) and *Dipodomys deserti* (desert kangaroo rat).

Nine species of small mammals were captured during the 2019 survey. One notable species captured, *Dipodomys deserti*, has been proposed for removal from consideration as a "Covered Species" in future updates to the MSHCP and the associated Incidental Take Permit. This species was captured only in the deep, wind-blown sand along the northern edge of the BCCE, west of the Western Area Power Administration Mead Substation. One notable species not captured during this survey was the *Chaetodipus penicillatus*, which has been proposed as a Covered Species in the future updates to the MSHCP. Recent versions of the BCCE management plan stated this species was common throughout the BCCE. The very similar *Chaetodipus formosus* (long-tailed pocket mouse) was captured along numerous transects. Within Nevada, *Chaetodipus penicillatus* is primarily found in flat sandy washes with dense brush having direct connectivity to the Colorado River and its tributaries, which is not present in the BCCE.

The primary goal of the 2019 survey was to verify and expand upon records of small mammal species present in the BCCE. BEC biologists accomplished this goal by confirming the presence of nine small mammal species in the study area.

1 INTRODUCTION

The Clark County Desert Conservation Program (DCP) manages the BCCE in accordance with the Clark County MSHCP (RECON, 2000) and associated Incidental Take Permit. The BCCE is habitat for *Gopherus agassizii* (Mojave desert tortoise), a species listed under the federal Endangered Species Act (ESA) as Threatened and under the Nevada Revised Statutes as Endangered. The primary purpose for the creation of the BCCE was to protect and preserve habitat for *Gopherus agassizii* and other MSHCP-Covered Species (Clark County, 2019).

The BCCE is located within the Eldorado Valley, southwest of the populated area of Boulder City. The BCCE is divided by U.S. Highway 95 (US-95) into a North Section (15,802 hectares) and South Section (19,172 hectares), with 1,040 hectares excluded from the BCCE and designated by Boulder City for energy development (Energy Zone). The BCCE is a limited use area with a limited number of open roads and no authorized camping. The ecosystem is characterized predominately as Mojave Desert scrub with no perennial water sources (Clark County, 2019).

1.1 Background and Need for the Project

The 2019 BCCE Management Plan (Clark County, 2019) states:

The management goal prescribed for the BCCE is to ensure that the property is retained in a natural condition, and to prevent any uses that would impair the conservation, protection, restoration and enhancement of the natural resource values, especially those values associated with habitat for the desert tortoise and other indigenous flora and fauna.

In accordance with the MSHCP, adaptive management and monitoring programs and processes are to be developed with the goal of establishing clear objectives for the long-term management and conservation of the resources within the planning area, particularly in the BCCE and other unique habitats.

Small mammals or rodents are widespread and play an important role in the functioning of the desert ecosystem. Understanding the small mammal community and monitoring key indicators for this community may assist resource managers in characterizing the general health of the ecosystem, identifying responses to implemented management actions like restoration, and monitoring impacts from sources like land development or climate change.

1.2 Project Description, Goals and Objectives

Prior to 2018, the species composition of the small mammal community within the BCCE was speculated but not documented. An initial survey was conducted in 2018. This effort had several challenges and focused its efforts on the open bajadas composing most of the area, resulting in an abbreviated list of small mammal species found in the area. The current (2019) survey was intended to update and augment the list of small mammal species found within the BCCE during the 2018 survey.

The goal of this survey was to verify and expand upon records of small mammal species present in the BCCE. The information collected will be utilized by the DCP for tracking changes in the small mammal species composition in the BCCE and measure the success of future management activities conducted in the area.

While some inferences can be made, this project was not intended to evaluate habitat preferences, relative abundance, or other population/ecological parameters. The goal was to develop a list of small mammal species present; the design of the survey was developed to achieve that goal, as described in the following sections.

2 METHODS AND MATERIALS

Surveys conducted for this project were developed to most efficiently accomplish the project goal of verifying and expanding upon records of small mammal species currently present in the BCCE. BEC biologists developed a Work Plan based on methods outlined in the 2018 survey (NewFields, 2018); revised protocol established in the Project Methods section of the Request for Proposals; alterations to the protocol based on the experience of the BEC biologists; generally accepted methods for small mammal trapping; and discussions with DCP biologists. DCP biologists reviewed and concurred with the Work Plan and the surveys were conducted.

2.1 Survey Planning Activities

The 2018 survey located transects using randomly generated points within the BCCE resulting in trapping efforts being located primarily in the Mojave Desert scrub habitat which dominates the majority of the BCCE. BEC biologists proposed, and DCP biologists concurred, this follow-up survey would not benefit in achieving the survey goals by primarily duplicating effort in the previously sampled areas or focusing primarily in this habitat. Because of this, trapping efforts were focused in microhabitats throughout the BCCE as well as within the dominant Mojave Desert scrub.

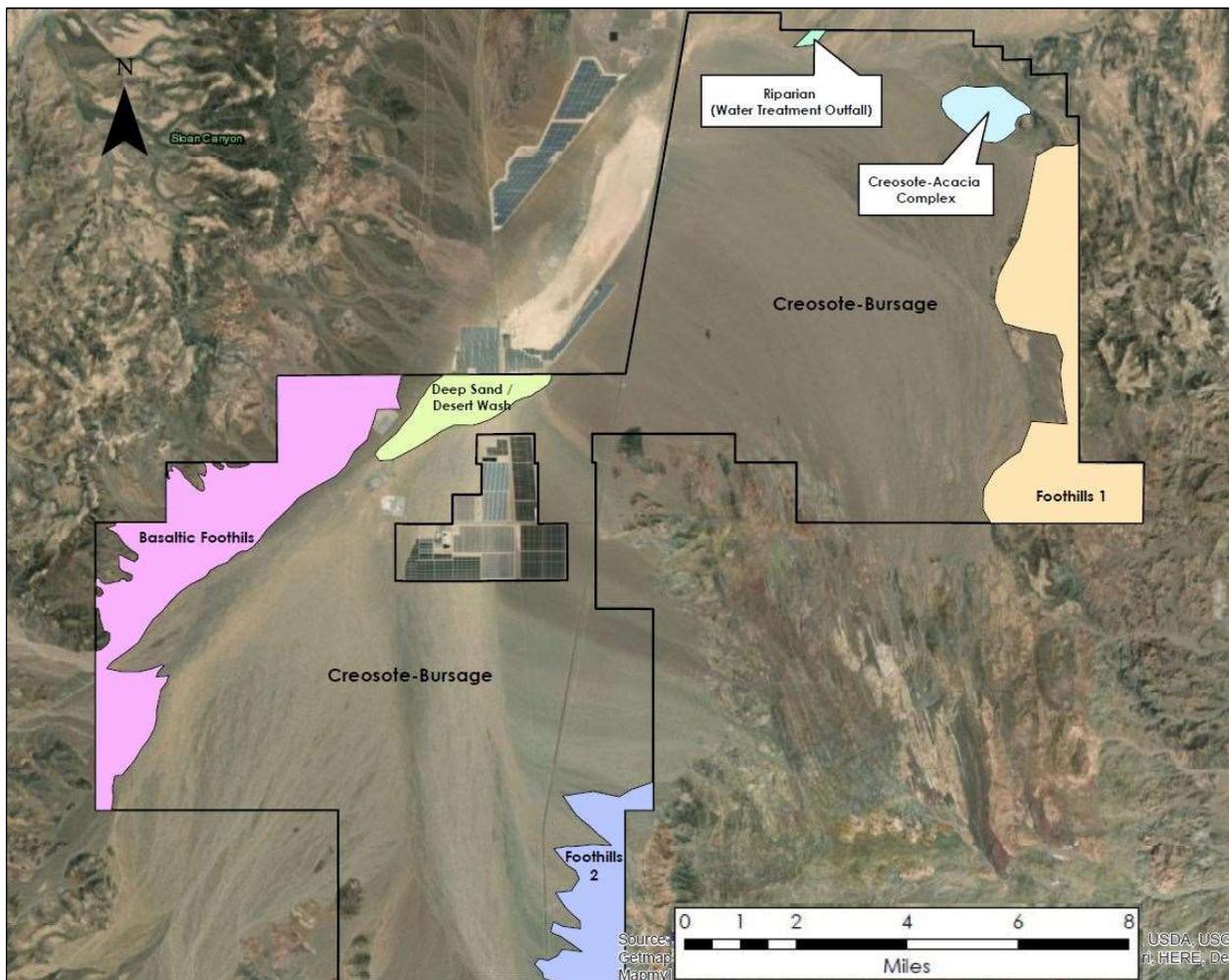


Figure 1: Preliminary map of habitat targeted for trapping within the BCCE.

Because of the presence-absence nature of the survey, BEC took a targeted approach to sampling efforts. Biologists identified and mapped unique or isolated habitats across the BCCE using available soils maps, topographic maps, aerial photography and vegetation association maps, including maps in the BCCE Management Plans (Clark County, 2015) (Clark County, 2017) (Clark County, 2019). A preliminary map of targeted habitats and survey locations was generated (**Figure 1**). The habitats and locations identified were the preliminary targets of initial sampling efforts. During a site reconnaissance, and throughout the survey activities, BEC biologists reevaluated the identified habitats and adapted the survey plan as needed to account for unidentified habitats or more efficiently distribute survey effort.

In addition to targeting unique or isolated habitats, biologists developed a list of species known or likely to occur, potential but not likely to occur, and not likely to occur within the BCCE (**Table 1: Small Mammal Species Expected to Occur within the BCCE**) with the objective of locating as many of these species as possible. This list was developed by reviewing museum records for species previously captured in the Eldorado and surrounding valleys; “Mammals of Nevada” (Hall, 1995); the DCP species accounts of covered and evaluation mammals (Clark County Desert Conservation Program); results of the 2018 survey (NewFields, 2018); and utilizing the previous experience and professional judgment of the project’s Lead Mammologist, Dr. Sean Neiswenter. **Table 1** includes an assessment of the habitat each species is likely to occupy based on the above sources.

Species were identified as potentially but unlikely to occur in the BCCE based on information indicating the preferred habitats of those species were not known to be present in the BCCE (e.g., mesic riparian habitat). Species were identified as highly unlikely to occur due to the lack of general habitat requirements or based on the project area not being within their known or expected geographic range and distribution.

Table 1: Small Mammal Species Expected to Occur within the BCCE

Scientific Name	Common Name	Typical Habitat
Known or Likely to Occur in BCCE		
<i>Ammospermophilus leucurus</i>	White-tailed antelope ground squirrel	Low-mid elevation desert scrub
<i>Chaetodipus formosus</i>	Long-tailed pocket mouse	Rocky areas with varied scrub with hard groundcover/rocky soils; base of cliffs or mouth of canyons
<i>Chaetodipus penicillatus</i> ^a	Desert pocket mouse	Soft alluvium, sandy, or silty soils, sparse desert vegetation
<i>Dipodomys merriami</i>	Merriam’s kangaroo rat	Sandy soils, low elevation, creosote bush (<i>Larrea tridentata</i>), open desert habitat, generalist
<i>Neotoma lepida</i>	Desert woodrat	Rock outcrops, dense vegetation
<i>Perognathus longimembris</i>	Little pocket mouse	Sandy soils, arid grasslands
<i>Peromyscus eremicus</i>	Cactus mouse	Generally rocky and brush habitats, often associated with cactus
<i>Peromyscus maniculatus</i>	Deer mouse	Common in disturbed areas, habitat generalist, in desert most often mesic, low to mid-elevation
<i>Xerospermophilus tereticaudus</i> ^b	Round tailed ground squirrel	Sandy soils, desert scrub, mesquite (<i>Prosopis</i> sp.), palo verde (<i>Parkinsonia</i> sp.)

Scientific Name	Common Name	Typical Habitat
Potentially but not likely to be present; preferred habitat is not likely present in BCCE; low abundance if present		
<i>Dipodomys deserti</i>	Desert kangaroo rat	Substantial accumulations of wind driven sand and sparse vegetation, sand dune specialist
<i>Onychomys torridus</i>	Southern grasshopper mouse	Arid grassland to desert scrub, low elevation
<i>Peromyscus crinitus</i>	Canyon mouse	Rocky slopes, canyons
<i>Reithrodontomys megalotis</i>	Western harvest mouse	Dense grass, arid grasslands or prairie, typically only mesic areas in desert
<i>Thomomys bottae</i>	Botta's pocket gopher	Low elevation, agriculture, scrub, in soft soils, avoids rocky areas and open desert
Unlikely to be present due to habitat requirements or known geographic range		
<i>Dipodomys panamintinus</i>	Panamint kangaroo rat	Mid-elevation, known only from one mountain in Clark County southeast of Searchlight, Nevada
<i>Mus musculus</i>	House mouse	Disturbed areas, commensal with humans, invasive
<i>Peromyscus boylii</i>	Brush mouse	Dense brushy habitat, often with tree cover, or rocky outcrops / canyons, mid elevation at low latitudes, mesic areas of desert
<i>Peromyscus truei</i>	Pinyon mouse	Near pinyon-juniper, rocky slopes, mid-high elevation
<i>Rattus rattus</i> / <i>Rattus norvegicus</i>	Roof rat/Norway rat	Disturbed areas, commensal with humans, invasive

^a Included based on summary of small mammals present in the BCCE in previous BCCE Management Plans

^b Included based on results of the 2018 survey

2.2 Survey Activities

Biologists Dr. Sean Neiswenter (Lead Mammalogist), Danny Rakestraw (Project Manager), and Danielle Viglione (Field Coordinator) conducted field surveys several days per week, with support from Rachel Kistler, Andre Nguyen, and Sirima Lavangnananda, from March 27 through May 30, 2019. The survey period was conducted over two months to distribute survey effort to reflect a range of the spring seasonal variations and avoid impacts of inclement weather. Trap setting occurred between 17:00 and 20:00, and trap collection occurred between 6:00 and 10:00. Over the course of the survey, temperatures recorded by biologists ranged from 14 to 31 degrees Celsius (58 to 87 degrees Fahrenheit) during trap setting and trap collection.



Photo 1: Field Staff Baiting Sherman® Live Traps

Each survey event was conducted by navigating to the target location previously determined based on habitat maps and observations made in the field. Adjustments to the targeted location were made in the field when the location was determined to be undesirable for trapping (i.e. habitat already trapped extensively, areas with no sign of rodents, disturbance, etc.).

Biologists determined the starting location and direction of transects based on habitat characteristics encountered in the field. Each biologist set the traps of between one and five transects, each with 10 to 30 trap stations, spaced approximately 10 meters apart. Each trap station consisted of two baited Sherman® live traps. Bait used for the project was a mixture of rolled oats and peanut butter (**Photo 1**).



Photo 2: Placement of Trap on Stable, Even Surface

Each trap was set by placing it on a stable, even surface, bait placed at the back of the trap (**Photo 2**). Each trap was tested to ensure shutting mechanisms were working properly. On nights where overnight temperatures were expected to be low, a cotton ball was also placed into each trap to ensure captured rodents were able to regulate their body temperature. Trap set time, temperature, and UTM coordinates were recorded on data sheets and the location of transects was documented on field maps for use by the biologists to navigate to with ease the following morning.



Photo 3: Team of Two Biologists Checking Trap and Recording Data

The following morning biologists returned to the mapped location to collect traps. Generally, a team of two biologists worked together, one checking and collecting traps and the other recording data (**Photo 3**). Universal Transverse Mercator (UTM) coordinates for start locations, temperature, and time were recorded for each transect. Biologists started at trap station 1 of each transect and recorded if the trap was open, sprung but empty, damaged, or occupied. For occupied traps, the biologists emptied the trap, identified and recorded the species; assessed and recorded general condition of the animal; and took photos of the specimen when possible. In some cases, a voucher specimen was collected by the appropriately permitted Lead Mammalogist to confirm species identification and for establishing a museum record. The transect end UTM coordinates, temperature, and time was recorded per transect as well. Description of the location, habitat type, and dominant vegetation was included.

2.3 Post-Survey Activities

At the end of each trapping event, a biologist returned to the office, uploaded and sorted photos taken during that event, uploaded UTM data points, and reviewed and scanned data sheets. A general tally of habitats targeted, and species successfully captured was recorded per trapping event. Biologists utilized this information to plan subsequent trapping efforts by targeting species or habitats not yet captured or surveyed.

Voucher specimens of each species trapped were collected. Standard museum skin and skeleton preparations have been accessioned at the Museum of Southwestern Biology at the University of New Mexico or the Angelo State Natural History Collection where they will be available for reference for future studies or management and monitoring activities.

Biologists entered data from data sheets into an Excel spreadsheet. A quality assurance/quality control process was implemented and applied to the spreadsheet to ensure completeness, accuracy, and consistency within the field-collected data. This spreadsheet was then uploaded into a geodatabase for submittal to the DCP.

3 RESULTS AND EVIDENCE OF RESULTS

3.1 Objectives Completed

The primary objective of this survey was to update and augment the list of small mammal species within the BCCE for future use in resource management and monitoring within the BCCE. The information provided below outlines how the team of biologists accomplished this objective.

The team of biologists successfully set 2,240 trap nights in 16 trapping events occurring between March 27 and May 30, 2019, and captured 152 individual specimens representing nine species. The results and observations made during this survey, in conjunction with those of the 2018 survey efforts, can be used as a general inventory of small mammal species present within the BCCE, and as supporting information for identifying small mammal species not likely to be present in large numbers.

3.2 Species and Habitat Focused Survey Efforts

As discussed in Section 2.1, survey efforts targeted isolated or unique habitats, as well as sampling the Mojave Desert scrub. During the initial sampling days, the biologists drove the majority of approved roads in the BCCE, evaluating the diversity and location of habitats in comparison to the preliminary habitat map and attempting to identify the unique locations that may provide habitat required by some of species identified as having unique or specific habitat associations. Based on this review, as well as review of locations sampled in the 2018 effort, the following locations were identified for the 2019 sampling efforts, as shown in **Figure 2**.

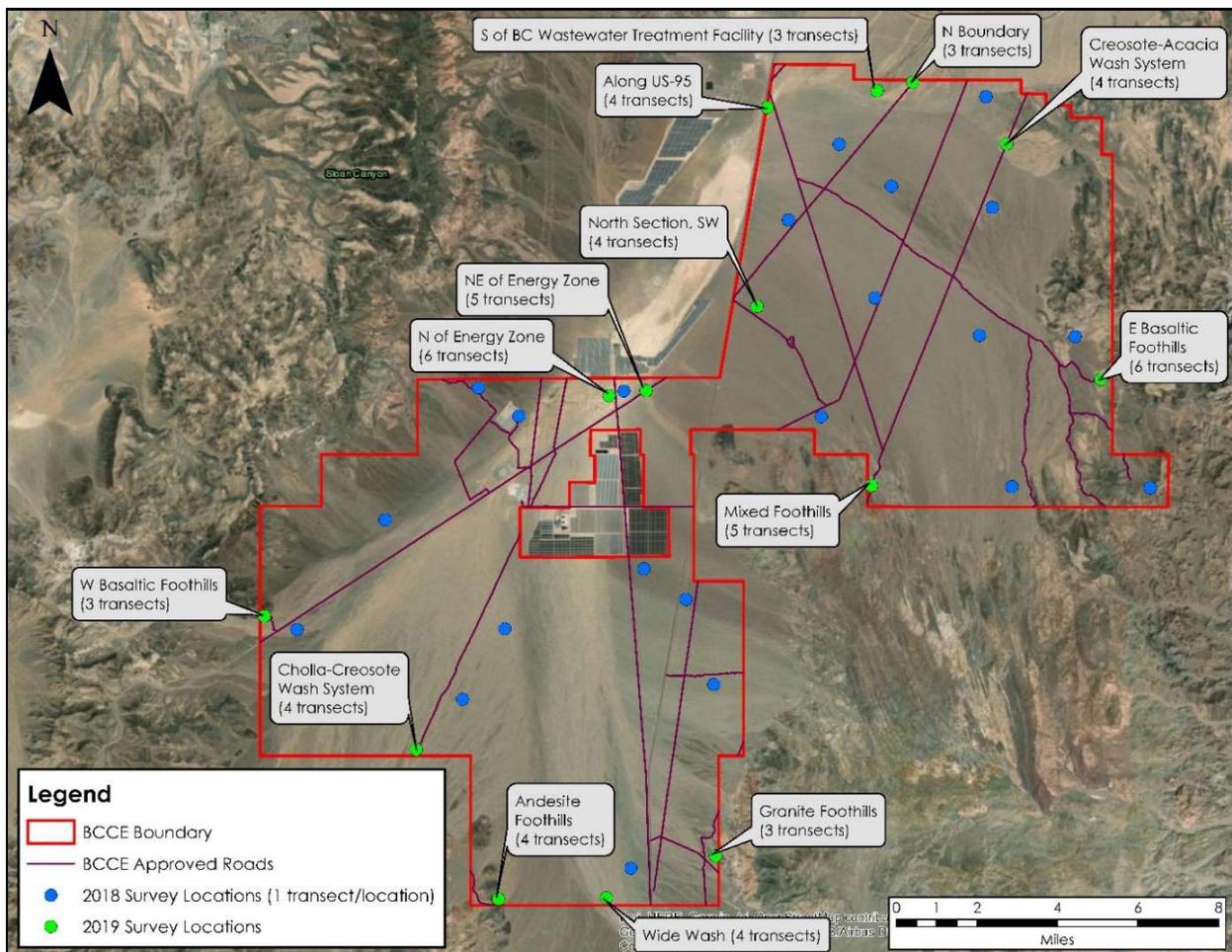


Figure 2: Map showing general locations of the 2018 and 2019 survey transects.

3.2.1 Mojave Desert Scrub

Mojave Desert scrub initially mapped as “creosote-bursage” (**Figure 1**) was identified as the dominant habitat throughout the BCCE. This habitat in the BCCE was observed to be largely homogenous, with only slight variations of substrate from sandy to gravelly/rocky. Creosote bush (*Larrea tridentata*) and

white bursage (*Ambrosia dumosa*) were dominant throughout this habitat, varying primarily in the level of dominance between the two and the size of the creosote bush specimens. This type of habitat was predicted to support the most common species and likely to trap *Ammospermophilus leucurus*, *Dipodomys merriami*, and *Perognathus longimembris*, with the potential to trap the more elusive *Onychomys torridus*.

Areas of Mojave Desert scrub were present to some degree in each of the more unique habitats observed and surveyed within the BCCE as well. Mojave Desert scrub was the most abundantly sampled habitat during the 2018 survey efforts. This habitat was the target habitat of two trapping events this year, one each in the North and South sections of the BCCE. The trapping event in the area referred to as North Section, Southwest was representative of the Mojave Desert scrub with a gravelly substrate (**Photo 4**), while the event in the South Section, designated as Northeast of Energy Zone, was representative of a more sandy substrate (**Photo 5**). Two additional trapping events occurred in habitat mapped as “deep sand/desert wash/salt desert scrub” during desktop studies but identified as sandy Mojave Desert scrub in the field, named North of Energy Zone (**Photo 6**).



Photo 4: North Section, Southwest - Gravelly Mojave Desert Scrub



Photo 5: Northeast of Energy Zone - Sandy Mojave Desert Scrub



Photo 6: North of Energy Zone - Sandy Mojave Desert Scrub

Biologists successfully trapped *Dipodomys merriami* (**Appendix A: Species Photo Log, Photo A and B**), *Neotoma lepida* (**Appendix A, Photo C and D**), *Onychomys torridus* (**Appendix A, Photo E and F**), and *Perognathus longimembris* (**Appendix A, Photo G and H**) in Mojave Desert scrub throughout the BCCE.

3.2.2 Deep Sand/Wind-Blown Sand

Deep sand/wind-blown sand was identified as the preferred habitat for *Dipodomys deserti* and the habitat was sought-out by the biologists due to the species’ status as an Evaluation Species within the MSHCP. *Dipodomys deserti* is a sand dune specialist and requires substantial accumulations of wind driven sand and sparse vegetation. As discussed in **Section 3.2.1**, and shown on **Figure 1**. One location within the South Section of the BCCE, north of the Energy Zone was identified during desktop studies to be “deep sand/desert wash” but was identified in the field to be Mojave Desert scrub habitat with a slightly sandy substrate, which is not preferred habitat for this particular species.



Photo 7: Northern Boundary – Deep Sand/Wind-Blown Sand; Larger Burrow Opening Indicative of *Dipodomys deserti*

However, during field reconnaissance, a small area along the northern boundary of the Northern Section of the BCCE was identified to include small drifts of wind driven sand and sign of *Dipodomys deserti*, specifically burrow systems with larger openings indicative of *Dipodomys deserti* (**Photo 7**). Vegetation was sparse in this area and

dominated by large creosote bush with annual forbs and grasses. The area is labeled “N. Boundary” on **Figure 2**.

Biologists conducted one trap event in this area, designated as Northern Boundary, and successfully captured the target species, *Dipodomys deserti* (**Appendix A, Photo I and J**).

3.2.3 Water Treatment Outfall

A “riparian/salt desert scrub” area associated with outfall from a nearby water treatment facility was identified during the desktop study. This type of habitat was predicted to possibly support *Chaetodipus penicillatus* due to possible presence of salt desert scrub habitat; *Reithrodontomys megalotis* and *Peromyscus maniculatus* due to possible presence of mesic habitat; *Thomomys bottae* due to soft, friable soil; and *Rattus rattus/Rattus norvegicus* and *Mus musculus* due to association with human disturbance.



Photo 8: South of Boulder City Wastewater Treatment Facility - Water Treatment Outfall

The area, identified as South of Boulder City Wastewater Treatment Facility, was vegetated, and the soils were very moist, but not characteristic of either riparian/mesic or salt desert scrub habitat. It was dominated by large creosote bush and matted areas of the annual, Mediterranean grass (*Schismus* sp.), and dense piles of windblown Russian thistle (**Photo 8**).

Biologists conducted one trap event in this area and successfully captured *Dipodomys merriami* (**Appendix A, Photo A and B**) and *Peromyscus eremicus* (**Appendix A, Photo K and L**).

3.2.4 Foothills & Rocky Outcrops

Three areas classified as foothills were identified in the desktop study: one on the east perimeter of the north section (originally mapped as “Foothills 1”), one on the southeast corner of the south section (originally mapped as “Foothills 2”), and a third, originally differentiated as “basaltic foothills” along the northwest corner of the south section. The names associated with each of these locations were revised to Eastern Basaltic Foothills, Mixed Foothills, and Western Basaltic Foothills to clarify their location and geologic origin.

Biologists targeted these habitats to capture the species which prefer rocky areas, including *Chaetodipus formosus*, *Neotoma lepida*, *Peromyscus eremicus*, and *Peromyscus crinitus*.

During site reconnaissance, biologists identified two additional areas of rocky habitat: a section of foothills on the southern perimeter of the North Section and a rocky outcrop on the southern edge of the South Section.

All the foothills were similar in that they were dominated by creosote bush and white bursage and primarily consisted of gravelly to rocky substrate. Some transects in these locations were set within or extended into Mojave Desert scrub habitats or washes located at the base of the foothills. Each location is discussed below.

Western Basaltic Foothills

Western Basaltic Foothills (previously mapped as “basaltic foothills”) consisted of a large, steep boulder-strewn hills surrounded by small, shallow, gravelly/rocky washes and Mojave Desert scrub (**Photo 9**).

Eastern Basaltic Foothills

Eastern Basaltic Foothills (previously mapped as “Foothills 1”) consisted of a large, continuous rocky area. Traps were set throughout the entire hillside, from the rocky overhangs at the top of the foothill, down onto the rocky slope (**Photo 10**), across a flat area of gravelly Mojave Desert scrub habitat, and onto a rocky outcrop (**Photo 11**). In addition to creosote bush and white bursage, Mojave yucca (*Yucca schidigera*), prickly pear cactus (*Opuntia* sp.), and cottontop cactus (*Echinocactus polycephalus*) and barrel cactus (*Ferocactus cylindraceus*) were also common in this area, along with annual forbs, and grasses.



Photo 9: Western Basaltic Foothills - Foothills and Surrounding Wash and Gravelly/Rocky Mojave Desert Scrub



Photo 10: Eastern Basaltic Foothills - Rocky Slope of Foothills



Photo 11: Eastern Basaltic Foothills - Gravelly Mojave Desert Scrub and Rocky Outcrop

Granite Foothills

Granite Foothills (previously mapped as “Foothills 2”) consisted of a system of rocky hills and deep washes with a gravelly base (**Photo 12**). Sign of coyote (*Canis latrans*) activity in the area was prevalent, including large amounts of scat and two den areas.

Mixed Foothills

One additional foothill area in the North Section was identified by biologists in the field and referred to as Mixed Foothills based on the mixed geology of the area. This area was similar to Granite Foothills in that it was a system of rocky hills and deep, gravel-based washes (**Photo 13**). A small portion of a rockier, steeper habitat was also trapped as part of this location. In addition to creosote bush and white bursage, catclaw acacia (*Acacia greggii*) was present in the washes.

Andesite Foothills

The additional foothill in the South Section area was identified by biologists in the field and referred to as Andesite Foothills. This area was very rocky and surrounded by a wide, shallow, gravelly/rocky wash. In addition to creosote bush and white bursage, catclaw acacia was present in the wash (**Photo 14**).



Photo 12: Granite Foothills - System of Rocky Foothills



Photo 13: Mixed Foothills - Rocky Foothills with Deep Washes



Photo 14: Andesite Foothills - Rocky Foothill Surrounded by Shallow Wash

Results for the Foothills

One trapping event occurred per each of the five areas identified as foothill habitat. The species captured in the foothills were *Ammospermophilus leucurus* (**Appendix A, Photo M and N**), *Chaetodipus formosus* (**Appendix A, Photo O and P**), *Neotoma lepida* (**Appendix A, Photo C and D**), *Peromyscus crinitus* (**Appendix A, Photo Q and R**), and *Peromyscus eremicus* (**Appendix A, Photo K and L**).

3.2.5 Desert Wash Systems

Three areas classified as Desert Wash Systems were trapped during this survey. One desert wash system was classified as “creosote-acacia complex” during the desktop study, targeted for trapping, and the name was modified to Creosote-Acacia Wash System, based on field observations. Two additional wash systems were identified during site reconnaissance, both along the southern edge of the South Section and were designated the Cholla-Creosote Wash and the Wide Wash. Species determined to likely occur in the wash systems included *Ammospermophilus leucurus*, *Chaetodipus penicillatus*, *Onychomys torridus*, and *Xerospermophilus tereticaudus*.

Creosote-Acacia Wash System

The Creosote-Acacia Wash was a system of shallow, low gradient washes with sandy to gravelly bottoms (**Photo 15**). Small rocky areas and boulders occurred along the walls of some of the washes. Creosote bush and white bursage were the dominant plant species; however, catclaw acacia, big galleta grass (*Hilaria rigida*) and many forbs and grasses were present throughout the washes.

Cholla-Creosote Wash System

The Cholla-Creosote Wash was a system of shallow, gravelly/rocky washes with a slightly higher gradient than the other washes located on the southwest end of the BCCE. In addition to creosote bush and white bursage, the area was distinct in that it contained large stands of silver cholla cactus (*Cylindropuntia echinocarpa*) (**Photo 16**). Coyote sign was prevalent in the area. Large amounts of scat and a large den area were observed during trapping activities.

Wide Wash System

The Wide Wash System, located on the southern boundary of the BCCE, was the most expansive of the wash systems identified within the BCCE (**Photo 17**). It was a shallow, low-gradient, gravelly wash dominated by large creosote bushes with white bursage, desert senna (*Senna armata*), Nevada ephedra (*Ephedra nevadensis*) and a variety of annual forbs and grasses. Some areas of the wash contained catclaw acacia and mesquite. The bases of many of the trees and large creosote bushes were surrounded by debris, likely deposited from flood events.



Photo 15: Creosote-Acacia Wash System - Shallow Wash System Containing Catclaw Acacia



Photo 16: Cholla-Creosote Wash System - Shallow Wash System Containing Silver Cholla Cactus



Photo 17: Wide Wash System - Expansive Wash System

Results for Wash Systems

One trapping event occurred per each of the three areas identified as desert wash system habitat. The species captured in the washes included *Ammospermophilus leucurus* (**Appendix A, Photo M and N**), *Chaetodipus formosus* (**Appendix A, Photo O and P**), *Dipodomys merriami* (**Appendix A, Photo A and B**), *Neotoma lepida* (**Appendix A, Photo C and D**), *Perognathus longimembris* (**Appendix A, Photo G and H**), and *Peromyscus eremicus* (**Appendix A, Photo K and L**).

3.2.6 Salt Desert Scrub/Fenceline Disturbance

Three areas in the BCCE were originally mapped as salt desert scrub habitat: the area near the water treatment outfall, an area just north of the Energy Zone, and an area along US-95 on the eastern edge of the dry lake. Salt desert scrub is potential habitat for *Chaetodipus penicillatus* and appropriate habitat for generalist species such as *Ammospermophilus leucurus*, *Dipodomys merriami*, and *Perognathus longimembris*.

During site reconnaissance, the water treatment outfall and the area north of the Energy Zone were observed to be more consistent with Mojave Desert scrub habitat than salt desert scrub. Those areas were trapped, and the results are summarized under the respective habitat type above.



Photo 18: Along US-95 - Fenceline Disturbance, Salt Desert Scrub, and Sandy Mojave Desert Scrub

The area mapped as salt desert scrub along US-95, east of the dry lake, contained a mix of habitats and although a small area of salt desert scrub was present, there was a high level of human disturbance due to proximity to a major roadway. Salt desert scrub habitat was present in small areas, including along the fenceline and in a small isolated, adjacent area (**Photo 18**). These areas were sandy/silty and dominated by large stands of creosote bush, white bursage, and fourwing saltbush (*Atriplex canescens*). Trash and tumbleweeds were present along the fence and throughout the area. Adjacent habitat was sandy Mojave Desert scrub.

Biologists conducted one trapping event along the fenceline of the highway right-of-way. No animals were captured immediately along the fenceline but *Dipodomys merriami* (**Appendix A, Photo A and B**) was captured in the salt desert scrub and in the adjacent sandy Mojave Desert scrub. The observed salt desert scrub was an isolated area, highly disturbed, and not associated with a wash. Biologists determined sufficient appropriate habitat for *Chaetodipus penicillatus* was not present and did not proceed with additional trapping events in the area.

3.3 Trapping Results

Through the evaluation of DCP documents, the 2018 small mammal survey, and a review of the records for specimens collected in the Eldorado Valley, the BEC team developed a list of species likely to be found in the survey areas, as well as species potentially or unlikely to be found and the habitat with which they would likely be associated. **Table 2: Trapping Results by Species and Habitat** shows the number of each of these species captured, during this effort, by habitat type and location. **Appendix B – Detailed Trapping Results per Transect** provides the detailed results of the trapping effort, by transect.

Table 2: Trapping Results by Species and Habitat

Species (Common Name)	Habitat	Location	Number Captured	
<i>Ammospermophilus leucurus</i> (White-tailed antelope ground squirrel)	Desert wash system surrounding foothills	Mixed Foothills	2	3
	Desert wash system	Wide Wash System	1	
<i>Chaetodipus formosus</i> (Long-tailed pocket mouse)	Foothills	Western Basaltic Foothills	4	30
		Eastern Basaltic Foothills	5	
		Granite Foothills	3	
		Andesite Foothills	3	
	Mojave Desert scrub – rocky, associated with base of foothills	Western Basaltic Foothills	6	
		Andesite Foothills	1	
	Foothills & desert wash system surrounding foothills	Mixed Foothills	6	
Desert wash system surrounding foothills	Andesite Foothills	1		
Desert wash system	Wide Wash System	1		
<i>Dipodomys deserti</i> (Desert kangaroo rat)	Deep sand/Wind-blown sand	Northern Boundary	2	2
<i>Dipodomys merriami</i> (Merriam’s kangaroo rat)	Mojave Desert scrub – sandy	North of Energy Zone	20	47
		Northeast of Energy Zone	16	
	Mojave Desert scrub – gravelly	North Section, Southwest	1	
	Water treatment outfall	South of Boulder City Wastewater Treatment Facility	3	
	Desert wash system	Creosote-Acacia Wash System	1	
		Wide Wash System	3	
Salt desert scrub/Fenceline disturbance	Along US-95	3		
<i>Neotoma lepida</i> (Desert wood rat)	Mojave Desert scrub - sandy	North of Energy Zone	2	8
	Foothills	Western Basaltic Foothills	1	
		Eastern Basaltic Foothills	4	
	Desert wash system	Wide Wash	1	
<i>Onychomys torridus</i> (Southern grasshopper mouse)	Mojave Desert scrub – sandy	Northeast of Energy Zone	1	1
<i>Perognathus longimembris</i> (Little pocket mouse)	Mojave Desert scrub – sandy	North of Energy Zone	9	26
		Northeast of Energy zone	8	
	Mojave Desert scrub – gravelly	North Section, Southwest	1	
	Desert wash system	Creosote-Acacia Wash System	1	
		Wide Wash System	7	

Species (Common Name)	Habitat	Location	Number Captured
<i>Peromyscus crinitus</i> (Canyon mouse)	Foothills	Western Basaltic Foothills	8
		Eastern Basaltic Foothills	4
	Rocky outcrop	Eastern Basaltic Foothills	1
	Mojave Desert scrub – rocky, associated with base of foothills	Eastern Basaltic Foothills	2
	Desert wash system surrounding foothills	Mixed Foothills	2
<i>Peromyscus eremicus</i> (Cactus mouse)	Water treatment outfall	South of Boulder City Wastewater Treatment Facility	6
	Foothills	Andesite Foothills	6
	Desert wash system surrounding foothills	Mixed Foothills	2
	Desert wash system	Creosote-Acacia Wash System	2
		Wide Wash System	2

4 EVALUATION/DISCUSSION OF RESULTS

4.1 Evaluation of 2018 Results

BEC biologists reviewed the 2018 survey results as part of the initial list compilation of small mammal species expected to occur within the BCCE prior to commencing the 2019 surveys. The 2018 survey efforts successfully trapped 22 individual animals from four small mammal species: *Chaetodipus formosus*, *Dipodomys deserti*, *Neotoma lepida*, and *Peromyscus eremicus*, while *Spermophilus tereticaudus* (synonym for *Xerospermophilus tereticaudus*) was reported observed with game cameras (NewFields, 2018).

After review of text and data, it was determined individuals identified as *Dipodomys deserti* during the 2018 survey were likely *Dipodomys merriami* based on physical characteristics and habitat associations of the species. BEC biologists listed both species as targets for the 2019 surveys.

Review of the representative photos of *Chaetodipus formosus*, *Neotoma lepida*, and *Peromyscus eremicus* provided in the 2018 survey report and habitat data from the areas in which they were reported captured were determined to be consistent with the species likely to occur within the BCCE.

An image captured by game cameras during the 2018 survey was identified to be of the species *Spermophilus tereticaudus*. However, due to the quality of the image, it was difficult to confirm that identification. BEC biologists determined it more likely was *Ammospermophilus leucurus*, a species more commonly found in the area.

4.2 Evaluation of 2019 Results

4.2.1 Species Captured

Dipodomys merriami was the most common species trapped in the sandy Mojave Desert scrub areas, with 47 individuals trapped, followed by *Perognathus longimembris* (26 individuals trapped). *Chaetodipus formosus* (30 individuals trapped) was the most common species trapped in the gravelly to rocky habitats found throughout the BCCE. *Peromyscus eremicus* (18 individuals) was trapped in wash systems,

foothills, and the water treatment outfall area, while *Peromyscus crinitus* (17 individuals) was caught in the foothills and their associated rocky wash systems and rocky Mojave Desert scrub.

Neotoma lepida (8 individuals) were captured in a variety of habitats, but were most abundant in the rocky foothills, which is a preferred habitat type for midden building. The species was likely caught in lower numbers than some of the other common species due to its aggressively solitary nature (Oelhafen, 2004).

Three *Ammospermophilus leucurus* were captured, but this species is likely to be more abundant than the numbers represent. Biologists observed *Ammospermophilus leucurus* while traveling to many of the trapping locations, but due to the nocturnal nature of the surveys and the diurnal nature of this species, it was less likely to be trapped than the other species.

Two *Dipodomys deserti* were trapped within the BCCE. This species has highly specific habitat requirements and very little of their required habitat existed within the boundaries of the BCCE. This species is further addressed in **Section 4.3 Covered/Evaluation Species**, below.

One *Onychomys torridus* was trapped in Mojave Desert scrub habitat. The small number of individuals of this species captured in this survey may be a result of the fact they are found in low densities due to their fiercely territorial nature and large home ranges (about 1.83 mice per hectare) (Kester, 1999).

4.2.2 Species Not Captured

Peromyscus maniculatus are habitat generalists, being found in cultivated fields, suburban environments, forests, grasslands, and in desert scrubland. However, individuals prefer areas with somewhat dense vegetation providing shelter for nesting, foraging and movement. In the desert scrub environment, such habitat is typically associated with disturbed or more mesic areas. Based on past experience with this species and his habitat observations within the BCCE, the Lead Mammologist believes this species has low potential to be present within the BCCE, though it cannot be completely discounted without more intensive surveys.

Xerospermophilus tereticaudus was included in the list of species likely to be present because the 2018 survey summary report identified the species as having been photographed on a game camera. Preferred habitat for this species is areas with wind-drifted sands accumulated in mounds around the base of mesquite, creosote bush or salt bush (Grinnell & Dixon, 1918). Such habitat was present on the northern boundary of the North Section of the BCCE, west of the Mead Substation. However, this species was not captured during this survey.

Reithrodontomys megalotis was included on the list based on the geographic distribution of the species; however, they were not observed within the BCCE during this survey. This species typically prefers dense grass or shrub cover, usually associated with a water source (Brylski, 1990).

Thomomys bottae was included on the list of species potentially present given it had been previously captured in the region based on the review of natural history collection records. This species occupies a wide range of habitats including desert grasslands and agricultural fields where the soil structure provides a substrate allowing for construction of tunnels and provides a ready food source. This species is rarely captured using the type of traps utilized for this survey. However, the biologists did not observe signs of this species (e.g., mounds). Additionally, habitat conducive to this species was not observed during this survey.

Dipodomys panamintinus was included in the initial list of potential species based on its status as an Evaluation Species in the MSHCP. However, the likelihood of capturing this species was minimal given the only known population of the species in southern Nevada is in a mountain range south of Searchlight and the species is typically found above 3,900 feet, well above the elevation of the BCCE (1,720 to 3,475 feet).

Peromyscus truei was included in the list of potential species due to its geographic range. However, this species is typically found in higher-elevation habitats and most often associated with the pinyon-juniper or chaparral vegetation associations not present within the BCCE.

Rattus rattus/Rattus norvegicus and *Mus musculus* are unlikely to be found within the BCCE due to their extremely commensal relationship with humans.

Chaetodipus penicillatus was included in the list of species potentially occurring in the area; however, appropriate habitat was not observed, and the species is unlikely to be found within the BCCE. This species is further addressed in **Section 4.3 Covered/Evaluation Species**.

4.3 Covered/Evaluation Species

No small mammal species currently classified as Covered under the MSHCP were identified as likely to be present in the BCCE and none of the MSHCP-Covered Species were captured during either the 2018 or 2019 phases of this survey. Two species classified as Evaluation Species were determined to have potential to be present within the BCCE based on narratives, previous documentation, and habitat models: *Dipodomys deserti* and *Chaetodipus penicillatus*.

4.3.1 *Dipodomys deserti* (Desert Kangaroo Rat)

Dipodomys deserti is found throughout the southwestern desert from New Mexico to California but is only found in areas of abundant, wind-blown sand. In areas where habitat is present, the species is not abundant, partly due to its aggressive and solitary behavior and high turnover rate of burrow use (Pauli, 2003). Based on the field reconnaissance conducted for this survey, only one area with habitat appropriate to support this species was found within the BCCE, along the Northern Boundary of the North Section (**Figure 2**). During the initial field visits and subsequent trapping efforts, sign of this species was observed within the fenced northern boundary and immediately north of the BCCE. Two specimens of this species were trapped within the BCCE boundary.

4.3.2 *Chaetodipus penicillatus* (Desert Pocket Mouse)

The BCCE Management Plan from 2009 states:

Rodents, especially kangaroo rats, pocket mice, and deer mice and their relatives, are probably the most important mammals in terms of distribution and relative abundance.

The 2009 BCCE Management Plan does not indicate which species of pocket mouse is present within the BCCE, but the 2013, 2015, 2017, and 2019 updates of the Plan (Clark County, 2015) (Clark County, 2017) (Clark County, 2019) expand on this information stating:

*The more abundant small mammals include rodents, such as the white-tailed antelope squirrel (*Ammospermophilus leucurus*) and desert pocket mouse (*Chaetodipus penicillatus*), and the black-tailed jackrabbit (*Lepus californicus*).*

Each update cites the original 2009 Management Plan for this information regarding the presence of *Chaetodipus penicillatus* in the BCCE. BEC biologists were unable to find any references or other

documentation within any of the BCCE Management Plans to support the statement that *Chaetodipus penicillatus* was the pocket mouse species intended to be referenced in the 2009 document.

In Nevada, this species is tied closely with flat, sandy wash bottoms that have connectivity with water ways of the Colorado River and relatively dense shrub layer associated with those tributaries (Micone, 2002). The wash systems within the BCCE and surrounding Eldorado Valley do not have connectivity to the Colorado River, its tributaries, or any other waterbodies, and the shrub layer is sparse.

A Habitat Suitability Map was developed by the U.S. Geological Survey for multiple species, including *Chaetodipus penicillatus*. Although the scale of the map in the report does not show a detailed representation of habitat suitability within the BCCE, the general trend supports a distribution for the species associated with the Colorado River and its tributaries. No predicted habitat of high suitability was mapped within the area of the BCCE (US Geological Survey, 2014).

Additionally, neither the 2018 nor the 2019 trapping efforts captured *Chaetodipus penicillatus* despite trapping the most suitable habitat; however, both efforts successfully captured the very similar *Chaetodipus formosus*. Each of the 30 individuals captured in the 2019 effort were in gravelly to rocky habitat, while *Chaetodipus penicillatus* is highly associated with sandy substrate. No *Chaetodipus* sp. were captured in the sandy habitats. BEC’s Lead Mammologist collected two voucher specimens and confirmed the species identification to be *Chaetodipus formosus*.

Based on research conducted by BEC biologists, habitat observations made in the field, and trapping results of the 2018 and 2019 surveys, *Chaetodipus penicillatus* is not likely present within the BCCE.

5 CONCLUSION

The primary goal of the 2019 survey was to verify and expand upon records of small mammal species present in the BCCE. BEC biologists accomplished this goal and developed the following list of small mammal species confirmed to be present within the BCCE:

Scientific Name	Common Name
<i>Ammospermophilus leucurus</i>	White-tailed antelope ground squirrel
<i>Chaetodipus formosus</i>	Long-tailed pocket mouse
<i>Dipodomys deserti</i>	Desert kangaroo rat
<i>Dipodomys merriami</i>	Merriam’s kangaroo rat
<i>Neotoma lepida</i>	Desert woodrat
<i>Onychomys torridus</i>	Southern grasshopper mouse
<i>Perognathus longimembris</i>	Little pocket mouse
<i>Peromyscus crinitus</i>	Canyon mouse
<i>Peromyscus eremicus</i>	Cactus mouse

Additional survey efforts may result in adding one or two species to this list, most likely *Peromyscus maniculatus* or *Xerospermophilus tereticaudus*. The results of the two phases of this survey provide a solid base of information for resource managers to continue developing more rigorous monitoring programs as discussed in the following section.

6 RECOMMENDATIONS

6.1 Small Mammal Population Ecology Studies and Monitoring Program

The two studies summarized in this report were conducted to develop a list of the small mammal species present in the BCCE, which is valuable for understanding the resources to be managed. However, a species list does not provide resource managers a mechanism for assessing the health of the small mammal community; documenting the beneficial effects of management actions such as restoration; or predicting and monitoring potential impacts of adjacent or regional development or climate change. The information obtained during these surveys will support the further development and refinement of the adaptive management and monitoring program required by the MSHCP, and the information collected in these surveys is a first step in that process.

Further population studies or more detailed, focused sampling for specific species may be of value to confirm the presence or absence, relative abundance, or detailed distribution of these species. However, such studies or surveys should be developed with clear goals of a monitoring program linked back to management objectives established in the Adaptive Management Program. Such goals would drive the specific objectives and scope of the surveys or studies.

6.2 *Dipodomys* Studies

Three species of *Dipodomys* are present within the MSHCP permit area, and two of these, *Dipodomys deserti* and *Dipodomys panamintinus caudatus*, are Evaluation Species under the current MSHCP permit. While *Dipodomys merriami* are common throughout the region, *Dipodomys deserti* are highly dependent on unique, relatively uncommon habitats in the region and *Dipodomys panamintinus caudatus* are known from only one isolated mountain range. Additional studies should be conducted to confirm where *Dipodomys deserti* populations are located and their relative abundance given their required habitat is frequently prime location for recreational and other activities.

Likewise, a study should be conducted to determine the full distribution of *Dipodomys panamintinus caudatus* in southern Nevada. Currently their distribution in the state is considered highly restricted; however, that may simply reflect a lack of study. *Dipodomys panamintinus* is difficult to distinguish morphologically from *Dipodomys merriami* and is currently only known from areas that have very limited access and rugged terrain. The distribution of *Dipodomys panamintinus* in northern Nevada has been expanded greatly due to the collection of specimens from north central Nevada (personal communication with Dr. John Demboski curator Denver Museum of Nature and Science). It is possible the southern distribution expands farther into Clark County than is currently known. The distribution in the southern Nevada area is currently thought to be isolated to one locality south west of Searchlight and in the Providence Mountains in California. Additional surveys should be conducted in the other remote, rugged, high-elevation mountain ranges that represent the preferred habitat for the species to determine if the species has a larger distribution than what is currently documented.

REFERENCES

- Brylski, P. (1990). *Western Harvest Mouse: Reithrodontomys megalotis* (1988-1990 ed., Vols. I-III). Sacramento: California Department of Fish and Game. Retrieved July 2019
- Clark County. (2015). *Boulder City Conservation Easement Management Plan Version 3.2*. Desert Conservation Program. Retrieved June 2019, from http://www.clarkcountynv.gov/airquality/dcp/Documents/Library/dcp%20reports/2015/BCCE%20Management%20Plan_Version%203.2_2015_final.pdf
- Clark County. (2017). *Boulder City Conservation Easement Management Plan Version 3.3*. Desert Conservation Program. Retrieved June 2019, from http://www.clarkcountynv.gov/airquality/dcp/Documents/Library/dcp%20reports/2017/BCCE%20Management%20Plan%20Version%203.3_Final_Feb2017.pdf
- Clark County. (2019). *Boulder City Conservation Easement Management Plan Version 3.4*. Desert Conservation Program. Retrieved June 2019, from <http://www.clarkcountynv.gov/airquality/dcp/Documents/mitigation/bcce/BCCE%20Management%20Plan%20%20Version%203.4%20Final.pdf>
- Clark County Desert Conservation Program. (n.d.). *Species Account Manual*. Retrieved 2019, from Mojave Max: <https://mojavemax.com/wp-content/uploads/2017/01/species-account-manual-mammals.pdf>
- Grinnell, J., & Dixon, J. (1918). *California Ground Squirrels: A Bulletin Dealing with Life Histories, Habits, and Control of the Ground Squirrels in California* (Vol. VII). California State Commission of Horticulture. Retrieved July 2019
- Hall, R. E. (1995). *Mammals of Nevada*. Reno, Nevada: University of Nevada Press.
- Kester, D. (1999). *Onychomys torridus: southern grasshopper mouse*. Retrieved July 8, 2019, from Animal Diversity Web: https://animaldiversity.org/accounts/Onychomys_torridus/
- Micone, K. (2002). *Demographics and Ecology of an Isolated Population of the Desert Pocket Mouse, Chaetodipus penicillatus sobrinus, in the Las Vegas Valley, Nevada*. Las Vegas: University of Nevada, Las Vegas.
- NewFields. (2018). *Final Report: Desert Upland Baseline Small Mammal Surveys*. Las Vegas: Desert Conservation Program. Retrieved March 2019
- Oelhafen, K. (2004). *Neotoma lepida: desert woodrat*. Retrieved July 8, 2019, from Animal Diversity Web: https://animaldiversity.org/accounts/Neotoma_lepida/
- O'Farrell, T. P. (2009). *Management Action Plan for the Boulder City Conservation Easement*. Las Vegas: Desert Conservation Program. Retrieved June 2019, from http://www.clarkcountynv.gov/airquality/dcp/Documents/Library/dcp%20reports/2009/Boulder%20City%20Conservation%20Easement%20Management%20Plan%201_0%20Aug%202009.pdf
- Pauli, J. (2003). *Dipodomys deserti: desert kangaroo rat*. Retrieved July 8, 2019, from Animal Diversity Web: https://animaldiversity.org/accounts/Dipodomys_deserti/

RECON. (2000). *Final Clark County Multiple Species Habitat Conservation Plan and Environmental Impact Statement for Issuance of a Permit to Allow Incidental Take of 79 Species in Clark County, Nevada*. San Diego. Retrieved June 2019, from <http://www.clarkcountynv.gov/airquality/dcp/pages/currenthcp.aspx>

US Geological Survey. (2014). *Mapping Habitat for Multiple Species in the Desert Southwest*. US Department of the Interior.

APPENDIX A
Species Photo Log



Photo A. *Dipodomys merriami* (Merriam's kangaroo rat)



Photo B. *Dipodomys merriami* (Merriam's kangaroo rat)



Photo C. *Neotoma lepida* (Desert woodrat)



Photo D. *Neotoma lepida* (Desert woodrat)



Photo E. *Onychomys torridus* (Southern grasshopper mouse)



Photo F. *Onychomys torridus* (Southern grasshopper mouse)



Photo G. *Perognathus longimembris*
(Little pocket mouse)



Photo H. *Perognathus longimembris*
(Little pocket mouse)



Photo I. *Dipodomys deserti* (Desert kangaroo rat)



Photo J. *Dipodomys deserti* (Desert kangaroo rat)



Photo K. *Peromyscus eremicus* (Cactus mouse), juvenile



Photo L. *Peromyscus eremicus* (Cactus mouse), adult



Photo M. *Ammospermophilus leucurus* (White-tailed antelope ground squirrel)



Photo N. *Ammospermophilus leucurus* (White-tailed antelope ground squirrel)



Photo O. *Chaetodipus formosus* (Long-tailed pocket mouse)



Photo P. *Chaetodipus formosus* (Long-tailed pocket mouse)



Photo Q. *Peromyscus crinitus* (Canyon mouse)



Photo R. *Peromyscus crinitus* (Canyon mouse)

APPENDIX B

Detailed Trapping Results per Transect

Location	Habitat Type	Transect #	Trap Nights	Species Captured *									Total
				AMLE	CHFO	DIDE	DIME	NELE	ONTO	PELO	PEER	PECR	
Andesite Foothills	Mojave Desert scrub - rocky, associated with base of foothills	30	40		1								1
	Desert wash system surrounding foothills	31	40		1								1
	Foothills, Desert wash system surrounding foothills	32	40		1						2		3
	Foothills	33	40		2						4		6
Cholla-Creosote Wash System	desert wash system	34	40										0
	desert wash system	35	40										0
	desert wash system	36	40										0
	Mojave Desert scrub - gravelly	37	20										0
Western Basaltic Foothills	Mojave Desert scrub - rocky, associated with base of foothills	38	40		6							2	8
	Foothills	39	40		3			1				6	10
	Foothills	40	40		1							2	3
Northeast of Energy Zone	Mojave Desert scrub - sandy	41	40				3			2			5
	Mojave Desert scrub - sandy	42	40				1			1			2
	Mojave Desert scrub - sandy	43	40				1						1

Location	Habitat Type	Transect #	Trap Nights	Species Captured *									Total
				AMLE	CHFO	DIDE	DIME	NELE	ONTO	PELO	PEER	PECR	
	Salt desert scrub/ Fenceline disturbance	56	40				2						2
	Salt desert scrub/ Fenceline disturbance	57	40				1						1
Northeast of Energy Zone	Mojave Desert scrub - sandy	58	40				7		1	5			13
TOTAL				3	30	2	47	8	1	26	18	17	152

- * AMLE *Ammospermophilus leucurus* White-tailed antelope ground squirrel
 CHFO *Chaetodipus formosus* Long-tailed pocket mouse
 DIDE *Dipodomys deserti* Desert kangaroo rat
 DIME *Dipodomys merriami* Merriam's kangaroo rat
 NELE *Neotoma lepida* Desert woodrat
 ONTO *Onychomys torridus* Southern grasshopper mouse
 PELO *Perognathus longimembris* Little pocket mouse
 PECR *Peromyscus crinitus* Canyon mouse
 PEER *Peromyscus eremicus* Cactus mouse