Final Project Report

Riparian Small Mammal Surveys

Riparian Reserve Units
Muddy River and Virgin River
Clark County, Nevada

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EXECUTIVE SUMMARY

The Multiple Species Habitat Conservation Plan (MSHCP) and the Riparian Reserve 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.

Prior to conducting the surveys for small mammals, 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 17 single-night trapping events between April 24 and June 5, 2020, during which 93 transects were set, each with 20 trap stations and two traps per station. In total, 3,720 trap-nights were completed, exceeding the planned trapping effort of 3,640 trap-nights.

Thirteen species of small mammals had been identified as likely to occur, five as unlikely to occur, and three as highly unlikely to occur within the Riparian Reserve Units based on their geographic range, known distribution, and habitat requirements; prior trapping records in and around the area; museum records; and habitat expected to be present within the Riparian Reserve Units according to available Desert Conservation Program (DCP) documents. One of these species expected to occur is listed in the MSHCP as an Evaluation Species: *Chaetodipus penicillatus sobrinus* (desert pocket mouse).

Eight of the 13 species of small mammals identified as likely to occur and two of the five species identified as unlikely to occur in the area were captured during the 2020 survey and sign of one additional species identified as likely to occur was observed. A total of 929 individual small mammals were captured during this project. *Peromyscus eremicus* (cactus mouse) represented 57% of all individuals captured and was captured in all the sites and on 89 of the 93 transects.

C. p. sobrinus, the MSHCP Evaluation Species, was captured in all but one of the sites, and was primarily found in the sandy habitats of the floodplains of the Muddy and Virgin Rivers where vegetation density was low enough to allow exposure of bare soils.

The primary goal of the 2020 survey was to develop a baseline record of small mammal species present within the Riparian Reserve Units. BEC biologists accomplished this goal by confirming the presence of 11 small mammal species in the study area.

1 INTRODUCTION

On behalf of Clark County; the cities of Boulder City, Henderson, Las Vegas, and North Las Vegas; and the Nevada Department of Transportation, the Clark County Desert Conservation Program (DCP) is responsible for managing Endangered Species Act (ESA) compliance under the Clark County Multiple Species Habitat Conservation Plan (MSHCP) and the associated Incidental Take Permit (ITP) granted under Section 10(a)(1)(B) of the ESA (Clark County Department of Air Quality, 2000). The ITP authorizes take of six avian species known to occur within riparian habitats in southern Nevada, including *Empidonax traillii extimus* (southwestern willow flycatcher), listed as Endangered under the ESA and the Nevada Revised Statutes (NRS), and *Coccyzus americanus* (yellow-billed cuckoo), listed as Threatened under the ESA and Sensitive under the NRS.

As a condition for the take of these covered species (Condition K.1 of the ITP), the DCP has acquired and manages approximately 601 acres of desert riparian habitat, establishing Riparian Reserve Units along the Muddy and Virgin rivers (**Appendix A: Project Maps**, **Figure 1 – Location Map**). These Riparian Reserve Units include occupied and potential habitat for each of these six MSHCP covered avian species. While the primary purpose for the acquisition of the lands and establishment of the Riparian Reserves is the restoration, conservation, and protection of desert riparian habitat for these covered avian species, other covered species potentially found in the areas are to be conserved as well, including small mammals.

1.1 Project Background and Need

Following acquisition of the lands and establishment of the Riparian Reserve Units, the DCP developed the *Riparian Reserve Units Management Plan* (Plan) (Clark County Desert Conservation Program, 2019). This plan identified four general goals and multiple associated objectives. Goal #1 established in the Plan is to, "Manage reserve units to provide habitat for the six MSHCP covered avian species," with the primary objective under this goal being to restore, create and enhance habitat for these avian species. In support of this goal and the associated objective, surveys have been conducted for multiple years to gain an understanding of the distribution, abundance, and trends of the populations of these species within the Riparian Reserves Units.

Goal #2 established in this Plan is to "Manage reserves to support resource values for other MSHCP and sensitive species when practicable." However, no information was available on the small mammal community within the Riparian Reserve Units. Information on these species was determined to be needed to support achievement of a portion of this goal.

1.2 Project Description

In 2019, the DCP contracted BEC Environmental, Inc. (BEC) to conduct an inventory of the small mammal community within the Riparian Reserve Units established along the Muddy River and the Virgin River in eastern Clark County. The project included establishing transects within the parcels of the Riparian Reserve Units, ensuring the parcels and habitats within each of the units were represented in the effort.

The Muddy River Reserve Unit is comprised of nine parcels, approximately 116.5 acres, located within and outside the unincorporated town of Moapa, Nevada (**Appendix A**, **Figure 2 – Muddy River Reserve Unit Map**). The Virgin River Reserve is comprised of 13 parcels, approximately 486.5 acres, dispersed throughout Mesquite, Bunkerville, Riverside, and Mormon Mesa, located east of Moapa Valley, Nevada (**Appendix A**, **Figure 3 – Virgin River Reserve Unit Map**).

1.3 Management Actions Addressed (As Identified in the MSHCP)

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 Riparian Reserve Units and other unique habitats.

Small mammals or rodents are widespread and play an important role in the functioning of ecosystems. 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.

1.4 Project Goals and Objectives

Prior to this survey, the species composition of the small mammal community within the Riparian Reserve Units was not documented. The goal of this project was to develop a baseline record of small mammal species present within the Riparian Reserve Units. The information collected would provide the DCP information to assist in evaluating changes in the small mammal species composition in the Units and assess the effects of future management and/or restoration activities conducted in the areas. The specific objective of this project was to conduct sufficient sampling intensity of the parcels within the Riparian Reserve Units, distributed among the habitats present within the units, to achieve the project goal.

While some inferences can be made, this project was not intended to evaluate habitat preferences, relative abundance, or other population/ecological parameters of the species found within the areas. 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 developing a baseline record of small mammal species currently present within the Riparian Reserves. BEC biologists developed a Work Plan based on generally accepted methods for small mammal trapping. DCP biologists reviewed and concurred with the Work Plan and the planned surveys were conducted.

2.1 Survey Planning Activities

The Work Plan was developed to describe the specific field methods to be implemented, the intended density and distribution of the trapping effort, and identify the species the team may encounter during the field surveys. The field methods to be implemented are described in **Section 2.2. Survey Activities**.

The proposed trap density and distribution of the trapping effort was evaluated based on the size, diversity, and complexity of habitat within the various parcels, with the intent of only using the level of trapping effort needed to adequately sample the habitats that were present. BEC biologists determined the potential diversity of habitat types across the Reserve Units using available soil maps, topographic maps, aerial photography, vegetation association maps, and information from other DCP documents.

While the initial intent was to distribute trapping effort evenly among the parcels within each Reserve Unit based on parcel size, the habitat evaluation indicated the distribution of effort should be adjusted slightly in some areas based on habitat distribution to ensure all habitats were adequately sampled. Using this evaluation of habitats, the biologists estimated the number of traps required to sample each of the habitat types per site and extrapolated an overall density based on these estimates. Based on this

evaluation, the planned trapping density was approximately six traps per acre for a total of approximately 3,640 trap nights across the 601 acres of Reserve.

In addition to establishing trap density and coverage of each of the habitats within the Units, biologists developed a list of species potentially occurring in the region and assessing their likelihood of occurring within the Reserve Units, 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 Muddy River and Virgin River corridors and surrounding rivers and tributaries, a review of "Mammals of Nevada" (Hall, 1995), and the previous experience and professional judgement of the project's Lead Mammologist, Dr. Sean Neiswenter. The likelihood of the species to occur within the Reserve Units was determined based on general habitat requirements or preferences of the species and potential for the habitat to be present, and the known or expected geographic range and distribution of the species.

2.2 Survey Activities

Biologists Dr. Sean Neiswenter (Lead Mammologist) and Danielle Viglione (Field Biologist) conducted field surveys three to five days per week, from April 24 through May 25, 2020, with one additional trapping session conducted with support from Scott Cambrin and Stefanie Ferrazzano (Clark County DCP), from June 4 to 5, 2020. Each trap session lasted between one and four nights and targeted a single site, with the exception of Bunkerville East and Mesquite West, which were trapped in the same session. Trap setting occurred between 1645 and 2000, and trap collection occurred between 0630 and 1015.

Each trap session was initiated with a site reconnaissance of part or all the target parcel(s) for that trap session. Because of the potential presence of sensitive and protected bird species within the parcels, biologists were careful to avoid disturbance of habitat and utilized small trails marked with flagging (presumably set by other biologist) or natural/existing breaks in the vegetation to access areas for trapping. Based on observations made in the field of habitat within the site and the target trap density for the Unit, biologists determined locations and direction for the transects to be set. Due to the configuration of habitat, waterways, and manmade barriers encountered throughout the sites, transects were not always set in a straight line and instead wound through openings in vegetation, curved along the target habitat, or were adjusted to avoid areas inundated with water. The biologists set between two and seven transects per night, each with 20 trap stations, spaced approximately 10 meters apart, adjusted based on terrain and habitat composition. Each trap station consisted of two Sherman® live traps baited with a mixture of rolled oats and peanut butter.

Each trap was set by placing it on a stable, even surface, and placing bait at the back of the trap. Each trap was tested to ensure shutting mechanisms were working properly. Trap set times and temperatures were recorded on field data sheets.

The following morning (approximately 0700 each day) biologists returned to the transect locations to check traps. The team of two biologists worked together to check and collect traps and record data. Universal Transverse Mercator (UTM) coordinates for transect start location, collection start temperature, and start time were recorded for each transect. Biologists then started at trap station "1" of each transect and recorded if the trap was open, sprung but empty or containing a non-mammal species, damaged, or occupied with a small mammal. For occupied traps, the biologists: emptied the trap; identified and recorded the species of the captured animal; assessed and recorded general condition of the animal; and, in some cases, took a photo of the specimen. The Lead Mammologist selectively collected voucher specimens (in accordance with his Nevada Department of Wildlife Scientific Collection Permit) to confirm species identification and to establish a museum record for the units. The UTM coordinates for transect end location, collection end temperature, and finish time were recorded per transect as well. Reserve Unit, parcel, general habitat description, trap specific habitat, and overall habitat and dominant

plant species and dominant plant species for the understory, mid-story, and overstory, when present. Incidental observations along the transect of presence or sign of small mammals within the site were documented.

Table 2-1: Small Mammal Species Expected to Occur within the Riparian Reserve Units includes an assessment of the habitat each species is likely to occupy based on the above sources.

Table 2-1: Small Mammal Species Expected to Occur within the Riparian Reserve Units

Scientific Name	Common Name	Typical Habitat
Likely to Occur: known to occur in the Riparian Reserve Units or associated with the prevalent habitats		
Ammospermophilus leucurus	White-tailed antelope ground squirrel	Low-mid elevation desert scrub
Castor canadensis[1]	North American beaver	Aquatic riparian
Chaetodipus formosus	Long-tailed pocket mouse	Rocky areas with varied scrub with hard groundcover/rocky soils; base of cliffs or mouth of canyons
Chaetodipus penicillatus sobrinus[2]	Desert pocket mouse	Soft alluvium, sandy, or silty soils, sparse desert vegetation
Dipodomys merriami	Merriam's kangaroo rat	Sandy soils, low elevation, creosote bush (*Larrea tridentata*), open desert habitat, generalist
Neotoma lepida	Desert woodrat	Rock outcrops, dense vegetation
Odontra zibethicus[1]	Muskrat	Aquatic riparian
Perognathus longimembris	Little pocket mouse	Sandy soils, arid grasslands
Peromyscus crinitus	Canyon mouse	Rocky slopes, canyons
Peromyscus eremicus	Cactus mouse	Generally rocky and brush habitats, often associated with cactus
Peromyscus maniculatus	Deer mouse	Common in disturbed areas, habitat generalist, in desert most often mesic, low to mid-elevation
Reithrodontomys megalotis	Western harvest mouse	Dense grass, arid grasslands or prairie, typically only mesic areas in desert
Thomomys bottae[1]	Botta's pocket gopher	Low elevation, agriculture, scrub, in soft soils, avoids rocky areas and open desert
Unlikely to Occur: Uncommon or microhabitat requirements not likely present in the Riparian Reserve Units; low abundance when present		
Dipodomys deserti[2]	Desert kangaroo rat	Substantial accumulations of wind driven sand and sparse vegetation, sand dune specialist
Mus musculus	House mouse	Disturbed areas, commensal with humans, invasive
Onychomys torridus	Southern grasshopper mouse	Arid grassland to desert scrub, low elevation
Peromyscus boylii	Brush mouse	Dense brushy habitat, often with tree cover, or rocky outcrops / canyons, mid elevation at low latitudes, mesic areas of desert
Rattus rattus / Rattus norvegicus	Roof rat/Norway rat	Disturbed areas, commensal with humans, invasive
Highly Unlikely to Occur: Very unlikely to be present due to habitat requirements or known geographic range		
Eutamias dorsalis	Cliff chipmunk	pinyon-juniper, mid-high elevation
Peromyscus truei	Pinyon mouse	Near pinyon-juniper, rocky slopes, mid-high elevation
Xerospermophilus tereticaudus	Round tailed ground squirrel	Sandy soils, desert scrub, mesquite (*Prosopis* sp.), palo verde (*Parkinsonia* sp.)

[1] Species sign was to be documented if observed, but species was not targeted with trapping efforts

[2] Indicates MSHCP Evaluation Species

2.3 Post-Survey Activities

After checking traps on all transects each morning, biologists set up a data processing field station to review photos and GPS data, and to complete and scan data sheets. A summary of species and individuals successfully captured was recorded per transect and for the day. Photos and GPS data recorded during each trapping session were uploaded upon return to the office.

For each voucher specimen collected, a standard museum skin and/or skeleton were prepared and catalogued for accession 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 to ensure completeness, accuracy, and consistency of the transcribed data within the field-collected data. This spreadsheet was then uploaded into a geodatabase for submittal to the DCP.

3 RESULTS AND EVIDENCE OF THE RESULTS

3.1 Objectives Completed

The primary goal of this project was to develop a baseline record of small mammal species currently present within the Riparian Reserve Units to allow the DCP to track changes in small mammal occurrences at these properties as the units are altered and/or restored. The specific objective was to sample the parcels within the Riparian Reserve Units, distributed among the habitats present within the units, to achieve the project goal. The information provided below outlines how the team of biologists accomplished this objective.

The team of biologists successfully achieved setting 3,720 trap-nights over 17 nights during six trapping sessions occurring between April 24 and June 5, 2020. The team captured 929 individual small mammals representing ten species. Observations of sign for one additional small mammal species occurred during several of the trapping sessions. The results and observations made during this survey can be used as a general inventory of small mammal species present within the Riparian Reserve Units, and as supporting information for identifying small mammal species not likely to be present or present in small numbers.

3.2 Survey Efforts and Parcel Observations

The following sections provide a general description of the habitats types and conditions observed in the parcels within each of the Riparian Reserve Units, and the distribution of the survey effort within the parcels and the habitat observed. The description of the habitats observed is not comprehensive or detailed, as the primary focus of this effort was a general inventory of the species present; attributing densities of any species to specific habitats was beyond the scope of this project.

Table 3-1: Transect Distribution Summary provides a summary of the distribution of transects and trap-nights per Reserve Unit and parcel, as well as the dates each of the parcels were trapped. **Appendix A**, **Figures 4** through **11** includes a map for each site showing the location of the transects trapped within that site. The transects in these Figures are depicted as straight lines connecting the transect start and endpoints. However, as noted in **Section 2.2 Survey Activities**, transects were set to most efficiently trap the target habitat while avoiding disturbance or other features and therefore, were not always set in a straight line. It should also be noted that, despite being the most current available imagery, the location and orientation of habitat, especially waterways, depicted in some of the Figures does not accurately represent what biologists encountered in the field. In some instances, it appears transects were set across or in the water; however, no transects were set in or crossing the Muddy or Virgin Rivers. **Appendix B:**

Transect Habitat Photo Log, provides representative photos of the general habitats encountered within each site as described in the following sections. **Appendix C: Species Photo Log**, provides representative photos of the species captured or sign of species observed. **Appendix D: Trapping Results per Transect** provides a summary of the species captured along each transect within each of the parcels.

Table 3-1: Transect Distribution Summary

Site Name	Parcel	Acreage	No. Transects	No. Trap Nights	Trap Dates
Muddy River Reserve Unit					
Muddy River	A	6	2	80	June 4-5
	B	6	2	80	
	C	2	1	40	May 1-4
	D	1	1	40	
	E	25	4	160	
	F	40	6	240	
	G	19	3	120	
	H	17	3	120	
	I	0.5	0	0	
Virgin River Reserve Unit					
Mormon Mesa	5-A	80	12	480	April 24-27
Riverside	3-A	100	15	600	May 22-25
	3-B	40	6	240	
Bunkerville West	2-I	40	6	240	May 8-11
	2-J	60	9	360	
Bunkerville East	2-A	17	3	120	May 15-19
	2-B	21	3	120	
	2-C	3	1	40	
	2-D	37	5	200	
	2-E	10	2	80	
	2-F	57	5	200	
	2-G	8	2	80	
Mesquite West	1-A	11	2	80	May 18-19
	Total	**601**	**93**	**3,720**	

3.2.1 Muddy River Reserve Unit

The Muddy River Reserve Unit is composed of three distinct and geographically separate locations: Parcels A through E, Parcel F, and Parcels G through I (**Appendix A**, **Figure 2**). **Table 3-2: Muddy River Reserve Unit Transect Habitat Summary**, at the end of this section, summarizes the number of transects distributed among the habitat and other characteristics of the parcels.

Parcels A through E

Parcels A through E are the northernmost group of parcels of the Muddy River Reserve Unit and are located on an upland above the Muddy River. A dirt road ran parallel to the river through Parcels A and B. Parcel A was mostly disturbed field and shrubland dominated by quailbush (*Atriplex lentiformis*), arrowweed (*Pluchea sericea*), and invasive grasses, with scattered domestic landscape tree species including palm and mulberry (*Morus* sp.). Parcel B included open dirt areas, dense stands of quailbush, and a stand of oak (*Quercus* sp.) trees. Parcel C included an open, disturbed field of dry grasses and an area of dense quailbush and tumbleweeds. Parcel D included the paved Hillside Drive; another old, disintegrating road; a disturbed field of dry grasses and forbs; and quailbush. Parcel E was the largest of the parcels and included a dirt road lined with arrowweed and quailbush; a rocky outcrop/foothills; an

upland mesa area formerly used as a palm tree nursery; and an area adjacent to the Muddy River with arrowweed, mesquite (*Prosopis* sp.), and active restoration efforts.

Biologists set four transects in Parcel E, and initially set only two in Parcels A through D due to their small size. However, biologists determined during the site visits a higher trap density was appropriate to more accurately survey the area, and four additional transects were set later in the project. **Appendix A**, **Figure 4 – Parcel A through E Transect Map** shows the specific locations of the transects set throughout this location.

Parcel F

Parcel F is the southernmost parcel of the Muddy River Reserve Unit and consists of upland foothills interspersed with ephemeral wash canyons. The western upland areas consisted of rocky Mojave desert scrub with creosote bush, bursage (*Ambrosia dumosa*), and various cactus species. The canyon wash systems were dominated by bare, rocky and sandy substrate with creosote bush, a variety of cactus species, and mesquite. The eastern edge of the parcel was semi-arid grassland with unidentified dry grasses and brushy/woodland dominated by quailbush, tamarisk (*Tamarix ramosissima*), and mesquite. The parcel was accessible via the dirt Hillside Drive along the eastern boundary of the parcel. From the road, the remainder of the parcel was only accessible on foot.

Appendix A, **Figure 5 – Parcel F Transect Map** shows the specific locations of the transects set throughout this parcel.

Parcels G through I

Parcels G through I were the easternmost group of parcels of the Unit and the only set of parcels east of the Muddy River. Parcel G consisted largely of very dense, mostly impenetrable tamarisk with areas of mesquite and quailbush and a system of deep-cut clay washes. The northeast corner of the parcel consisted primarily of alkali sacaton (*Sporobolus airoides*) with interspersed tamarisk and mesquite. Parcel H was adjacent to a residential area and primarily consisted of open shrubland of tamarisk, mesquite, quailbush, alkali sacaton, and Mojave seablite (*Suaeda moquinii*) with berms and areas of dried, cracked mud. The southeast corner of Parcel H and all of Parcel I consisted of a steep bluff which was not safely accessible for trapping, therefore no transects were set in Parcel I.

Typical access to these parcels along a Southern Nevada Water Authority road was restricted during this trapping session; access approval to use the right-of-way could not be obtained due to the current public health concerns. The biologists accessed these parcels via other routes, which were less efficient, but the biologists were able to set representative transects in most of the parcels. **Appendix A**, **Figure 6 – Parcel G through I Transect Map** shows the specific locations of the transects set throughout this location.

Table 3-2: Muddy River Reserve Unit Transect Habitat Summary

Parcel	Transect Habitat Summary	No. of Transects	Photo Number[1]
A	Disturbed field; shrubland	1	1
	Arrowweed and quailbush-lined dirt road	1	2
	Parcel Total Transects	**2**	
B	Quailbush stands	1	3
	Oak grove	1	4
	Parcel Total Transects	**2**	
C	Dry grass field; dense quailbush and tumbleweeds	1	5
	Parcel Total Transects	**1**	
D	Disturbance with dry grass and quailbush	1	6
	Parcel Total Transects	**1**	

Parcel	Transect Habitat Summary	No. of Transects	Photo Number[1]
E	Arrowweed and quailbush-lined dirt road	1	7
	Rocky outcrop/foothill	1	8
	Former palm tree nursery onto mesa upland	1	9 & 10
	Active restoration area/arrowweed floodplain	1	11
	Parcel Total Transects	**4**	
F	Canyon/wash system	2	12
	Rocky foothill/mesa top	1	13
	Grassy lowland; brushy/woodland	3	14
	Parcel Total Transects	**6**	
G	Clay wash system	2	15
	Alkali sacaton field	1	16
	Parcel Total Transects	**3**	
H	Open shrubland	3	17
	Parcel Total Transects	**3**	
I	No transects set in this parcel due to size and access	-	18
	Parcel Total Transects	**0**	

[1] Photos are located in **Appendix B**.

3.2.2 Virgin River Reserve Unit

The Virgin River Reserve consists of five sites along the Virgin River: Mormon Mesa, Riverside, Bunkerville West, Bunkerville East, and Mesquite West (south to north). Mormon Mesa and Mesquite West are both single-parcel sites while Riverside and both Bunkerville sites are made up of a series of parcels (**Appendix A**, **Figure 3**).

3.2.2.1 Mormon Mesa

Mormon Mesa is composed of a single parcel, 5-A, straddling the Virgin River floodplain east of the community of Moapa Valley (**Appendix A**, **Figure 3**). The site includes three general habitat types: a small upland area to the east, an area of grassy mesquite bosque in the southwest, and dense stands of tamarisk with varying degrees of soil saturation and mastication due to restoration efforts. The east side of the parcel had a small portion of rocky upland habitat typical of Mojave desert scrub dominated by creosote bush bordered by a small, sandy area. West of this upland, the parcel included dense, impenetrable stands of tamarisk and arrowweed. Biologists located one access trail into the interior of the parcel, to the large, open area of treated and masticated tamarisk, with tamarisk debris covering the ground and saltbush (*Atriplex* sp.) interspersed throughout some portions. A series of trails led farther into the parcel which consisted of saturated areas composed of impenetrable tamarisk and areas of more open, marshy habitat with various grasses, small stands of mesquite, and various emergent wetland species. The trail led to a deep, mucky, ponded area, preventing safe access from the east to the southwest portion of the parcel.

The southwest portion of the parcel was accessed from the west by crossing the Virgin River. This area consisted of a mesquite bosque habitat not observed elsewhere on the parcel, and was dominated by arrowweed, mesquite, and various grasses. The soil was somewhat saturated during trap setting and appeared to be even more saturated with areas of inundation during trap pickup, but no small mammals were affected. Cattle were actively grazing in this portion of the parcel during the trap session.

Table 3-3: Mormon Mesa Transect Habitat Summary summarizes the number of transects distributed among the habitat and other characteristics of the parcel. **Appendix A**, **Figure 7 – Mormon Mesa Transect Map** shows the specific locations of the transects set throughout this site.

Table 3-3: Mormon Mesa Transect Habitat Summary

Parcel	Transect Habitat Summary	No. of Transects	Photo Number[1]
5-A	Rocky upland	1	19
	Sandy area at base of upland	1	20
	Edge of masticated tamarisk	2	21
	Central area of masticated tamarisk interspersed with saltbush	1	22
	Along muddy trail in tamarisk	1	23
	Along marshy trail in tamarisk	1	24
	Along open portion of trail through tamarisk	1	25
	Mesquite bosque	4	26
	Parcel Total Transects	**12**	

[1] Photos are located in **Appendix B**.

3.2.2.2 Riverside

The Riverside site consists of two large parcels, 3-A and 3-B. **Appendix A**, **Figure 8 – Riverside Transect Map** shows the specific locations of the transects set throughout this location**.** The paved New Gold Butte Road bisected parcel 3-A, effectively separating upland, foothill habitat to the east and shrubland and floodplain habitat to the west. West of and parallel to New Gold Butte Road within the floodplain, a dirt road and irrigation canal were present, as was an abandoned structure. The habitat between New Gold Butte Road and the irrigation ditch was semi-arid shrubland dominated by quailbush, tamarisk, and Mojave seablite. The dirt road was lined with arrowweed, quailbush, and willow (*Salix* sp.). The southern portion of 3-A had a field of saltgrass (*Distichlis spicata*) and mesquite on the west side of the dirt road. A three-part braided system of the Virgin River flowed through the large central portion of the parcels creating an active floodplain habitat dominated by arrowweed, mesquite, and willows. The unpaved Foster Lane intersected the west side of the site, with rocky upland foothills to the west and dense arrowweed and tamarisk to the east transitioning into the central active floodplain.

During survey and reconnaissance activities, biologists observed recreational activities on site, mostly in the northern portion of 3-B, possibly due to easy access. These activities included fishing, swimming, camping, and use of off-highway vehicles. Biologists also observed cattle throughout the parcel and observed tracks and disturbance from heavy machinery around the river edge.

Table 3-4: Riverside Transect Habitat Summary summarizes the number of transects distributed among the habitat and other characteristics of the parcels within this site. **Appendix A**, **Figure 8** shows the specific locations of the transects set throughout this site.

Table 3-4: Riverside Transect Habitat Summary

Parcel	Transect Habitat Summary	No. of Transects	Photo Number[1]
3-A	Eastern uplands	2	27
	Eastern upland canyon/wash system	2	28
	Arrowweed/willow-lined dirt road	2	29
	Abandoned structure and surrounding disturbance	1	30
	Semi-arid shrubland	1	31
	Active arrowweed floodplain	5	32 & 33
	Sandy tamarisk	1	34
	Saltgrass and mesquite grassland	1	35
	Parcel Total Transects	**15**	
3-B	Western rocky uplands	1	36
	Arrowweed/tamarisk-lined Foster Lane	1	37
	Active arrowweed floodplain	5	38 & 39
	Parcel Total Transects	**6**	

[1] Photos are located in **Appendix B**.

3.2.2.3 Bunkerville West

Bunkerville West consists of two large parcels, 2-I to the west and 2-J to the east (**Appendix A**, **Figure 9 – Bunkerville West Transect Map**), with a wide variety of habitat types, as well as a number of features which generated access challenges for biologists.

Parcel 2-J was bisected by an old, isolated channel of the Virgin River, beginning at the north central portion of the parcel, extending to the south and southwest, and into the southern portion of Parcel 2-I. This old river channel was ponded in areas, had a relatively steep bank, was heavily vegetated with dense arrowweed, and was bounded by a barbed wire fence and dirt path, all of which somewhat impeded access to the northwest portion in this parcel.

The area east and south of this old channel within Parcel 2-J included multiple areas with a variety of combinations of habitat features. These areas were:

- an area of mostly dry grasses and shrub species such as quailbush and Mojave seablite interspersed with mesquite;
- an area of moist to saturated soils with a variety of green grasses, rushes, yerba mansa (*Anemopsis californica*), and cattails (*Typha* sp.) interspersed with mesquite and tamarisk;
- an area dominated by saltgrass and arrowweed with some mesquite and a dense tamarisk stand; and
- an area that transitioned from grasses with relatively dry soils, to moist soils with various emergent herbaceous species, then transitioned to arid shrubland.

The area south of the old river channel within Parcel 2-I included three distinct habitats. The area between the southern Parcel boundary and the old dirt path and fence was dry grassy field, likely used as a pasture in the past. Dense quailbush ran along the south side of the fenceline, and a dense tamarisk forest was present between the fence and the old river channel.

North of the old river channel, to the northern boundary of Parcel 2-J and to the edge of the active Virgin River channel which bisected Parcel 2-I diagonally from the northeast to the southwest, was active floodplain with sandy to silty soils and areas with vegetation ranging from sparse to moderately dense with combinations of arrowweed, tamarisk, willow, and grasses.

The banks of this portion of the river were very steep and easily eroded, and combined with the velocity of the water, was not safely passable by biologists. Therefore, the northwest portion of Parcel 2-I could not be accessed or trapped. The habitat in that section of the parcel was observed from a distance and via aerial photography, and appears to be consistent with the areas south of the river that were trapped, and is likely to have a similar small mammal community.

During survey activities, biologists observed cattle entering the parcel from the southern-adjoining property through an open gate, into the grassy fields of the southern portion of 2-J. Several traps were crushed by cattle within the parcel. Biologists also observed flooding of the southeast portion of 2-J which explained the variation from dry to moist in different portions of the grassy fields.

Table 3-5: Bunkerville West Transect Habitat Summary summarizes the number of transects distributed among the habitat and other characteristics of the parcels within this site. **Appendix A**, **Figure 9** shows the specific locations of the transects set throughout this site.

Table 3-5: Bunkerville West Transect Habitat Summary

Parcel	Transect Habitat Summary	No. of Transects	Photo Number[1]
2-I	Dirt path through dry grass field	1	40
	Dry grass field; dense quailbush fenceline	1	41
	Trail in dense tamarisk; dense arrowweed; open shrubland	1	42 – 44
	Open, sandy shoreline	1	45
	Sandy arrowweed edge in floodplain	1	46
	Trail in dense tamarisk forest; dense arrowweed floodplain; sandy shoreline	1	47 – 49
	Parcel Total Transects	**6**	
2-J	Semi-arid grassland	2	50
	Muddy, moist soils with grasses, arrowweed, and reeds	2	51
	Fenceline/dirt path between dry grass field and dense arrowweed stand	2	52
	Dry grass field transitioning into moist marshy field	1	53
	Saltgrass arrowweed floodplain	2	54
	Parcel Total Transects	**9**	

[1] Photos are located in **Appendix B**.

3.2.2.4 Bunkerville East

Bunkerville East consists of seven parcels, 2-A through 2-G (**Appendix A**, **Figure 10 – Bunkerville East Transect Map**). The southern 15 acres of parcel 2-F was fenced and being used as a cattle pasture; therefore, this area was not sampled during this project, as directed by the DCP.

The surveyed portion of Parcel 2-F consisted of a large field of dry grass interspersed with mesquite in the southern portion, a dirt path surrounded by an area of quailbush and arrowweed semi-arid grassland, and an area of tamarisk-beetle infested tamarisk forest surrounded by a berm of dirt and construction debris in the central portion. This area may have been used as pasture lands in the past based on a review of the aerial photos and features in the field. The northern portion of this parcel consisted of sandy arrowweed and willow floodplain associated with the Virgin River which flows along the northern boundary of the parcel.

The river and this associated floodplain habitat extended into the other six parcels and makes up the northern portion of Parcel 2-G. The remainder of 2-G was consistent with the quailbush and arrowweed semi-arid grassland found in Parcel 2-F.

The tamarisk forest and berm of construction debris described in Parcel 2-F continued into the south half of Parcel 2-E and the southeast corner of Parcel 2-D. The remainder of 2-E and 2-D, all of Parcel 2-C, most of 2-B, and the southwestern portion of 2-A consisted of sandy floodplain strewn with flood debris and sparce to abundant arrowweed interspersed with willow and mesquite. The northern portion of 2-A had an area of upper floodplain with a large stand of mesquite and very dense arrowweed which continued north into a forest of large tamarisk with an open, sandy understory. The tamarisk in this portion of the site did not seem to be as affected by tamarisk beetles at the time of the survey.

Table 3-6: Bunkerville East Transect Habitat Summary summarizes the number of transects distributed among the habitat and other characteristics of the parcels within this site. **Appendix A**, **Figure 10** shows the specific locations of the transects set throughout this site.

Table 3-6: Bunkerville East Transect Habitat Summary

Parcel	Transect Habitat Summary	No. of Transects	Photo Number[1]
2-A	Sandy upper floodplain with dense arrowweed interspersed with mesquite	2	55
	Sandy upper floodplain with mature tamarisk stand with grassy understory	1	56
	Parcel Total Transects	**3**	
2-B	Open, sandy riverbank habitat interspersed with arrowweed	2	57
	Sandy riverbank with dense arrowweed	1	58
	Parcel Total Transects	**3**	
2-C	Sandy open floodplain with some herbaceous cover; interspersed with flood debris and arrowweed	1	59
	Parcel Total Transects	**1**	
2-D	Sandy open floodplain with some herbaceous cover; interspersed with flood debris and arrowweed	1	59
	Sandy open floodplain with; interspersed with islands of flood debris and arrowweed and mesquite	1	60
	Arrowweed, mesquite, and tamarisk stand in floodplain	1.5	61
	Edge of sandy tamarisk stand	1.5	62
	Parcel Total Transects	**5**	
2-E	Sandy floodplain with islands of flood debris and arrowweed	1	63
	Top of construction debris/dirt berm along edge of the tamarisk forest	1	64
	Parcel Total Transects	**2**	
2-F	Dry grass interspersed with mesquite	2	65
	Along dirt path; through the quailbush and arrowweed semi-arid grassland	2	66
	Fenceline at north boundary of active pasture	1	67
	Parcel Total Transects	**5**	
2-G	Sandy arrowweed and willow floodplain/shoreline	2	68 & 69
	Parcel Total Transects	**2**	

[1] Photos are located in **Appendix B**.

3.2.2.5 Mesquite West

Mesquite West is one parcel, 1-A, which was a very dense, mostly willow forest (**Appendix A**, **Figure 11 – Mesquite West Transect Map**). Water was actively flowing through the parcel interior, limiting areas in which traps could be set. The parcel was available to biologists via the adjacent golf course to the east; however, access to the interior of the parcel was limited due to density of vegetation. Some of the traps became inundated with water overnight, indicating the water level had risen since trap setting, but no small mammals were affected.

Table 3-7: Mesquite West Transect Habitat Summary summarizes the number of transects distributed among the habitat and other characteristics of the parcels within this site. **Appendix A**, **Figure 11** shows the specific locations of the transects set throughout this site.

Table 3-7: Mesquite West Transect Habitat Summary

Parcel	Transect Habitat Summary	No. of Transects	Photo Number[1]
1-A	Eastern boundary between dense willow forest and golf course	1	70
	Dense willow forest	1	71
	Parcel Total Transects	**2**	

[1] Photos are located in **Appendix B**.

3.3 Survey Results

Over the course of 17 nights between April 24 and June 5, 2020, biologists set 93 small mammal live trapping transects, each with 20 trap stations, two traps per station, resulting in 3,720 trap-nights, exceeding the planned trapping effort of 3,640 trap-nights.

Eight of the 13 species of small mammals identified as likely to occur and two of the five species identified as unlikely to occur in the area prior to the study were captured during the 2020 survey and sign of one additional species identified as likely to occur was observed. A total of 929 individual small mammals were captured during this project. *Peromyscus eremicus* (cactus mouse) represented 57% of all individuals captured in all the sites and was found on 89 of the 93 transects.

Table 3-8: Trapping Results by Unit and Site/Location provides a summary of the number of individuals of each species captured during this effort by Unit and Site. **Appendix C** provides representative photos of the species captured or sign of species observed. **Appendix D** provides the total number of individuals captured along each transect by the Site and Parcel.

C. p. sobrinus, the MSHCP Evaluation Species, was captured in all but one of the sites, and was primarily found in the sandy habitats of the floodplains of the Muddy and Virgin Rivers where vegetation density was low enough to allow exposure of bare soils.

The primary goal of the 2020 survey was to develop a baseline record of small mammal species present within the Riparian Reserve Units. BEC biologists accomplished this goal by confirming the presence of 11 small mammal species in the study area and assessing the presence and distribution of the Evaluation species, *C. p. sobrinus*.

Table 3-8: Trapping Results by Unit and Site/Location

Reserve Unit	Site/Location	Species Captured/Observed	No. of Individuals[1]
Muddy River	**Parcels A through E**	*Ammospermophilus leucurus*	Observed
		Chaetodipus penicillatus sobrinus	2
		Dipodomys merriami	2
		Neotoma lepida	3
		Peromyscus eremicus	67
		Reithrodontomys megalotis	1
	Parcel F	*Ammospermophilus leucurus*	Observed
		Chaetodipus formosus	3
		Chaetodipus penicillatus sobrinus	2
		Dipodomys merriami	1
		Peromyscus eremicus	9
	Parcel G and H	*Neotoma lepida*	1
		Peromyscus eremicus	43
		Total Individuals Captured	**134**
Virgin River	**Mormon Mesa**	*Ammospermophilus leucurus*	Observed
		Chaetodipus formosus	1
		Chaetodipus penicillatus sobrinus	1
		Neotoma lepida	1
		Onychomys torridus	1
		Peromyscus eremicus	23
		Reithrodontomys megalotis	4
		Total Individuals Captured	**31**
	Riverside	*Ammospermophilus leucurus*	2
		Chaetodipus formosus	24
		Chaetodipus penicillatus sobrinus	11
		Dipodomys merriami	21
		Mus Musculus	4
		Neotoma lepida	35
		Onychomys torridus	4
		Peromyscus eremicus	190
		Reithrodontomys megalotis	8
		Thomomys bottae	Sign
		Total Individuals Captured	**299**
	Bunkerville West	*Chaetodipus penicillatus sobrinus*	3
		Dipodomys merriami	7
		Mus Musculus	9
		Neotoma lepida	13
		Onychomys torridus	2
		Peromyscus eremicus	64
		Peromyscus maniculatus	63
		Peromyscus sp.*	1
		Reithrodontomys megalotis	12
		Thomomys bottae	Sign
		Total Individuals Captured	**174**
	Bunkerville East	*Chaetodipus penicillatus sobrinus*	8
		Dipodomys merriami	17
		Mus Musculus	10
		Neotoma lepida	37
		Onychomys torridus	1
		Peromyscus eremicus	111
		Peromyscus maniculatus	64
		Reithrodontomys megalotis	12

Reserve Unit	Site/Location	Species Captured/Observed	No. of Individuals[1]
		Thomomys bottae	Sign
		Total Individuals Captured	**260**
	Mesquite West	*Mus Musculus*	1
		Neotoma lepida	7
		Peromyscus eremicus	22
		Reithrodontomys megalotis	1
		Thomomys bottae	Sign
		Total Individuals Captured	**31**
		Total Individuals Captured	**134**
Total		**11 Species**	**929**

[1] Observed: Incidental observation of species within the area
Sign: Sign of species observed within the area
* Individual could not be identified beyond genus due to missing tail

4 EVALUATION/DISCUSSION OF RESULTS

4.1 General Abundance Observations

This study was not intended or designed to calculate or otherwise evaluate the density or relative abundance of small mammal populations. However, after completing the field effort, two potentially related general trends were noticed.

Fewer individual animals were captured in areas with minimal plant interspace and exposed soil due to dense vegetation, either in the form of a thick understory of herbaceous vegetation or a thick impenetrable shrub overstory of native or non-native species, or due to layers of masticated tamarisk debris left in the area. Vegetation in most of the Mormon Mesa and all of Mesquite West sites exhibited these characteristics, as did microhabitats within other sites. While this observation could be an artifact of the difficulty in accessing and trapping such areas, the biologists on this study were confident they effectively trapped the areas they accessed, and believe they would have captured animals if they had been present in significant numbers.

Similarly, fewer individuals were captured in areas with saturated soils or fluctuating water levels. During this study, the majority of the Mesquite West site, and portions of the Mormon Mesa, Bunkerville East, and Bunkerville West sites included areas of saturated soils or inundation. Biologists established transects in or adjacent to the areas with saturated soils. In several of these areas, the degree of saturation or inundation increased over the course of the night, and in a few cases the traps were sitting in water the next morning (no animals drowned during this study). The biologists did not evaluate or investigate if the cause of the rise in water levels were due to fluctuations in river flow, overflow irrigation from adjacent parcels, or other sources. Regardless, areas with frequent or unpredictable inundation may impact the suitability of an area for some small mammal species.

4.2 Animal Condition

The general condition of most of the individuals captured during this project was assessed as good by the biologists. However, the biologists observed some individuals showing signs of current or past infestation of bot fly larvae (*Oestridae* sp.). Bot flies are obligate parasites that have evolved with their host species, forming a physiological relationship which is minimally harmful to the host. Bot fly species typically associate with one or two host species but may infest other species.

During this study, 26 of the 929 individuals captured showed signs of current or previous presence of a bot fly infestation. Twenty-four of these individuals were captured in the Riverside site (23 *Peromyscus eremicus*, 1 *Chaetodipus formosus*) and two were captured in the Bunkerville East site (1 *P. eremic*us, 1

Dipodomys merriami). While a very small proportion of the animals captured were infested, it is of note that the majority of the infested individuals were *P. eremicus*, which is consistent with the host-specific nature of a bot fly species. Additionally, *P. eremicus* was the most common species captured during this study.

4.3 Captured Species

The following sections provide a general summary of observations associated with each of the species or groups of species captured during this Project.

Peromyscus eremicus (**Appendix C, Photo 1**) was the most common species, with 529 individuals trapped, accounting for 57% of all individuals trapped throughout the survey. They were trapped in every location and were captured in all but 10 of the 93 transects set for the project. They were uncommon in rocky, upland foothill areas. They were also present in low numbers in the more moist, marshy habitats, which in general had much lower rodent occurrence compared to other habitats. The southern, grassy field portion of parcel 2-F at Bunkerville East was the other area with very low occurrence of this species. In this portion of the site, *Peromyscus maniculatus* was more common than *P. eremicus*.

Peromyscus maniculatus (**Appendix C, Photo 2**) was the second most frequently trapped species, with 127 individuals (14%) captured throughout the project. Although the number of captures was high, *P. maniculatus* were only captured in the Bunkerville East and Bunkerville West sites. The habitats found in the Bunkerville sites were similar to those found elsewhere, most similarly Riverside, so it is not unlikely for the species to occur elsewhere; however, they may be in low densities or absent due to the overwhelming presence of *P. eremicus*.

One individual *Peromyscus* could not be identified as *P. maniculatus* or *P. eremicus* due to a previous injury resulting in a missing tail, the primary identifying characteristic between the two species.

Neotoma lepida (**Appendix C, Photo 3**) was also an abundantly trapped species, with 97 individuals captured (10%). They were present in each of the sites but were less common in Muddy River (not captured in Parcel F) and Mormon Mesa. This species was commonly found in areas of dense tamarisk, rocky outcrops in the uplands, and in the Bunkerville sites along the floodplain in the stands of woody flood debris.

Forty-eight *Dipodomys merriami* (**Appendix C, Photo 4**) were captured, primarily in the sandy habitats throughout the sites. They were not captured at Mormon Mesa or Mesquite West and in low numbers at Muddy River (not captured in Parcel G or H) likely due to the dense vegetation and lack of open, sandy habitat.

Thirty-eight *Reithrodontomys megalotis* (**Appendix C, Photo 5**) were captured in grassier habitats throughout the project. They were found in each of the sites, but were not captured in Parcels F, G, and H of Muddy River. Appropriate habitat was present in these parcels and the species may be present in low abundance.

Twenty-eight *Chaetodipus formosus* (**Appendix C, Photo 6**) and 27 *Chaetodipus penicillatus sobrinus* (**Appendix C, Photo 7**) were trapped across most of the sites. Neither species was found in Mesquite West, which is not unexpected due to lack of appropriate habitat for either species. *C. formosus* was not captured in either of the Bunkerville sites which lacked rocky habitat preferred by the species. *C. penicillatus* was present in sandy areas in all of the sites aside from Mesquite West.

Twenty-four *Mus musculus* (**Appendix C, Photo 8**) were trapped. They were not captured at Mormon Mesa or Muddy River. These two areas are not in close proximity to agricultural fields and this may be the reason for the species absence in these areas.

Biologists trapped eight *Onychomys torridus* (**Appendix C, Photo 9**) during survey efforts. The species was not captured at Mesquite West or Muddy River. Habitat for the species was not present at Mesquite West; however, habitat for the species occurs within the Muddy River parcels and it is likely to be present but in low abundance.

The least frequently trapped species was *Ammospermophilus leucurus* (**Appendix C, Photo 10**), with only two individuals being captured, both in the upland wash areas of the Riverside parcels; however, this species was observed in the upland area of Mormon Mesa and at several parcels of the Muddy River. Their absence from the Bunkerville sites and Mesquite West is not surprising due to lack of desert scrub habitat.

Thomomys bottae was a species not targeted for capture due to the methodology required to trap the species. Given the distinct burrowing nature of this species, biologists were to note signs of their presence. Sign of *T. bottae* (**Appendix C, Photo 11**) was observed at Riverside, Bunkerville East, Bunkerville West, and on the golf course adjacent to Mesquite West in areas of soft soil. Riverside and both Bunkerville sites were adjacent to agricultural lands.

4.4 Uncaptured Species

Castor canadensis, *Odontra zibethicus*, *Perognathus longimembris*, and *Peromyscus crinitus* were species listed as likely to occur within the project area.

Castor canadensis and *Odontra zibethicus* were two of the species biologists did not intend to set traps for or target due to size of species, but instead note observations of the species or signs of their presence. No sign of either species was observed; however, residents near the Muddy River Reserve Unit informed biologists *C. canadensis* had been observed along the nearby stretch of river and the Riparian Management Plan (Clark County Desert Conservation Program, 2019) noted sign of this species was previously observed at Bunkerville West. Although neither species was observed, it is not unlikely that *C. canadensis* and *O. zibethicus* occur within or in the vicinity of the Reserve Units.

Perognathus longimembris was not captured or observed during surveys. The species is found primarily in fine, sandy substrate with native desert grasses. Appropriate habitat was not observed in the Reserve Units. Although sandy substrate was widespread, this was primarily in the floodplains and did not support desert grass species. *P. longimembris* likely occurs in the greater vicinity but may not occur or may occur in very low numbers within the Reserve Unit parcels.

Peromyscus crinitus was not captured or observed during surveys. The species is primarily associated with rocky outcrops and boulders along cliffs and mountains. Although a few areas of rocky outcrops were observed and surveyed in several parcels, these outcrops were associated with small foothills and not cliffs or mountains. *P. crinitus* likely occurs in the greater vicinity but may not occur or may occur in very low numbers within the Reserve Unit parcels. If this species is present, it would most likely be found in Parcels F, H, and I of the Muddy River Reserve due to the rocky upland habitat present in these parcels.

Dipodomys deserti, *Peromyscus boylii*, and *Rattus rattus* were all listed as unlikely to occur within the project area due to microhabitat requirements or other habitat associations of each of the species not being expected to occur within the parcels. Biologists confirmed the specific habitats required for these species were not present within any of the sites.

Eutamias dorsalis, *Peromyscus truei*, and *Xerospermophilus tereticaudus* were all listed as highly unlikely to occur within the project area due to the habitat requirements and/or known geographic range of each of the species. Biologists confirmed the specific habitats required for these species were not present within any of the sites.

4.5 Covered/Evaluation Species

No small mammal species currently listed as "Covered Species" under the MSHCP and ITP were identified as likely to be present in the Riparian Reserve Units and none were captured or observed during this project.

One species, *Chaetodipus penicillatus sobrinus*, identified as an "Evaluation Species" under the MSHCP was identified as likely to occur within the Riparian Reserve Units based on the species being associated with habitats possessing sandy soils, shrub interspace, and a proximity to active waterways of the Colorado River and its tributaries. During this project, the species was captured within all the Riparian Reserve Unit sites with the exception of Mesquite West, which lacked sandy soils and shrub interspace and was primarily inundated willow forest.

Another species, *Dipodomys deserti*, identified as an "Evaluation Species" under the MSHCP was identified as unlikely to occur within the Riparian Reserve Units based on the species being sand dune specialists, and being strongly associated with substantial accumulations of wind driven sand and sparse vegetation. Although some of the sites had large areas of sparsely vegetated sand, this habitat was the result of deposition from the river along the floodplain, not wind. Biologists did not capture this species and did not observe any sign of it during the project.

5 CONCLUSION

The primary goal of this survey was to develop a baseline record of small mammal species currently present within the Riparian Reserve Units. BEC biologists accomplished this goal and developed the following list of small mammal species confirmed to be present within the Reserve Units:

Scientific Name	Common Name
Ammospermophilus leucurus	White-tailed antelope ground squirrel
Chaetodipus formosus	Long-tailed pocket mouse
Chaetodipus penicillatus sobrinus	Desert pocket mouse
Dipodomys merriami	Merriam's kangaroo rat
Mus musculus	House mouse
Neotoma lepida	Desert woodrat
Onychomys torridus	Southern grasshopper mouse
Peromyscus eremicus	Cactus mouse
Peromyscus maniculatus	Deer mouse
Reithrodontomys megalotis	Western harvest mouse
Thomomys bottae	Botta's pocket gopher

The small mammal species observed within the Riparian Reserve Units are generally consistent with what would be expected in the habitats present in the areas. Additional survey efforts may result in adding one or two species to the list of species captured throughout the Units, or within particular sites or parcels. However, the results of this survey provide a solid collection of information for resource managers use as a baseline for developing more rigorous monitoring programs or focused studies to address management and conservation concerns as discussed in the following section.

6 RECOMMENDATIONS

Below are recommendations which may be considered for future action for gathering additional information to support the management and conservation of the small mammal community or particular species of concern within these units.

6.1 Small Mammal Community Composition Monitoring

This project provided a solid baseline of information documenting the species composition of the small mammal community throughout the two Riparian Reserve Units, as well as within each of the sites. The authors of this report recommend implementing surveys similar to those completed for this study periodically to document substantial changes in the species composition of the small mammal community as a result of environmental changes, management or conservation actions implemented, or changes in the land use or land management throughout the region. The frequency of such studies would be driven by timeframe and degree of changes observed in these factors.

6.2 Monitor Tamarisk Removal Effects on Small Mammal Community Composition and Abundance

As discussed previously, dense impenetrable stands of tamarisk found in several sites within the Riparian Reserve Units have replaced the native vegetation and small mammal abundance in these areas appeared to be lower than in other locations throughout the Reserve. The DCP has initiated restoration efforts to return the Riparian Reserve to a more productive ecosystem, which included the removal of tamarisk, as well as other measures. Given the significant effort to be implemented to restore these areas and this habitat, the authors of this report recommend development and implementation of a project focused specifically on monitoring the changes in the species composition and relative abundance of the small mammal community in these restoration areas. This project should be a subset of the overall small mammal community composition monitoring recommended above, if implemented, but could be an independent effort if necessary. Such information could assist in documenting the effectiveness of the restoration efforts to achieving a diverse and resilient ecosystem.

6.3 Chaetodipus penicillatus sobrinus *Habitat Delineation*

This study confirmed *C. p. sobrinus* is present and relatively widespread throughout many of the sites within the Riparian Reserve Units where appropriate habitat was observed. In the event this species is elevated to the status of a Covered species in the amended MSHCP, further evaluation of the species and consideration in management plans for the riparian areas may be warranted. The current study sampled the breadth of habitats within the Riparian Reserve Unit and was able to develop a general understanding of the distribution of the species, but it did not delineate or designate habitats observed given that was not within the scope of the project. The authors of this report recommend development and implementation of a focused project to achieve the following objectives: delineate suitable habitat for this species throughout the Riparian Reserve Units using habitat modeling, identify areas potentially suitable for the species with implementation of restoration efforts, and conduct surveys to confirm the distribution and abundance of the species within these habitats. Such information would be of value in monitoring the distribution and relative abundance of the species and could be used to inform conservation and management actions within the Reserve.

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APPENDIX A

Project Maps

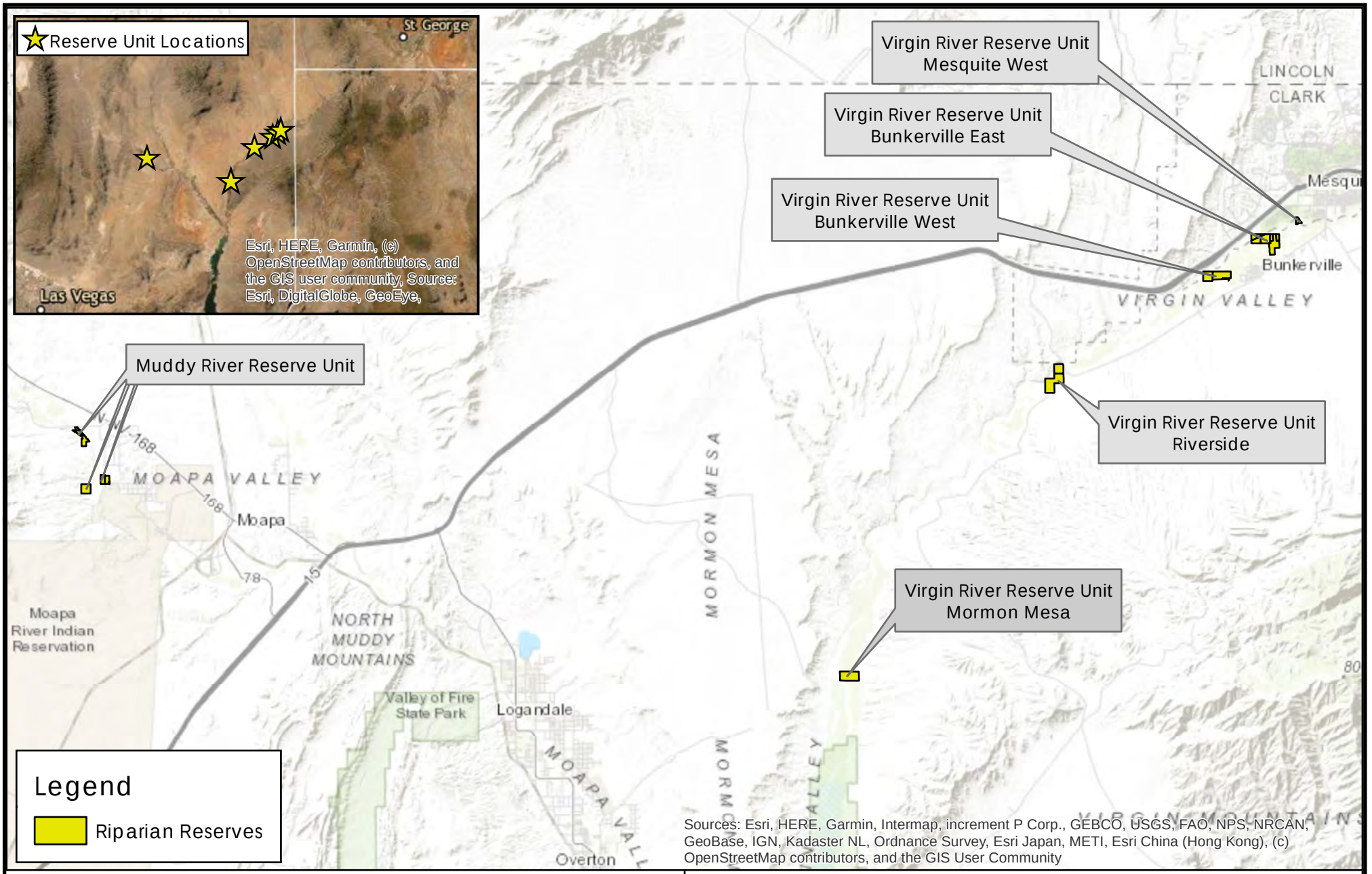

Figure 1 - Location Map

Riparian Reserve Units

Clark County, Nevada

bec environmental, inc.
Environmental Services

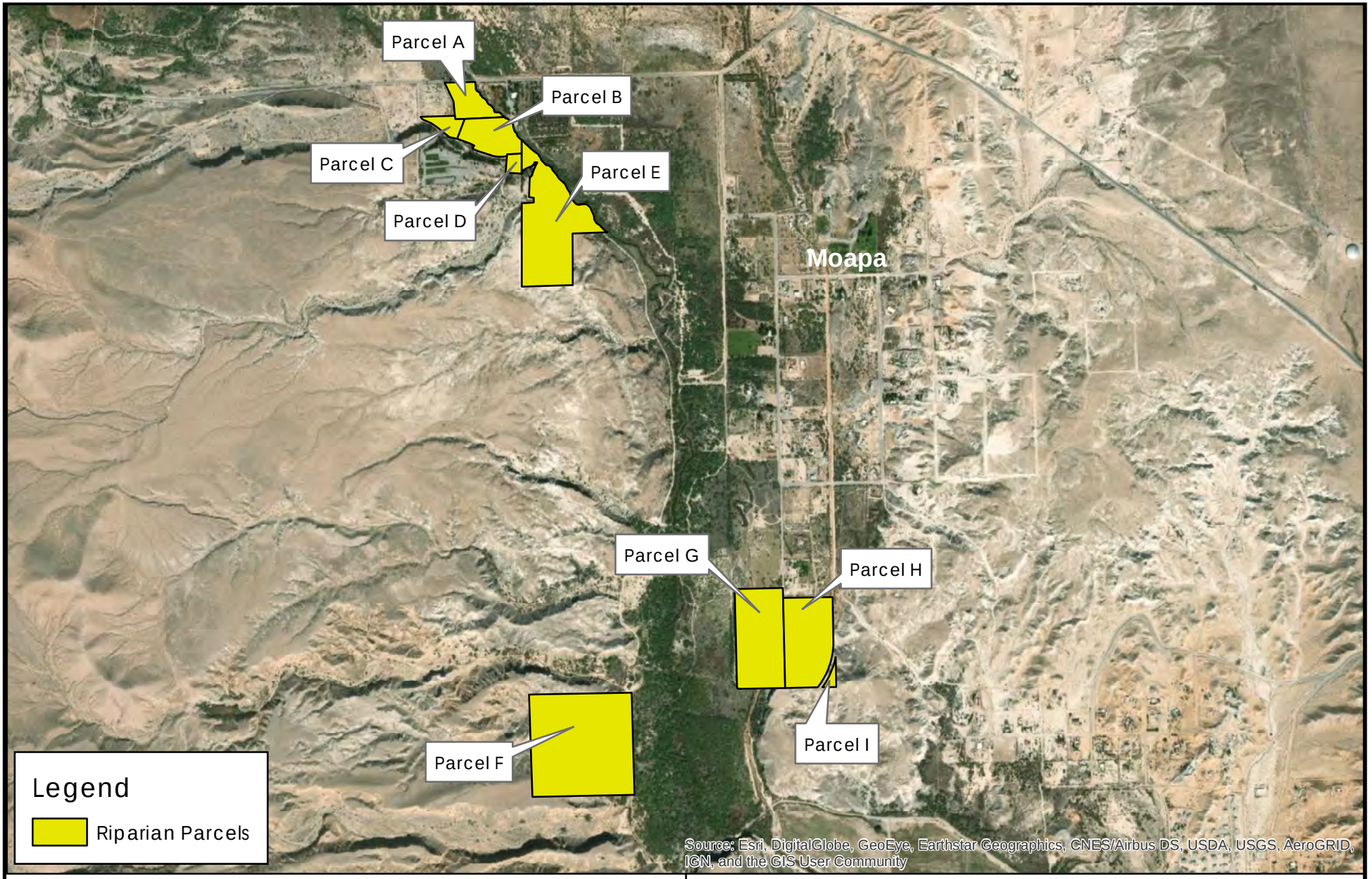

Figure 2 - Muddy River Reserve Unit Map

Clark County, Nevada

0 300 600 1,200 1,800

Meters

N

bec environmental, inc.

Environmental Services

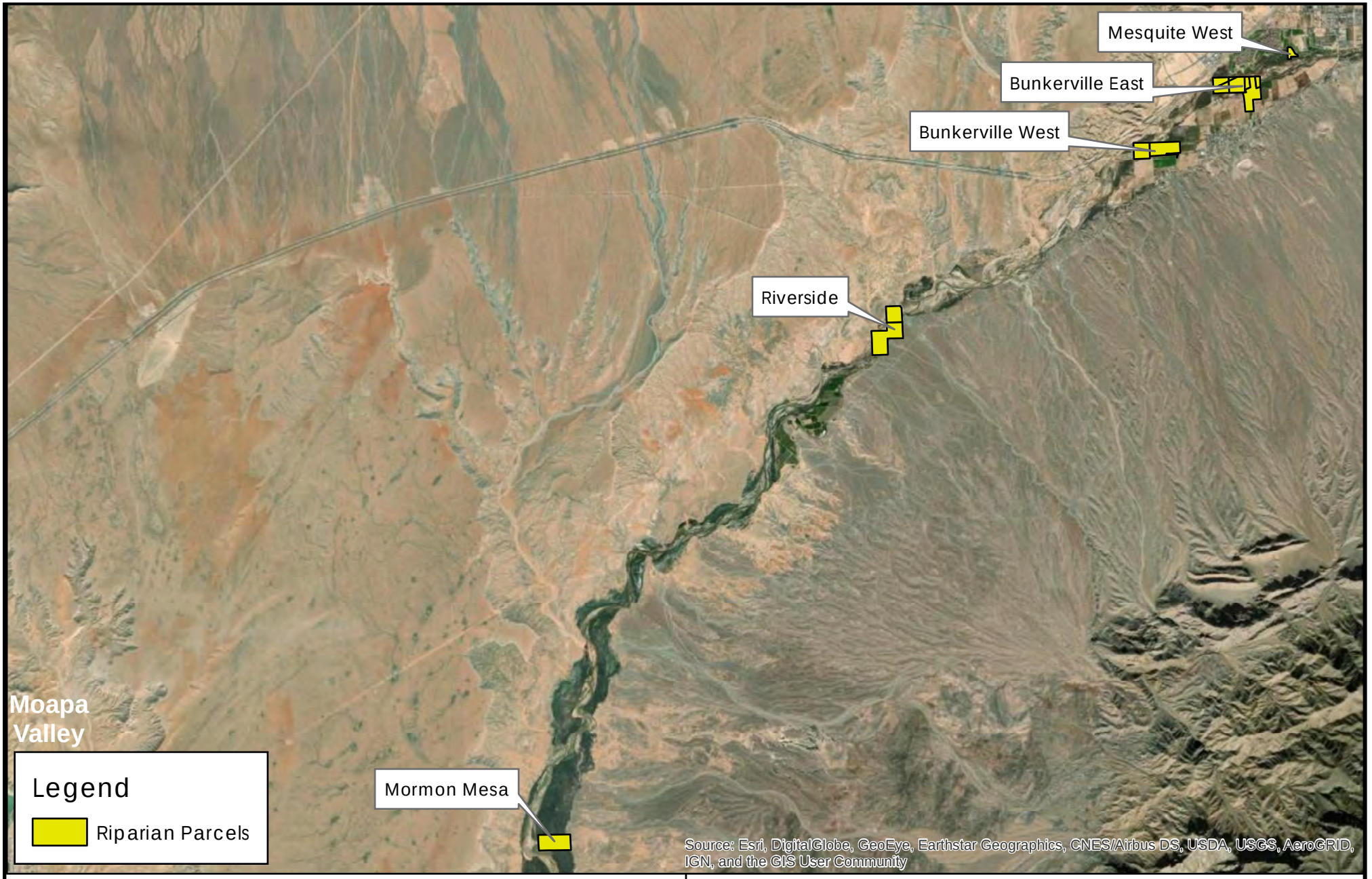

Figure 3 - Virgin River Reserve Unit Map

Clark County, Nevada

0 2,000 4,000 8,000 12,000

Meters

N

bec environmental, inc.
Environmental Services

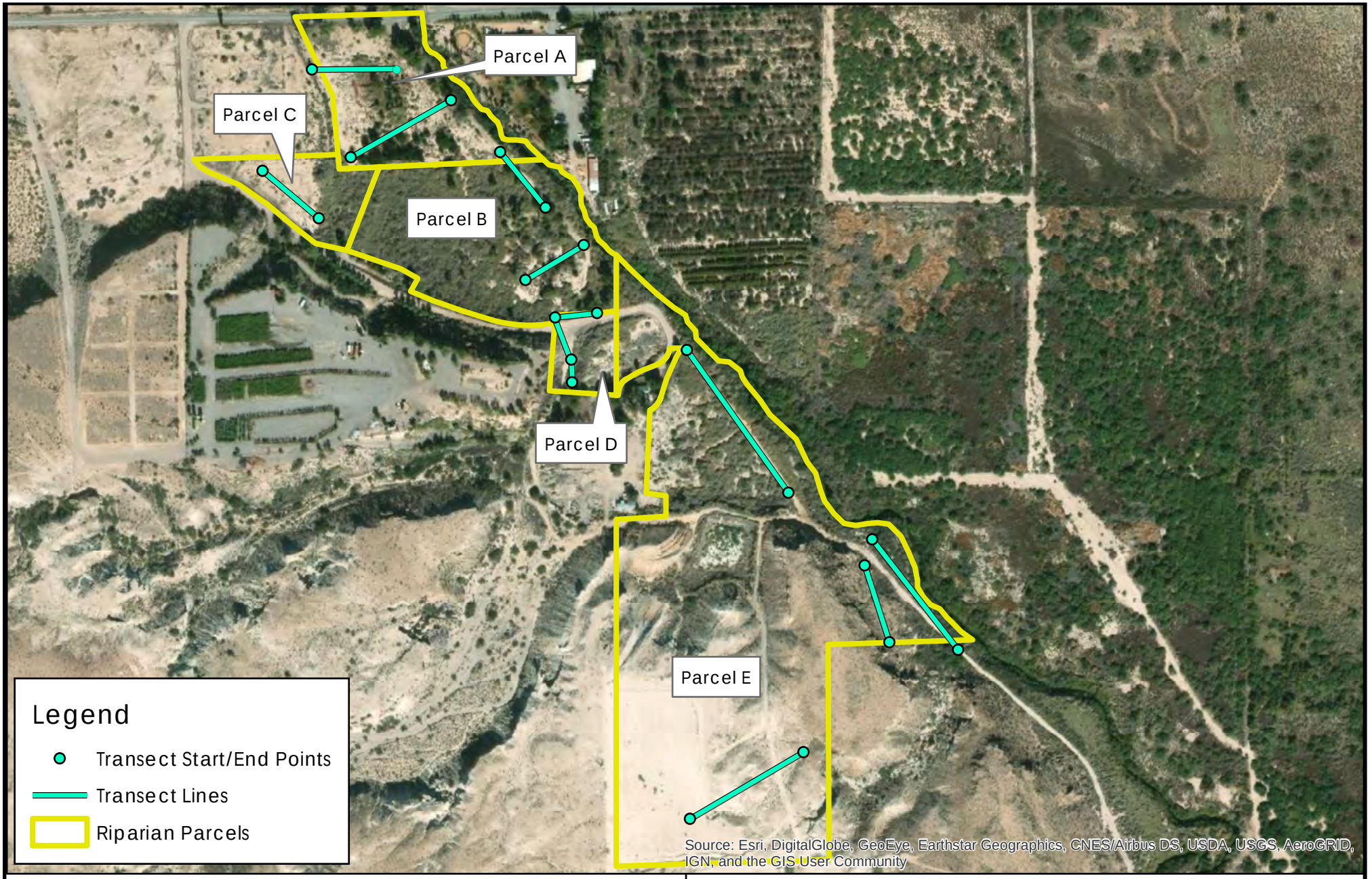

Figure 4 - Parcel A through E Transect Map

Muddy River Reserve Unit

0 75 150 300 450

Meters

N

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Figure 5 - Parcel F Transect Map

Muddy River Reserve Unit

0 50 100 200 300

Meters

N

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Environmental Services

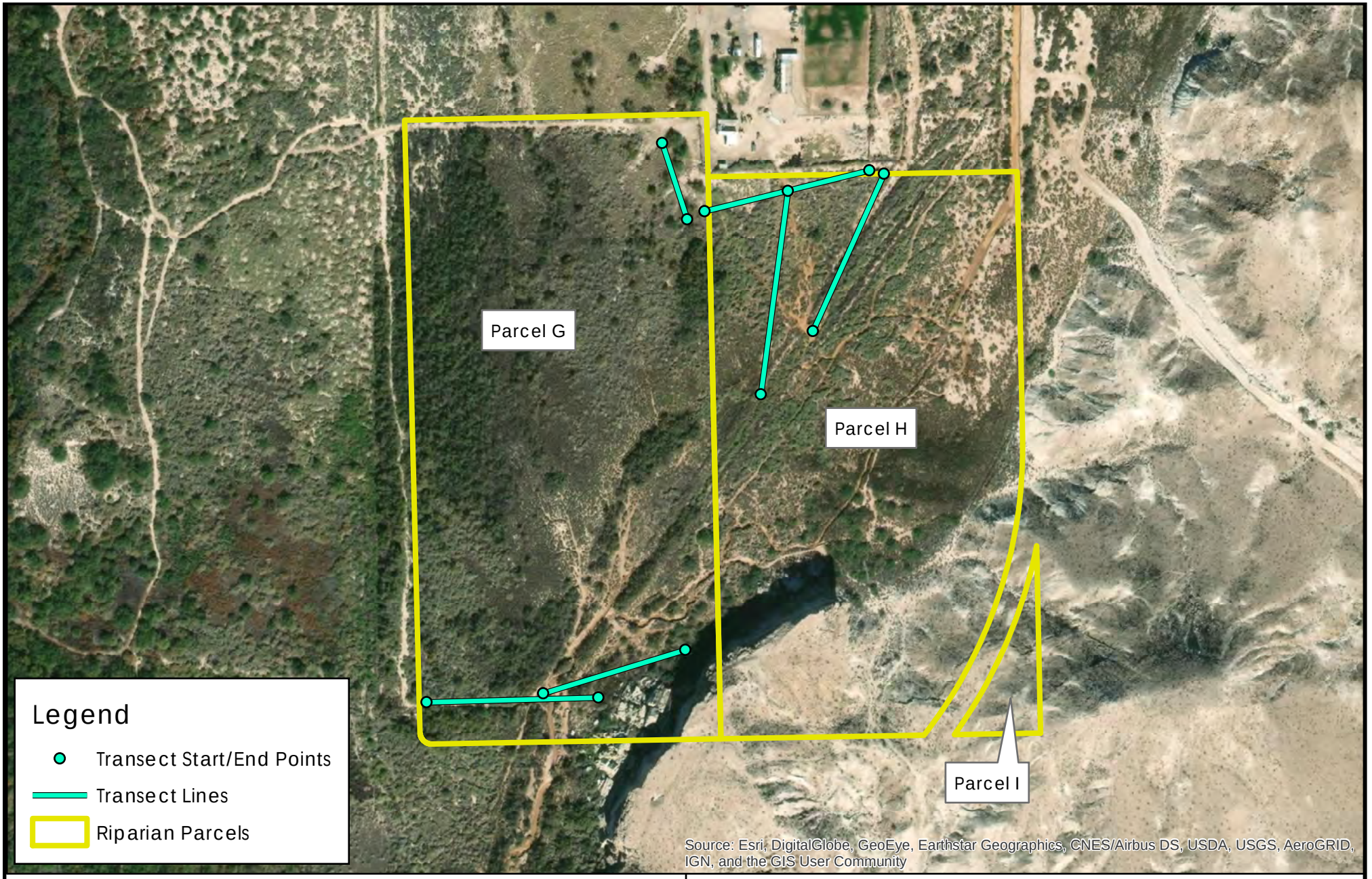

Figure 6 - Parcel G through I Transect Map

Muddy River Reserve Unit

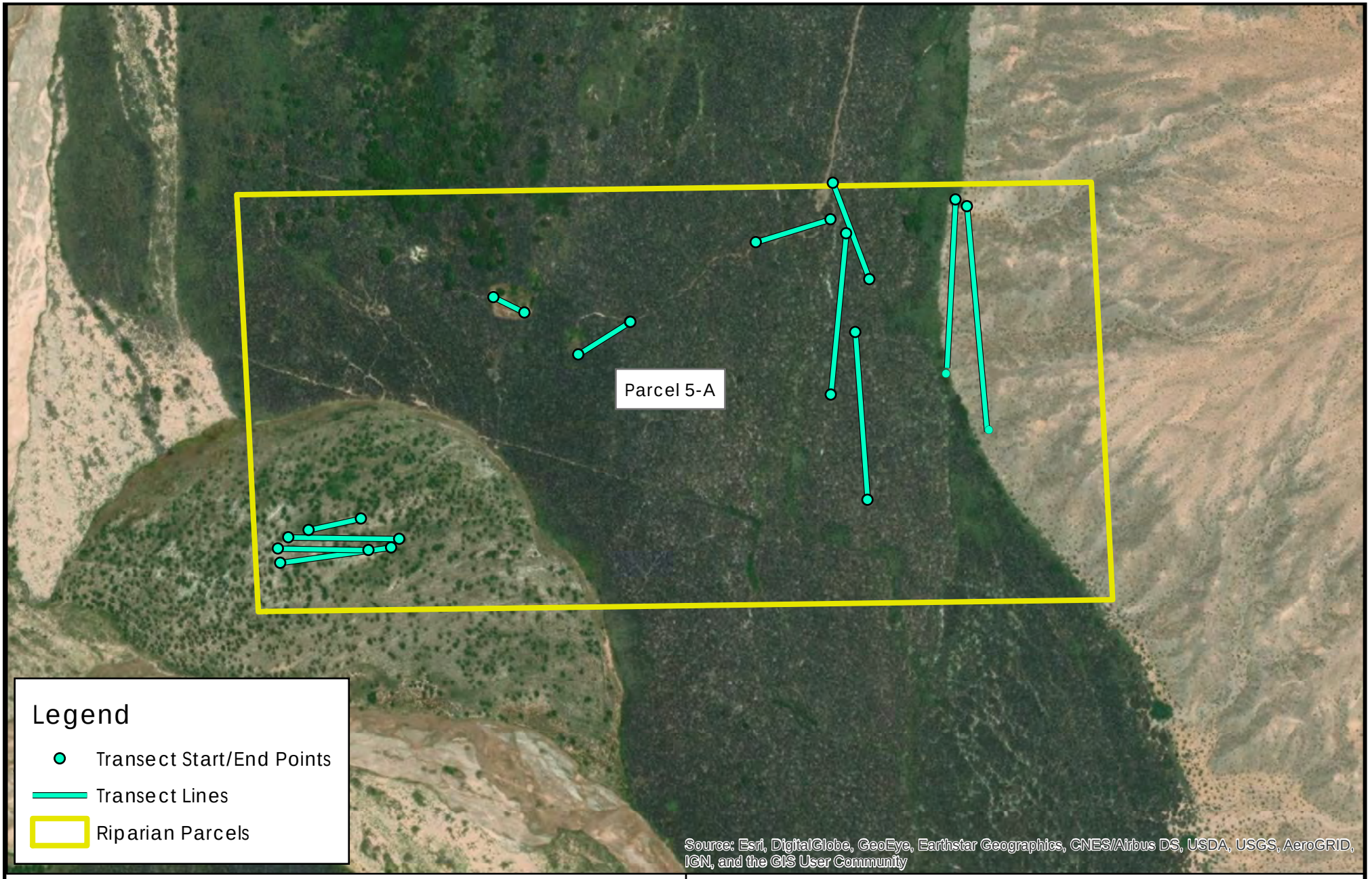

Figure 7 - Mormon Mesa Transect Map

Virgin River Reserve Unit

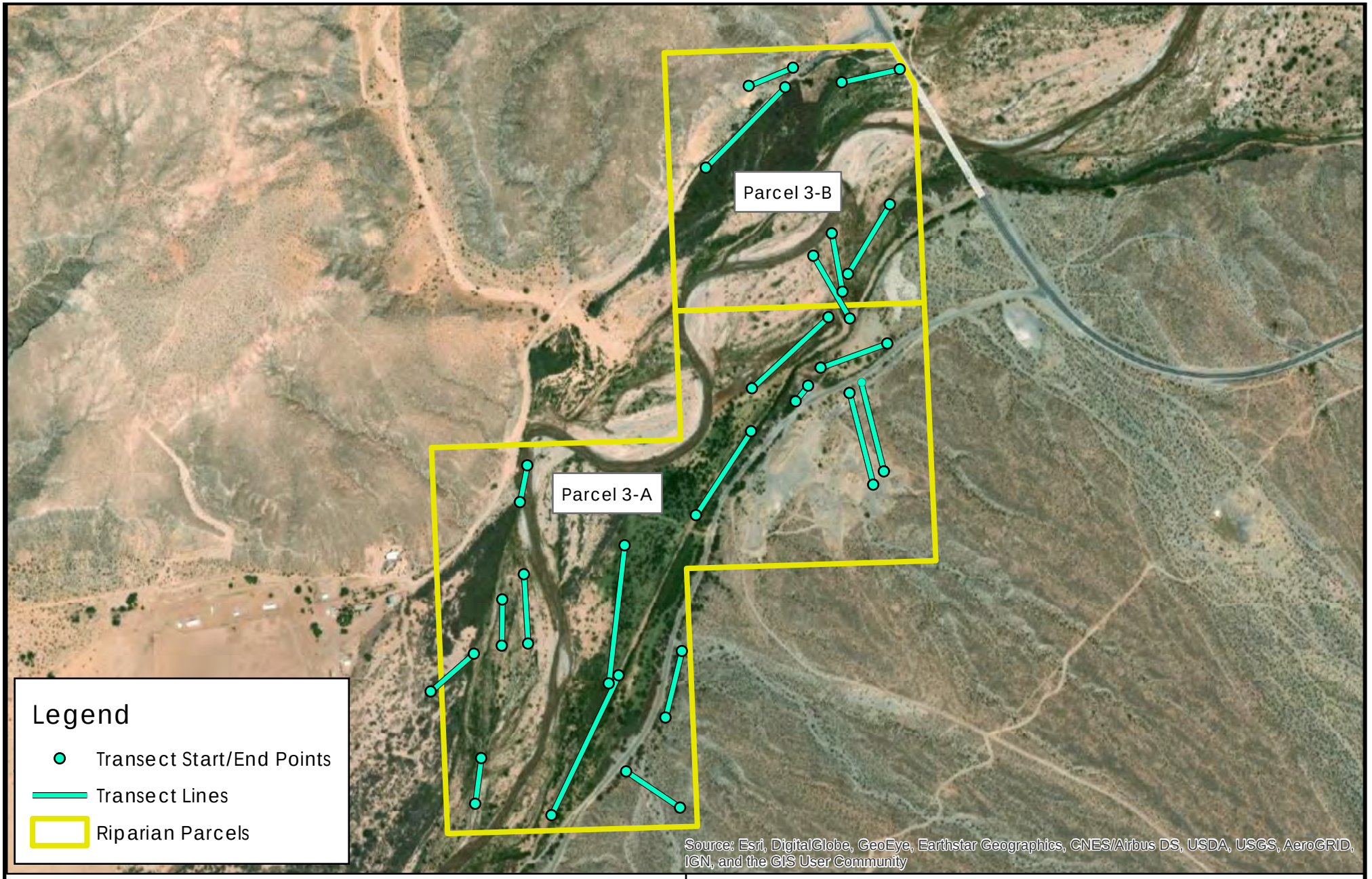

Figure 8 - Riverside Transect Map

Virgin River Reserve Unit

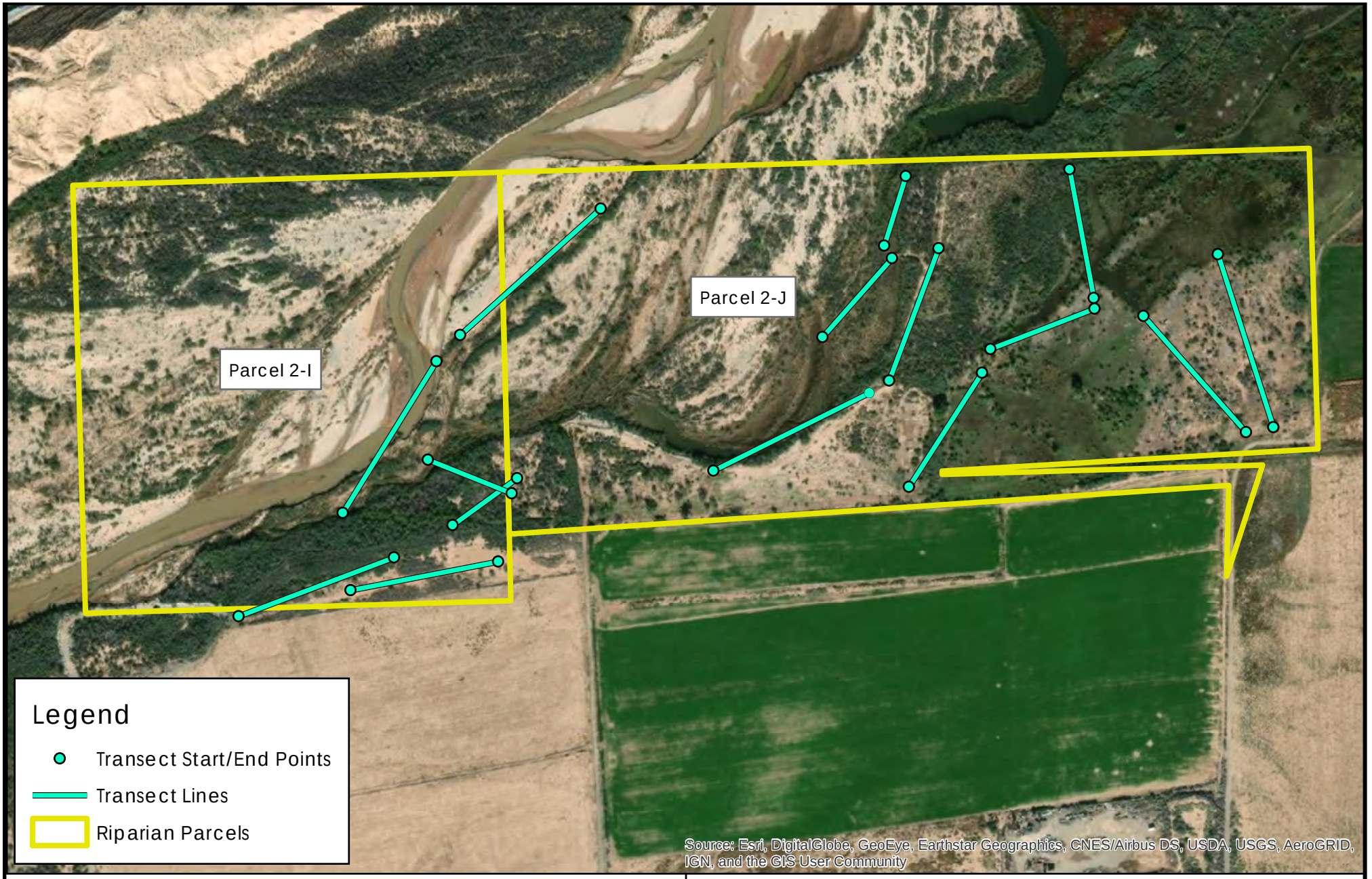

Figure 9 - Bunkerville West Transect Map

Virgin River Reserve Unit

0 75 150 300 450

Meters

N

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Environmental Services

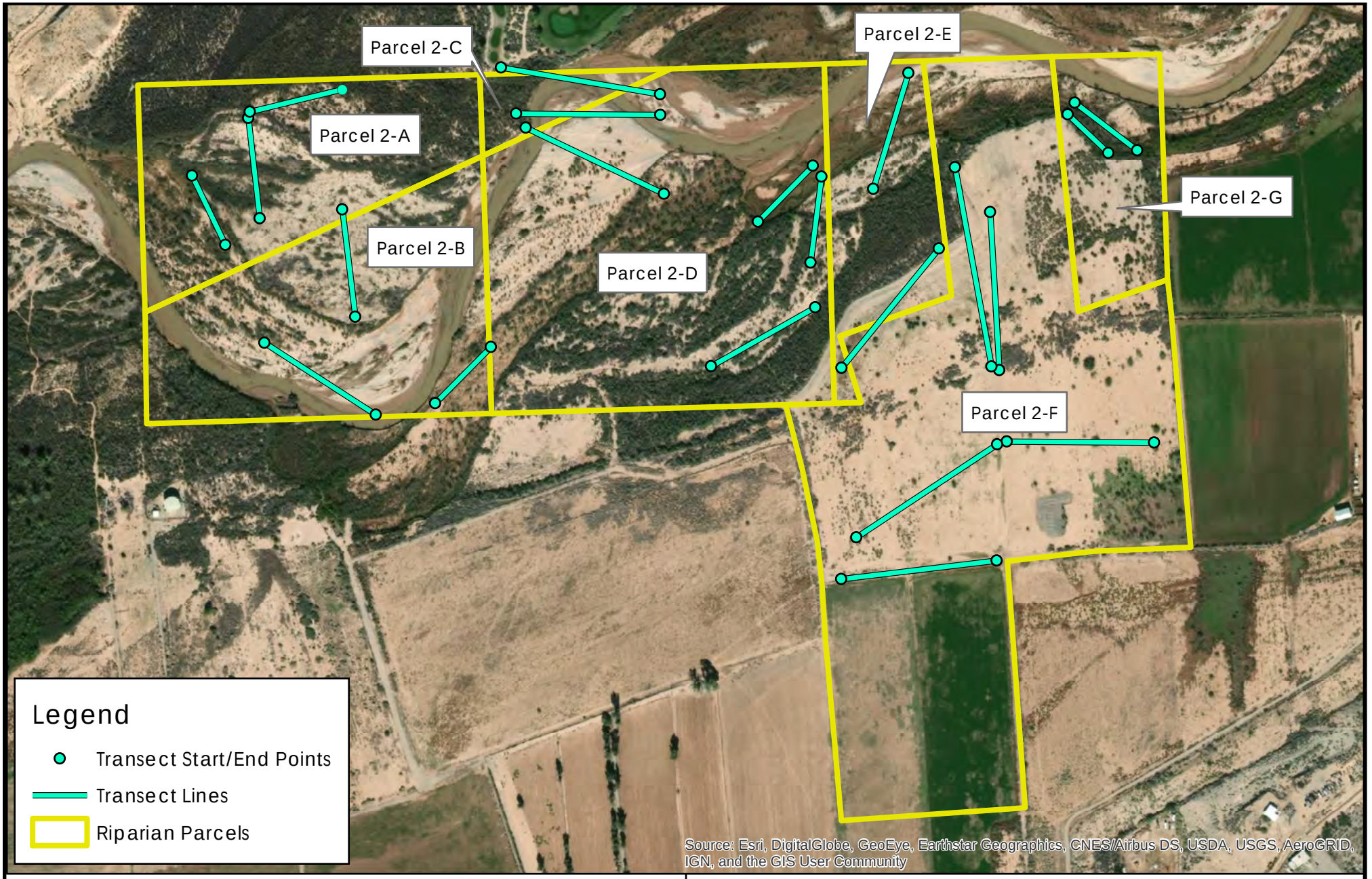

Figure 10 - Bunkerville East Transect Map

Virgin River Reserve Unit

0 90 180 360 540

Meters

N

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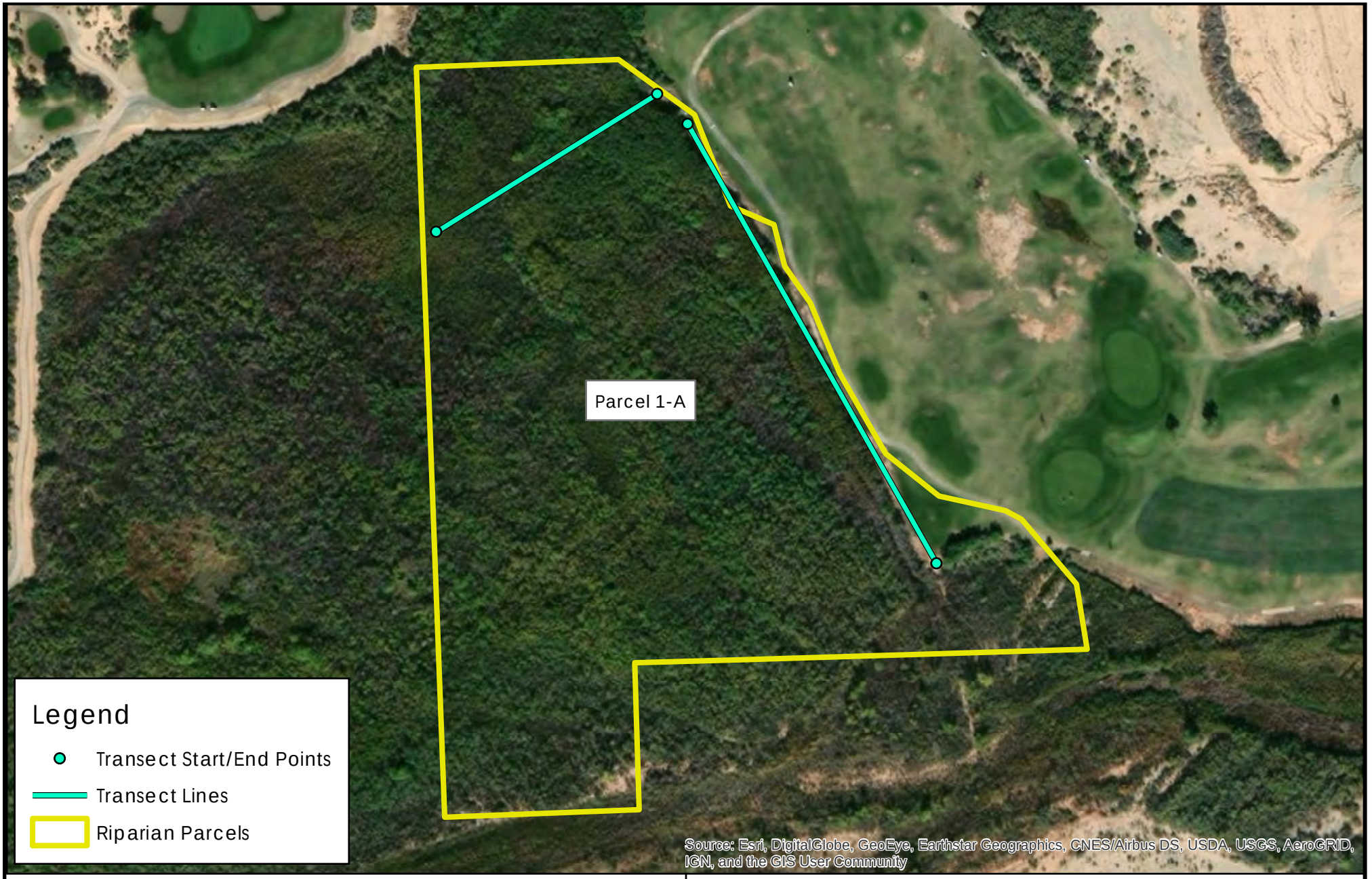

Figure 11 - Mesquite West Transect Map

Virgin River Reserve Unit

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APPENDIX B

Transect Habitat Photo Log

Photo 1

Muddy River, Parcel A; Disturbed field; shrubland

Photo 2

Muddy River, Parcel A; Arrowweed and quailbush-lined dirt road

Photo 3

Muddy River, Parcel B; Quailbush stands

Photo 4

Muddy River, Parcel B; Oak grove

Photo 5

Muddy River, Parcel C; Dry grass field; dense quailbush and tumbleweeds

Photo 6

Muddy River, Parcel D; Disturbance with dry grass and quailbush

Photo 7

Muddy River, Parcel E; Arrowweed and quailbush-lined dirt road

Photo 8

Muddy River, Parcel E; Rocky outcrop/foothill

Photo 9

Muddy River, Parcel E; Former palm tree nursery

Photo 10

Muddy River, Parcel E; Mesa upland

Photo 11

Muddy River, Parcel E; Active restoration area/arrowweed floodplain

Photo 12

Muddy River, Parcel F; Canyon/wash system

Photo 13

Muddy River, Parcel F; Rocky foothill/mesa top

Photo 14

Muddy River, Parcel F; Grassy lowland; brushy/woodland

Photo 15

Muddy River, Parcel G; Clay wash system

Photo 16

Muddy River, Parcel G; Alkali sacaton field

Photo 17

Muddy River, Parcel H; Open shrubland

Photo 18

Muddy River, Parcel H & I; Inaccessible steep bluff habitat

Photo 19

Virgin River, Mormon Mesa, Parcel 5-A; Rocky upland

Photo 20

Virgin River, Mormon Mesa, Parcel 5-A; Sandy area at base of upland

Photo 21

Virgin River, Mormon Mesa, Parcel 5-A; Edge of masticated tamarisk

Photo 22

Virgin River, Mormon Mesa, Parcel 5-A; Central area of masticated tamarisk interspersed with saltbush

Photo 23

Virgin River, Mormon Mesa, Parcel 5-A; Along muddy trail in tamarisk

Photo 24

Virgin River, Mormon Mesa, Parcel 5-A; Along marshy trail in tamarisk

Photo 25

Virgin River, Mormon Mesa, Parcel 5-A; Along open portion of trail through tamarisk

Photo 26

Virgin River, Mormon Mesa, Parcel 5-A; Mesquite bosque

Photo 27

Virgin River, Riverside, Parcel 3-A; Eastern uplands

Photo 28

Virgin River, Riverside, Parcel 3-A; Eastern upland canyon/wash system

Photo 29

Virgin River, Riverside, Parcel 3-A; Arrowweed/willow-lined dirt road

Photo 30

Virgin River, Riverside, Parcel 3-A; Abandoned structure and surrounding disturbance

Photo 31

Virgin River, Riverside, Parcel 3-A; Semi-arid shrubland

Photo 32

Virgin River, Riverside, Parcel 3-A; Active arrowweed floodplain

Photo 33

Virgin River, Riverside, Parcel 3-A; Active arrowweed floodplain

Photo 34

Virgin River, Riverside, Parcel 3-A; Sandy tamarisk

Photo 35

Virgin River, Riverside, Parcel 3-A; Saltgrass and mesquite grassland

Photo 36

Virgin River, Riverside, Parcel 3-B; Western rocky uplands

Photo 37

Virgin River, Riverside, Parcel 3-B; Arrowweed/tamarisk-lined Foster Lane

Photo 38

Virgin River, Riverside, Parcel 3-B; Active arrowweed floodplain

Photo 39

Virgin River, Riverside, Parcel 3-B; Active arrowweed floodplain

Photo 40

Virgin River, Bunkerville West, Parcel 2-I; Dirt path through dry grass field

Photo 41

Virgin River, Bunkerville West, Parcel 2-I; Dry grass field; dense quailbush fenceline

Photo 42

Virgin River, Bunkerville West, Parcel 2-I; Trail in dense tamarisk

Photo 43

Virgin River, Bunkerville West, Parcel 2-I; Dense arrowweed

Photo 44

Virgin River, Bunkerville West, Parcel 2-I; Open shrubland

Photo 45

Virgin River, Bunkerville West, Parcel 2-I; Open, sandy shoreline

Photo 46

Virgin River, Bunkerville West, Parcel 2-I; Sandy arrowweed edge in floodplain

Photo 47

Virgin River, Bunkerville West, Parcel 2-I; Trail in dense tamarisk forest

Photo 48

Virgin River, Bunkerville West, Parcel 2-I; Dense arrowweed floodplain

Photo 49

Virgin River, Bunkerville West, Parcel 2-I; Sandy shoreline

Photo 50

Virgin River, Bunkerville West, Parcel 2-J; Semi-arid grassland

Photo 51

Virgin River, Bunkerville West, Parcel 2-J; Muddy, moist soils with grasses, arrowweed, and reeds

Photo 52

Virgin River, Bunkerville West, Parcel 2-J; Fenceline/dirt path between dry grass field and dense arrowweed stand

Photo 53

Virgin River, Bunkerville West, Parcel 2-J; Dry grass field transitioning into moist marshy field

Photo 54

Virgin River, Bunkerville West, Parcel 2-J; Saltgrass arrowweed floodplain

Photo 55

Virgin River, Bunkerville East, Parcel 2-A; Sandy upper floodplain with dense arrowweed interspersed with mesquite

Photo 56

Virgin River, Bunkerville East, Parcel 2-A; Sandy upper floodplain with mature tamarisk stand with grassy understory

Photo 57

Virgin River, Bunkerville East, Parcel 2-B; Open, sandy riverbank habitat interspersed with arrowweed

Photo 58

Virgin River, Bunkerville East, Parcel 2-B; Sandy riverbank with dense arrowweed

Photo 59

Virgin River, Bunkerville East, Parcel 2-C; Sandy open floodplain with some herbaceous cover; interspersed with flood debris and arrowweed

Photo 60

Virgin River, Bunkerville East, Parcel 2-D; Sandy open floodplain interspersed with islands of flood debris, arrowweed, and mesquite

Photo 61

Virgin River, Bunkerville East, Parcel 2-D; Arrowweed, mesquite, and tamarisk stand in floodplain

Photo 62

Virgin River, Bunkerville East, Parcel 2-D; Edge of sandy tamarisk stand

Photo 63

Virgin River, Bunkerville East, Parcel 2-E; Sandy floodplain with islands of flood debris and arrowweed

Photo 64

Virgin River, Bunkerville East, Parcel 2-E; Top of construction debris/dirt berm along edge of the tamarisk forest

Photo 65

Virgin River, Bunkerville East, Parcel 2-F; Dry grass interspersed with mesquite

Photo 66

Virgin River, Bunkerville East, Parcel 2-F; Along dirt path, through the quailbush and arrowweed semi-arid grassland

Photo 67

Virgin River, Bunkerville East, Parcel 2-F; Fenceline at north boundary of active pasture

Photo 68

Virgin River, Bunkerville East, Parcel 2-F; Sandy arrowweed and willow floodplain/shoreline

Photo 69

Virgin River, Bunkerville East, Parcel 2-F; Sandy arrowweed and willow floodplain/shoreline

Photo 70

Virgin River, Mesquite West, Parcel 1-A; Eastern boundary between dense willow forest and golf course

Photo 71

Virgin River, Mesquite West, Parcel 1-A; Dense willow forest

APPENDIX C

Species Photo Log

Species Photo Log
Riparian Small Mammal Surveys
Final Project Report (Deliverable 04)

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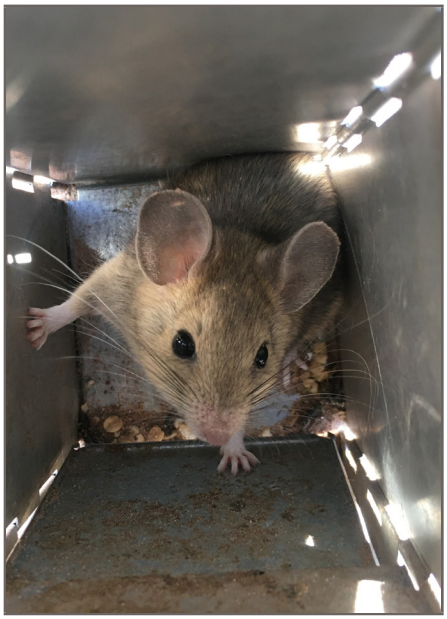
Photo 1

Peromyscus eremicus

Photo 2

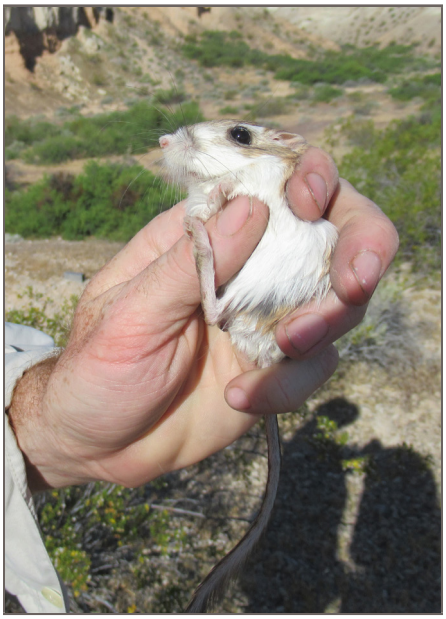
Peromyscus maniculatus

Photo 3



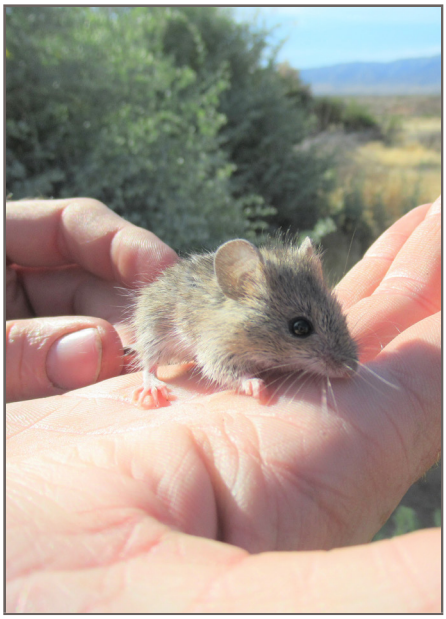
Neotoma lepida

Photo 4



Dipodomys merriami

Photo 5



Reithrodontomys megalotis

Photo 6

Chaetodipus formosus

Photo 7

Chaetodipus penicillatus sobrinus

Photo 8

Mus musculus

Photo 9

Onychomys torridus

Photo 10

Ammospermophilus leucurus

Photo 11

Sign of *Thomomys bottae*

APPENDIX D

Trapping Results per Transect

Sites	Transect #	Species[1]																						Transect Total
		AMLE	CACA	CHFO	CHPE	DIDE	DIME	EUDO	MUMU	NELE	ODZI	ONTO	PELO	PEBO	PECR	PEER	PEMA	PESP	PETR	RARA	REME	THBO	XETE	
Muddy River Reserve Unit																								
Muddy River	13				1											1								2
	14			1			1									1								3
	15				1											1								2
	16			2																				2
	17															5								5
	18															1								1
	19															1								1
	20															8								8
	21															5								5
	22									1						5								6
	23															12								12
	24									1						7								8
	25															5								5
	26															3								3
	27															6								6
	28															8								8
	29															8								8
	30									1						13								14
	90				1		1									3								5
	91				1					1						8					1			11
	92															10								10
	93						1									8								9
	Total	**0**	**0**	**3**	**4**	**0**	**3**	**0**	**0**	**4**	**0**	**0**	**0**	**0**	**0**	**119**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**134**
Virgin River Reserve Unit																								
Mormon Mesa	1				1					1		1				4								7
	2			1																				1
	3																							0
	4															5					2			7
	5															2								2
	6															5								5
	7															4								4
	8															2								2
	9																							0
	10																				1			1
	11															1								1
	12																				1			1
	TOTAL	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**0**	**0**	**0**	**23**	**0**	**0**	**0**	**0**	**4**	**0**	**0**	**31**

Sites	Transect #	Species[1]																						Transect Total
		AMLE	CACA	CHFO	CHPE	DIDE	DIME	EUDO	MUMU	NELE	ODZI	ONTO	PELO	PEBO	PECR	PEER	PEMA	PESP	PETR	RARA	REME	THBO	XETE	
Bunkerville West	31				1		1		1							4	2				2			11
	32						1		1	1						3	4							10
	33								1							2								3
	34									1						4								5
	35						2			1						6	2							11
	36															1	1							2
	37											1				7	16				2			26
	38									7						5	10	1						23
	39						1									7	4				1			13
	40								2			1				5	3				1			12
	41				1				1	3						10	9				1			25
	42						1									2	4							7
	43				1		1									3	5							10
	44								3							3	2				2			10
	45															2	1				3			6
	Total	**0**	**0**	**0**	**3**	**0**	**7**	**0**	**9**	**13**	**0**	**2**	**0**	**0**	**0**	**64**	**63**	**1**	**0**	**0**	**12**	**0**	**0**	**174**
Bunkerville East	46																1				1			2
	47																				1			1
	48																3							3
	49				1					1						7								9
	50								2	1						11	4				1			19
	51								2	1						8	7							18
	52									1						3	1							5
	53						3			1						2	1				1			8
	54						1			5						9								15
	55								1							4	2							7
	56				1		1		1							5	6							14
	57						1			3						8	6				1			19
	58						3			2						10								15
	59				1					4						9								14
	60								1							12	10							23
	61						3			2		1				1	1							8
	62				1		1			5						1					3			11
	63									7						6	2							15
	64				3		2		3								1							9
	65									4						10	6				1			21
	66				1		2									5	13				3			24
	TOTAL	**0**	**0**	**0**	**8**	**0**	**17**	**0**	**10**	**37**	**0**	**1**	**0**	**0**	**0**	**111**	**64**	**0**	**0**	**0**	**12**	**0**	**0**	**260**
Mesquite West	67								1	5						10					1			17
	68									2						12								14
	TOTAL	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**7**	**0**	**0**	**0**	**0**	**0**	**22**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**31**

Sites	Transect #	Species[1]																						Transect Total
		AMLE	CACA	CHFO	CHPE	DIDE	DIME	EUDO	MUMU	NELE	ODZI	ONTO	PELO	PEBO	PECR	PEER	PEMA	PESP	PETR	RARA	REME	THBO	XETE	
Riverside	69			7												5								12
	70			2												2								4
	71						4			3		1				8								16
	72				2					4						12								18
	73				2					1						7								10
	74	2		7												9								18
	75						1			3						14								18
	76			5						5						13								23
	77									3						18								21
	78						1		1	3		1				6								12
	79															7					2			9
	80						1			2		1				1					1			6
	81				1		3			2						10					3			19
	82				1				2							11								14
	83						1									3								4
	84				2					2						19								23
	85						3			3						9								15
	86						1			1						3					1			6
	87				1		5			1						6								13
	88						1		1			1				15								18
	89			3	2					2						12					1			20
	Total	**2**	**0**	**24**	**11**	**0**	**21**	**0**	**4**	**35**	**0**	**4**	**0**	**0**	**0**	**190**	**0**	**0**	**0**	**0**	**8**	**0**	**0**	**299**
Project Total		**2**	**0**	**28**	**27**	**0**	**48**	**0**	**24**	**97**	**0**	**8**	**0**	**0**	**0**	**529**	**127**	**1**	**0**	**0**	**38**	**0**	**0**	**929**

1

Species Code	Scientific Name	Common Name
AMLE	*Ammospermophilus leucurus*	White-tailed antelope ground squirrel
CACA	*Castor canadensis*	North American beaver
CHFO	*Chaetodipus formosus*	Long-tailed pocket mouse
CHPE	*Chaetodipus penicillatus sobrinus*	Desert pocket mouse
DIDE	*Dipodomys deserti*	Desert kangaroo rat
DIME	*Dipodomys merriami*	Merriam's kangaroo rat
EUDO	*Eutamias dorsalis*	Cliff chipmunk
MUMU	*Mus musculus*	House mouse
NELE	*Neotoma lepida*	Desert woodrat
ODZI	*Odontra zibethicus*	Muskrat
ONTO	*Onychomys torridus*	Southern grasshopper mouse

Species Code	Scientific Name	Common Name
PELO	*Perognathus longimembris*	Little pocket mouse
PEBO	*Peromyscus boylii*	Brush mouse
PECR	*Peromyscus crinitus*	Canyon mouse
PEER	*Peromyscus eremicus*	Cactus mouse
PEMA	*Peromyscus maniculatus*	Deer mouse
PETR	*Peromyscus truei*	Pinyon mouse
RARA	*Rattus rattus / R. norvegicus*	Roof rat/Norway rat
REME	*Reithrodontomys megalotis*	Western harvest mouse
THBO	*Thomomys bottae*	Botta's pocket gopher
XETE	*Xerospermophilus tereticaudus*	Round tailed ground squirrel
PESP	*Peromyscus* sp.	Deer mouse genus