Clark County 2024–2025 Bat Recording Analysis Final Project Report

APRIL 2026

PREPARED FOR

Desert Conservation Program
Clark County Department of Environment and Sustainability

PREPARED BY

SWCA Environmental Consultants

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EXECUTIVE SUMMARY

The Clark County (the County) Desert Conservation Program performed bat acoustic surveys at ten locations within the Clark County Multiple Species Habitat Conservation Plan (MSHCP: Clark County 2000) Reserve System properties between 2024 and 2025. Bat acoustic surveys were conducted to better understand bat species presence and distribution at these County properties. These data can be compared with future data to quantify the success of management and restoration efforts at the County's surveyed properties. The County contracted with SWCA Environmental Consultants to analyze these data, determine species presence through manual call identification, describe bat habitat features within each of the County's surveyed properties, and present bat activity by location.

Bat acoustic surveys detected one of the three species designated as "covered" by the MSHCP: silver-haired bat (*Lasionycteris noctivagans*). These surveys also detected one species of bat proposed to be covered under an amendment to the MSHCP: Townsend's big-eared bat (*Corynorhinus townsendii*); one bat species designated as "evaluation:" small-footed myotis (*Myotis ciliolabrum*); and ten undesignated species of bat. In total, 13 bat species were recorded across all the County's surveyed properties. A description of bat activity and habitat features at each of the County's surveyed properties is described herein.

1 INTRODUCTION

Clark County's (the County's) Desert Conservation Program manages compliance with the Endangered Species Act (ESA) through the Clark County Multiple Species Habitat Conservation Plan (MSHCP) (Clark County 2000). This is accomplished, in part, through the management of a reserve system, which includes Riparian Reserve Units (RRUs), as well as the Boulder City Conservation Easement (BCCE). Under the current MSHCP (Clark County 2000), special status plant and animal species are listed as either "covered," "evaluation," or "watch list" species. The MSHCP and incidental take permit from U.S. Fish and Wildlife Service (USFWS) provide coverage for 78 species for which sufficient information was available to allow incidental take and for which adequate management prescriptions exist to help protect them. Evaluation species require additional information and development of management plans. Watch list species have inadequate information to assess population range, status, conservation potential, or risk of extinction within the County (Clark County 2000).

In the current MSHCP, three species of bats are listed as covered (silver-haired bat [*Lasionycteris noctivagans*], long-eared myotis [*Myotis evotis*], and long-legged myotis [*Myotis volans*]), and two species are listed as evaluation species (Townsend's big-eared bat [*Corynorhinus townsendii*] and western small-footed myotis [*Myotis ciliolabrum*]). As part of a proposed update to the MSHCP, two additional bat species are proposed to be listed as covered: spotted bat (*Euderma maculatum*) and Townsend's big-eared bat (Clark County 2019).The purpose of this project is to document presence and activity of these covered, evaluation, and proposed-covered bat species within the reserve system; these data build upon a baseline record against which future restoration activities can be measured.

1.1 Description of the Project

In 2026, the County solicited analysis of bat acoustic survey data collected on its RRUs (Figure 1) and on the BCCE (Figure 2), collectively referred to hereafter as the project area. SWCA Environmental Consultants (SWCA) was selected to conduct analysis of these data, including manual call identification to species, description of activity patterns, and analysis of bat habitat use within each survey location. Bat acoustic detectors were deployed by the County at a total of five points located within the following RRUs: Muddy River, Virgin River Subunit 2 (Bunkerville South), and Virgin River Subunit 3 (Riverside) (see Figure 1). Bat detectors were also deployed at five survey points within the BCCE (see Figure 2). These surveys will build on baseline presence/absence and activity data for all bat species on these properties, including any current or proposed MSHCP-covered and evaluation bat species.

1.2 Background and Need

On November 19, 2000, the USFWS issued the *Intra-Service Biological and Conference Opinion on Issuance of an Incidental Take Permit to Clark County, Nevada, for a Multiple Species Habitat Conservation Plan* (Biological and Conference Opinion) (USFWS 2000). On March 28, 2001, the USFWS issued an amended incidental take permit for the County MSHCP (USFWS 2001).

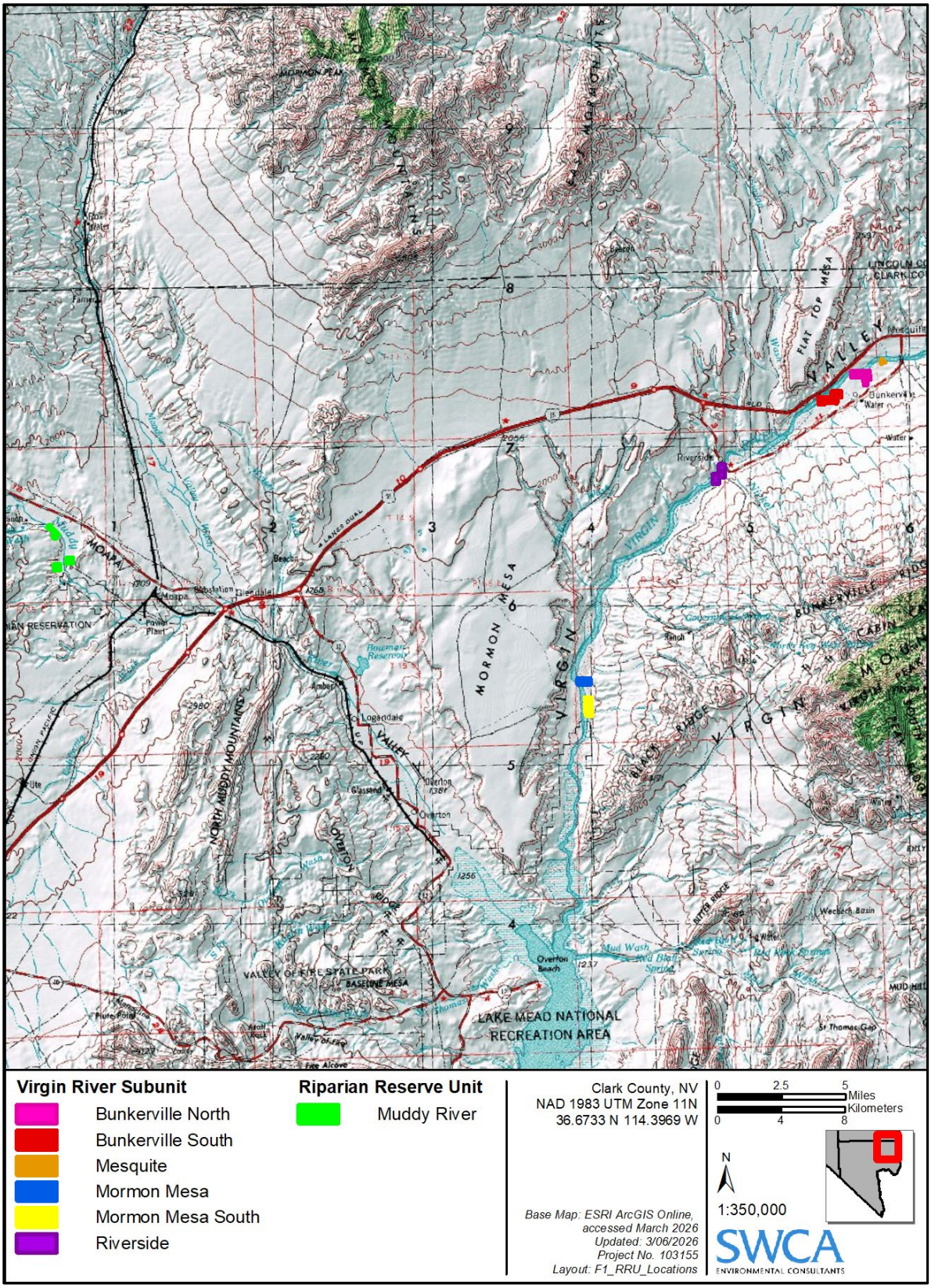

Figure 1. RRU locations.

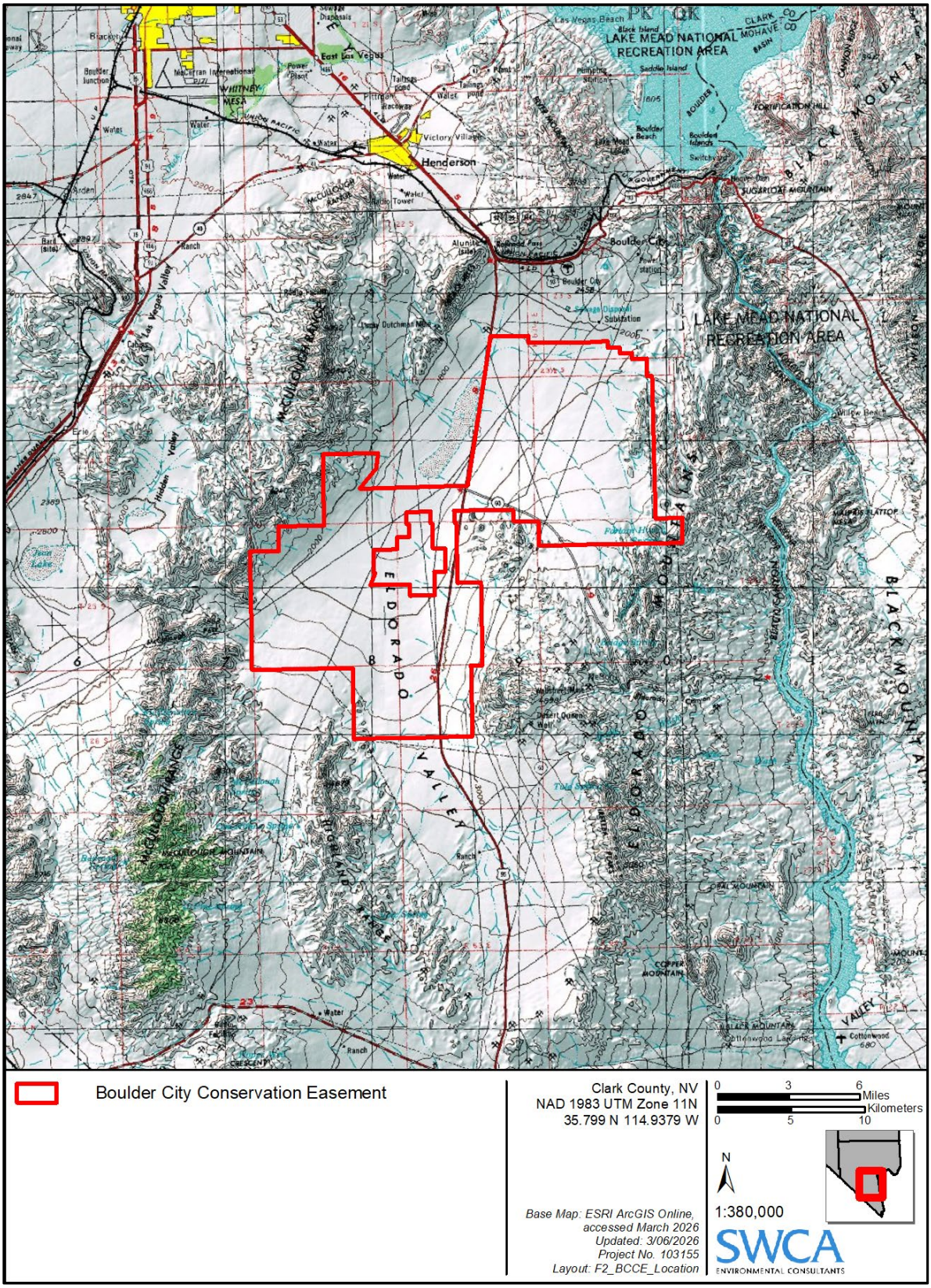

Figure 2. BCCE location.

1.2.1 RRUs

According to both the Biological and Conference Opinion and Condition K.1 of the associated incidental take permit, the County must acquire private property that contains desert riparian habitat along the Virgin River, Muddy River, and Meadow Valley Wash in Clark County. Many of the wildlife species covered under the MSHCP are reliant on desert riparian habitat for such activities such as breeding, foraging, and roosting, and the acquisition of these properties serves to ensure durable conservation and management of these areas. To date, the County has acquired approximately 316 ha (781 acres) of land along the Muddy and Virgin Rivers in northeastern Clark County, Nevada.

1.2.2 BCCE

Implementation of the MSHCP required the establishment of a conservation easement in the Eldorado Valley. This easement, known as the BCCE, was established in July 1995 through an agreement between Clark County and Boulder City. According to both the Biological and Conference Opinion (USFWS 2000) and Condition P of the associated incidental take permit (USFWS 2001), the County is required to take measures necessary to ensure maintenance of connectivity for Mojave desert tortoise (*Gopherus agassizii*) and other covered species within the BCCE. While the BCCE is primarily managed for protection of the desert tortoise, it was recognized that proper management of desert tortoise habitat could also be beneficial for protecting habitat for other species covered by the MSHCP, including bats (Clark County 2023a).

1.3 Management Actions, Goals, and Objectives

The *Clark County Desert Conservation Program Riparian Reserve Units Management Plan* (RRU Management Plan) (Clark County 2023b) identifies goals and objectives that help guide management directives on the RRUs. The second goal listed in this plan is to "manage reserves to support resource values for other MSHCP and sensitive species when practicable" (Clark County 2023b:35). In addition, the *Clark County Desert Conservation Program Boulder City Conservation Easement Management Plan* (BCCE Management Plan) (Clark County 2023a) identifies goals and objectives that help guide management directives within the BCCE. The second goal listed in the BCCE Management Plan is to "protect and manage the BCCE for other MSHCP covered species" (Clark County 2023a:40).

Management of species covered under the MSHCP and their habitats requires an in-depth understanding of baseline conditions within a given management unit. Collection of species' abundance and distribution data is a critical first step in monitoring of and conservation management efforts for the MSHCP-covered species found in Clark County. The primary goal of this project is to determine which bat species utilize properties managed by the County so that future management decisions can be tailored to support and enhance the presence of those species. The objective for this project is to establish a baseline record of all bat species recorded on the County's reserve system properties. These data can be used to track changes in presence and activity of MSHCP-covered bat species that use these properties, and to measure the success of management and restoration efforts conducted therein.

2 METHODS AND MATERIALS

2.1 Bat Acoustic Surveys

Between 2024 and 2025, the County's desert conservation program deployed bat acoustic detectors at ten survey points within the MSHCP Reserve System to document species occurrence and habitat use (Table 1. Figures 3–6). Detectors were deployed at five survey locations within the RRUs in 2024 and at five survey locations within the BCCE in 2025. Unauthorized diversion of a section of the Virgin River within the Riverside Subunit in 2023 resulted in survey point RS-09 becoming inaccessible. To facilitate surveyor access and optimum recording conditions, this survey point was moved approximately 70 meters to the northwest and relabeled as RS-09a (see Figure 4).

Bat acoustic surveys of the RRUs were conducted from May 16 to June 16, 2024, within the Muddy River Unit, Virgin River Subunit 2 (Bunkerville South), and Virgin River Subunit 3 (Riverside) (see Figure 1). Bat acoustic surveys of the BCCE were conducted from May 13 to June 11, 2025. These locations were selected for acoustic surveys as they exhibited the highest relative species diversity based on analysis of baseline bat acoustic data collected in 2018 and 2019 (SWCA 2020). At each survey point, an Anabat Swift (Titley Scientific) acoustic detector was secured to either a telescoping painter's pole or an existing, fixed structure (i.e., fencing). Microphones were elevated several meters above ground and were generally oriented horizontally towards potential bat attractant features such as streambeds, springs, and natural corridors, when present. Detectors were programmed to run on a nightly basis from approximately sunset to sunrise (hereafter referred to as a survey-night) for 30 consecutive nights (see Table 1).

2.2 Data Processing and Analysis

A total of approximately 92,213 acoustic recordings, or files, were recorded during bat acoustic surveys in 2024–2025. SWCA bat biologist Michael Swink first removed all files classified as noise from the dataset, which resulted in the identification of 60,861 potential bat echolocation files. These files were batch processed using Sonobat version 30.2 bat call analysis software, which resulted in the automated identification of these files to species at 80% accuracy. Sonobat provides multiple regional classifier suites that contain various bat species lists known to occur within each geographic region. Due to the high species diversity of bats historically documented to occur within Clark County (Bradley et al. 2006; Reid 2006; Williams et al. 2006; Las Vegas Wash Coordinating Committee 2011; Nevada Department of Wildlife [NDOW] 2022), multiple regional classifiers were used during batch processing and manual file vetting to confirm presence of potential bat species within the project area.

A total of 1,206 bat echolocation files were manually identified to species using multiple reference materials, including bat acoustic identification keys (Szewczak 2018, 2022; Tyburec 2019) and vouchered reference recordings provided by Sonobat. Due to various factors, including environmental noise, echoes, and non-bat vocalizations, a subset of manually reviewed files were not identifiable to species. These files were assigned one of the user-defined frequency classes defined in Table 2. All files identified by the Sonobat automated classifier to species were identified to species or a user-defined category. To conduct an unbiased analysis between survey locations, bat activity was calculated for each species as the number of files per survey-night (number of files per point divided by the number of survey-nights per point) to control for variation in sampling effort among survey points. Bat acoustic data cannot be used to directly estimate bat populations since an individual may produce numerous detected calls. However, these data can be used to determine species occurrence and relative activity levels among bat species and survey locations.

Table 1. 2024–2025 Bat Acoustic Survey Schedule and Locations.

Location	Survey Point ID	Survey Start Date	Survey End Date	Completed Survey-Nights*
RRU	BS-11; MR-02; RS-08; RS-09a	5/16/2024	6/14/2024	30
	MR-04	5/16/2024	6/16/2024	25
BCCE	BCCE-01; BCCE-05; BCCE-08; BCCE-12; BCCE-16	5/13/2025	6/11/2025	30

*The detector at survey point MR-04 did not record the entire survey-nights between May 28 and June 2 and on June 16, 2024, due to equipment malfunction.

Table 2. Frequency Class Labels for Files Not Identified to Species.

Frequency Class	User-defined categories
HIGHF	Various species with pulses having a minimum characteristic frequency higher than ~30 kilohertz
LOF	Various species with pulses having a minimum characteristic frequency lower than ~30 kilohertz
50KMYO	Call sequences that exhibit identification characters consistent with Myotis species that create commuting phase call pulses around 50 kilohertz (i.e., California myotis [*Myotis californicus*] and Yuma myotis [*Myotis yumanensis*])
40KMYO	Call sequences that exhibit identification characters consistent with Myotis species that create commuting phase call pulses around 40 kilohertz (i.e., western small-footed myotis [*Myotis ciliolabrum*], little brown myotis [*Myotis lucifugus*], and long-legged myotis [*Myotis volans*])
EPFULANO	Call sequences that exhibit identification characters consistent with big brown bat (*Eptesicus fuscus*) and silver-haired bat (*Lasionycteris noctivagans*)
NoID	Bat, but no grouping or user-defined category applies; recording quality insufficient for identification

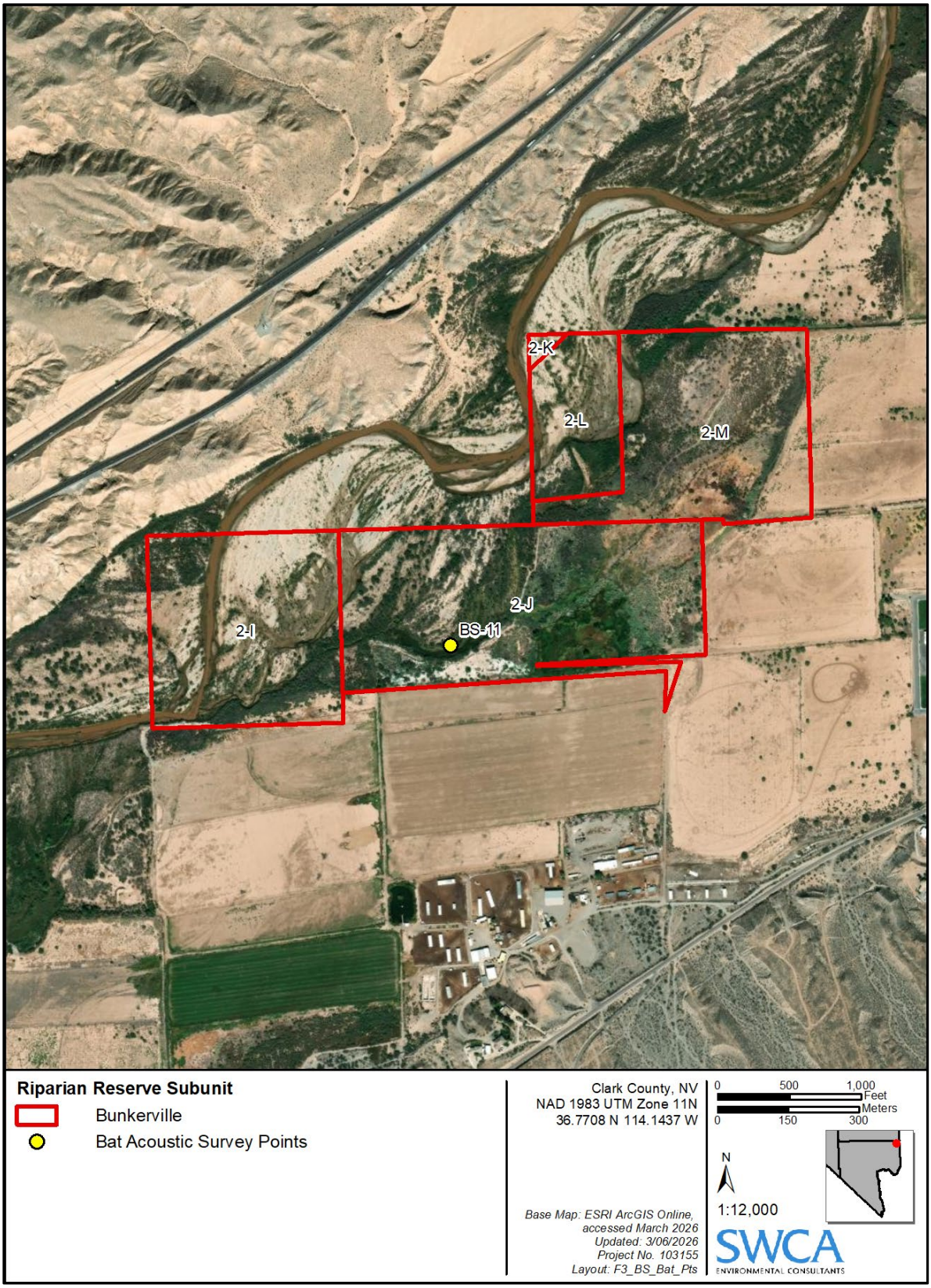

Figure 3. Bat acoustic survey locations within the Bunkerville Riparian Reserve Subunit.

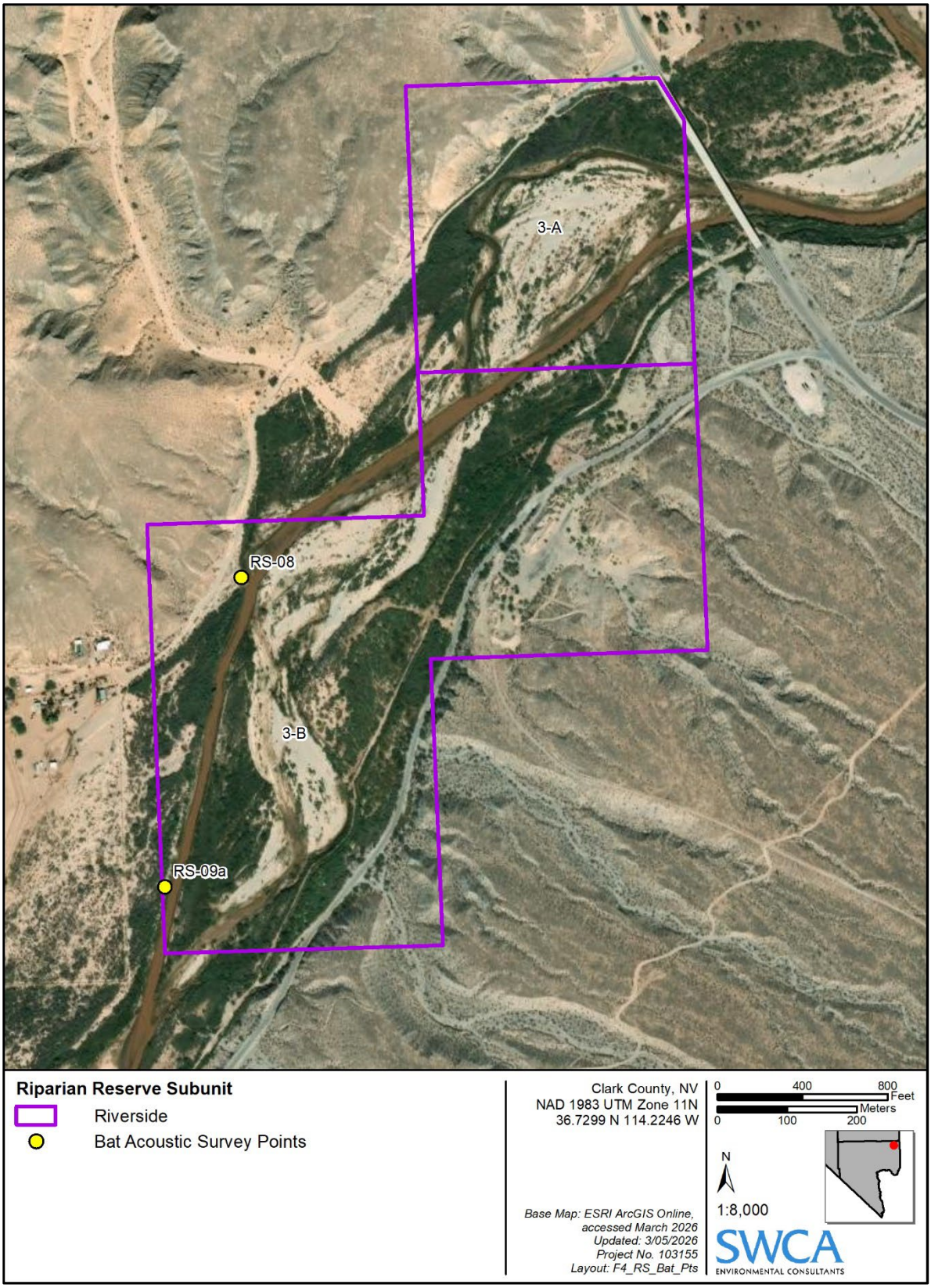

Figure 4. Bat acoustic survey locations within the Riverside Riparian Reserve Subunit.

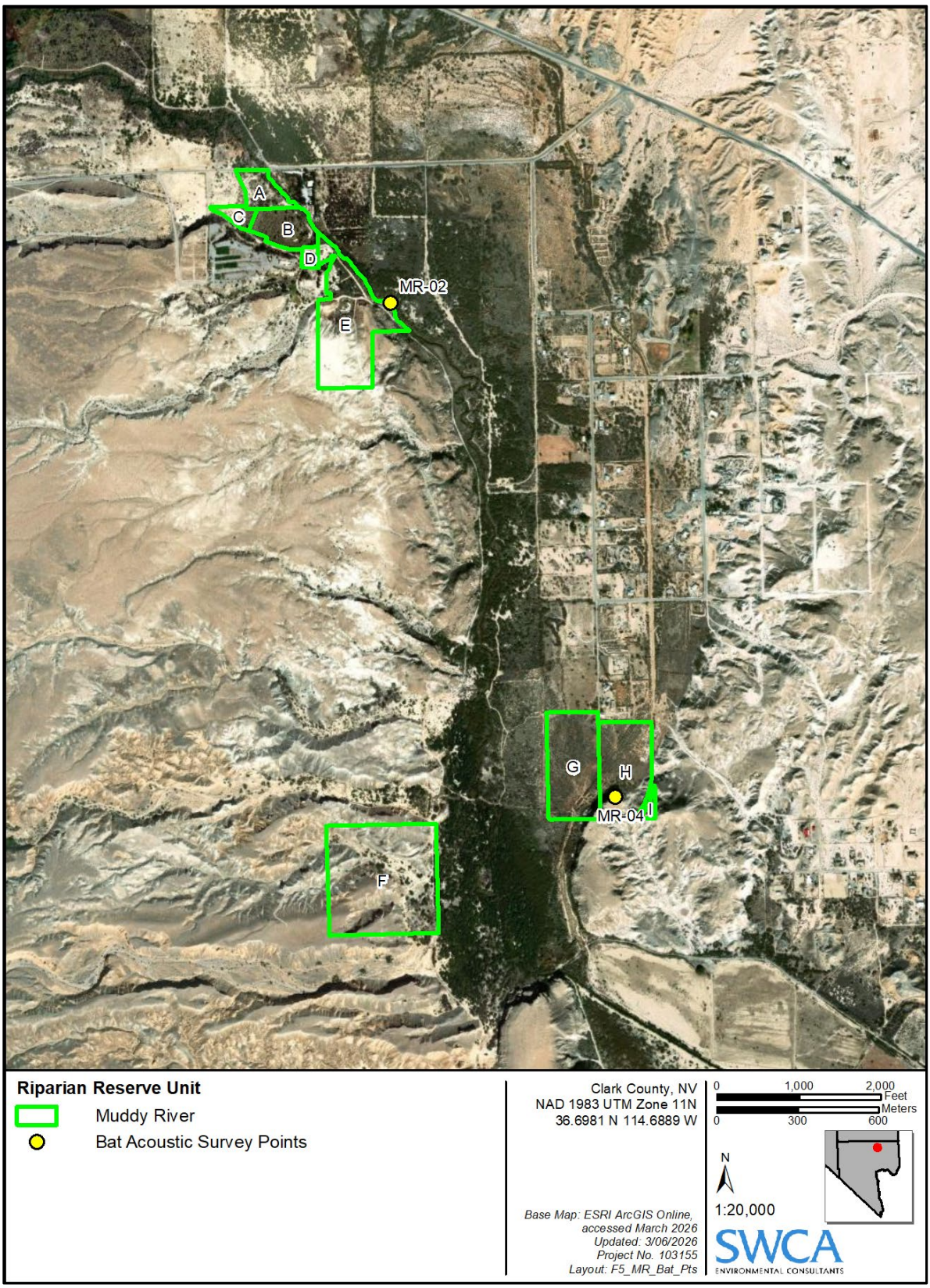

Figure 5. Bat acoustic survey locations within the Muddy River RRU.

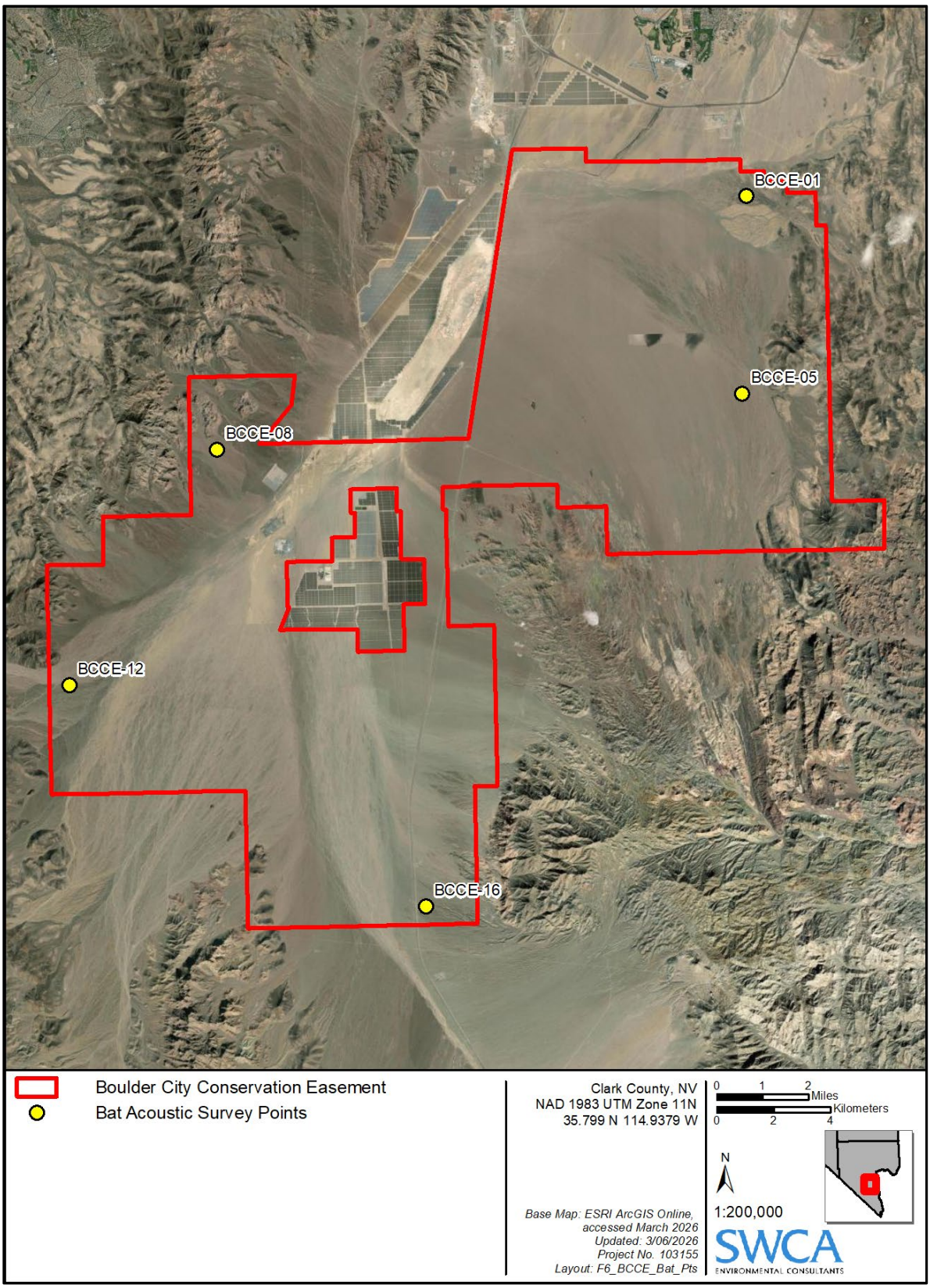

Figure 6. Bat acoustic survey locations within the BCCE.

3 RESULTS AND EVIDENCE OF THE RESULTS

3.1 Objectives Completed

The primary goal of this project was to determine which species of bats occur within properties managed by the County so that future management decisions can support bat species presence. To achieve this goal, the objective for this project was to identify bat species from existing passive bat recordings to determine if any MSHCP-covered species or species proposed for coverage were detected. The results of this analysis are presented below.

3.2 Survey Effort

For this project, acoustic detectors were deployed at 10 locations throughout the project area and recorded a total of 92,213 acoustic files. Bat acoustic detectors were deployed at each survey point for a total of 30 nights; however, only 25 survey-nights were completed at survey point MR-04 due to equipment malfunction (see Table 1). Detectors operated for a total of 295 survey-nights; 145 survey-nights were completed at the RRUs and 150 survey-nights were completed at the BCCE.

3.3 Findings

In total, 13 bat species were recorded across all the County's properties (Table 3). Twelve bat species were detected at one or more of the RRUs; in contrast, a total of four bat species were documented at the BCCE. Within the BCCE, bat activity was highest at survey point BCCE-12, followed by BCCE-08, which together accounted for 69% of the total activity recorded at the BCCE (Figure 7; Appendix A). Most of this activity was attributed to two species, canyon bat (*Parastrellus hesperus*) and Brazilian free-tailed bat (*Tadarida brasiliensis*). Within the RRUs, bat activity was highest at survey point MR-04, accounting for 34% of the total activity recorded at the RRUs (Figure 8; see Appendix A). Similar to data recorded at the BCCE, the majority of bat activity that was documented during acoustic surveys of the RRUs was attributable to canyon bats and Brazilian free-tailed bats.

3.3.1 MSHCP Species

Based on the results of the manual call identification process, bat acoustic surveys detected one species covered by the County MSHCP, silver-haired bat. The silver-haired bat was recorded at all RRU survey points (i.e., BS-11, MR-02, MR-04, RS-08, and RS-09a) in 2024. Highest activity estimates for this species were observed within the Muddy River RRU at point MR-02 and in the Riverside Subunit at RS-09a. Silver-haired bats roost under bark or in woodpecker holes in large trees in the summer. In southern Nevada, silver-haired bats are most commonly documented within riparian forest areas but are also known to travel up to 9 miles (15 kilometers) to foraging areas (Wilson et al. 1999; Nevada Bat Working Group [NBWG] 2024).

Bat acoustic surveys also detected Townsend's big-eared bat, an MSHCP-proposed covered and evaluation bat species, and western small-footed myotis, an evaluation bat species. Townsend's big-eared bat was detected at Riverside RS-08 and at Muddy River points MR-02 and MR-04, and western small-footed myotis was detected at points BCCE-08 and BCCE-12 (see Appendix A).

MSHCP-covered bat species that were not detected in the project area include long-legged myotis, which is generally found at mid to high elevations and absent from low desert areas in Nevada; and long-eared myotis, which in Nevada has only been encountered within pinyon-juniper woodland and forested areas at higher elevations (NDOW 2022; NBWG 2024). Spotted bat, a species proposed for listing as covered under the MSHCP, was also not detected acoustically during this project. However, there are occurrence records for this species in riparian marsh along the upper Muddy River drainage within the Warm Springs Natural Area (Williams et al. 2006) and along the Muddy River in the project area (SWCA 2023, 2024b).

Table 3. Bat Species Identified Acoustically Within the Project Area in 2024-2025, by Location.

Common Name	Scientific Name	6-letter Code	MSHCP*	Survey Locations(s) Detected†
Pallid bat	*Antrozous pallidus*	ANTPAL	–	BS, MR, RS
Townsend's big-eared bat	*Corynorhinus townsendii*	CORTOW	E, PC	MR, RS
Big brown bat	*Eptesicus fuscus*	EPTFUS	–	BS, MR, RS
Silver-haired bat	*Lasionycteris noctivagans*	LASNOC	C	BS, MR, RS
Northern hoary bat	*Lasiurus cinereus*	LASCIN	–	BS, MR, RS
Western yellow bat	*Lasiurus xanthinus*	LASXAN	–	MR, RS
California myotis	*Myotis californicus*	MYOCAL	–	BCCE, BS, MR, RS
Western small-footed myotis	*Myotis ciliolabrum*	MYOCIL	E	BCCE
Fringed myotis	*Myotis thysanodes*	MYOTHY	–	MR
Yuma myotis	*Myotis yumanensis*	MYOYUM	–	BS, MR, RS
Pocketed free-tailed bat	*Nyctinomops femorosaccus*	NYCFEM	–	BS, RS
Canyon bat	*Parastrellus hesperus*	PARHES	–	BCCE, BS, MR, RS
Brazilian [Mexican] free-tailed bat	*Tadarida brasiliensis*	TADBRA	–	BCCE, BS, MR, RS

* MSHCP status (Clark County 2000, 2019): C=covered; E=evaluation; PC=proposed covered
† Clark County Desert Conservation Program Reserve System Properties: BCCE = Boulder City Conservation Easement; BS = Bunkerville South; MR = Muddy River; RS = Riverside

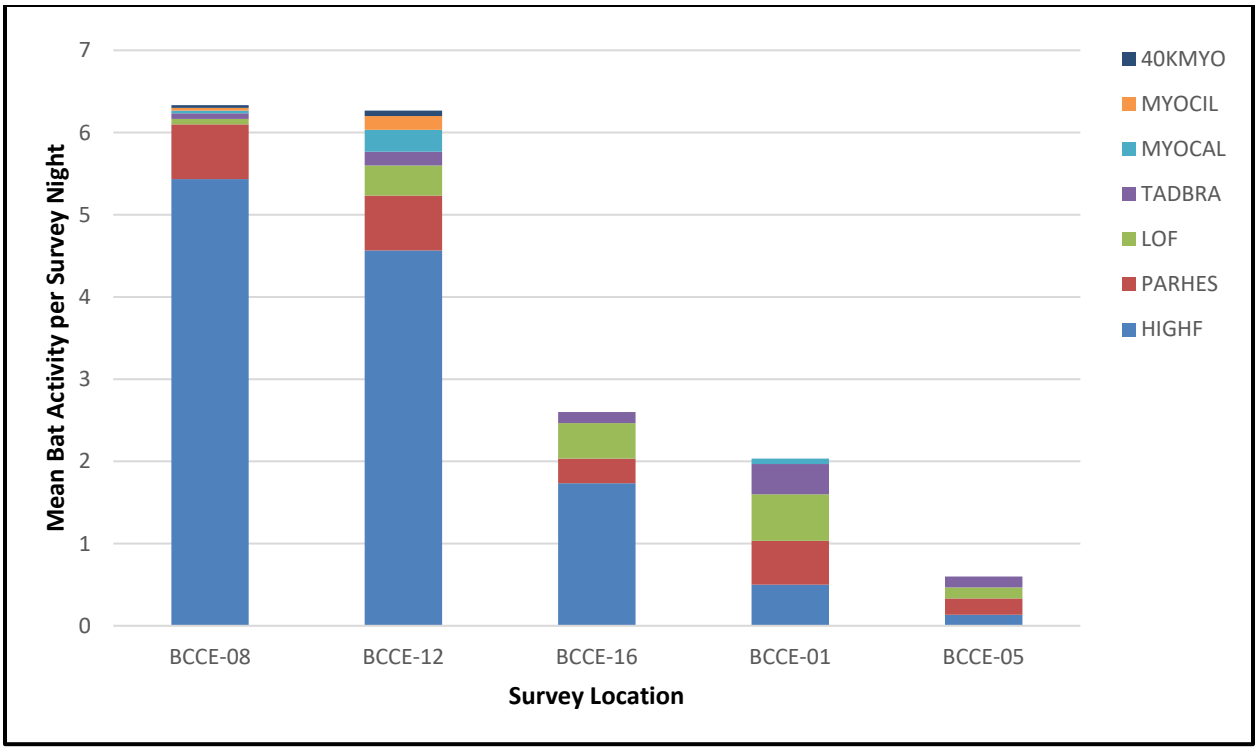

Figure 7. Bat activity within the BCCE in 2025, by species, survey-night, and location.

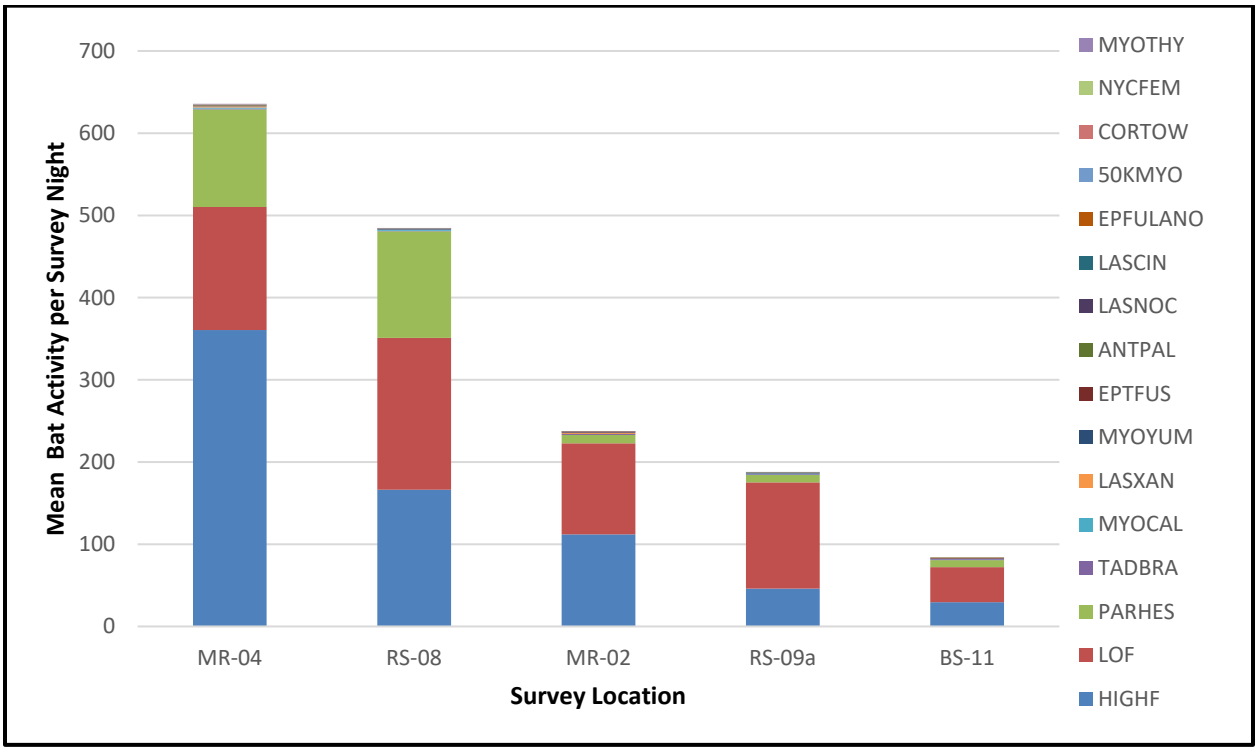

Figure 8. Bat activity within the RRUs in 2024, by species, survey-night, and location.

4 EVALUATION/DISCUSSION OF RESULTS

4.1 Analysis Factors

Many of the manually reviewed files recorded various sources of environmental noise, such as echoes, wind, vehicle traffic and other anthropogenic sources, as well as small mammal, bird, and/or insect vocalizations. Echoes are generated in ultrasonic detector recordings when the microphone is located near solid surfaces (e.g, cliff walls and wash banks) or surface water features. These types of non-target noise sources can decrease recording quality and confound both automated and manual bat species classification. Similarly, recordings of bat echolocations that are outside the effective microphone range often lack sufficient resolution and diagnostic features, and bats that closely approach the microphone can generate oversaturated recordings, which can preclude accurate identification to species.

Bat acoustic data files cannot be used to directly estimate bat populations since an individual may be responsible for numerous detected calls. However, these data can be used to determine species occurrence and relative activity levels among bat species and survey locations. Bat activity and species composition in any given area are highly variable and influenced by a variety of biotic and abiotic factors, including climatic fluctuation; seasonal activity patterns such as reproduction, migration, and hibernation; changes in the abundance and location of prey items and water sources; and roosting and foraging habitat availability. As a result, the species diversity and activity patterns observed in these bat acoustic survey data reflect the temporal and spatial scales at which these surveys were performed.

4.2 Habitat Conditions

This project builds upon a baseline bat occurrence dataset for the County's MSHCP properties. Bat acoustic surveys within the RRUs resulted in a total of 13 bat species detected, including one MSHCP-covered bat species, one proposed covered/evaluation species, and one evaluation species. Analysis of bat acoustic survey data collected within the BCCE in 2025 yielded detection of five total bat species, including one MSHCP-covered and one evaluation species. Goals identified in both the BCCE Management Plan (Clark County 2023a) and RRU Management Plan (Clark County 2023b) include managing these properties to protect MSHCP-covered species. Baseline vegetation community and structure data for the MSHCP properties are necessary to inform habitat management interventions to successfully manage bat species at these properties. This section includes a closer analysis of bat species presence and distribution for each set of connected parcels within the RRUs and at the BCCE, as well as a qualitative assessment of existing vegetation conditions therein. Additional quantitative and qualitative description of vegetative conditions within these properties is provided in SWCA (2024c, 2025a).

4.2.1 Bunkerville South

Much of Bunkerville South (Parcels 2-I and 2-J) appear to be subject to regular flooding, and some of the most abundant plants within these two parcels are sapling arrowweed (*Pluchea sericea*) and tamarisk (*Tamarix* spp.) less than 3 meters (m) (9.8 feet) tall. Bunkerville Parcels 2-I and 2-J host very few large riparian tree species, such as Fremont cottonwood (*Populus fremontii*), Goodding's willow (*Salix goodingii*), and narrowleaf willow (*Salix exigua*), which may be utilized by tree-roosting bat species. Most of the mature riparian vegetation within these parcels consists of tamarisk and screwbean mesquite (*Prosopis pubescens*) 2–5 m (6.6–16.4 feet) tall, and these stands have virtually no continuous canopy cover or nearby surface water (Figure 9). Additionally, much of the tamarisk is dead or dying. Large areas within the parcels exhibit low vegetative density, likely associated with recent anthropogenic channel diversion and/or flood and high-flow events on the Virgin River. A total of 0.9 hectares (ha) (2.2 acres)

were scoured by spring flooding in 2022, leaving sandbars and areas of unvegetated bare ground (Figure 10). Parcels 2-I and 2-J also feature flowing channels, a pond, and a wet meadow (Figure 11).

Figure 9. Typical open, scrubby habitat at Bunkerville South Parcels 2-I and 2-J.

Figure 10. Backwater ponds within Bunkerville South Parcel 2-I provide bat foraging habitat.

Figure 11. Open water (left) and wet meadow (right) habitats at Bunkerville South Parcel 2-J.

Wet meadow habitat is located in the eastern half of Parcel 2-J and largely comprises sedges and other wetland grasses, with relic Goodding's willow and scattered tamarisk (SWCA 2020). Vegetative conditions within Bunkerville South in 2024 were observed to be drier relative to prior years.

4.2.1.1 BAT HABITAT FEATURES

Acoustic detectors were deployed at one survey point within the Bunkerville South Subunit. Survey point BS-11 is located in Parcel 2-J within a wet meadow and near a large backwater pond (see Figure 11 and Figure 12). Vegetation at BS-11 consisted of saltgrass (*Distichlis spicata*), cattail (*Typha* spp.), arrowweed, honey mesquite (*Prosopis glandulosa*), and tamarisk.

In total, nine bat species were recorded within Bunkerville South in 2024: pallid bat (*Antrozous pallidus*), big brown bat (*Eptesicus fuscus*), silver-haired bat (an MSHCP-covered bat species), hoary bat (*Lasiurus cinereus*), California myotis (*Myotis californicus*), Yuma myotis (*Myotis yumanensis*), pocketed free-tailed bat (*Nyctinomops femorosaccus*), canyon bat, and Brazilian free-tailed bat. Canyon bat and Brazilian free-tailed bat accounted for most of the echolocation files recorded at Bunkerville South that were identifiable to species. Suitable bat roosting habitat is scarce within the Bunkerville South Subunit (although scattered Goodding's willow in Parcel 2-J may be utilized by tree-roosting bat species) and many of the bat species recorded at Bunkerville South were likely foraging or moving through the site.

Figure 12. Bat acoustic survey point BS-11 in the Bunkerville South (2I/2J) Subunit.

Suitable foraging habitat within the subunit includes dense riparian scrub, ponds and backwater features, and wet meadow habitat, which likely support high densities of flying insects that many bat species prey on, such as flies, moths, and beetles. Backwaters, ponds, and other areas of stagnant, standing water located along the floodplain provide potential foraging and drinking resources to several bat species.

4.2.2 Riverside

Much like Bunkerville South, Riverside Parcels 3-A and 3-B comprise mostly open, scrubby habitat typically found in riparian areas that experience frequent flooding (Figure 13). An irrigation ditch runs along the center of Parcel 3-A, the banks of which support tall stands of narrowleaf willow (Figure 14).

Large areas of dense arrowweed, screwbean mesquite, and honey mesquite are present in the central portion of Parcel 3-A.

Figure 13. Scrubby, open habitat within the floodplain at Riverside Parcels 3-A and 3-B.

Figure 14. Narrowleaf willow along the irrigation ditch at Riverside Parcels 3-A and 3-B.

4.2.2.1 BAT HABITAT FEATURES

Acoustic detectors were deployed at two survey points within the Riverside Subunit; RS-08 was deployed in the northwestern corner of Parcel 3-A above cut bank and sandbar features on the Virgin River. RS-08 is situated between creosote desert scrub to the north and patches of arrowweed and dense tamarisk to the south and west. Survey point RS-09a is located at the southwestern end of Parcel 3-A, near the river's edge in a wet meadow area vegetated by tamarisk, arrowweed, and screwbean mesquite trees (Figure 15).

In total, eleven bat species were recorded within the Riverside Subunit in 2024: pallid bat, Townsend's big-eared bat (an MSHCP-proposed covered and evaluation species), big brown bat, silver-haired bat (a MSHCP-covered bat species), hoary bat, western yellow bat, California myotis, Yuma myotis, pocketed free-tailed bat, canyon bat, and Brazilian free-tailed bat. Bat activity data collected at survey point RS-08, as measured by the mean files per survey-night, were nearly twice as high as the activity levels recorded at RS-09a (see Figure 8; Appendix A). Dense riparian scrub and wet meadow habitat along the banks of the Virgin River likely support high densities of flying insects that bats prey upon, such as flies, moths, and mosquitoes. The irrigation channel located in Parcel 3-A, when flowing,

provides a potential slow-moving water source for bats (see Figure 14). Adjacent to the floodplain, upland desert habitat may provide suitable foraging habitat for pallid bats, which forage on the desert floor or in low brush for scorpions, centipedes, and small terrestrial vertebrates, such as lizards.

As suitable bat roosting habitat within the Riverside Subunit is limited, many of the bat species recorded at Riverside were likely foraging or moving through the site. Along this stretch of the Virgin River, however, suitable bat roosting habitat is varied and widespread. Crevices located in the eroded cliff walls in the northern end of the parcel may provide suitable roosting habitat for canyon bat and California myotis. Fan palm trees (*Washingtonia* spp.), which are scattered throughout the residential areas south of the unit, are known to be utilized by the western yellow bat as roosting substrate. Many of the bat species recorded at the Riverside Subunit are also known to roost in abandoned buildings and/or under bridges (pallid bat, big brown bat, California myotis, Yuma myotis, canyon bat, and Brazilian free-tailed bat), and many of these potential roosts are located near the subunit within the Virgin River floodplain.

Figure 15. Bat acoustic survey points RS-08 (left) and RS-09a (right) in the Riverside (3A/3B) Subunit.

4.2.3 Muddy River

Vegetation at the Muddy River RRU is highly diverse. The Muddy River RRU primarily comprises creosote bush upland and mesic forest, and the unit lacks the desert riparian habitat that occurs at the Virgin River Subunits. Parcels A through E are dominated by horticultural plantings (e.g., pine [*Pinus* spp.] and California fan palm [*Washingtonia filifera*]) (Figure 16), creosote bush (*Larrea tridentata*) scrubland, or big saltbush (*Atriplex lentiformis*). Parcel F is dominated almost completely by creosote bush scrub, with smaller patches of honey mesquite, particularly in the central and southeast portions of the parcel (Figure 17). Parcels G through I largely comprise very dense thickets of big saltbush and Mojave seablite (*Suaeda moquinii*) mixed with scattered honey mesquite and tamarisk (Figure 18). While the Muddy River runs near the Muddy River RRU, it does not run through any of the southern Parcels and only forms the eastern boundary of Parcels A through E. This portion of the Muddy River is also deeply incised, and true desert riparian vegetation, consisting of widely scattered tamarisk and velvet ash (*Fraxinus velutina*), is generally limited to within a couple of meters of the riverbank.

Figure 16. Horticultural trees adjacent to riparian habitat at Muddy River Parcels A-E.

Figure 17. Creosote bush habitat with scattered honey mesquite at Muddy River Parcel F.

Figure 18. Varied desert scrub habitat at Muddy River Parcels G-I.

4.2.3.1 BAT HABITAT FEATURES

Acoustic detectors were deployed at five survey points within the Muddy River Unit. MR-02 was deployed directly adjacent to the Muddy River; dominant vegetation near MR-02 consisted of arrowweed and giant reed (*Arundo donax*); this area was recently restored with native species plantings, including Fremont cottonwood, willow (*Salix* spp.), mesquite (*Prosopis* spp.), seep willow (*Baccharis* spp.), and alkali sacaton (*Sporobolus airoides*) (Figure 19). MR-04 was deployed in rocky, upland areas near rock crevices. Dominant vegetation near MR-04 consisted of a large patch of honey mesquite adjacent to mixed salt desert scrub dominated by big saltbush and Mojave seablite (Figure 20 and see Figure 19).

Figure 19. Bat acoustic survey points MR-02 (left) and MR-04 (right) in the Muddy River RRU.

Figure 20. A large rock wall (left) located immediately south of acoustic survey point MR-04 contains long, vertical fissures (right) that may provide cliff-roosting bat habitat.

In total, eleven bat species were recorded within the Muddy River parcel: pallid bat, Townsend's big-eared bat (an MSHCP-proposed covered and evaluation species), big brown bat, silver-haired bat (a MSHCP-covered bat species), hoary bat, western yellow bat, California myotis, fringed myotis (*Myotis thysanodes*), Yuma myotis, canyon bat, and Brazilian free-tailed bat. Various, potential bat roosting and foraging habitat features are located near or adjacent to the Muddy River Unit, which is reflected in the high bat use and species diversity observed at this location. Based on acoustic analysis, bat activity within the project area was highest at survey point MR-04, which was located near the base of a cliff wall with

deep crevices and fissures. Dense riparian and upland vegetation within and adjacent to MR-04 likely supports flying insect populations that various bat species prey upon.

Many bat species detected within the unit are known to roost in trees, and include big brown bat, hoary bat (*Lasiurus cinereus*), silver-haired bat (an MSHCP-covered bat species), and western yellow bat (and, to a lesser extent, pallid bat, and California myotis). Bats likely roost in large, deciduous riparian trees located within and near the unit, such as Fremont cottonwood, velvet ash, and Goodding's willow. Western yellow bat, in particular, has been documented utilizing the Warm Springs Natural Area just north of the Muddy River unit (Williams et al. 2006; Southern Nevada Water Authority 2011), and likely roosts in the dead fronds of fan palm trees within and adjacent to the unit.

Extensive vertical fissures within eroded cliff walls located in the southeastern portion of the unit (see Figure 20) may provide suitable roosting habitat for various observed species such as California myotis, Yuma myotis, and canyon bat. Many of the bat species detected in the Muddy River unit may also be roosting in buildings, bridges, and other man-made structures that are located in the vicinity, such as pallid bat, Townsend's big-eared bat, big brown bat, California myotis, Yuma myotis, canyon bat, and Brazilian free-tailed bat. Adjacent to the unit, large areas of upland desert scrub may provide suitable terrestrial foraging habitat for pallid bats, which are known to glean prey items from the desert floor or low brush, including beetles, scorpions, centipedes, and lizards (Wilson et al. 1999; Reid 2006).

4.2.4 BCCE

Mojave Desert scrub, which is co-dominated by creosote bush and burrobush (*Ambrosia dumosa*), is the dominant vegetation community across the Mojave Desert, and this community covers over 97% of the BCCE (Clark County 2023a) (Figure 21). The remainder of the BCCE comprises salt desert scrub (1.5%), mesquite/acacia habitat (less than 1%), and previously disturbed habitat (Clark County 2023a). There are also scattered, dense populations of silver cholla (*Cylindropuntia echinocarpa*) along the foothills of the BCCE. Mesquite-acacia habitat is present along ephemeral washes within the BCCE (Figure 22).

Figure 21. Examples of typical Mojave Desert scrub habitat within the BCCE.

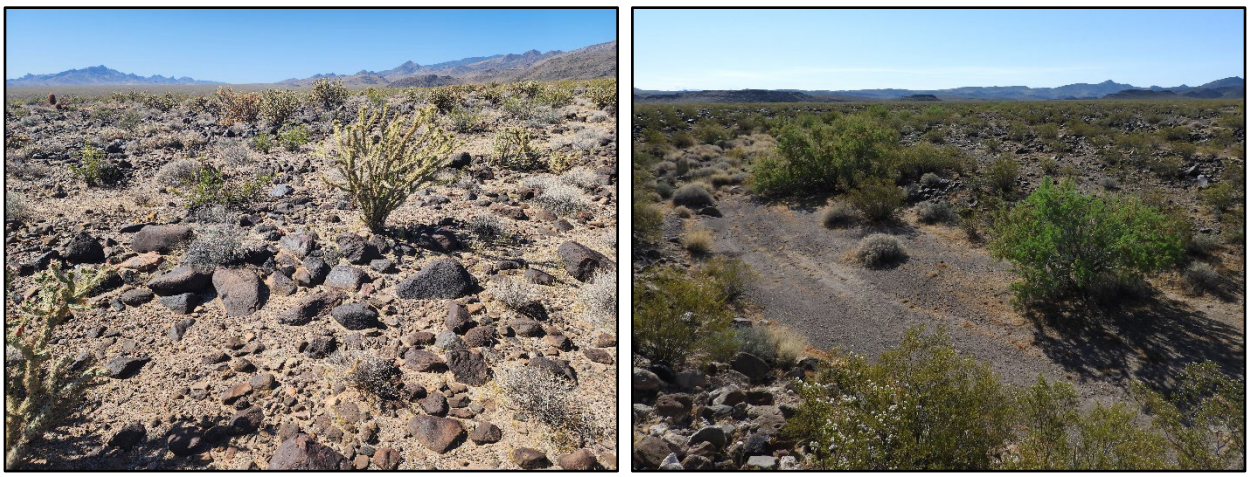

Figure 22. Examples of dense cholla (left) and mesquite-acacia desert wash (right) habitat within the BCCE.

4.2.4.1 BAT HABITAT FEATURES

Acoustic detectors were deployed at five survey points within the BCCE (Figure 23–Figure 25). Based on Southwest Regional Gap Analysis Project land cover data (U.S. Geological Survey 2004), all five survey points are located within creosote bush-white bursage scrub. Survey points BCCE-01, BCCE-05, and BCCE-12 were located on flat to gently sloped terrain where ground cover was dominated by large rocks and/or desert pavement (see Figures 23-24). BCCE-08 was located atop a rock-covered hill and BCCE-16 was located on a rocky slope adjacent to a large wash (see Figures 24-25).

Relative to the RRU acoustic data, bat species diversity and activity data collected within the BCCE were much lower. These differences may be explained by the relative paucity of bat attractant features and roosting habitat within the BCCE. In total, four bat species were recorded within the BCCE: California myotis, western small-footed myotis (an MSHCP evaluation species), canyon bat, and Brazilian free-tailed bat. Most of the bat echolocation files documented within the BCCE were identified as canyon bat or Brazilian free-tailed bat. Cliffs, crevices, and rockpiles located in the mountains and foothills that surround the BCCE may provide suitable roosting habitat for California myotis, western small-footed myotis, and canyon bat. Bat species detected in the BCCE are those that are known to occur in desert scrub habitat. Based on acoustic analysis, bat activity within the project area was highest at survey point BCCE-12, which was located adjacent to braided ephemeral washes. The higher bat activity recorded at this location may be attributed to the detector placement along linear topographic features, such as ephemeral washes, that provide a flight path or landmark that bats use. BCCE-12 was also located near McCullough Pass, which may also provide a flight corridor for bats.

Figure 23. Bat acoustic survey points BCCE-01 (left) and BCCE-05 (right).

Figure 24. Bat acoustic survey points BCCE-08 (left) and BCCE-12 (right).

Figure 25. Bat acoustic survey point BCCE-16.

5 CONCLUSION

This project builds upon a baseline bat occurrence dataset for the County's MSHCP properties. Bat acoustic surveys within the RRUs resulted in a total of 12 bat species detected, including one MSHCP-covered bat species, one proposed covered/evaluation species, and one evaluation species. Bat acoustic surveys within the BCCE yielded four total bat species, including one evaluation species. Goals identified in both the Riparian Reserves Management Plan (Clark County 2023b) and the BCCE Management Plan (Clark County 2023a) include managing these properties to protect MSHCP-covered species. Notable conclusions about bat occurrence and habitat use within the County's properties include:

- Thirteen species of bats were acoustically detected within the project area. The highest bat species diversity was observed at the Muddy River Unit (11 species) and the Riverside Subunit (11 species), which is likely associated with an abundance of both attractant features and potential roosting sites within and near these locations.
- Bat acoustic surveys detected one species covered by the Clark County MSHCP, silver-haired bat at the RRUs. The silver-haired bat uses hollow trees, bark, and woodpecker holes as maternity and day/night roost sites.
- Acoustic surveys also detected Townsend's big-eared bat, an MSHCP-proposed covered and evaluation bat species, and western small-footed myotis, an evaluation bat species. Townsend's big eared bat produces low-amplitude vocalizations, and can also hunt by sight alone; as a result, it is rarely detected acoustically and so may be under-represented in this dataset. This species was detected at the Muddy River (MR-02 and MR-04) Unit and the Riverside (RS-08) Subunit.
- Most of the bat echolocation files that were documented within the project area, and identified to species, were identified as canyon bat or Brazilian free-tailed bat. These are both widespread and abundant species that roost and forage in a variety of habitat types. Brazilian free-tailed bat, a regular visitor to MSHCP reserve system properties, is considered the most economically valuable bat species in North America as they prey heavily on agricultural pests (Bat Conservation International 2020).
- Pocketed free-tailed bat was detected in the Riverside and Bunkerville South Subunits, both located along the Virgin River, in 2024. These represent the first acoustic detections of this species collected for this monitoring project, although this species has also been recently documented during acoustic surveys of this ecoregion (SWCA 2025b). The distribution, foraging, and roosting ecology of this species in Nevada is still largely unknown and warrants further investigation.

6 RECOMMENDATIONS

Based on observations from the 2024–2025 bat acoustic surveys and factors discussed in this report, recommendations are provided below to support the County's long-term goals for the RRUs and the BCCE:

- Habitat loss is one of the primary threats to bat populations worldwide (Frick et al. 2020). Bat acoustic data collected for this project indicates that multiple bat species, including MSHCP-covered species, are foraging, and likely roosting, within and adjacent to County-managed lands. As directed by the *Clark County Desert Conservation Program Riparian Reserves Management Plan* (Clark County 2023b), the County should continue to purchase parcels along the Meadow Valley Wash, Virgin River, and Muddy River watersheds, to further protect and enhance habitat for bats and other MSHCP-covered species. SWCA recommends adding bat acoustic survey

locations at these new properties to further document baseline bat occurrence, habitat use patterns within the Reserve System.

- Bat acoustic surveys should be continued for subsequent years to help build on baseline data and to track changes in species occurrence and activity throughout the acquisition, restoration, and monitoring stages. These surveys should use the protocols established for this project to ensure datasets are standardized and comparable. Future acoustic survey design should continue sampling at multiple locations within a given sampling period to control for temporal variation and facilitate robust comparative analysis of bat activity between locations.
- Capture surveys within each of the County's Reserve system properties would provide additional bat species occurrence and life history data and could result in the detection of additional bat species that have potential to occur within the project area but have not been recorded acoustically.
- To manage for the benefit of the MSHCP-covered silver-haired bat and other tree-roosting species, future restoration efforts should be focused on the protection of existing stands, and the establishment of new stands, of large, deciduous riparian tree species such as Fremont cottonwood, velvet ash, and Goodding's willow. Any dead, hollow trees that are located within the project area and do not present a safety hazard should also be protected, when practicable, as they can provide valuable bat roosting substrate in addition to nesting, perching, and foraging habitat for various breeding bird species.

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APPENDIX A

BAT SPECIES ACTIVITY MATRIX

Appendix A. Mean Bat Acoustic Files Per Survey Night, by Species/Frequency Class and Location

Location	Survey Point	Bat Species (6-letter Code) Activity (bat files per survey night) within the Project Area*																		Total per Survey Point	Percent of Project Total
		40KMYO	50KMYO	ANTPAL	CORTOW	EPFU/LANO	EPTFUS	HIGHF	LASCIN	LASNOC	LASXAN	LOF	MYOCAL	MYOCIL	MYOTHY	MYOYUM	NoID	NYCFEM	PARHES	TADBRA	
RRU	BS-11	-	0.00	0.17	0.00	0.37	0.77	29.60	0.20	0.13	0.00	42.57	0.40	-	0.00	0.27	18.03	0.07	8.60	1.00	102.17	4.72
	MR-02	-	0.00	0.13	0.07	0.10	0.63	112.00	0.10	0.37	1.17	110.73	0.00	-	0.03	0.97	122.53	0.00	10.13	1.10	360.07	16.62
	MR-04	-	0.32	0.40	0.48	0.20	0.72	360.64	0.28	0.20	1.40	149.60	1.32	-	0.04	0.36	192.12	0.00	118.72	0.96	827.76	38.21
	RS-08	-	0.30	0.30	0.03	0.03	0.37	166.27	0.13	0.07	0.33	184.83	1.03	-	0.00	0.63	96.87	0.00	129.57	0.63	581.40	26.83
	RS-09a	-	0.03	0.13	0.00	0.07	0.10	46.13	0.33	0.30	0.27	129.17	0.60	-	0.00	0.70	87.30	0.10	8.87	1.03	275.13	12.70
BCCE	BCCE-01	0.00	-	-	-	-	-	0.50	-	-	-	0.57	0.07	0.00	-	-	0.37	-	0.53	0.37	2.40	0.11
	BCCE-05	0.00	-	-	-	-	-	0.13	-	-	-	0.13	0.00	0.00	-	-	0.27	-	0.20	0.13	0.87	0.04
	BCCE-08	0.03	-	-	-	-	-	5.43	-	-	-	0.07	0.03	0.03	-	-	0.47	-	0.67	0.07	6.80	0.31
	BCCE-12	0.07	-	-	-	-	-	4.57	-	-	-	0.37	0.27	0.17	-	-	0.77	-	0.67	0.17	7.03	0.32
	BCCE-16	0.00	-	-	-	-	-	1.73	-	-	-	0.43	0.00	0.00	-	-	0.37	-	0.30	0.13	2.97	0.14
Total		0.10	0.65	1.13	0.58	0.77	2.59	727.01	1.05	1.07	3.17	618.47	3.72	0.20	0.07	2.93	519.09	0.17	278.25	5.59	2166.59	100.00
Percent Total		0.00	0.03	0.05	0.03	0.04	0.12	33.56	0.05	0.05	0.15	28.55	0.17	0.01	0.00	0.14	23.96	0.01	12.84	0.26	-	-
Percent Total by Species		-	-	0.38	0.19	-	0.86	-	0.35	0.35	1.05	-	1.24	0.07	0.02	0.97	-	0.06	92.59	1.86	-	-

* Refer to Table 3 in the main document for full species names.

APPENDIX B

BAT SPECIES VOUCHER SPECTROGRAMS

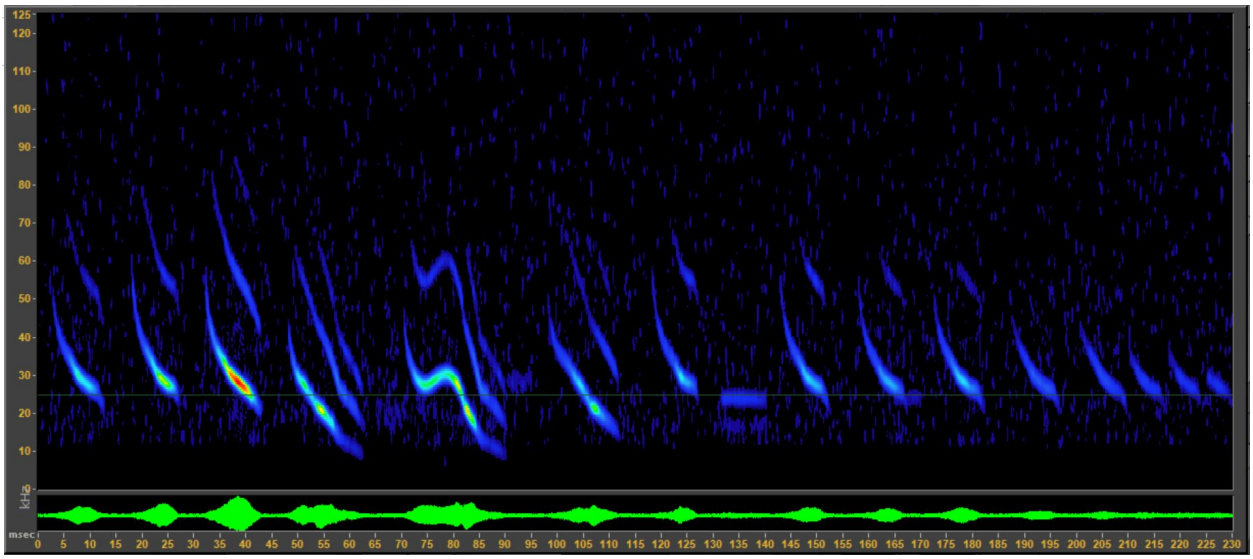

Figure B-1. Pallid bat (*Antrozous pallidus*) spectrogram with social directives, June 3, 2024, BS-11.

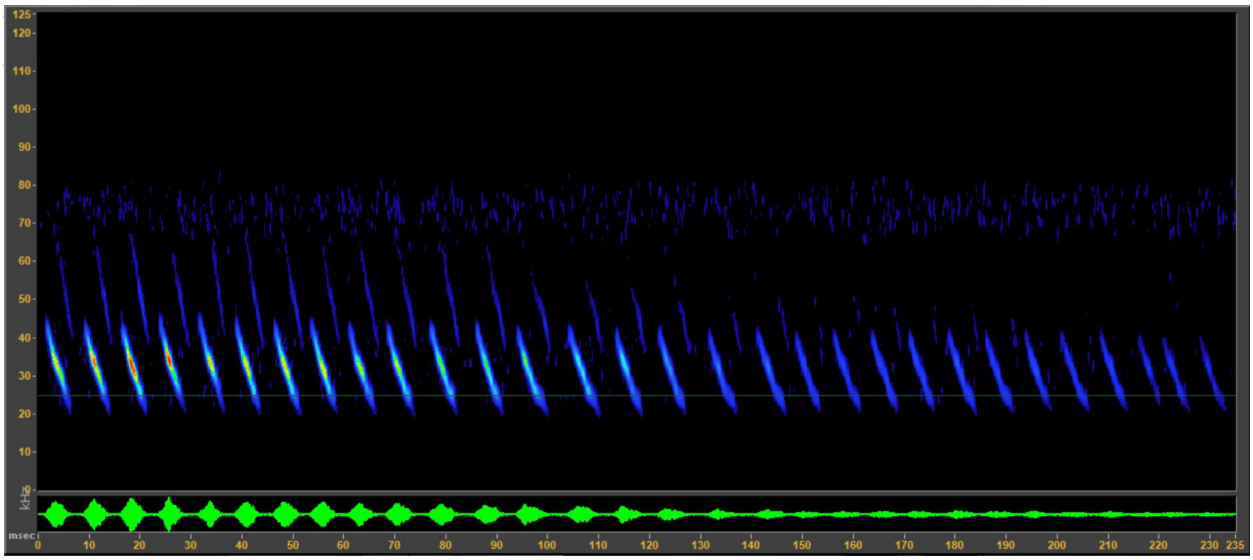

Figure B-2. Townsend's big-eared bat (*Corynorhinus townsendii*) spectrogram, June 18, 2024, MR-04.

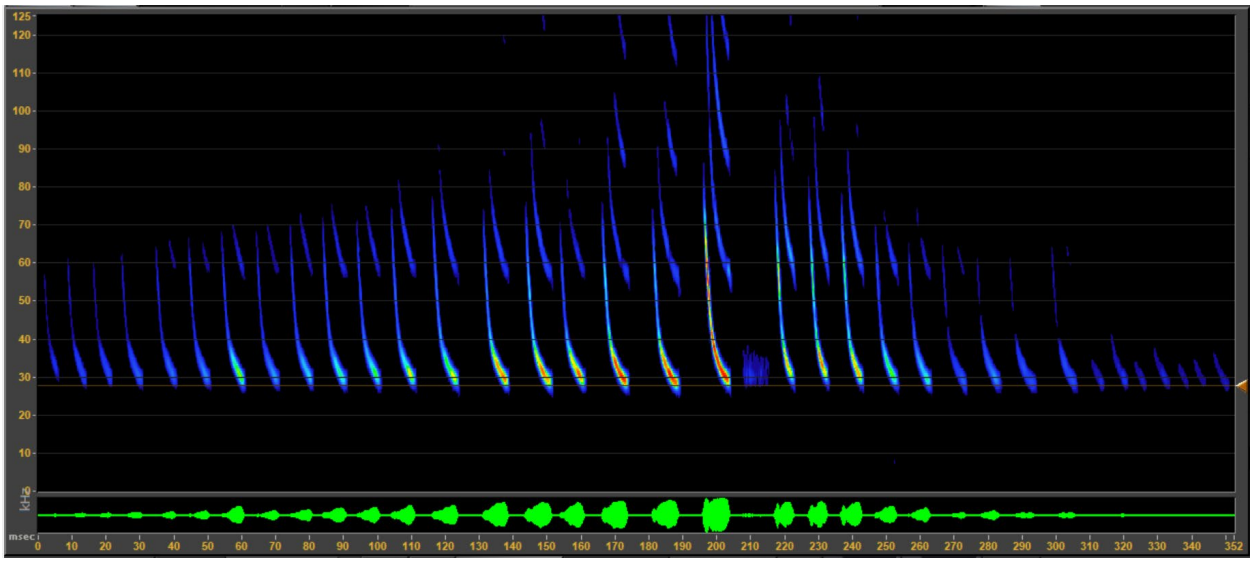

Figure B-3. Big brown bat (*Eptesicus fuscus*) spectrogram, May 28, 2024, BS-11.

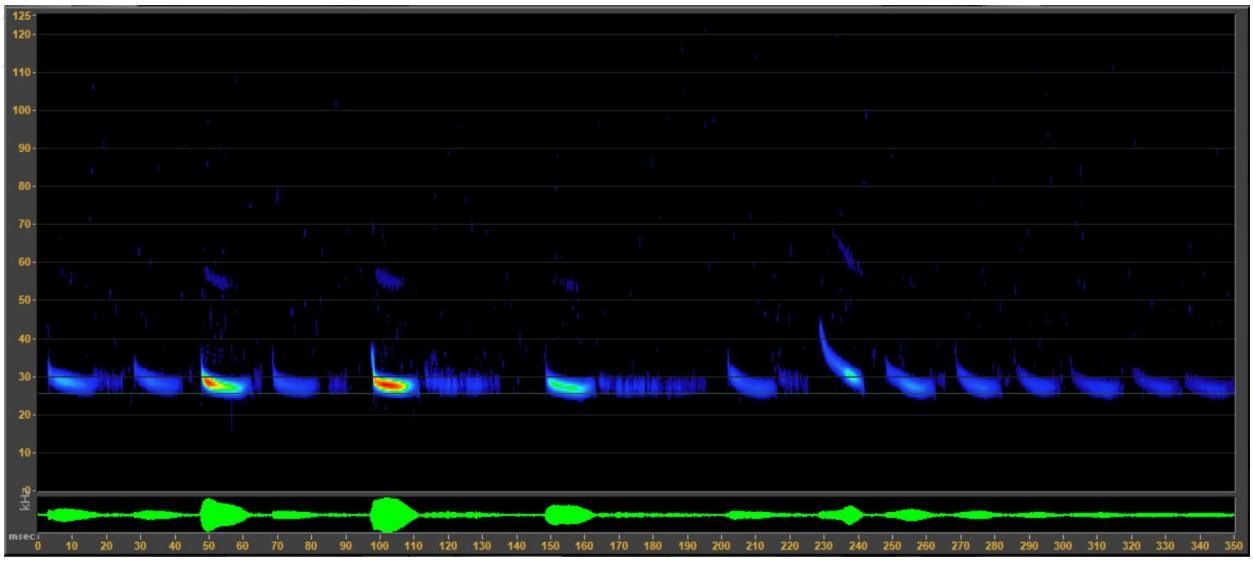

Figure B-4. Silver-haired bat (*Lasionycteris noctivagans*) spectrogram, May 19, 2024, BS-11.

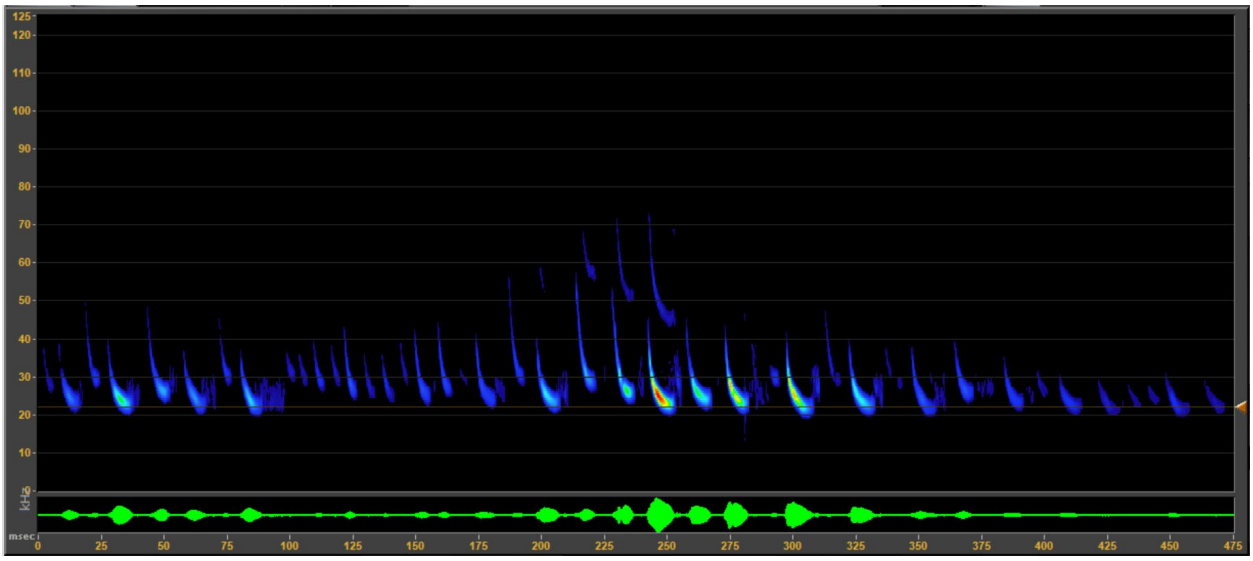

Figure B-5. Hoary bat (*Lasiurus cinereus*) spectrogram, May 22, 2024, BS-11.

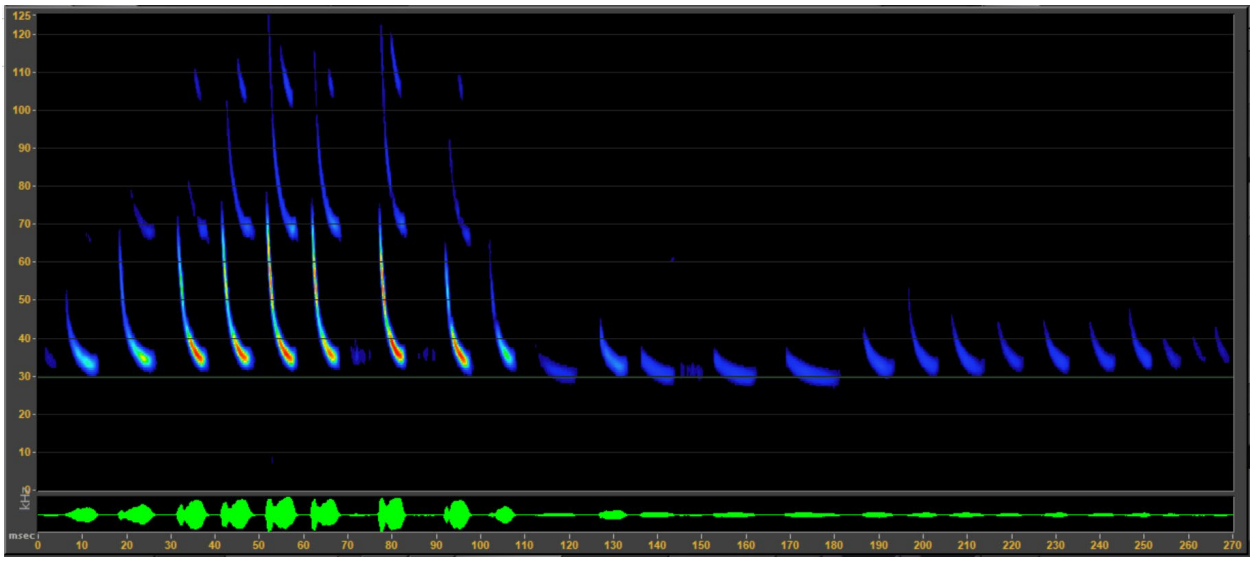

Figure B-6. Western yellow bat (*Lasiurus xanthinus*) spectrogram, May 31, 2024, MR-02.

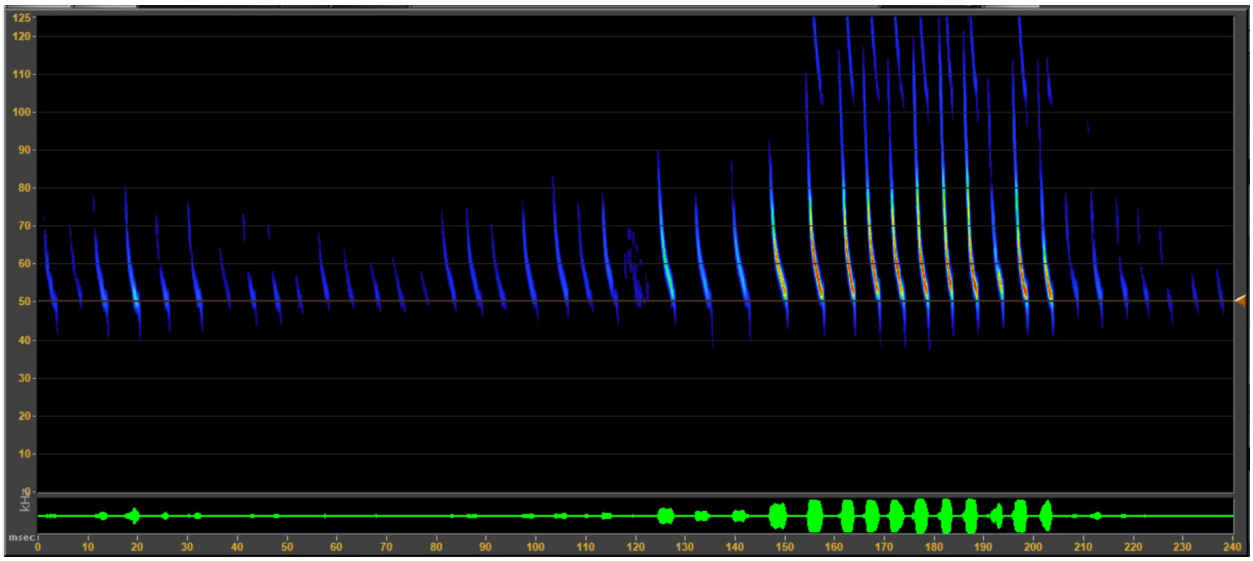

Figure B-7. California myotis (*Myotis californicus*) spectrogram, May 26, 2024, MR-04.

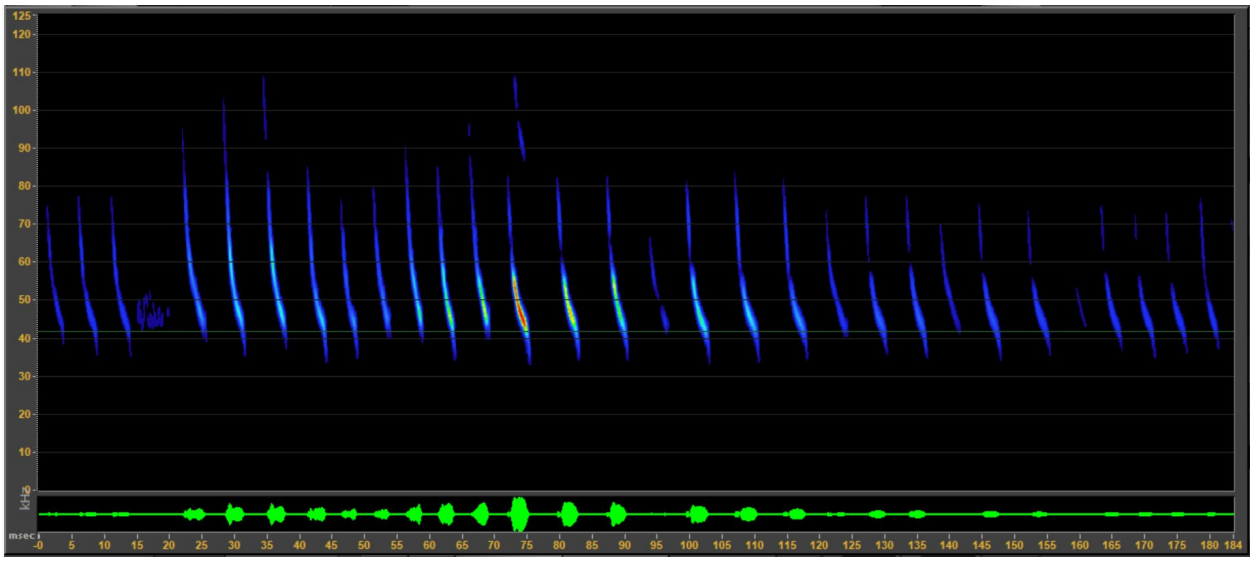

Figure B-8. Western small-footed myotis (*Myotis ciliolabrum*) spectrogram, May 26, 2025, BCCE-12.

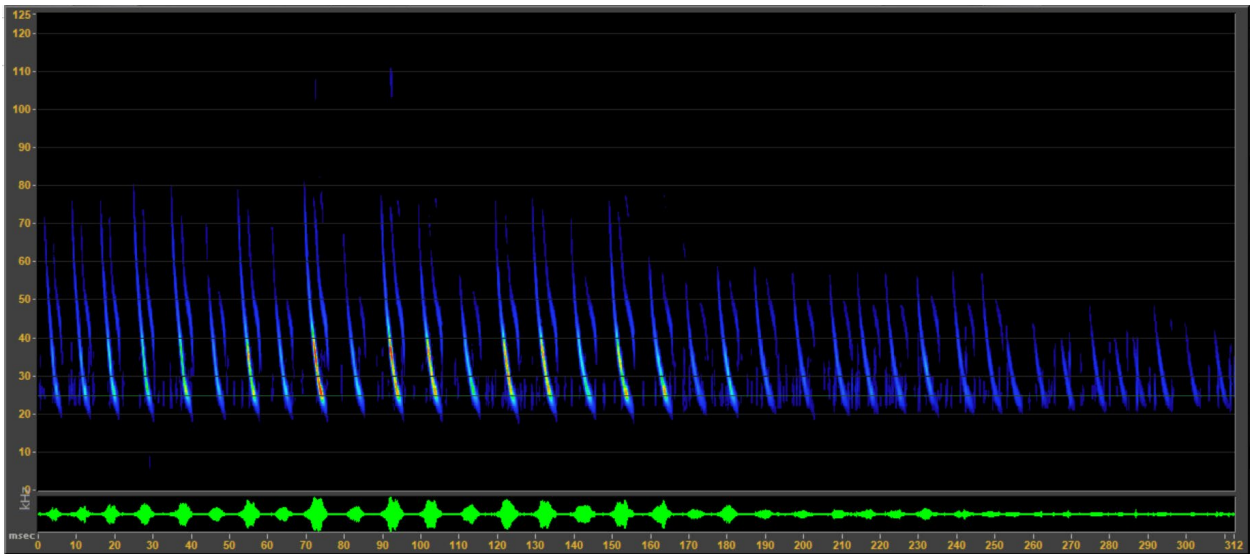

Figure B-9. Fringed myotis (*Myotis thysanodes*) spectrogram, June 13, 2024, MR-04.

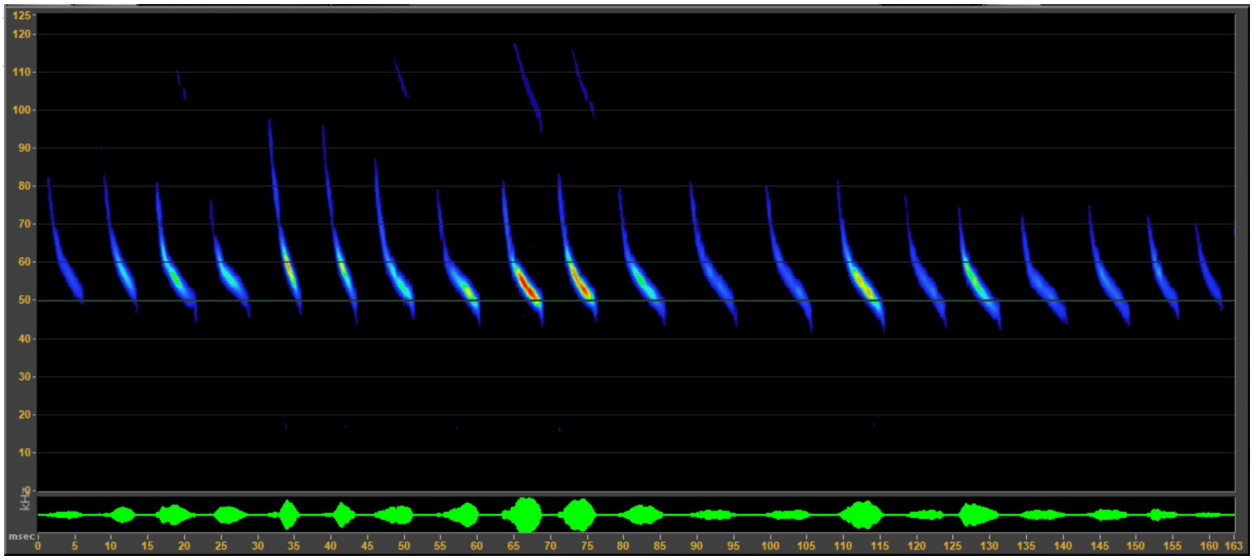

Figure B-10. Yuma myotis (*Myotis yumanensis*) spectrogram, May 16, 2024, BS-11.

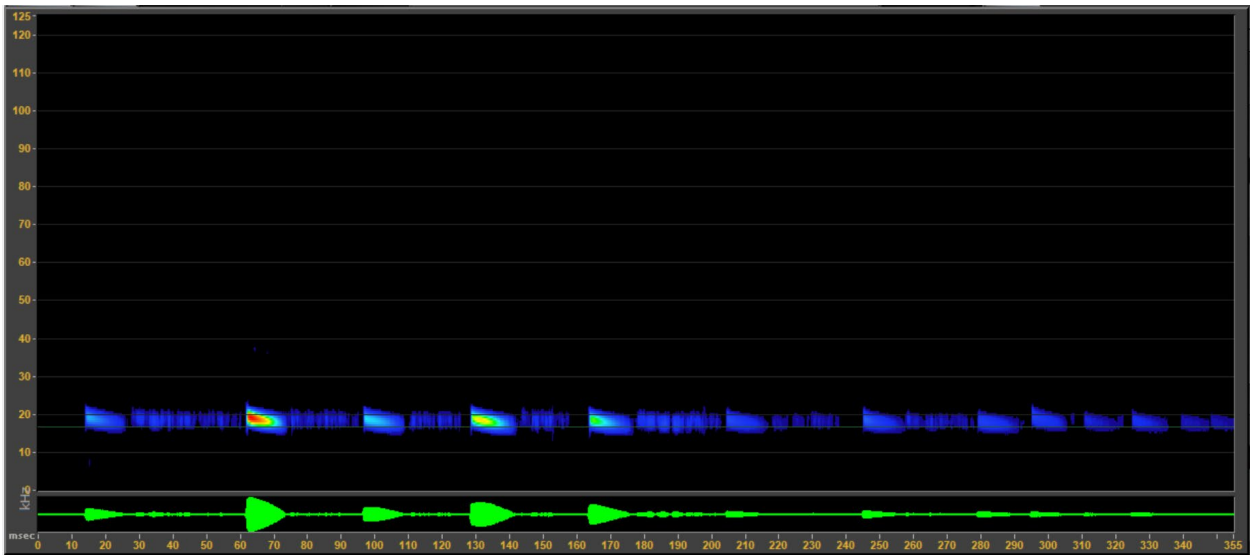

Figure B-11. Pocketed free-tailed bat (*Nyctinomops femorosaccus*) spectrogram, May 27, 2024, BS-11.

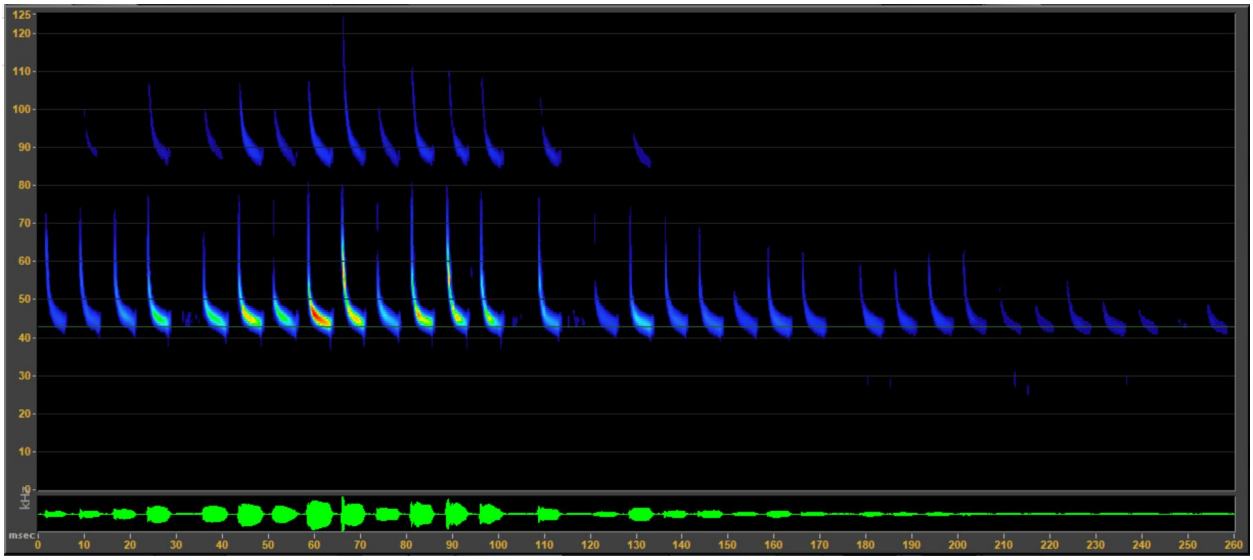

Figure B-12. Canyon bat (*Parastrellus hesperus*) spectrogram, June 3, 2025, BCCE-12.

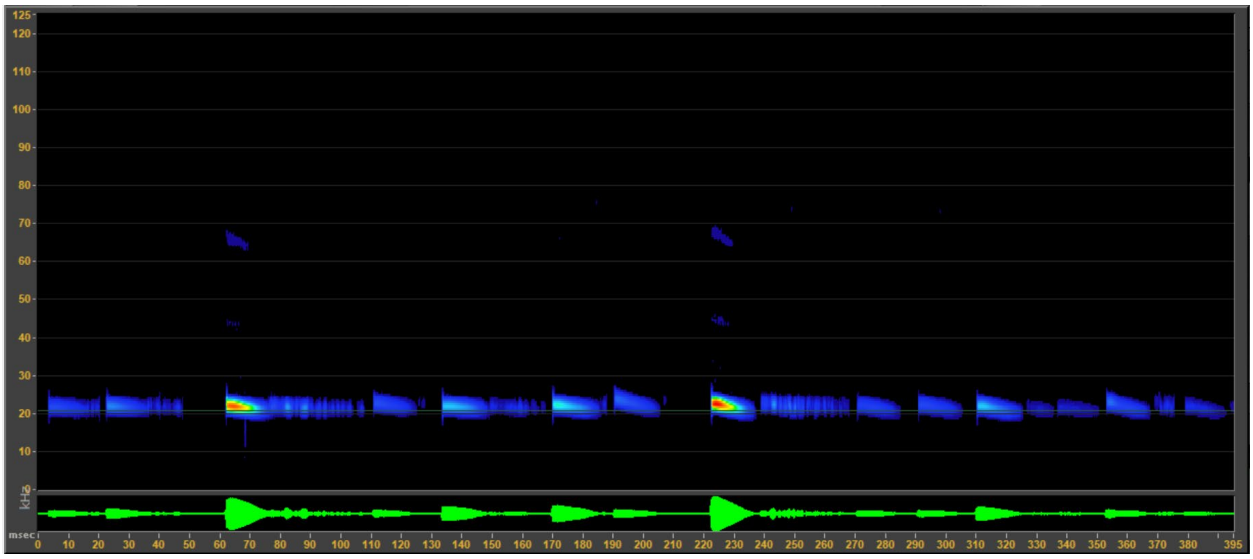

Figure B-13. Brazilian free-tailed bat (*Tadarida brasiliensis*) spectrogram, June 6, 2025, BCCE-12.