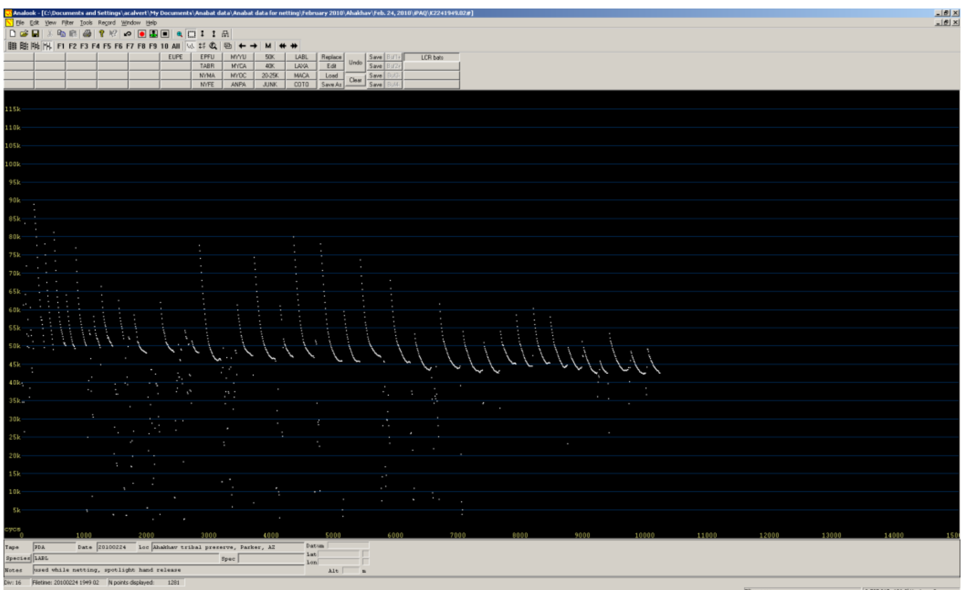
Lower Colorado River
Multi-Species Conservation Program

Balancing Resource Use and Conservation

Monitoring of LCR MSCP Bat Species as Determined by Acoustic Sampling – Summary Findings 2011



U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

October 2012

Lower Colorado River Multi-Species Conservation Program
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Lower Colorado River Multi-Species Conservation Program

Monitoring of LCR MSCP Bat Species as Determined by Acoustic Sampling – Summary Findings 2011

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Multi-Species Conservation Program
Bureau of Reclamation
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Acronyms and Abbreviations

BWRNWR	Bill Williams River National Wildlife Refuge
CNWR	Cibola National Wildlife Refuge
ESA	Endangered Species Act
kb	kilobyte(s)
kHz	kilohertz
LCR	lower Colorado River
LCR MSCP	Lower Colorado River Multi-Species Conservation Program
MLWA	Mittry Lake Wildlife Area
PSRA	Picacho State Recreation Area

Symbols (if any)

%	percent

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ABSTRACT

We deployed four permanent acoustic detector stations along the lower Colorado River (LCR) in order to analyze seasonal and general activity patterns of the western red bat **(***Lasiurus blossevillii)*, western yellow bat (*Lasiurus xanthinus)*, Townsend's big-eared bat *(Corynorhinus townsendii)*, and the California leaf-nosed bat *(Macrotus californicus)*. Our detectors were placed at Bill Williams River National Wildlife Refuge (BWRNWR), Cibola National Wildlife Refuge (CNWR), Picacho State Recreation Area (PSRA), and Mittry Lake Wildlife Area (MLWA). Our detectors collected calls nightly from June 2010 to July, August, September, and October at the four stations. We analyzed calls for the focal species using filtered data that consisted of the total number of calls passing our species-specific filters. We then individually analyzed those calls passing the filters and verified them. We found seasonal activity to be highest in the summer and spring and lowest in the fall and winter. Filtered and verified western red bat activity was found to be highest at BWRNWR. Western yellow bats had the highest filtered and verified activity at MLWA. Townsend's big-eared bat filtered activity was highest at CNWR, but verified activity peaked at PSRA. Filtered California leaf-nosed activity was highest at CNWR, with MLWA seeing the most verified activity. We observed a spike in western yellow bat activity during the winter at the MLWA station, which may indicate a wintering population or an early migratory event.

We also provide recommendations for future acoustic monitoring along the LCR.

INTRODUCTION

This document is a summary of acoustic data collected at four Anabat® stations along the lower Colorado River (LCR). The purpose of this project is to implement conservation measures identified within the LCR Multi-Species Conservation Program (LCR MSCP). The LCR MSCP is a multi-stakeholder Federal and non-Federal partnership responding to the need to balance the use of LCR water resources and the conservation of native species and their habitats in compliance with the Endangered Species Act (ESA). This program works toward the recovery of listed species through habitat and species conservation and reduces the likelihood of additional species listings under the ESA. This project specifically targets conservation measures that address the data gaps necessary to implement the conservation needs for the western red bat (*Lasiurus blossevillii*), western yellow bat (*Lasiurus xanthinus*), Townsend's big-eared bat (*Corynorhinus townsendii*), and California leaf-nosed bat (*Macrotus californicus*). In implementing the conservation measures required for the four focal species, permanent Anabat stations were deployed in 2008 along the LCR as a long-term monitoring methodology. The objective for this project is to continue collecting and analyzing acoustic data from the four permanent stations located at Mittry Lake Wildlife Area (MLWA), Bill Williams River National Wildlife Refuge (BWRNWR), Picacho State Recreation Area (PSRA), and Cibola National Wildlife Refuge (CNWR).

METHODS

Permanent Anabat detectors were deployed in four locations along the LCR in 2008 (figures 1–4). The first station at BWNWR was installed on a ridge overlooking Mosquito Flats along the south side of the Bill Williams River (figure 1). Mosquito Flats is a large area of mature cottonwoods (*Populous fremontii*) and Goodding's willows (*Salix gooddingii*) with salt cedar (*Tamarix* spp.) and mesquite (*Prosopis* spp.) in the understory and along the margins. A small number of California Fan Palms (*Washingtonia filifera*) are also present along the river's edge. The 2004 vegetation classification of the site is CW IV, although there is a diverse mixture of mature cottonwoods, willows, salt cedar, and mesquite, and it would be more accurately classified as class II or III. The station and the microphone were positioned to detect bats flying over the canopy of this dense riparian woodland. The second station was located within CNWR on the Island Unit in a wet, grassy meadow with scattered mature Goodding's willows. Marsh, agricultural fields, and dense stands of mesquite and salt cedar were adjacent to this station. The 2004 vegetation classification is SC IV, but there is a diversity of habitat at and adjacent to the site. The third station was deployed at MLWA, along the southeast shoreline of Mittry Lake, within an area of arrow weed (*Pluchea sericea)*, salt cedar, and mesquite. The microphone is directed toward a patch of mesquite and cottonwoods, with marsh vegetation

Figure 1.—Permanent Anabat station located at BWRNWR.

Figure 2.—Permanent Anabat station located at CNWR.

Figure 3.—Permanent Anabat station located at PSRA.

Figure 4.—Permanent Anabat station located at MLWA.

just beyond. The 2004 classification is SC IV. The final station was located at PSRA just west of the parking area of the lower boat launch. It is on a dirt ridge in a stand comprised of mesquite, salt cedar, and arrow weed. The microphone is aimed toward a cottonwood/willow re-vegetation site that could be classified as CW II. The 2004 classification apparently did not identify the restoration areas at PSRA, as the entire area is classified as SC IV.

These four stations provided an estimate of bat species diversity and presence across time. The three stations consisted of Anabat II detectors with associated ZCAIM, while a single station used an Anabat SD1. Each station also included sensors and a data logger for temperature, wind, and humidity. CF cards at our stations accumulated data at the rate of about 12 megabytes per night during periods of very high bat activity (about 1,500 calls per night, which is about 4 months for the 1-gigabyte cards) that we used. Our visits to the stations were generally more frequent, however, in order to more timely address any maintenance issues. Recording for this analysis began in June 2010 and ended in July to October 2011 at varying sites (table 1). Data from 2008 to June 2010 were analyzed and reported previously (Vizcarra et al. 2010).

Table 1.—Monitoring dates of permanent Anabat detectors along the LCR

Anabat site	Start date	End date	Total nights
BWRNWR	June 3, 2010	October 12, 2011	497
CNWR	June 3, 2010	September 14, 2011	394
PSRA	June 25, 2010	July 20, 2011	376
MLWA	June 18, 2010	August 5, 2011	414
Total			1,681

We quantified the volume of call minutes for western yellow bats, western red bats, Townsend's big-eared bats, and California leaf-nosed bats using the following procedures. Acoustic bat calls were recorded nightly, and calls for the four focal species were processed using filters and methods provided by Susan Broderick (S. Broderick personal communication; Broderick 2008). It was determined in the 2010 final report (Vizcarra et al. 2010) that files above 8 kilobytes (kb) containing recognizable calls were often misidentified by our filters due to the presence of large amounts of interference from insect, vegetation, and electronic noise. Therefore, files larger than 8 kb were omitted from our analysis. After this omission, we ran files through the "All bats" filter designed by Chris Corben. We ran the remaining calls through species-specific filters and analyzed them individually to sort out species with similar call envelopes to the four focal species. We ran western red bats and California leaf-nosed bats through an additional filter because of their similarities with other species. We ran western red bat calls through two species-specific filters (low H and high H), then applied a canyon bat *(Parastrellus hesperus)* filter to clean out the canyon bat calls the western red bat filter initially missed. We applied the high H filter after discussions with Ms. Broderick and Mr. Allen Calvert (personal communication, 2011) revealed they had recorded western red bat calls at higher frequencies along the LCR. We analyzed California leaf-nosed bat calls by running them through a species-specific filter, then applied a high 40–50 kilohertz (kHz) filter to separate calls of California myotis *(Myotis californicus)* and Yuma myotis (*Myotis yumanensis)*. We compared our calls and tested our filters on known reference calls recorded along the LCR provided by Ms. Broderick and Mr. Calvert (personal communication, 2011) and reference calls from across the Southwestern United States.

Townsend's big-eared bats have been classified as a whispering bat, which makes them difficult to identify with an Anabat detector. These bats produce a dual harmonic and were not positively identified unless the presence of this diagnostic harmonic was detected. We used call minutes in order to reduce bias in estimating bat activity at Anabat stations. A call minute was defined as a 1-minute interval in which a particular species is recorded at least once, regardless of the number of call sequences, or the number of files for that species recorded within that minute (Broderick 2010; Brown 2006; Kalcounis et al. 1999). The call minutes index reduces the bias associated with the tendency for individual bats to be detected multiple times or for multiple bats of a single species to be detected within an individual file (Miller 2001; Williams et al. 2006; Vizcarra et al. 2010). We used these Anabat files to determine the potential presence of the four focal species across two scales: all filtered data and verified data within filters. All filtered data consisted of total calls classified within each of the four species filters. These data provided a broad scale of potential presence across months. Verified data consisted of calls definitively categorized as the given species via comparison with reference calls. Verified calls provided a conservative, yet near absolute presence of a given species. We then compared all filtered data and verified data across months.

RESULTS

Overall, the stations functioned well during this reporting period, with a few exceptions. The unit at PSRA recorded a low amount of calls from June 2010 to February 2011. We visited the station in October 2010 and noted the low activity levels, but the unit seemed to be functioning properly. We visited again in March 2011 and noted low activity levels again. This time it was determined that the cable needed to be replaced. The PSRA station also malfunctioned and did not collect data from June 27, 2011, to July 13, 2011. The unit at CNWR also failed to collect data from February 23, 2011 to May 9, 2011. A fire at Cibola on

August 29, 2011, melted most of the external components at the station, though the Anabat and microphone continued to function for another couple of weeks until the battery voltage became too low. The external components were replaced over the next few months. However, the station battery was apparently damaged during the fire, and some additional data were lost as a result. Full function at this station was not restored until January 16, 2012. A total of 586,559 bat call files were recorded at the four permanent stations. A total of 441,550 (75 percent [%]) were usable bat call files. A total of 1,206 (14%) files were omitted for being above 8 kb, and 63,803 (11%) files were filtered out with the "All bats" filter. The station at MLWA recorded a total of 134,493 (23%) files, PSRA recorded 73,640 (13%), BWRNWR recorded 200,592 (34%), and CNWR recorded 177,834 (30%) (table 2). We scaled our species graphs with a logarithmic call minute axis to better differentiate between the relatively low verified minutes and the abundant filtered minutes. Some graphs are scaled up to display verified call minutes that did not show up when only 1 call minute was recorded for an entire month (see appendix 1).

Table 2.—Bat call files recorded at permanent stations

Anabat site	Total files	Usable files	>8 kb	All bats filter
BWRNWR	200,592	170,820 (85%)	16,767 (8%)	13,005 (6%)
CNWR	177,834	140,867 (79%)	3,455 (2%)	33,512 (19%)
PSRA	73,640	40,980 (56%)	19,437 (26%)	13,223 (18%)
MLWA	134,493	88,883 (65%)	41,547 (31%)	4,063 (4%)
Total	586,559	441,450	81,206	63,803

Western Red Bat

We recorded 2,551 call minutes that passed our western red bat and canyon bat filters, resulting in 5.1 call minutes per night at BWRNWR. We verified a total of 276 western red bat call minutes at BWRNWR, for a total of 0.56 call minutes per night (figure 5).

We recorded 1,065 call minutes that passed our western red bat and canyon bat filters, resulting in 2.7 call minutes per night at CNWR. We verified a total of 155 western red bat call minutes at CNWR, for a total of 0.39 call minutes per night (figure 6).

We recorded 326 call minutes that passed our western red bat and canyon bat filters, resulting in 0.9 call minutes per night at PSRA. We verified a total of 16 western red bat call minutes at PSRA, for a total of 0.04 call minutes per night (figure 7).

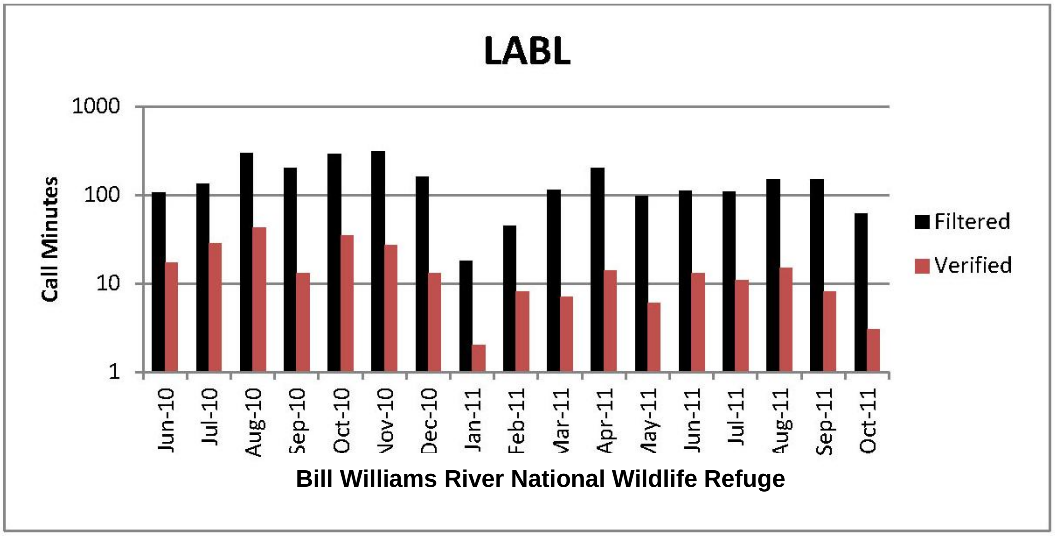

Figure 5.—Western red bat call minutes at BWRNWR.

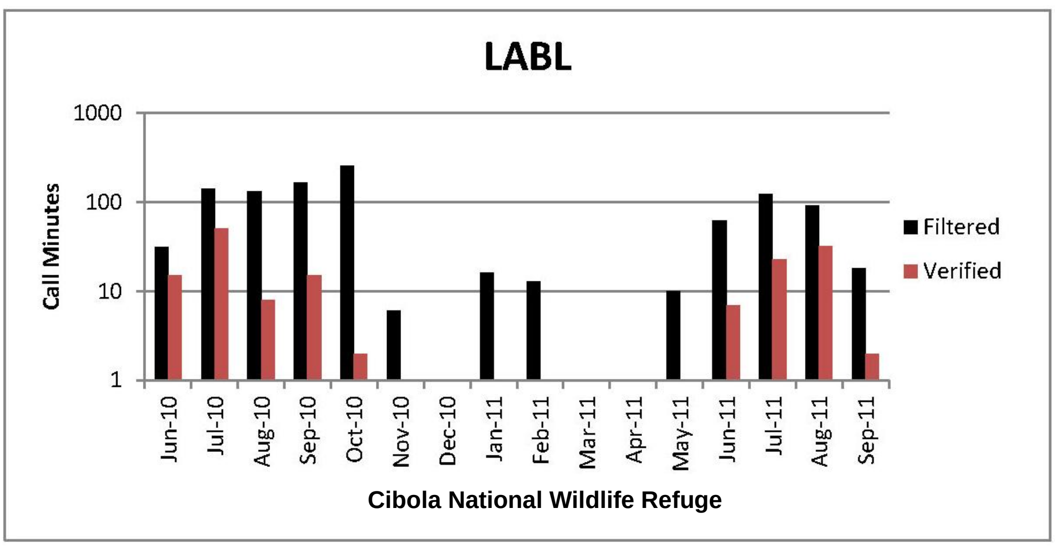

Figure 6.—Western red bat call minutes at CNWR.

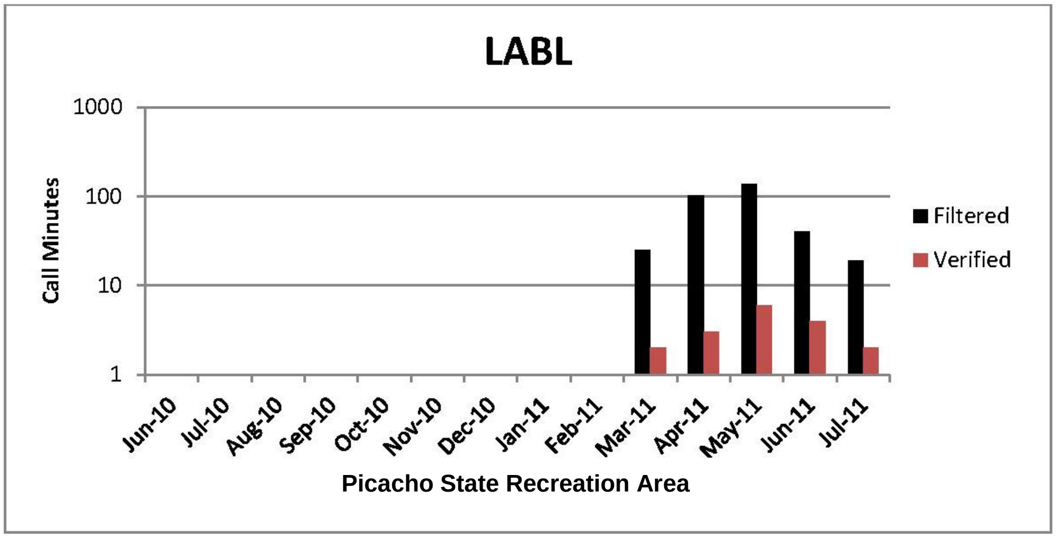

Figure 7.—Western red bat call minutes at PSRA.

We recorded 339 call minutes that passed our western red bat and canyon bat filters, resulting in 0.8 call minutes per night at MLWA. We verified a total of 70 western red bat call minutes at MLWA, for a total of 0.17 western red bat call minutes per night (figure 8). The jump in spring and summer activity indicates an influx of migrants.

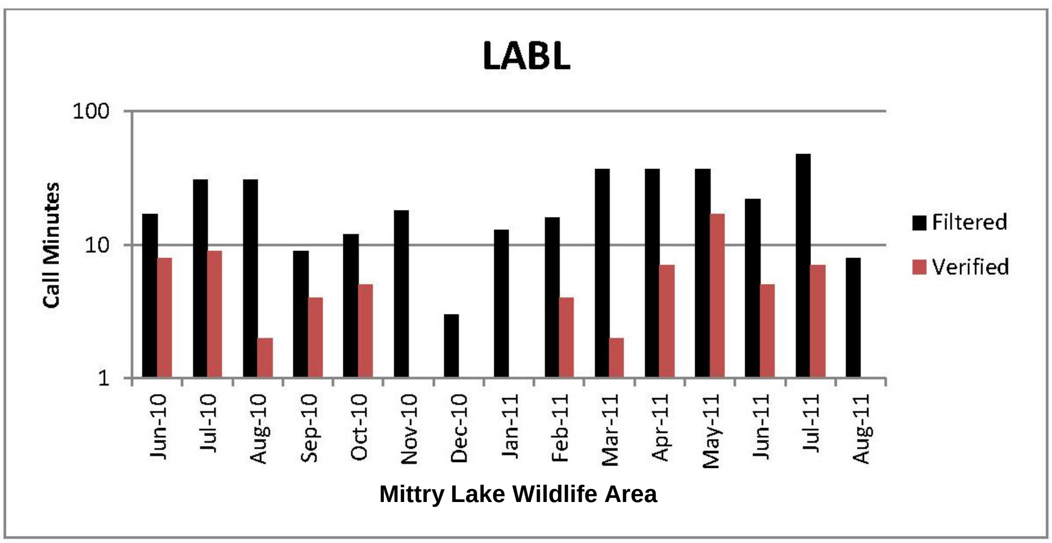

Figure 8.—Western red bat call minutes at MLWA.

Western Yellow Bat

We recorded 2,770 call minutes that passed our western yellow bat filter, resulting in 5.6 call minutes per night at BWRNWR. We verified a total of 124 western yellow bat minutes at BWRNWR, for a total of 0.25 call minutes per night (figure 9).

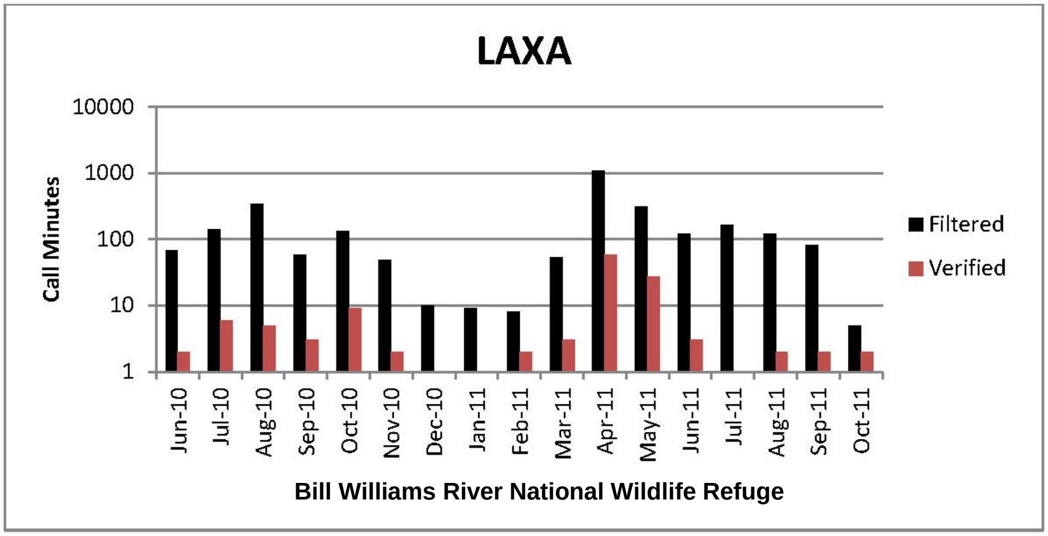

Figure 9.—Western yellow bat call minutes at BWRNWR.

We recorded 1,879 call minutes that passed our species-specific western yellow bat filter, resulting in 4.8 call minutes per night at CNWR. We verified a total of 39 western yellow bat call minutes at CNWR, for a total of 0.1 call minutes per night (figure 10).

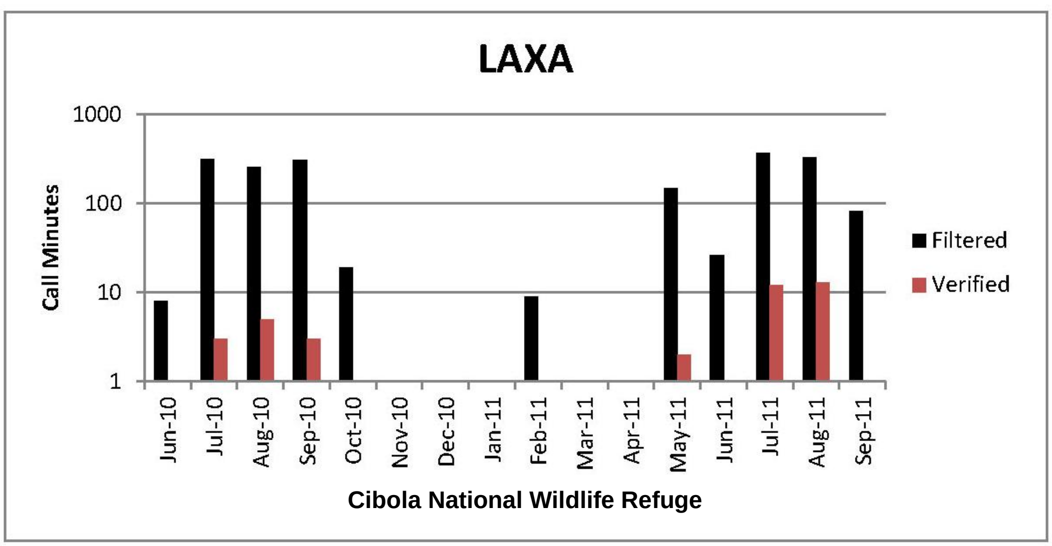

Figure 10.—Western yellow bat call minutes at CNWR.

We recorded 141 call minutes that passed our western yellow bat filter, resulting in 0.4 call minutes per night at PSRA. We verified a total of 2 western yellow bat call minutes PSRA, for a total of 0.005 call minutes per night (figure 11).

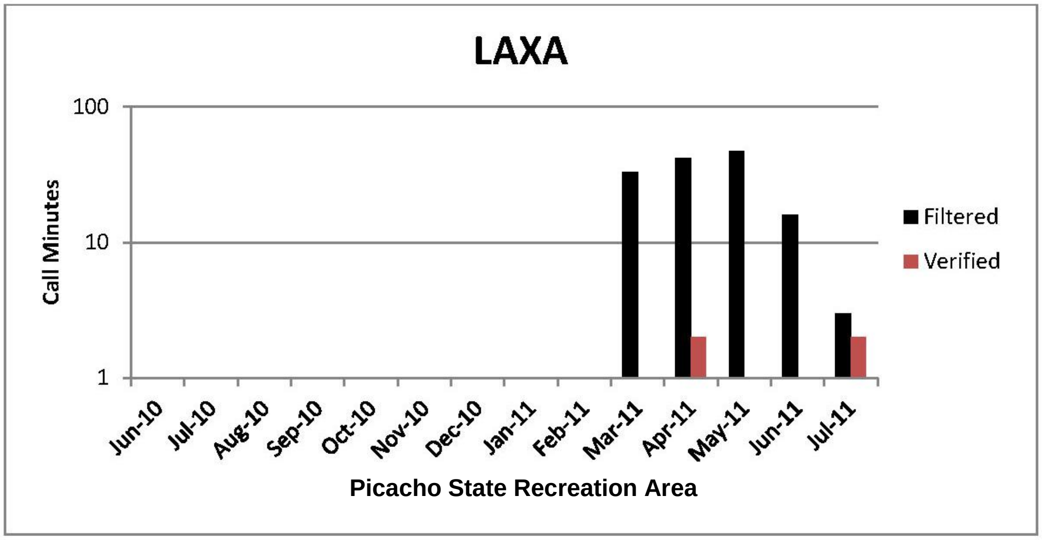

Figure 11.—Western yellow bat call minutes at PSRA.

We recorded 3,331 call minutes that passed our species-specific western yellow bat filter, resulting in 8.0 call minutes per night at MLWA. We verified a total of 148 western yellow bat call minutes at MLWA, for a mean total of 0.36 western yellow bat call minutes per night (figure 12).

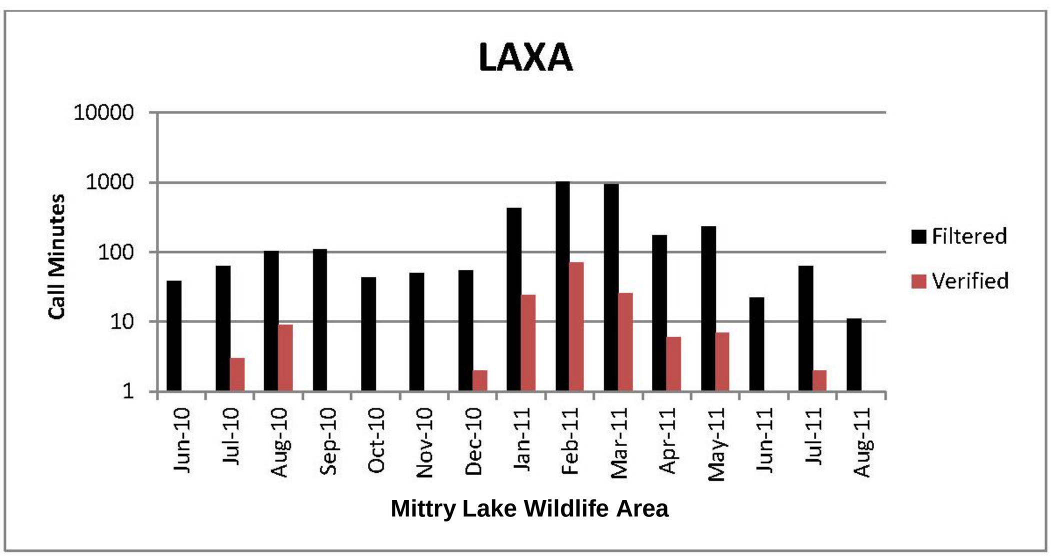

Figure 12.—Western yellow bat call minutes at MLWA.

Townsend's Big-eared Bat

We recorded 9,548 call minutes that passed our Townsend's big-eared bat filter, resulting in 19.2 call minutes per night at BWRNWR. We verified a total of 1 Townsend's big-eared bat call minute at BWRNWR, for a total of 0.002 call minutes per night (figure 13).

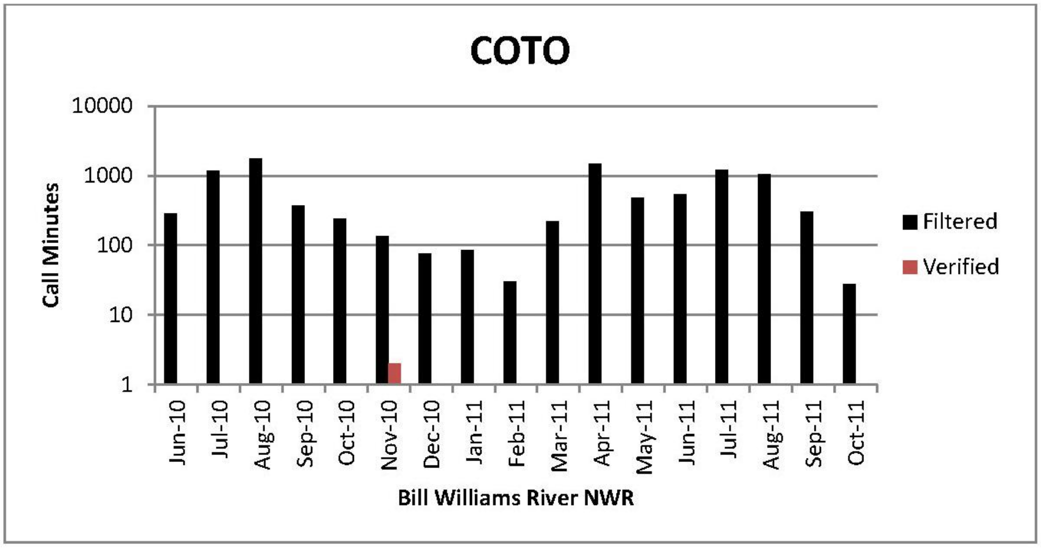

Figure 13.—Townsend's big-eared bat call minutes at BWRNWR.

We recorded 11,810 call minutes that passed the species-specific Townsend's big-eared bat, resulting in 30.0 call minutes per night at CNWR. We verified a total of 0 Townsend's big-eared bat minutes at CNWR, for a total of 0 call minutes per night (figure 14).

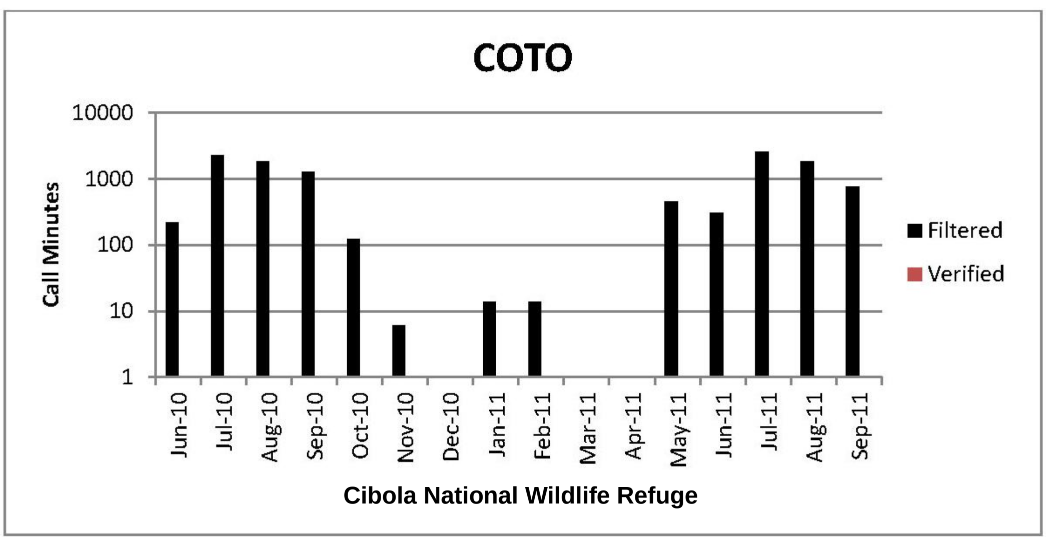

Figure 14.—Townsend's big-eared bat call minutes at CNWR.

We recorded 3,155 call minutes that passed our Townsend's big-eared bat filter, resulting in 8.4 call minutes per night at PSRA. We verified a total of 2 Townsend's big-eared bat call minutes at PSRA, for a total of 0.005 call minutes per night (figure 15).

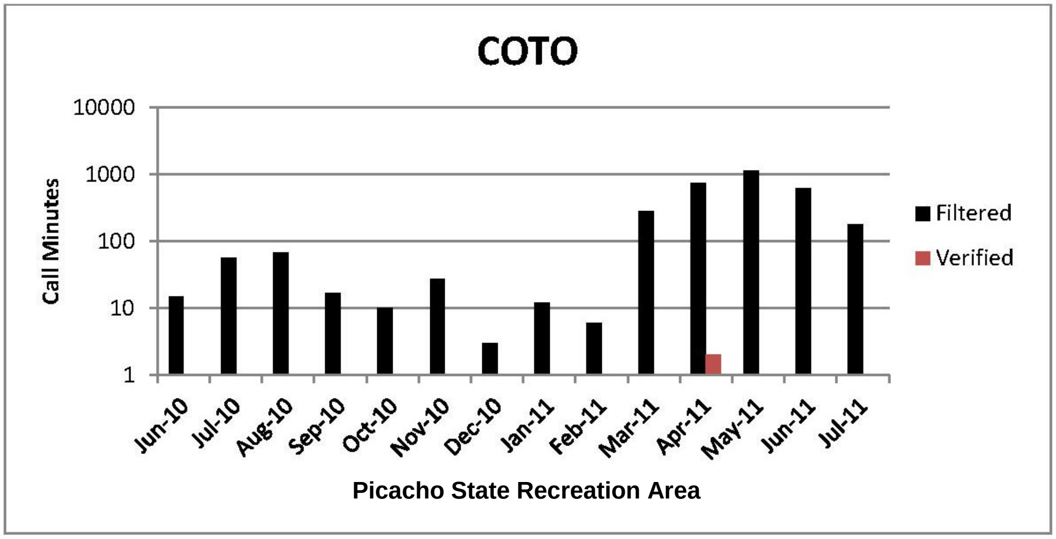

Figure 15.—Townsend's big-eared bat call minutes at PSRA.

We recorded 5,016 call minutes that passed the species-specific Townsend's big-eared bat, resulting in 12.1 call minutes per night at MLWA. We verified a total of 1 Townsend's big-eared bat call minute at MLWA, for a total of 0.002 call minutes per night (figure 16).

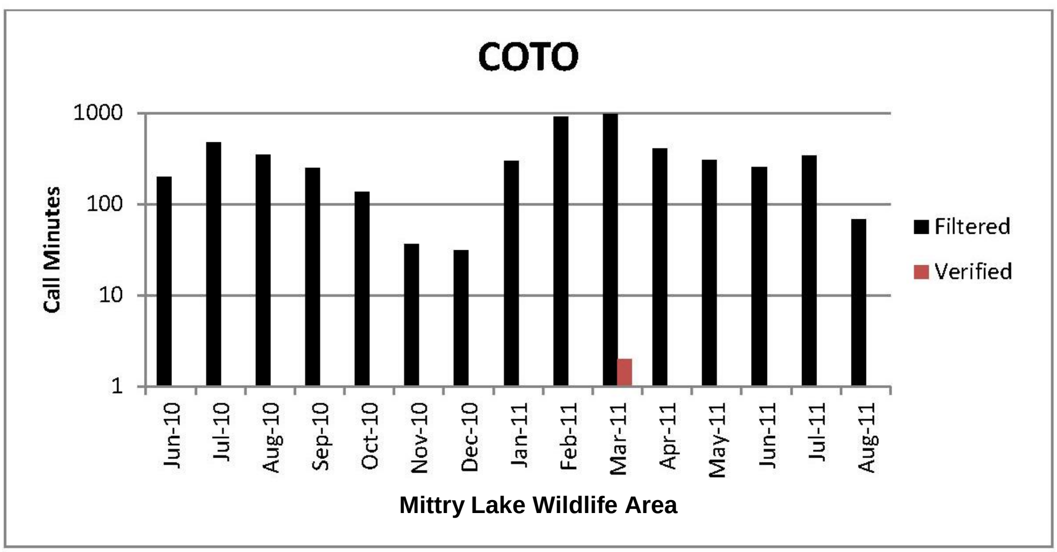

Figure 16.—Townsend's big-eared bat call minutes at MLWA.

California Leaf-nosed Bat

We recorded 20,253 call minutes that passed our California leaf-nosed and high 40–50-kHz filters, resulting in 40.8 call minutes per night at BWRNWR. We verified a total of 5 California leaf-nosed bat call minutes at BWRNWR, for a total of 0.01 call minutes per night (figure 17). We recorded 32,613 call minutes that passed our California leaf-nosed and high 40–50-kHz filters, resulting in 82.8 call minutes per night at CNWR. We verified a total of 17 California leaf-nosed bat minutes at CNWR, resulting in a total of 0.04 call minutes per night (figure 18).

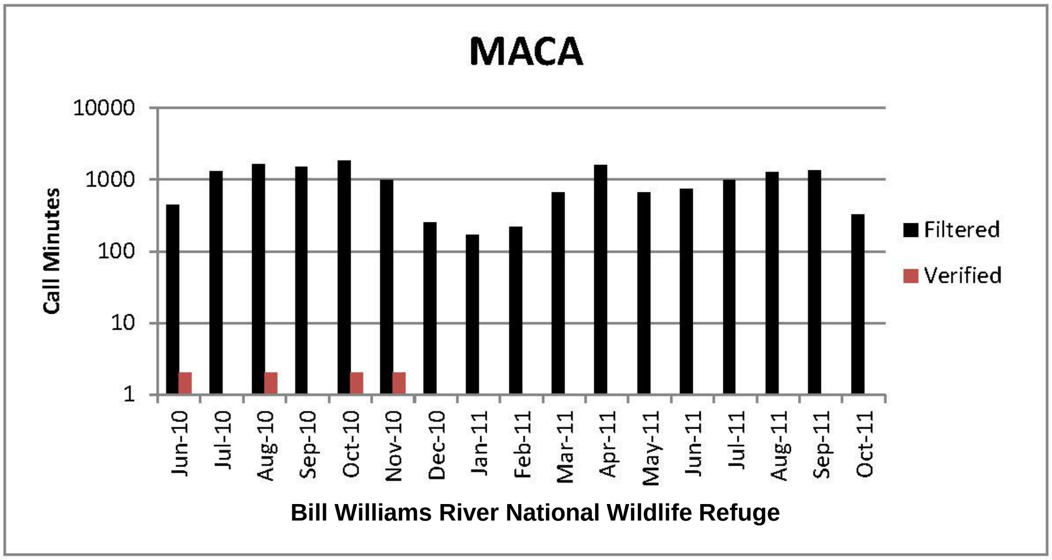

Figure 17.—California leaf-nosed bat call minutes at BWRNWR.

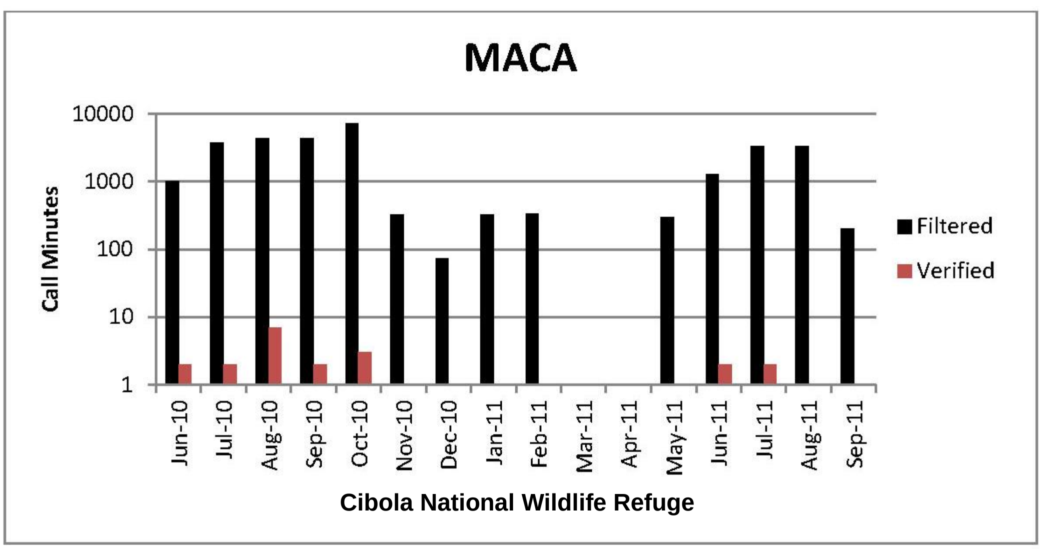

Figure 18.—California leaf-nosed bat call minutes at CNWR.

We recorded 7,221 call minutes that passed our California leaf-nosed and high 40–50-kHz filters, resulting in 19.2 call minutes per night at PSRA. We verified 13 California leaf-nosed bat call minutes at PSRA, for a total of 0.03 call minutes per night (figure 19).

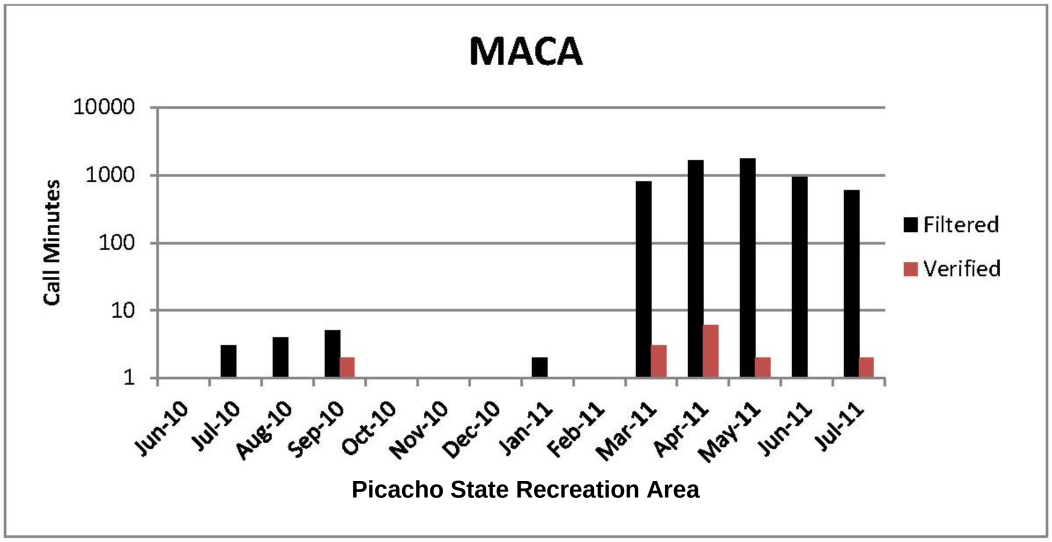

Figure 19.—California leaf-nosed bat call minutes at PSRA.

We recorded 7,947 call minutes that passed our California leaf-nosed and high 40–50-kHz filters, resulting in 19.2 call minutes per night at MLWA. We verified 73 California leaf-nosed bat call minutes at MLWA, for a total of 0.18 call minutes per night (figure 20).

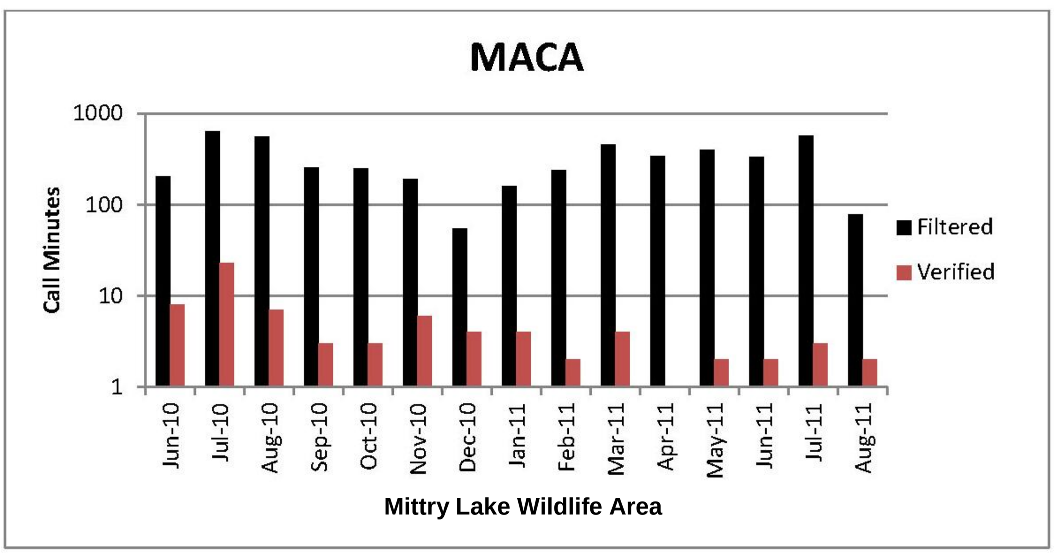

Figure 20.—California leaf-nosed bat call minutes at MLWA.

DISCUSSION

We detected all four focal species at each station using our filtered criteria, but when using the verified criteria, we could not confirm the presence of the Townsend's big-eared bat at CNWR. The discrepancy seen in the high number of filtered call minutes versus our verified call minutes can be attributed to Anabat's inability to distinguish between bats with similar call envelopes and the limits of our filters. Our western red bat and canyon bat filters inevitably led to some California myotis and even canyon bat calls passing the filters. Our western yellow bat filter allowed some big brown bat (*Eptesicus fuscus*) and cave myotis (*Myotis velifer*) calls to be included in our filtered data. The Townsend's big-eared bat filter permitted Pallid bat (*Antrozous pallidus*) calls to be incorporated in our filtered data. Our California leaf-nosed bat and high 40–50-kHz filters had a difficult time filtering out calls from California and Yuma myotis calls. In addition, our permanent stations are all set in riparian areas that contain clutter. Riparian areas are inherently difficult to acoustically monitor bat activity within due to the physical and acoustic properties of clutter (Corben 2006). Separating calls into phonic groups before running focal species filters would have the effect of reducing our filtered data call numbers, but may result in some focal species calls being mislabeled in these phonic groups. The 2011 and 2012 acoustic survey seasons were based on measuring bat use intensity within data at four acoustic stations installed by the Bureau of Reclamation along the LCR. While this intensity measure provides a qualitative comparison of bat activity within the individual stations, it is not quantitatively comparable across the station locations. We propose a third year of acoustic data analysis that will allow for a quantitative comparison across stations. This third year will follow the same data collection and processing as outlined for the first two years. However, we will analyze these data in a presence/absence framework rather than an intensity measure. This framework will allow us to compare bat species assemblages across the four stations using the characteristics of the stations and the vegetative patch they are nested within as covariates. We will use the presence/absence of each of the four LCR MSCP bat species to create a proportion of occupied days within each week. We will then compare these proportions across year, month, and site-specific covariates using ANOVA and Fischer's LSDs.

CNWR had the highest volume of filtered call minutes for the focal species, followed by BWRNWR, MLWA, and PSRA. Verified data volume was highest at BWRNWR, followed by MLWA, CNWR, and PSRA. The highest volume of filtered and verified data was recorded in the spring and summer. We did, however, observe an unexpected spike in western yellow bat activity at MLWA in January, February, and March. Both our filtered and verified data supported the presence of western yellow bats at MLWA in the winter. This is an interesting occurrence, as western yellow bats are thought to be migratory and summer residents at this latitude (Williams 2001; O'Farrell et al. 2004; O'Farrell 2006). These observations indicate the presence of a wintering population of western yellow bats at MLWA or an early migration event. A previous study conducted on the LCR also indicates cold season western yellow bat activity at MLWA and Imperial National Wildlife Refuge (Vizcarra et al. 2010).

We found filtered western red bat activity documented by call minutes per night was highest at BWRNWR, followed by CNWR, PSRA, and MLWA; other studies documented a similar pattern (Vizcarra et al. 2010). Filtered seasonal activity was generally lowest in the winter and highest in the summer and fall. This was true for BWRNWR and CNWR, but MLWA had higher activity in summer and spring. Our verified seasonal activity was in line with our filtered activity. Broderick (2008) acoustically sampled along the LCR using temporary stations to assess seasonal use of the habitat creation areas and found western red bat activity to be highest in the summer. Broderick (2010) also found seasonal activity to be highest in the summer and fall.

We recorded the highest filtered western yellow bat activity at MLWA, followed by BWRNWR, CNWR, and PSRA. Vizcarra et al. (2010) reported like results for western yellow bat activity with call minutes per night. Once again, our verified call minutes agreed with the filtered call minutes. MLWA had the highest western yellow bat activity, followed by BWRNWR, CNWR, and PSRA. Filtered seasonal activity was generally highest in the summer, with the spike in the late winter/early spring activity at MLWA. Activity was lowest in the winter at BWRNWR and CWNWR. Our verified data fit this same activity pattern with the exception of western yellow bat activity peaking at BWRNWR in the spring. Broderick (2008, 2010) also noted these western yellow bat seasonal activity patterns.

We recorded the highest filtered Townsend's big-eared bat activity at CNWR, followed by BWRNWR, MLWA and PSRA. A previous study noted similar trends with the exception of higher Townsend's big-eared bat use at BWRNWR than CNWR (Vizcarra et al. 2010). The short duration, broken nature, and frequency modulated call of Townsend's big-eared bat make this species difficult to detect with acoustic methods. Thus, our verified calls make up a very small portion of the filtered calls due to this detection difficulty. PSRA saw the most Townsend's big-eared bat activity with 2 verified minutes. MLWA and BWRNWR had 1 verified minute each, and CNWR had 0 verified minutes. Trapping conducted by J. Diamond (Diamond and Mixan in press) in 2011 and 2012 produced captures of Townsend's big-eared bats in the winter at BWRNWR and at restoration sites at 'Ahakhav Tribal Preserve and Havasu National Wildlife Refuge along the LCR. Summer captures were made at BWRNWR and Ahakhav Tribal Preserve (A. Calvert, personal communication). Filtered seasonal activity was higher in the spring and summer than in the fall and winter. Our verified activity consisted of 4 call minutes recorded in the spring and fall. Broderick (2008, 2010) had similar activity patterns in the spring and summer, detecting a single Townsend's big-eared bat call.

Filtered California leaf-nosed bat activity was highest at CNWR, followed by BWRNWR, MLWA and PSRA. In contrast, Vizcarra et al. (2010) found the highest activity at BWRNWR, followed by MLWA, CNWR, and PSRA. Our filtered call minutes did not match our verified call minutes with MLWA, seeing the most activity, followed by CNWR, PSRA, and BWRNWR. Trapping conducted by Diamond (Diamond and Mixan in press) at Imperial National Wildlife Refuge, which is in close proximity to MLWA, produced the most captures of California leaf-nosed bats compared to five other sample sites along the LCR. California leaf-nosed bat call envelopes overlap with California myotis and Yuma myotis, which can make it difficult for the filters to distinguish between them. If there was high activity by Yuma or California myotis at CNWR and BWRNWR, this could explain why our filtered and verified data do not match up. Filtered seasonal activity was highest in the summer, followed by the fall. Winter had the lowest seasonal activity. Our verified data also fit this pattern. Broderick (2008) documented California leaf-nosed bat activity to be highest in the spring and fall, followed by the summer. We recorded similar activity patterns to Broderick (2010), with summer seeing the most activity.

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APPENDIX 1

Verified and Filtered Call Minutes for the Focal Species per Site

Table 1.—Filtered and verified focal species call minutes – BWNWR

Call minutes	LABL	LAXA	COTO	MACA
Filtered	2,551	2,770	9,548	20,253
Verified	276	124	1	5

Table 2.—Filtered and verified focal species call minutes – CNWR

Call minutes	LABL	LAXA	COTO	MACA
Filtered	1,065	1,879	11,810	32,613
Verified	155	39	0	17

Table 3.—Filtered and verified focal species call minutes – PSRA

Call minutes	LABL	LAXA	COTO	MACA
Filtered	326	141	3,155	7,221
Verified	16	2	2	13

Table 4.—Filtered and verified focal species call minutes – MLWA

Call minutes	LABL	LAXA	COTO	MACA
Filtered	339	3,331	5,016	7,947
Verified	70	148	1	73