Lower Colorado River Multi-Species Conservation Program

Balancing Resource Use and Conservation

Post-Development Acoustic Monitoring of LCR MSCP Bat Species

2018 Annual Report

BUREAU OF RECLAMATION

December 2019

Work conducted under LCR MSCP Work Task F4

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U.S. Fish and Wildlife Service
National Park Service
Bureau of Land Management
Bureau of Indian Affairs
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The Nature Conservancy

Lower Colorado River Multi-Species Conservation Program

Post-Development Acoustic Monitoring of LCR MSCP Bat Species

2018 Annual Report

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Multi-Species Conservation Program
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ACRONYMS AND ABBREVIATIONS

AKTP	‘Ahakhav Tribal Preserve
AKTP 1	‘Ahakhav Tribal Preserve acoustic monitoring station #1
ANPA	pallid bat *(Antrozous pallidus*)
BLCA	Beal Lake Conservation Area
BLCA 1	Beal Lake Conservation Area acoustic monitoring station #1
Cibola NWR Unit #1	Cibola National Wildlife Refuge Unit #1 conservation area
CLNB	California leaf-nosed bat (*Macrotus californicus*)
Crane Roost	Cibola National Wildlife Refuge Unit #1 acoustic monitoring station
CVCA	Cibola Valley Conservation Area
CVCA 1	Cibola Valley Conservation Area acoustic monitoring station #1
CVCA 2	Cibola Valley Conservation Area acoustic monitoring station #2
EPFU	big brown bat (*Eptesicus fuscus*)
EUMA	spotted bat (*Euderma maculatum*)
EUPE	western mastiff bat (*Eumops perotis*)
HH 1	Hunters Hole acoustic monitoring station #1
i.e.	*id est*; that is
LACI	hoary bat (*Lasiurus cinereus*)
LCR	lower Colorado River
LCR MSCP	Lower Colorado River Multi-Species Conservation Program
MYCA	California myotis (*Myotis californicus*)
MYOC	Arizona myotis (*Myotis occultus*)
MYYU	Yuma myotis (*Myotis yumanensis*)
PAHE	canyon bat (*Parastrellus hesperus*)
PTBB	pale Townsend’s big-eared bat (*Corynorhinus townsendii* also known as *Plecotus townsendii pallescens* and *Corynorhinus townsendii townsendii*)
PVER	Palo Verde Ecological Reserve
PVER 1	Palo Verde Ecological Reserve acoustic monitoring station #1
PVER 2	Palo Verde Ecological Reserve acoustic monitoring station #2
Reclamation	Bureau of Reclamation
TABR	Mexican free-tailed bat (*Tadarida brasiliensis*)
WRBA	western red bat (*Lasiurus blossevillii*)
WYBA	western yellow bat (*Lasiurus xanthinus*)
YEW	Yuma East Wetlands
YEW 1	Yuma East Wetlands acoustic monitoring station #1

Symbols

%	percent

CONTENTS

Page

Executive Summary ES-1

Introduction 1
Study Area 2
Methods 12
Data Collection Methods 12
Analook Visual Verification Methods 13
Kaleidoscope Auto-Classifier Methods 13
Activity and Occupancy 14
Results 15
Analook Visual Verification Results 15
Western Red Bat 15
Western Yellow Bat 20
California Leaf-nosed Bat 25
Pale Townsend's Big-eared Bat 29
Verified Call Results Yearly Comparison at All Post-Development Stations 29
Kaleidoscope Auto-Classifier Results 31
Western Red Bat 31
Pale Townsend's Big-eared Bat 34
Other Species 36
Discussion 44
Western Red Bat 45
Western Yellow Bat 46
California Leaf-nosed Bat 47
Pale Townsend's Big-eared Bat 48
Other Species 48
Literature Cited 51

Tables

Table Page

1 Station name, acronym, number of nights recorded during the sampling period, and year of station deployment 12
2 Western red bat detections in 2015, 2016, 2017, and 2018 16
3 Western yellow bat detections in 2015, 2016, 2017, and 2018..... 20
4 California leaf-nosed bat detections in 2015, 2016, 2017, and 2018..... 25
5 Number of western red bat calls detected by the Kaleidoscope auto-classifier, Analook filter, and visual verification in 2018..... 32
6 Number of pale Townsend's big-eared bat calls detected by the Kaleidoscope auto-classifier, Analook filter, and visual verification..... 34

Figures

Figure Page

1 Study area and location of acoustic monitoring stations. 3
2 The 'Ahakhav Tribal Preserve acoustic monitoring station (AKTP 1). 4
3 The BLCA acoustic monitoring station (BLCA 1). 5
4 The Cibola NWR Unit #1 original bat acoustic monitoring station location (CNU 1) and current location (Crane Roost). 6
5 The CVCA acoustic monitoring stations (CVCA 1 and CVCA 2). 8
6 The Hunters Hole acoustic monitoring station (HH 1). 9
7 The PVER acoustic monitoring stations (PVER 1 and PVER 2)..... 10
8 The Yuma East Wetlands acoustic monitoring station (YEW 1)..... 11
9 Western red bat average nightly call minutes station comparison..... 19
10 Western red bat proportion of nights occupied station comparison..... 19
11 Western yellow bat average nightly call minutes station comparison. 24
12 Western yellow bat proportion of nights occupied station comparison. 24
13 California leaf-nosed bat average nightly call minutes station comparison..... 28
14 California leaf-nosed bat proportion of nights occupied station comparison..... 28
15 Western red bat verified call results across all post-development stations..... 29
16 Western yellow bat verified call results across all post-development stations..... 30
17 California leaf-nosed bat verified call results across all post-development stations..... 31
18 Western red bat Kaleidoscope results station comparison..... 33
19 Pale Townsend's big-eared bat activity Kaleidoscope results station comparison..... 35

Figures (continued)

Figure Page

20 Pale Townsend's big-eared bat occupancy Kaleidoscope results station comparison. 35
21 Kaleidoscope results for 2015, 2016, 2017, and 2018 at AKTP 1. 36
22 Kaleidoscope results for 2015, 2016, 2017, and 2018 at BLCA 1. 37
23 Kaleidoscope results for 2015, 2016, 2017, and 2018 at Crane Roost. 38
24 Kaleidoscope results for 2015, 2016, 2017, and 2018 at CVCA 1. 39
25 Kaleidoscope results for 2015, 2016, 2017, and 2018 at CVCA 2. 40
26 Kaleidoscope results for 2015, 2016, 2017, and 2018 at HH 1. 41
27 Kaleidoscope results for 2015, 2016, 2017, and 2018 at PVER 1. 42
28 Kaleidoscope results for 2015, 2016, 2017, and 2018 at PVER 2. 43
29 Kaleidoscope results for 2015, 2016, 2017, and 2018 at YEW 1. 44

Attachments

Attachment

1 Monthly Activity and Occupancy
2 Station Malfunctions

EXECUTIVE SUMMARY

Acoustic bat call data were analyzed from nine acoustic monitoring stations (Anabat™) along the lower Colorado River from June 1 to August 31, 2015–18. These stations were located within six Lower Colorado River Multi-Species Conservation Program (LCR MSCP) conservation areas (Beal Lake Conservation Area [BLCA], Palo Verde Ecological Reserve [PVER], Cibola Valley Conservation Area [CVCA], Cibola National Wildlife Refuge Unit #1 Conservation Area, Yuma East Wetlands [YEW], and Hunters Hole) and one additional habitat creation site ('Ahakhav Tribal Preserve) that consist of Fremont cottonwood-Goodding's willow (*Populus fremontii-Salix gooddingii*), honey mesquite (*Prosopis glandulosa*), marsh, and backwater habitats. The acoustic recordings were analyzed with the Analook Zero-Crossings Analysis using call filters (with visual verification method) for the calls of four bat species for which habitat and/or conservation actions are being implemented by the LCR MSCP: western red bat (*Lasiurus blossevilli*), western yellow bat (*Lasiurus xanthinus*), California leaf-nosed bat (*Macrotus californicus*), and pale Townsend's big-eared bat[1] (*Corynorhinus townsendii pallescens* also known as *Plecotus townsendii pallescens* and *Corynorhinus townsendii townsendii*). The acoustic recordings were also analyzed for the calls of the western red bat, pale Townsend's big-eared bat, and 10 additional bat species using the Kaleidoscope auto-classifier (Kaleidoscope Pro version 4.3.1) in order to compare the effectiveness of this software at detecting and distinguishing bat species along the lower Colorado River against the Analook Zero-Crossings Analysis using call filters (with visual verification method). In addition to documenting species presence, the project documents the variation in bat activity across time and space to inform LCR MSCP habitat credit accomplishments and habitat management.

Western red bats, western yellow bats, and California leaf-nosed bats were detected at least once at all Anabat™ acoustic monitoring stations from 2015 through 2018. The only pale Townsend's big-eared bat call detected with the Analook visual verification method at any location from 2015 through 2018 occurred at CVCA 2 in August 2017. Activity (presented as average nightly call minutes) and occupancy (presented as proportion of nights occupied) varied among monitoring sites, years, and species. Through the Analook visual verification method, western red bats were recorded with the greatest activity at PVER 1, western yellow bats at CVCA 1, and California leaf-nosed bats at CVCA 2. Western red bat activity and occupancy stayed relatively stable from 2015 through 2018. Western yellow bat activity and occupancy dropped substantially after 2015, remained similar in 2016 and 2017, and dropped again in 2018. California leaf-nosed bat activity and occupancy increased in 2017 and 2018 from 2015 and 2016 levels.

[1] Genetic analyses on the pale Townsend's big-eared bat indicate that the lower Colorado River is likely in the range of the Pacific Townsend's big-eared bat (*Corynorhinus townsendii townsendii*) rather than the pale Townsend's big-eared bat (Piaggio and Perkins 2005). The bats recorded along the lower Colorado River will be referred to as pale Townsend's big-eared bats in this report, as the nomenclature change has not yet been verified by the U.S. Fish and Wildlife Service.

Pale Townsend's big-eared bat activity was only detected with the Analook visual verification method at one conservation area: the CVCA (CVCA 2) due to the quiet nature of their calls but was recorded to have the greatest number of calls at YEW 1 during the reporting period June – August 2015–18, using the Kaleidoscope auto-classifier. The Kaleidoscope auto-classifier for pale Townsend's big-eared bats showed promising results compared with the Analook filters and may lead to more efficient processing of these calls. The Analook filters marked 74,663 files as potential pale Townsend's big-eared bat calls, while the Kaleidoscope auto-classifier identified 514 calls. The Kaleidoscope auto-classifier likely overestimated activity for western red bats (62,375) and marked more potential calls than the Analook filters (53,036). Activity and occupancy for LCR MSCP species and other species assessed with the Kaleidoscope auto-classifier were recorded at the greatest levels at the largest, most mature and complex conservation areas and at the additional habitat creation site ('Ahakhav Tribal Preserve).

INTRODUCTION

This document is a summary of acoustic bat call data collected at nine acoustic monitoring stations (Anabat™) in six Lower Colorado River Multi-Species Conservation Program (LCR MSCP) conservation areas (Beal Lake Conservation Area [BLCA], Palo Verde Ecological Reserve [PVER], Cibola Valley Conservation Area [CVCA], Cibola National Wildlife Refuge Unit #1 Conservation Area [Cibola NWR Unit #1], Yuma East Wetlands [YEW], and Hunters Hole) and one additional habitat creation site ('Ahakhav Tribal Preserve [AKTP]) along the lower Colorado River (LCR). The purpose of this project is to monitor the presence of bat species for the LCR MSCP. In addition to documenting species presence, the project documents the variation in bat activity across time and space to inform LCR MSCP habitat credit accomplishments and habitat management.

Acoustic sampling is an effective and economical means to monitor bat populations. Analyses of recordings from ultrasonic bat detectors are now widely applied when assessing bat distribution and activity over a range of temporal scales in various landscape contexts. Two methods were used for identifying bat acoustic calls recorded: the Analook Zero-Crossings Analysis using call filters (with visual verification method) and the Kaleidoscope auto-classifier (Kaleidoscope Pro version 4.3.1). Activity (presented as average nightly call minutes) and occurrence (presented as proportion of nights occupied) estimates were calculated for the 2 covered species (western red bat [*Lasiurus blossevilli*] and western yellow bat [*Lasiurus xanthinus*]), 2 evaluation species (California leaf-nosed bat [*Macrotus californicus*]), and pale Townsend's big-eared bat[1] [*Corynorhinus townsendii pallescens* also known as *Plecotus townsendii pallescens* and *Corynorhinus townsendii townsendii*]), and 10 other species. The results for the Analook filters (with visual verification) and the Kaleidoscope auto-classifier were compared for the western red bat and pale Townsend's big-eared bat to assess the potential utility of auto-classification as a cost-effective means of call analyzation. (Note: No auto-classifier exists for the western yellow bat or California leaf-nosed bat.)

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. This program works toward the recovery of listed species through habitat and species conservation and reduces the likelihood of additional species listings under the Endangered Species Act. The LCR MSCP is required to create 765 acres of western red bat roosting habitat and 765 acres of western yellow bat roosting or foraging habitat (LCR MSCP 2004). It is also evaluating the need to cover two additional species under the LCR MSCP permit: the California leaf-nosed bat and pale Townsend's big-eared bat.

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[1] Genetic analyses on the pale Townsend's big-eared bat indicate that the LCR is likely in the range of the Pacific Townsend's big-eared bat (*Corynorhinus townsendii townsendii*) rather than the pale Townsend's big-eared bat (Piaggio and Perkins 2005). The bats recorded along the LCR will be referred to as pale Townsend's big-eared bats in this report, as the nomenclature change has not yet been verified by the U.S. Fish and Wildlife Service.

STUDY AREA

The study area consists of nine Anabat™ monitoring stations located along the LCR from the Havasu National Wildlife Refuge in the north to Hunters Hole located near the international border with Mexico (figure 1). Eight of the stations are located on conservation areas created by the LCR MSCP through their Habitat Conservation Plan (LCR MSCP 2004), which requires the creation of over 8,100 acres of various land cover types to provide habitat for targeted LCR MSCP covered species. Four land cover types are integrated in the LCR MSCP and include cottonwood-willow (*Populus fremontii-Salix gooddingii*) (hereafter cottonwood-willow) (5,940 acres), honey mesquite (*Prosopis glandulosa*) (1,320 acres), marsh (512 acres), and backwater (360 acres). Native species used in the conservation area plantings include coyote willow (*Salix exigua*), desert broom (*Baccharis sarothroides*), Fremont cottonwood, Goodding's willow, heliotrope (*Heliotropium curassavicum*), honey mesquite, mule fat (*Baccharis salicifolia*), quailbush (*Atriplex lentiformis*), and willow baccharis (*Baccharis salicina*). Conservation areas are planted in phases and contain a mixture of mature and maturing vegetation. In addition, some conservation areas, such as YEW and the BLCA on the Havasu National Wildlife Refuge, are taking longer to mature and have shorter canopy heights compared to sites at the CVCA and PVER.

One acoustic monitoring station is located at the AKTP in Parker, Arizona. The Colorado River Indian Tribes planted and manage this habitat creation area (figure 2). The AKTP 154 acres in size and consists of cottonwood-willow and honey mesquite. It exhibits vegetation characteristics similar to the LCR MSCP conservation areas and is analyzed with the data from those areas. AKTP 1 is located in cottonwood-willow habitat.

The BLCA is located on the Havasu National Wildlife Refuge within the historic floodplain of the LCR. The BLCA is 119 acres in size and consists of cottonwood-willow, honey mesquite, and marsh habitat (figure 3). BLCA 1 is located in cottonwood-willow habitat.

Cibola NWR Unit #1 is located in the Cibola National Wildlife Refuge near Cibola, Arizona. This conservation area is nearly 950 acres in size and consists of a mosaic of 786 acres of the cottonwood-willow and honey mesquite land cover types, with additional agriculture, native vegetation and undeveloped land. CNU 1 was initially deployed in 2011 at the Cibola NWR Unit #1 Nature Trail area but was relocated to the Crane Roost area in 2013 because it was determined that the area is more similar to other conservation area sites (figure 4). The station was renamed Crane Roost, as it is in a different location.

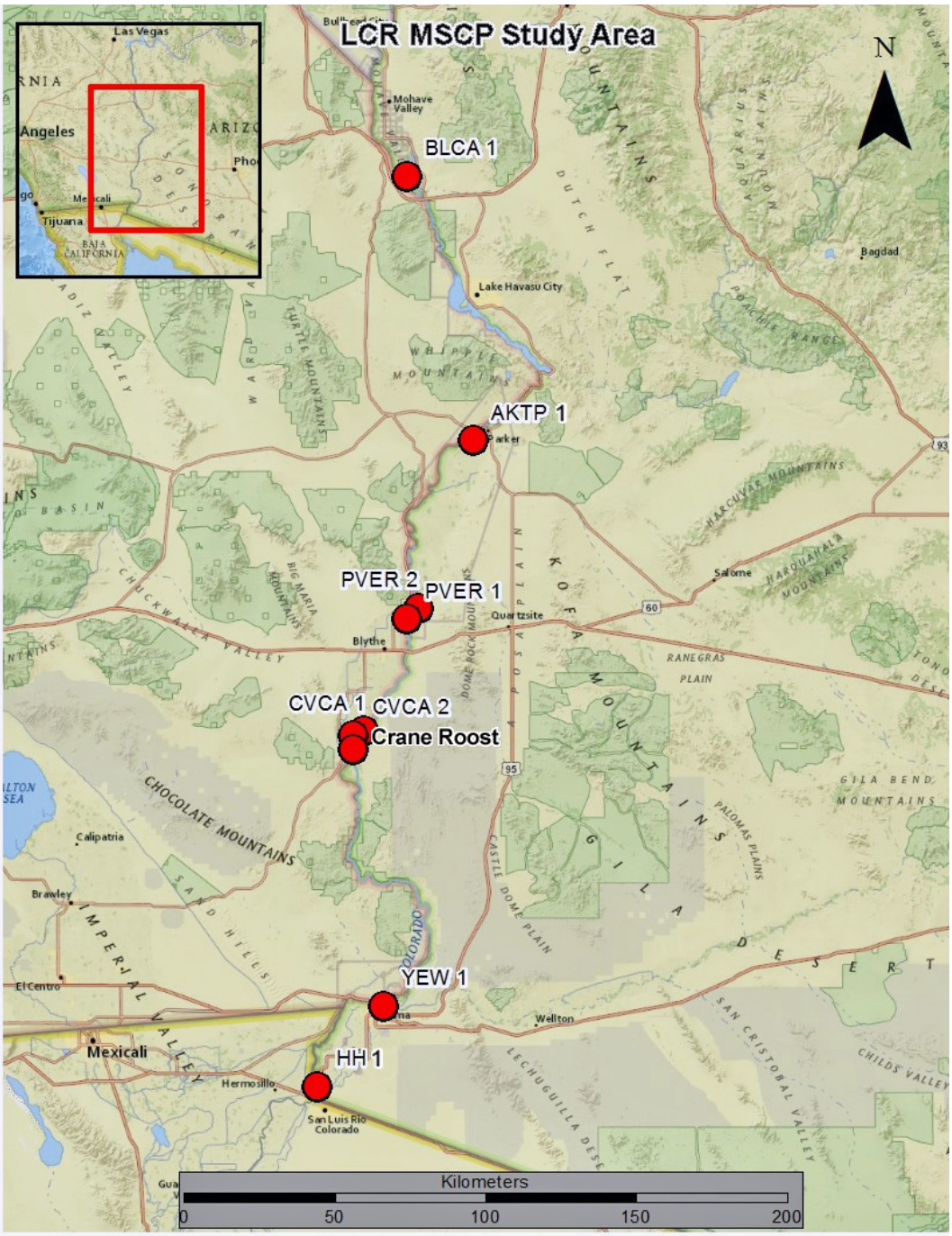

Figure 1.—Study area and location of acoustic monitoring stations.

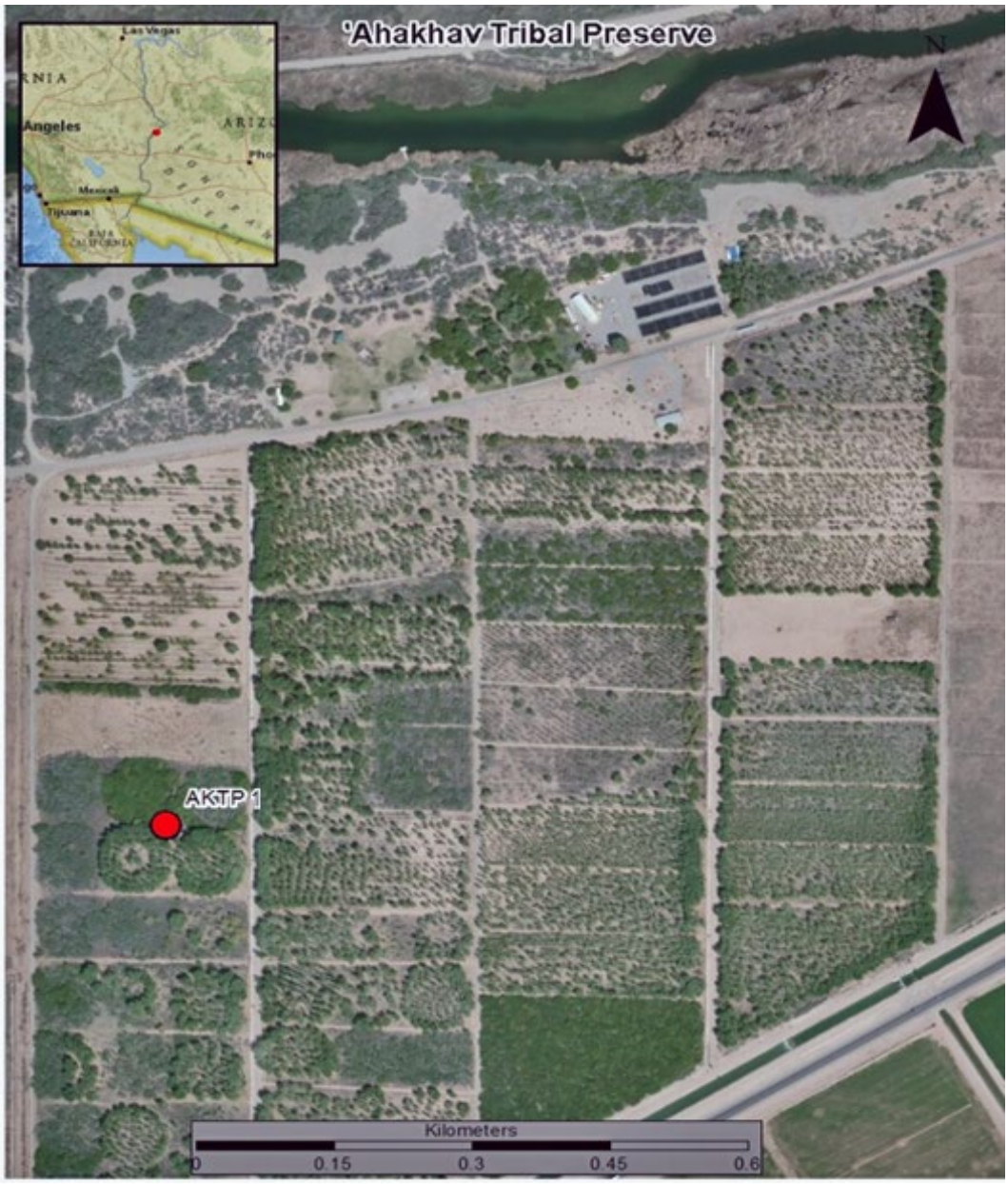

Figure 2.—The 'Ahakhav Tribal Preserve acoustic monitoring station (AKTP 1).

Figure 3.—The BLCA acoustic monitoring station (BLCA 1).

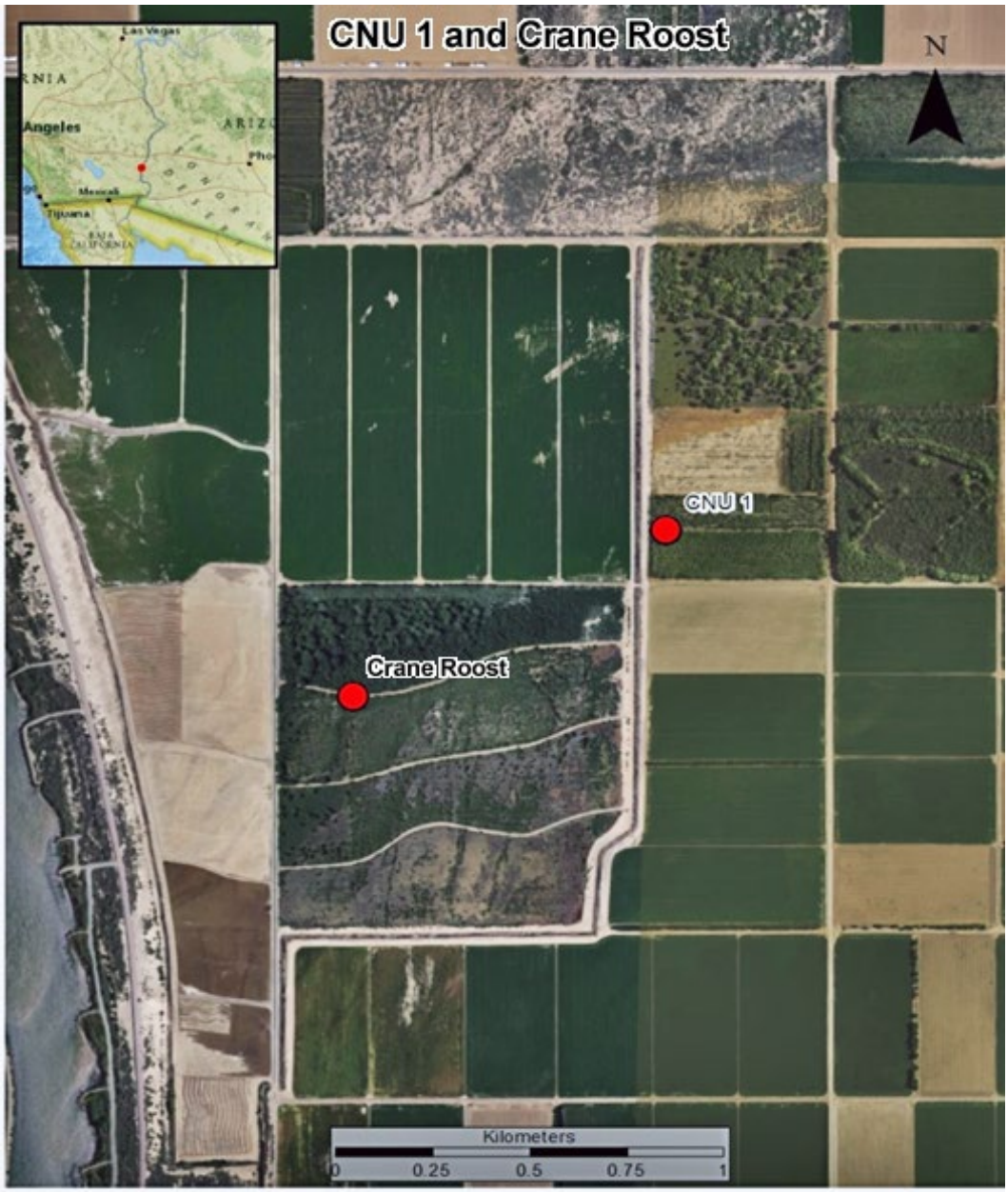

Figure 4.—The Cibola NWR Unit #1 original bat acoustic monitoring station location (CNU 1) and current location (Crane Roost).

The CVCA is located north of Cibola, Arizona, on Arizona Game and Fish owned lands. It consists of 1,122 acres of cottonwood-willow and honey mesquite. The first acoustic monitoring station (CVCA 1) was deployed in mature cottonwood-willow habitat in 2011. The second station (CVCA 2) was deployed in less dense cottonwood-willow habitat 2013 (figure 5).

Hunters Hole is located adjacent to the international border with Mexico near San Luis, Arizona. Hunters Hole is 44 acres, planted on an irrigated field, and consists of cottonwood-willow, honey mesquite, native grasses, and marsh habitat (figure 6). HH 1 is located on the edge of cottonwood-willow habitat.

The PVER is located northeast of Blythe, California, on California Department of Fish and Wildlife lands within the historic floodplain of the LCR. The PVER is over 1,350 acres in size and consists of 1,023 acres of the cottonwood-willow and honey mesquite land cover types. The first acoustic monitoring station (PVER 1) was deployed in mature cottonwood-willow habitat in 2012. The second acoustic monitoring station (PVER 2) was deployed in less dense cottonwood-willow habitat in 2013 to provide sufficient coverage for this large conservation area (figure 7).

YEW is located in Yuma, Arizona, on lands owned by the Quechan Tribe, city of Yuma, and the Arizona Game and Fish Department. YEW is 380 acres and consists of cottonwood-willow, honey mesquite, and marsh habitat (figure 8). YEW 1 is located in cottonwood-willow habitat.

Figure 5.—The CVCA acoustic monitoring stations (CVCA 1 and CVCA 2).

Figure 6.—The Hunters Hole acoustic monitoring station (HH 1).

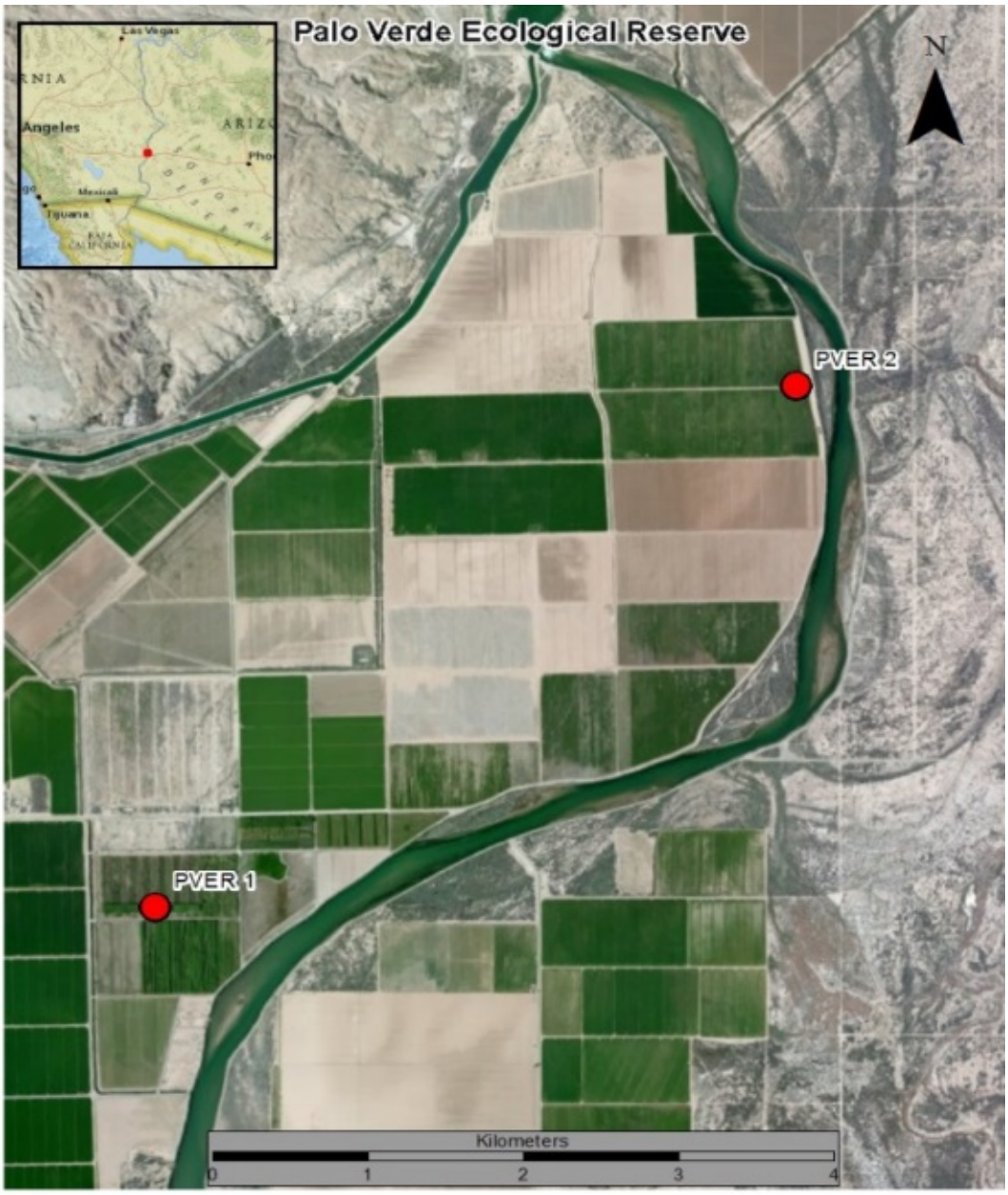

Figure 7.—The PVER acoustic monitoring stations (PVER 1 and PVER 2).

Figure 8.—The Yuma East Wetlands acoustic monitoring station (YEW 1).

METHODS

Data Collection Methods

Data were summarized from nine permanent Anabat™ detectors in six LCR MSCP conservation areas and one additional habitat creation area along the LCR (table 1; see figure 1).

Table 1.—Station name, acronym, number of nights recorded during the sampling period, and year of station deployment

Conservation area or habitat creation area (listed north to south)	Station acronym	Nights recorded 2015	Nights Recorded 2016	Nights Recorded 2017	Nights Recorded 2018	Year deployed
Beal Lake Conservation Area	BLCA 1	92	92	92	92	2008
ʻAhakhav Tribal Preserve	AKTP 1	61	92	57	84	2012
Palo Verde Ecological Reserve	PVER 1	92	92	92	92	2012
	PVER 2	26	77	43	82	2013
Cibola Valley Conservation Area	CVCA 1	92	92	8	82	2011
	CVCA 2	92	92	91	92	2013
Cibola National Wildlife Refuge Unit #1 Conservation Area	Crane Roost	92	76	77	92	2011
Yuma East Wetlands	YEW 1	69	92	92	37	2013
Hunters Hole	HH 1	92	92	62	62	2013
Totals (percent of nights recorded)	**–**	**708 (86%)**	**797 (96%)**	**614 (74%)**	**715 (86%)**	**–**

These nine stations provide a temporal and spatial estimate of bat activity and daily occupancy. These stations consist of Anabat™ II detectors with associated ZCAIM (a device that takes a frequency signal from an Anabat™ detector, detects the zero-crossings in the signal, and stores the signals on a compact flashcard), and Anabat™ SD1 and SD2 detectors. Compact flashcards at the 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). This provides approximately 4 months of data collection for the 4-gigabyte cards used. Data were recorded from June 1 through August 31 of each year in order to determine bat presence during summer. The stations were surveyed and data downloaded from the flashcards in June, July, and August, with an additional trip in May to address any maintenance issues.

During the 2015, 2016, 2017, and 2018 sampling seasons, several equipment malfunctions resulted in periods of data loss (attachment 2). The Anabat™ units were checked the day after they were installed for the season; the day after, the data on each flashcard were downloaded and the flashcards replaced, if necessary, to ensure they collected data the first night. The units cannot be checked remotely to ensure they are functioning between site visits.

Analook Visual Verification Methods

The volume of call minutes was quantified for the two covered and two evaluation LCR MSCP species. Acoustic bat calls were recorded nightly from sunset to sunrise, and the files were processed using filters and methods that had been developed by a previous LCR MSCP acoustic monitoring project (Broderick 2008). Using Analook software, a series of acoustic filters was created for the focal bat species. The analysis was based on first running files through an "All bats" filter to eliminate any files with significant background and insect noise. Background and insect noise usually occurs at low frequencies and can be confused with bat calls. The "All bats" filter recognizes the patterns of background and insect noise and removes these files from consideration. Then, the remaining calls were run through species-specific filters and analyzed individually to sort out species with similar call shapes and frequencies to the four focal species. Western red bat calls were then run through two species-specific filters (a low frequency and a high frequency). The low-frequency filter detected bat calls ending between 40–47.5 kilohertz, while the high-frequency filter detected bat calls ending between 52–80 kilohertz. The high-frequency filters were applied after discussions with Bureau of Reclamation (Reclamation) biologists (Broderick and Calvert 2011, personal communication) revealed they had recorded western red bat calls at higher frequencies along the LCR. Pale Townsend's big-eared bats are known to emit low-intensity vocalizations in an attempt to capture their Lepidopteran prey, which makes them difficult to detect with acoustic methods (O'Farrell and Gannon 1999). Pale Townsend's big-eared bats produce a dual harmonic and cannot be positively identified unless the presence of this diagnostic harmonic is detected. The calls were compared and the filters tested on hand-release reference calls recorded along the LCR provided by Reclamation biologists (Broderick and Calvert 2011, personal communication) and reference calls from across the Southwestern United States. All calls that were flagged as a species of interest were visually analyzed, and only those calls that fit all of the call parameters for the given species, and that could confidently be identified, are presented.

Kaleidoscope Auto-Classifier Methods

All recordings were also analyzed using the Kaleidoscope auto-classifier (Kaleidoscope Pro version 4.3.1) in an effort to determine if this is a cost-effective

means of analyzing calls and to compare this method with the Analook filters and visual verification method. The Kaleidoscope software does not have an auto-classifier for California leaf-nosed bats or western yellow bats, but western red bats and pale Townsend's big-eared bats were evaluated as well as other calls the auto-classifier identified.

The Kaleidoscope auto-classifier was used to assess the data in two ways: (1) as a comparison with LCR MSCP species verified calls and (2) as an index for overall bat activity at each station. The auto-classifier has 12 species classifiers for the study area: pallid bat *(Antrozous pallidus*), pale Townsend's big-eared bat, big brown bat (*Eptesicus fuscus*), spotted bat (*Euderma maculatum*), western mastiff bat (*Eumops perotis*), western red bat, hoary bat (*Lasiurus cinereus*), California myotis (*Myotis californicus*), Arizona myotis (*Myotis occultus*), Yuma myotis (*Myotis yumanensis*), canyon bat (*Parastrellus hesperus*), and Mexican free-tailed bat (*Tadarida brasiliensis*).

Output from the Kaleidoscope auto-classifier was not visually verified, and it is likely that many calls were misidentified. Calls can be misidentified by the auto-classifier because certain species can produce similar calls to others that can only be identified by visual verification. Species that have similar calls and can be misidentified by the classifier are big brown bats, hoary bats, and Mexican free-tailed bats, which all can have characteristics of each other's calls. Hoary bats are seasonally migratory and found at higher elevations during summer. They are most likely not present in conservation areas during the months of June, July, or August. Calls identified as hoary bats are almost certainly big brown bats or Mexican free-tailed bats during our sampling period. California myotis and Yuma myotis can also produce similar calls. Arizona myotis calls can be similar to cave myotis (*Myotis velifer*), but there is no classifier for this species; therefore, some Arizona myotis calls are almost certainly misidentified cave myotis calls.

The Kaleidoscope activity index can be used as a quantitative measure of bat activity at each station, between stations and years. It can be utilized to detect increases, decreases, or constant activity at acoustic monitoring stations.

Activity and Occupancy

Call minutes were used in order to reduce bias in estimating bat activity at Anabat™ stations. A call minute is 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 reduced 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; Vizcarra et al. 2010; Williams et al. 2006). Bat minutes measure activity while reducing the

tendency to classify calls as the result of one bat making multiple calls or many bats making a single call. Therefore, data were also analyzed using a presence/absence framework as the measure of occupancy and are presented as nights occupied and proportion of nights occupied at the stations. The approach is based on naïve occupancy (i.e., if the species is present and within range of the stations, it will be detected). Therefore, detection probabilities are not taken into account (i.e., imperfect detections). It should be noted that detection is indicative of presence, but non-detection of the species is not equivalent to absence (MacKenzie et al. 2002). Monitoring was limited to the distance in which the station could record reliable bat calls, and it is not known if a bat was present or absent just beyond the range of the station. Stations were compared based on average nightly call minutes per species, per station as well as proportion of nights a species occupied the station area during the year. Because results may be biased based on station malfunctions, data based on average nightly call minutes per month were also compared, which removed nights when a station was not recording. As such, the comparisons among stations represent a qualitative measure of activity and are not to be extrapolated to evaluate population dynamics or occupancy trends. It is believed that these methods provide a simple, standardized way of comparing activity across the stations and species.

RESULTS

Analook Visual Verification Results

Average nightly call minutes (activity) and proportion of nights occupied (occupancy) for the focal and evaluation species at each conservation area ranged widely across sites and years. Seasonal activity and occupancy are presented below, and graphs for this information can be found in attachment 1.

Western Red Bat

Western red bats were detected in 2015, 2016, 2017, and 2018 using the Analook visual verification method. None were detected at the AKTP or Hunters Hole in 2015, but they were detected in 2016. They were not detected at AKTP 1 in 2017 or 2018 (table 2). Average nightly call minutes (activity) and proportion of nights occupied (occupancy) of western red bats at each conservation area ranged widely across sites and years, with occupancy generally reflecting seasonal patterns of activity for visually verified results, while occupancy was 100% (or nearly 100%) at every site for the Kaleidoscope results. All results have been rounded to the nearest hundredth.

Table 2.—Western red bat detections in 2015, 2016, 2017, and 2018

Conservation area or habitat creation area	Station acronym	2015	2016	2017	2018
‘Ahakhav Tribal Preserve	AKTP 1	None detected	X	None detected	None detected
Beal Lake Conservation Area	BLCA 1	X	X	X	X
Cibola National Wildlife Refuge Unit #1 Conservation Area	Crane Roost	X	X	X	X
Cibola Valley Conservation Area	CVCA 1	X	X	X	X
	CVCA 2	X	X	X	X
Hunters Hole	HH 1	None detected	X	X	X
Palo Verde Ecological Reserve	PVER 1	X	X	X	X
	PVER 2	X	X	X	X
Yuma East Wetlands	YEW 1	X	X	X	X

Western Red Bat Yearly Comparison

2015
The greatest average nightly call minute (2.85) and proportion of nights occupied (0.71) for western red bats during the 2015 season were recorded at PVER 1 (figures 9 and 10).

2016
The greatest average nightly call minutes (1.72) recorded during the 2016 season were recorded at CVCA 1, but the greatest proportion of nights occupied (0.55) were recorded at PVER 1 (figures 9 and 10).

2017
The greatest average nightly call minutes (2.26) and proportion of nights occupied (0.78) for western red bats during the 2017 season were recorded at PVER 1 (figures 9 and 10).

2018
The greatest average nightly call minutes (1.41) and proportion of nights occupied (0.73) for western red bats during the 2018 season were recorded at PVER 1 (figures 9 and 10).

Western Red Bat Station Comparison

AKTP 1
AKTP 1 had the lowest yearly average activity and occupancy of any of the stations from 2015 through 2018, with the only western red bat activity (0.2) and occupancy (0.2) recorded during 2016 (figures 9 and 10). Monthly average nightly call minutes and proportion of nights occupied for 2015–18 are shown in attachment 1, figure 1-1. Station malfunctions in June and July of 2015 and 2017 may partly explain the lack of detections at this site. This station recorded a large amount of low-quality calls in 2018, suggesting there are microphone issues, vegetation is too close to the detector, and/or insect noise is interfering with the recordings.

BLCA 1
Yearly average activity (0.45) and occupancy (0.27) were greatest at BLCA 1 during 2015, and the lowest during 2016 (0.14 for activity and occupancy) (figures 9 and 10). The greatest monthly activity (0.58) and occupancy (0.39) occurred during July 2015 (attachment 1 [figure 1-2]). In 2018, activity (0.31) and occupancy (0.23) were similar to those observed in 2017.

Crane Roost
At Crane Roost, yearly average activity (0.28) and occupancy (0.22) was greatest in 2018 (figures 9 and 10), with the greatest monthly activity recorded in August 2015 (0.35) and the greatest occupancy (0.23) recorded in August 2015 and in July and August 2018 (attachment 1 [figure 1-3]). Station malfunctions in 2016 and 2017 may partly explain the lower activity recorded in these years.

CVCA 1
A large peak in activity (3.77) and occupancy (0.74) was observed at CVCA 1 in July 2016 (attachment 1 [figure 1-4]). This peak led to yearly average activity (1.72) being greatest in 2016, but the greatest yearly average occupancy was in 2015 (0.44). The lowest yearly average activity (0.25) and occupancy (0.16) was recorded in 2018 (figures 9 and 10). Station malfunctions resulted in missing data for June 2017 and 2018 and reduced data in July and August 2017.

CVCA 2
The greatest activity (0.94) and occupancy (0.48) was observed at CVCA 2 in August 2018 (attachment 1 [figure 1-5]). However, yearly average activity (0.42) and occupancy (0.29) were greatest during the 2017 season at CVCA 2 (figures 9 and 10). The least amount of yearly average activity (0.18) was recorded during 2016, with the least amount of occupancy (0.15) documented equally in 2015 and 2016 (figures 9 and 10). Only 1 night of data were missing due to a station malfunction in June 2017.

HH 1

Activity and occupancy were both low and sporadic at HH 1. The greatest yearly average activity (0.12) and occupancy (0.08) were recorded in 2018. No activity was recorded in 2016, and no year had detections in every month surveyed (figures 9 and 10; attachment 1 [figure 1-6]).

PVER 1

The greatest yearly average activity (2.85 in 2015) and occupancy (0.78 in 2017) from any site were noted at PVER 1 (figures 9 and 10), with activity at its' greatest in July 2015 (4.13) and occupancy at its' greatest in August 2017 (0.90) (attachment 1 [figures 1-7]). The lowest yearly average activity (1.09) and occupancy (0.55) were documented in 2016 (figures 9 and 10).

PVER 2

Bat activity and occupancy were lower at PVER 2, and station malfunctions impacted data collection in all four years. Yearly average activity (0.24) and occupancy (0.22) were greatest at PVER 2 in 2018 (figures 9 and 10). The greatest monthly activity (0.39) and occupancy (0.32) were recorded in August 2018 (attachment 1 [figure 1-8]). Activity and occupancy had been very low at PVER 2 from 2015 to 2017 but saw an increase in 2018.

YEW 1

At YEW 1, the greatest monthly activity (0.63) and occupancy (0.33) were recorded in June 2018 (attachment 1 [figure 1-9]). The greatest yearly average activity at YEW 1 was recorded in 2016 (0.27), with the greatest occupancy recorded in 2017 (0.21) (figures 9 and 10). The least yearly average activity (0.09) and occupancy (0.08) were recorded in 2015 (figures 9 and 10). A station malfunction reduced the amount of data collected in June 2015 and again in July and August of 2018.

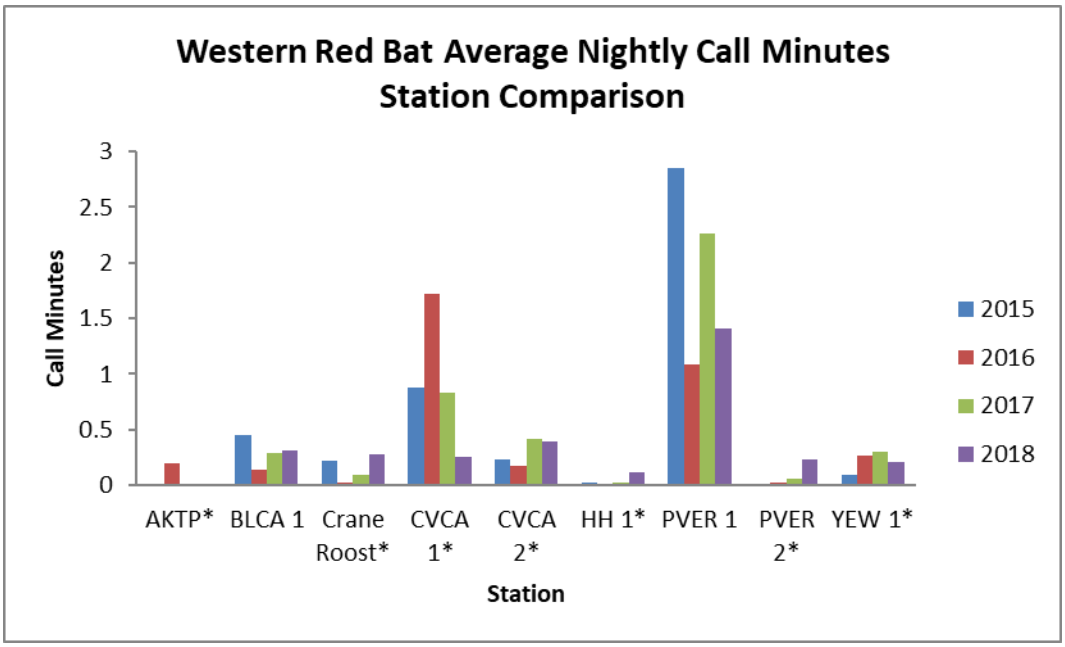

Figure 9.—Western red bat average nightly call minutes station comparison.
* Station malfunction occurred at site.

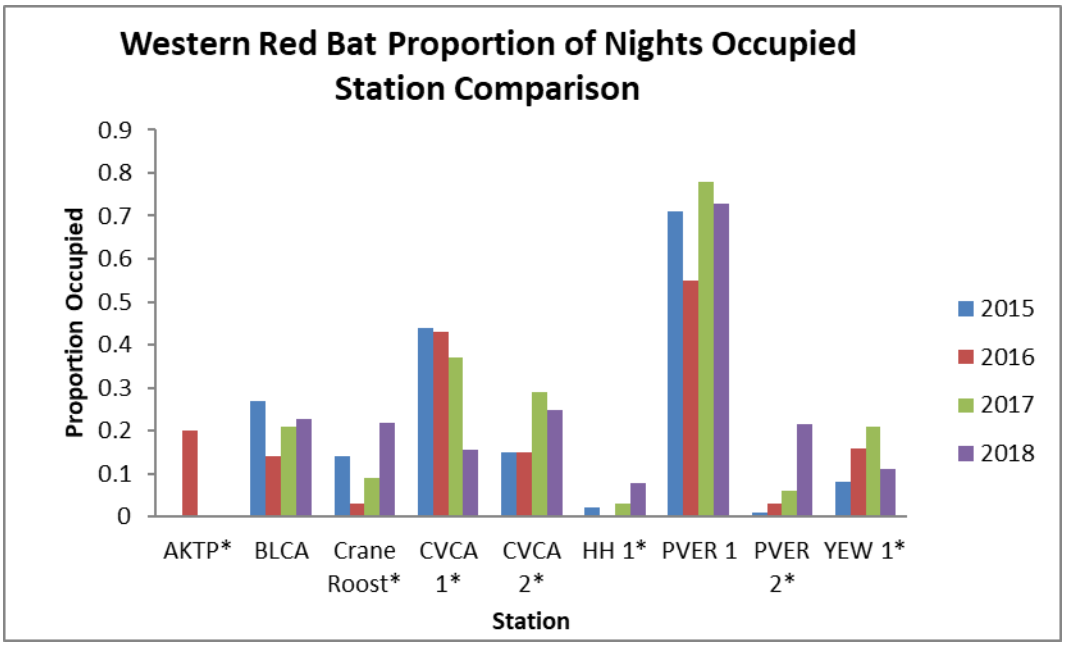

Figure 10.—Western red bat proportion of nights occupied station comparison.
* Station malfunction occurred at site.

Western Yellow Bat

Western yellow bats were detected at all stations during the 2015, 2016, 2017, and 2018 seasons using the Analook visual verification method, with the exception of PVER 2 during the 2016 season and AKTP 1 during the 2017 and 2018 seasons (table 3). Average nightly call minutes (activity) and proportion of nights occupied (occupancy) of western yellow bats at each conservation area ranged widely across sites and years, with occupancy generally reflecting seasonal patterns of activity for Analook visually verified results (figures 12 and 13). No kaleidoscope auto-classifier exists for western yellow bats, so a comparison between Analook verified and Kaleidoscope auto-classifier results could not be undertaken.

Table 3.—Western yellow bat detections in 2015, 2016, 2017, and 2018

Conservation area or habitat creation area	Station acronym	2015	2016	2017	2018
ʻAhakhav Tribal Preserve	AKTP 1	X	X	None detected	None detected
Beal Lake Conservation Area	BLCA 1	X	X	X	X
Cibola National Wildlife Refuge Unit #1 Conservation Area	Crane Roost	X	X	X	X
Cibola Valley Conservation Area	CVCA 1	X	X	X	X
	CVCA 2	X	X	X	X
Hunters Hole	HH 1	X	X	X	X
Palo Verde Ecological Reserve	PVER 1	X	X	X	X
	PVER 2	X	None detected	X	X
Yuma East Wetlands	YEW 1	X	X	X	X

Western Yellow Bat Yearly Comparison

2015

The greatest average nightly call minutes (16.81) and proportion of nights occupied (0.97) for western yellow bats during the 2015 season occurred at CVCA 1 (figures 11 and 12).

2016
The greatest average nightly call minutes (4.22) and proportion of nights occupied (0.91) for western yellow bats during the 2016 season occurred at CVCA 1 (figures 11 and 12).

2017
The greatest average nightly call minutes (5.3) and proportion of nights occupied (0.8) for western yellow bats during the 2017 season occurred at CVCA 1 (figures 11 and 12).

2018
The greatest average nightly call minutes (0.93) and proportion of nights occupied (0.35) for western yellow bats during the 2018 season occurred at PVER 1 (figures 11 and 12).

Western Yellow Bat Station Comparison

AKTP 1
Yearly average activity and occupancy were moderate at AKTP 1 from 2015 (1.9 and 0.41) through 2016 (2.64 and 0.52), with no activity or occupancy recorded in 2017 or 2018 (figures 11 and 12). The majority of activity was detected in July at the AKTP (attachment 1 [figure 1-10]). Station malfunctions in June and July of 2015 and 2017 reduced the amount of data collected for those months. This station may have a problematic microphone, vegetation clutter around the microphone, and/or insect noise interfering with recordings.

BLCA 1
Yearly average activity and occupancy were consistently low at BLCA 1 from 2015 to 2018. The greatest activity (0.09) was recorded in 2016 and the greatest occupancy in 2015 (0.08). The least amount of activity (0.03) and occupancy (0.03) were recorded in 2018 (figures 11 and 12). Monthly average nightly call minutes and proportion of nights occupied for 2015–18 are shown in attachment 1, figure 1-11.

Crane Roost
Yearly average activity and occupancy were the lowest at Crane Roost from 2015 through 2018 compared to all other conservation areas, with the greatest activity (0.05) and occupancy (0.05) recorded in 2017 and the least recorded equally in 2015 and 2016 (0.03 and 0.03) (figures 11 and 12). Activity (0.05) and occupancy (0.04) in 2018 were similar to those recorded in 2017. Station malfunctions in 2016 and 2017 may partly explain the lower activity recorded in these years. Monthly average nightly call minutes and proportion of nights occupied for 2015–18 are shown in attachment 1, figure 1-12.

CVCA 1

A large peak in yearly average activity (16.81) and occupancy (0.97) was observed at CVCA 1 in 2015 (figures 11 and 12), with the greatest activity recorded in July (25.81) and August (20.48) and occupancy remaining constant throughout 2015 for each month (0.97) (attachment 1 [figure 1-13]). Activity and occupancy were the greatest at CVCA 1 from 2015 through 2017 compared to all other conservation areas (figures 11 and 12). CVCA 1 had much lower activity and occupancy in 2018 compared to 2015–17. The station malfunctioned in June 2018; however, this minor malfunction (10 nights) does not explain the precipitous drop in activity and occupancy in 2018. Station malfunctions resulted in missing data for June 2017 and reduced data in July and August of 2017.

CVCA 2

Much like CVCA 1, a peak in yearly average activity (1.3) and occupancy (0.45) was also observed at CVCA 2 during 2015 compared to 2016 (0.41 and 0.22) and 2017 (0.4 and 0.3) (figures 11 and 12). Like CVCA 1, the greatest activity and occupancy occurred during July and August with little recorded in June (attachment 1 [figure 1-14). Like CVCA 1, there was a drop in activity (0.10) and occupancy (0.09) in 2018 compared to 2015 through 2017. Only 1 night of data were missing due to a station malfunction in June 2017.

HH 1

Activity and occupancy were generally consistent at HH 1 from 2015 through 2017, with yearly average activity and occupancy recorded at its' greatest levels during 2015 (0.54 and 0.41), followed by 2017 (0.5 and 0.3) and 2016 (0.44 and 0.3) (figures 11 and 12). The greatest monthly activity and occupancy at HH 1 were recorded in July 2015, 2016, and 2017 (attachment 1 [figure 1-15]). A drop in yearly average activity (from 0.5 to 0.04) and occupancy (from 0.3 to 0.04) occurred in 2018, compared to 2015 through 2017 (figures 11 and 12). This may be the result of a station malfunction in July 2018 that limited recordings to 2 nights that month.

PVER 1

A high amount of activity and occupancy was recorded at PVER 1, with a peak in 2015 (6.12 and 0.68) (figures 11 and 12). While activity varied from 2015 through 2017, yearly average occupancy remained relatively stable in 2015 (0.68), 2016 (0.63), and 2017 (0.58). The greatest monthly activity was recorded in July from 2015 through 2017, but the greatest monthly occupancy was recorded in August (attachment 1 [figure 1-16]). The greatest activity and occupancy were recorded at PVER 1 during 2018 compared to all other stations. However, 2018 represented the lowest activity (0.93) and occupancy (0.35) recorded at PVER 1 from 2015 through 2018.

PVER 2

Yearly average activity and occupancy were much lower at PVER 2 than other stations, with none recorded in 2016. The greatest yearly average activity (0.27) and occupancy (0.15) were recorded during 2015 (figures 11 and 12). Activity and

occupancy in 2018 were both 0.12. The greatest monthly activity and occupancy were recorded during August, with only 2018 seeing activity across all months (attachment 1 [figure 1-17]). Station malfunctions impacted data collection in all four years.

YEW 1

At YEW 1, a peak in yearly average activity (2.55) and occupancy (0.7) was recorded in 2015. The least amount of yearly average activity (0.01) and occupancy (0.01) were recorded in 2018 (figures 11 and 12). The greatest monthly activity and occupancy were observed in July 2015, 2016, and 2017 (attachment 1 [figure 1-18]). A station malfunction reduced the amount of data collected in June 2015 and July and August of 2018.

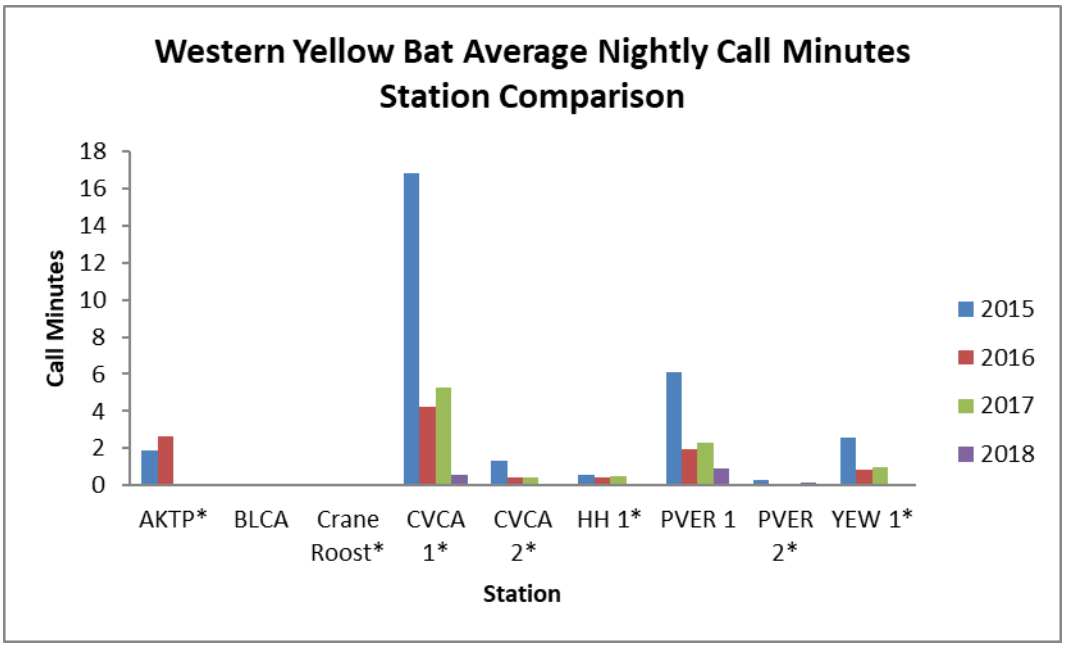

Figure 11.—Western yellow bat average nightly call minutes station comparison.
Call minutes recorded at the BLCA for 2015–18 were 0.08, 0.09, 0.04, and 0.03. Call minutes recorded at Crane Roost were 0.03 in 2015 and 2016 and 0.05 in 2017 and 2018. Call minutes recorded at HH 1 in 2018 were 0.04.
* Station malfunction occurred at site.

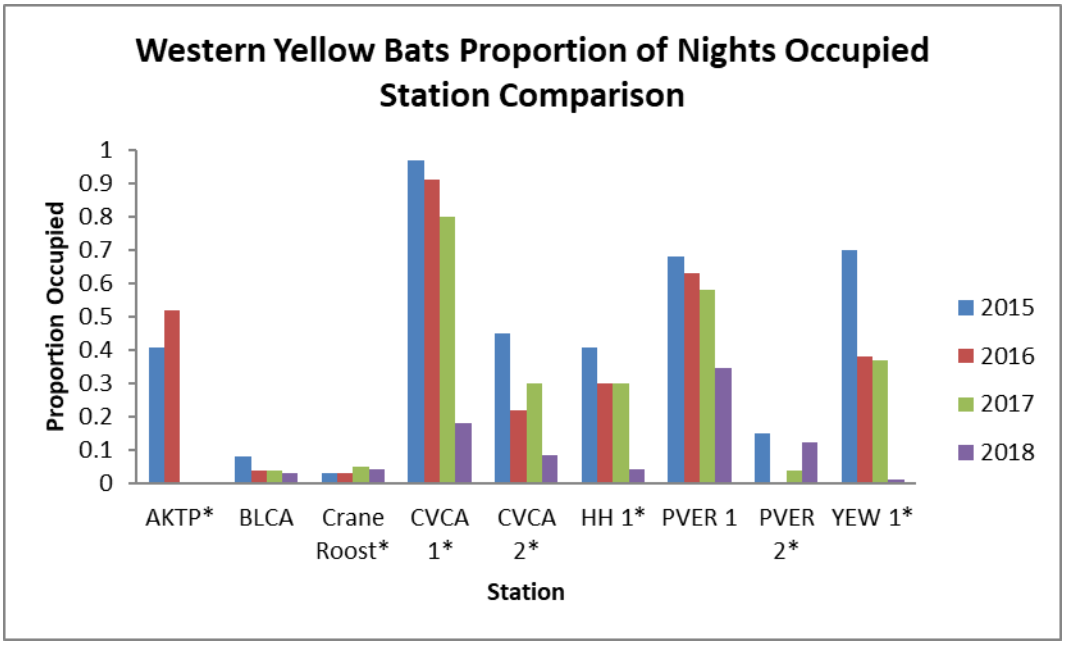

Figure 12.—Western yellow bat proportion of nights occupied station comparison.
* Station malfunction occurred at site.

California Leaf-nosed Bat

California leaf-nosed bats were detected in 2015, 2016, 2017, and 2018 using the Analook visual verification method. None were detected at AKTP 1, BLCA 1, HH 1, or PVER 1 during the 2015 season, but they were detected during 2016 at those sites. No California leaf-nosed bats were detected at Crane Roost, CVCA 1, CVCA 2, or YEW 1 during the 2016 season, but they were detected in 2015. No California leaf-nosed bats were detected at CVCA 1 during the 2017 season, and none were detected at CVCA 1 or YEW 1 during the 2018 season. No California leaf-nosed bats were detected at PVER 2 during the 2015, 2016, 2017, or 2018 seasons (table 4). Average nightly call minutes (activity) and proportion of nights occupied (occupancy) of western yellow bats at each conservation area ranged widely across sites and years. California leaf-nosed bat activity and occupancy were recorded sporadically and in low numbers due to the low amplitude calls this species produces. No kaleidoscope auto-classifier exists for California leaf-nosed bats, so a comparison between verified and auto-classifier results could not be undertaken.

Table 4.—California leaf-nosed bat detections in 2015, 2016, 2017, and 2018

Conservation area or habitat creation area	Station acronym	2015	2016	2017	2018
‘Ahakhav Tribal Preserve	AKTP 1	None detected	X	X	X
Beal Lake Conservation Area	BLCA 1	None detected	X	X	X
Cibola National Wildlife Refuge Unit #1 Conservation Area	Crane Roost	X	None detected	X	X
Cibola Valley Conservation Area	CVCA 1	X	None detected	None detected	None detected
	CVCA 2	X	None detected	X	X
Hunters Hole	HH 1	None detected	X	X	X
Palo Verde Ecological Reserve	PVER 1	None detected	X	X	X
	PVER 2	None detected	None detected	None detected	None detected
Yuma East Wetlands	YEW 1	X	None detected	X	None detected

California Leaf-nosed Bat Yearly Comparison

2015
The greatest average nightly call minutes (0.14) and proportion of nights occupied (0.11) for California leaf-nosed bats during the 2015 season occurred at YEW 1 (figures 13 and 14).

2016
The greatest average nightly call minutes (0.02) and proportion of nights occupied (0.02) for California leaf-nosed bats during the 2016 season occurred equally at BLCA 1 and PVER 1 (figures 13 and 14).

2017
The greatest average nightly call minutes (0.38) and proportion of nights occupied (0.25) for California leaf-nosed bats during the 2017 season occurred at CVCA 2 (figures 13 and 14).

2018
The greatest average nightly call minutes (0.38) and proportion of nights occupied (0.22) for California leaf-nosed bats during the 2018 season occurred at Crane Roost (figures 13 and 14).

California Leaf-nosed Bat Station Comparison

AKTP 1
Average yearly and monthly activity and occupancy were low at AKTP 1 from 2015 to 2018, with none recorded during 2015 (figures 13 and 14). Activity and occupancy were only detected during July 2016 (0.03 and 0.03), August 2017 (0.06 and 0.06), and August 2018 (0.10 and 0.10) (figures 13 and 14; attachment 1 [figure 1-19]). Station malfunctions in June and July of 2015 and 2017 reduced the amount of data collected for those months.

BLCA 1
Yearly average activity (0.16) and occupancy (0.15) were greatest at BLCA 1 during 2017 (figures 13 and 14). Activity and occupancy were only recorded in June 2016, and none was recorded during 2015. The greatest monthly activity (0.26) was documented equally in August 2017 and 2018. The greatest monthly occupancy (0.26) was documented in August 2018 (attachment 1 [figure 1-20]).

Crane Roost
The greatest activity and occupancy at any site in 2018 occurred at Crane Roost. Yearly average activity (0.38) and occupancy (0.22) at Crane Roost were greater in 2018 compared to 2015 through 2017. Activity and occupancy were only recorded in June 2015, and none was recorded during 2016 (figures 13 and 14). Monthly

activity and occupancy were documented across all months in 2017 and 2018 (attachment 1 [figure 1-21]). Station malfunctions in 2016 and 2017 may partly explain the lower activity recorded in these years.

CVCA 1
Yearly average activity and occupancy were low at CVCA 1, with the greatest recorded in 2015 (0.04 and 0.04), and none recorded in 2016, 2017, or 2018 (figures 13 and 14). Station malfunctions resulted in missing data for June 2017, reduced data in July and August of 2017, and reduced data in June 2018 (attachment 1 [figure 1-22]).

CVCA 2
The greatest yearly average activity and occupancy for any site occurred at CVCA 2 from 2015 to 2017. The greatest yearly average activity (0.38) and occupancy (0.25) at CVCA 2 occurred during 2017, with none recorded during 2016 (figures 13 and 14). Yearly average activity and occupancy were 0.11 and 0.10 in 2018. The greatest monthly activity (0.58) was documented in July 2017, and the greatest occupancy (0.39) occurred in August 2017 (attachment 1 [figure 1-23]). Only 1 night of data was missing due to a station malfunction in June 2017.

HH 1
Yearly average activity (0.09) and occupancy (0.03) were greatest at HH 1 during 2017, with very little recorded in 2016 (0.01 and 0.01) and 2018 (0.03 and 0.03), and none recorded in 2015 (figures 13 and 14). All activity and occupancy recorded at HH1 was observed in August (attachment 1 [figure 1-24]).

PVER 1
Yearly average activity (0.16) and occupancy (0.12) were greatest at PVER 1 during 2018 (figures 13 and 14). Monthly activity and occupancy were recorded in July and August of 2017, very little recorded in 2016 (0.02 and 0.02), and none recorded in 2015 (attachment 1 [figure 1-25]).

PVER 2
No activity or occupancy were recorded at PVER 2 from 2015 to 2018 (figures 13 and 14). Station malfunctions impacted data collection in all four years.

YEW 1
A moderate amount of activity was recorded at YEW 1, with the greatest yearly average activity and occupancy observed in 2015 (0.14 and 0.11). Very little activity (0.04) and occupancy (0.04) were recorded in 2017, and none were recorded in 2016 and 2018 (figures 13 and 14). Station malfunction reduced the amount of data collected in June 2015 and July and August of 2018 (attachment 1 [figure 1-26]).

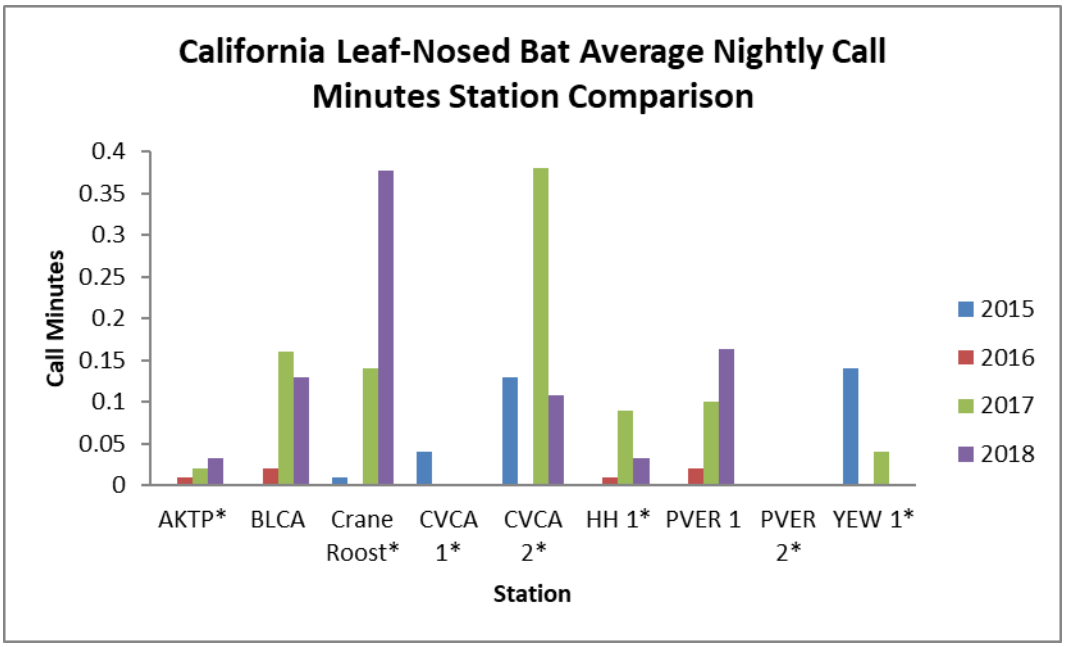

Figure 13.—California leaf-nosed bat average nightly call minutes station comparison.
* Station malfunction occurred at site.

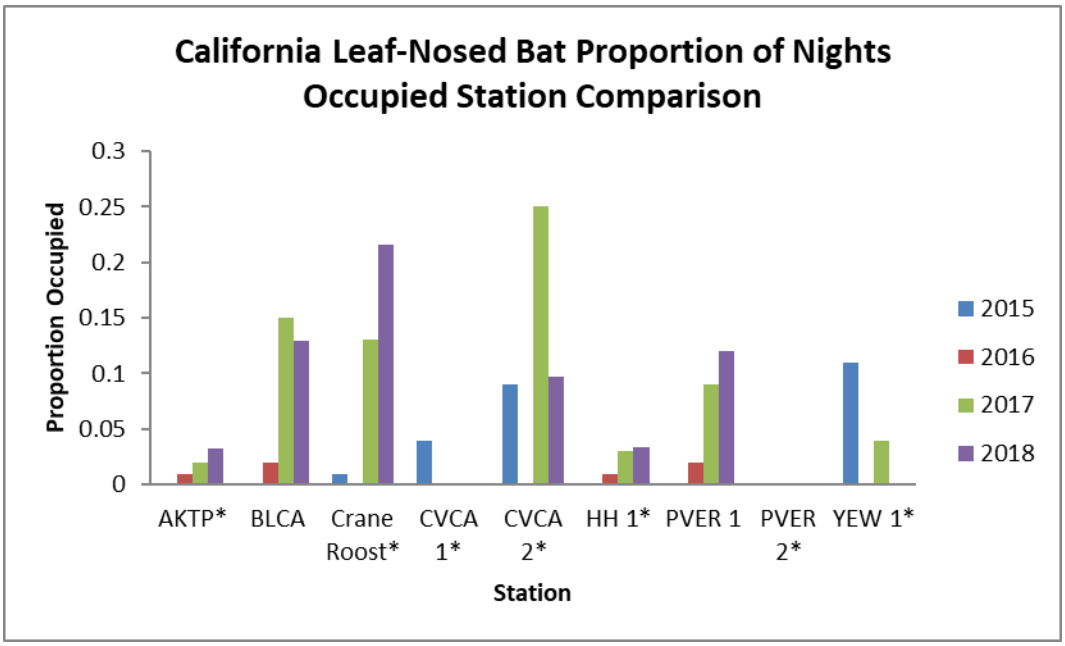

Figure 14.—California leaf-nosed bat proportion of nights occupied station comparison.
* Station malfunction occurred at station.

Pale Townsend's Big-eared Bat

Because of the conservative method of identifying Townsend's big-eared bat (*Corynorhinus townsendii*) calls to species and subspecies using the Analook verification method and the nature of their whispering calls, no pale Townsend's big-eared bat calls were detected during 2015, 2016, or 2018 at any location. One pale Townsend's big-eared bat call was verified at CVCA 2 during August 2017.

Verified Call Results Yearly Comparison at All Post-Development Stations

Western Red Bat

Western red bat activity across all post-development stations was relatively stable from 2015 through 2018, ranging from 0.36 call minutes in 2018 to 0.53 in 2015. The proportion of nights occupied were also stable, ranging from 0.19 in 2016 to 0.23 in 2017 (figure 15).

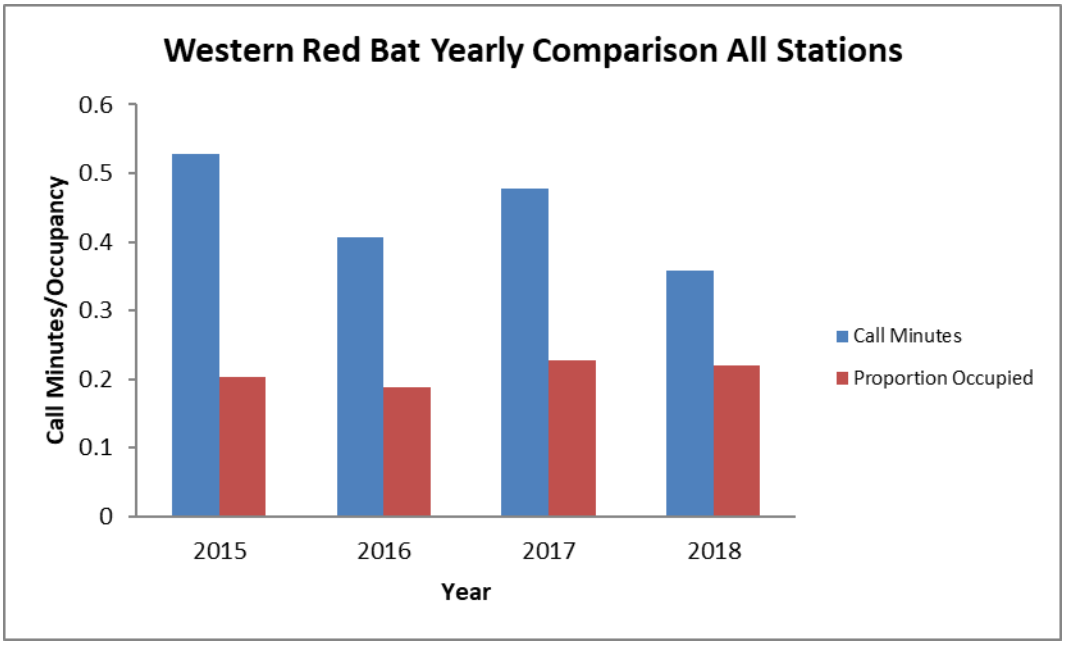

Figure 15.—Western red bat verified call results across all post-development stations.

Western Yellow Bat

Western yellow bat activity has dropped precipitously since 2015. Activity was similar from 2016 (1.17) to 2017 (1.07) before dropping to 0.20 in 2018. Occupancy decreased but was relatively stable in 2015 (0.43), 2016 (0.34), and 2017 (0.28) but dropped in 2018 (0.10) (figure 16).

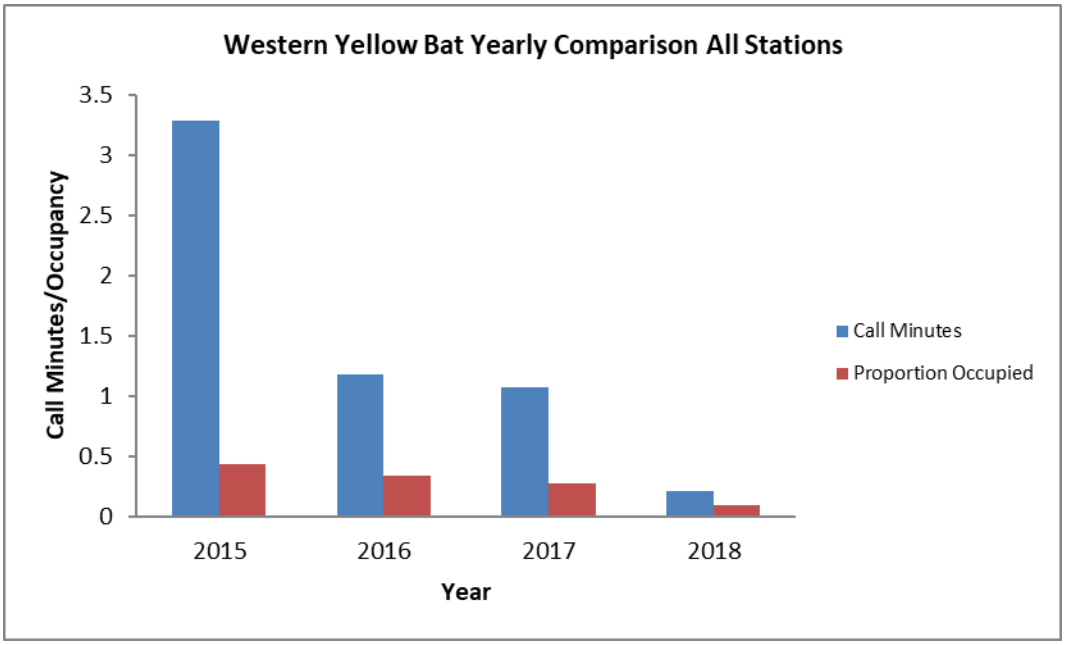

Figure 16.—Western yellow bat verified call results across all post-development stations.

California Leaf-Nosed Bat

California leaf-nosed bat activity and occupancy across all stations has increased in 2017 and 2018, but they both remain relatively low due in part to the quiet nature of their calls, which reduces the effectiveness of acoustic monitoring stations to detect their presence. Activity and occupancy ranged from a low in 2016 (0.01 and 0.01) to a high in 2017 (0.10 and 0.08) (figure 17).

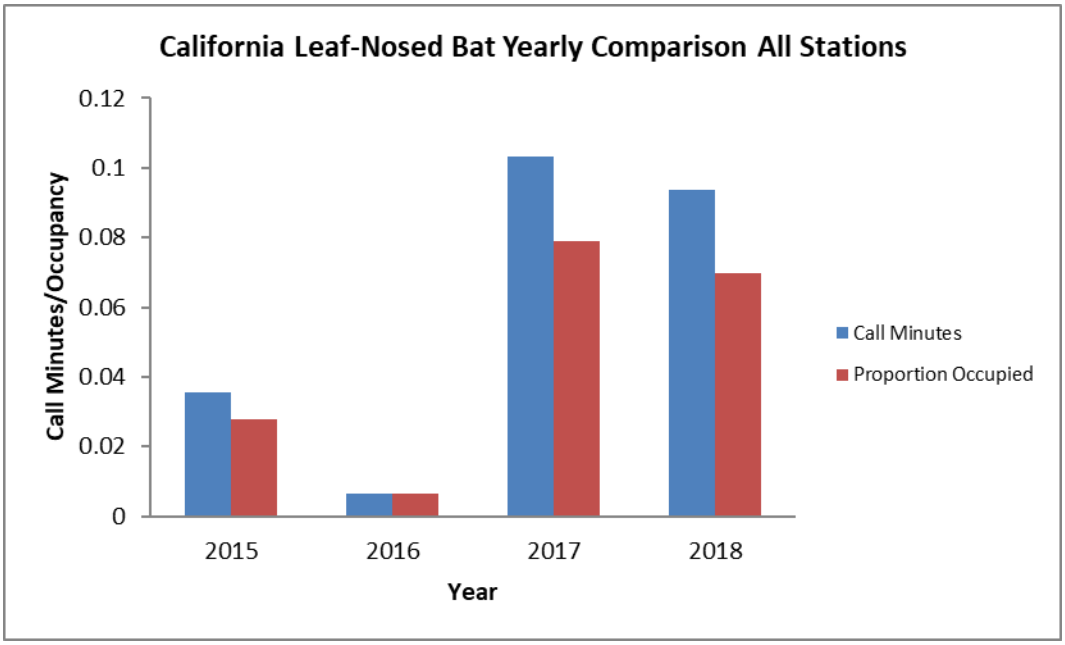

Figure 17.—California leaf-nosed bat verified call results across all post-development stations.

Kaleidoscope Auto-Classifier Results

Western Red Bat

The Kaleidoscope auto-classifier produced different results than the Analook filters and Analook visual verification methods. The Kaleidoscope auto-classifier and Analook filters serve a similar purpose in that they both attempt to identify calls to the species level based on diagnostic characteristics of those species calls. The Kaleidoscope auto-classifier identified a greater number of calls as western red bats (62,375 total) than the Analook filters (53,036) at most sites, with the exception of CVCA 1, CVCA 2, PVER 1, and PVER 2 (table 5). Both the auto-classifier and Analook filters identified a greater number of calls as western red bats than the verified results (1,437) (table 5).

Table 5.—Number of western red bat calls detected by the Kaleidoscope auto-classifier, Analook filter, and visual verification in 2018

Station acronym	Kaleidoscope results	Analook filter results	Visual verification results
AKTP 1	3,715	755	2
BLCA 1	20,189	12,750	117
Crane Roost	8,931	4,627	60
CVCA 1	6,855	8,548	265
CVCA 2	4,580	6,971	124
HH 1	1,010	366	16
PVER 1	13,518	15,202	744
PVER 2	634	2,312	29
YEW 1	2,943	1,505	80
Total	62,375	53,036	1,437

The Kaleidoscope auto-classifier consistently identified more occupancy than the visual verification methods from 2015 through 2018, with most acoustic monitoring stations displaying over 90% of nights occupied (and often 100%). The exceptions were:

- AKTP 1 in 2017 and 2018
- CVCA 1 in 2018
- HHCA 1 during 2015, 2017, and 2018
- PVER 2 during 2016 and 2018
- YEW 1 during 2018

BLCA 1 had the greatest average nightly call minutes during the 2015, 2016, and 2017 seasons, followed by PVER 1 (figure 18). The Crane Roost station had the greatest average nightly call minutes during the 2018 season, followed by BLCA 1. The lowest average nightly call minutes were recorded at HH 1 and PVER 2, which matches results from the Analook visual verification methods.

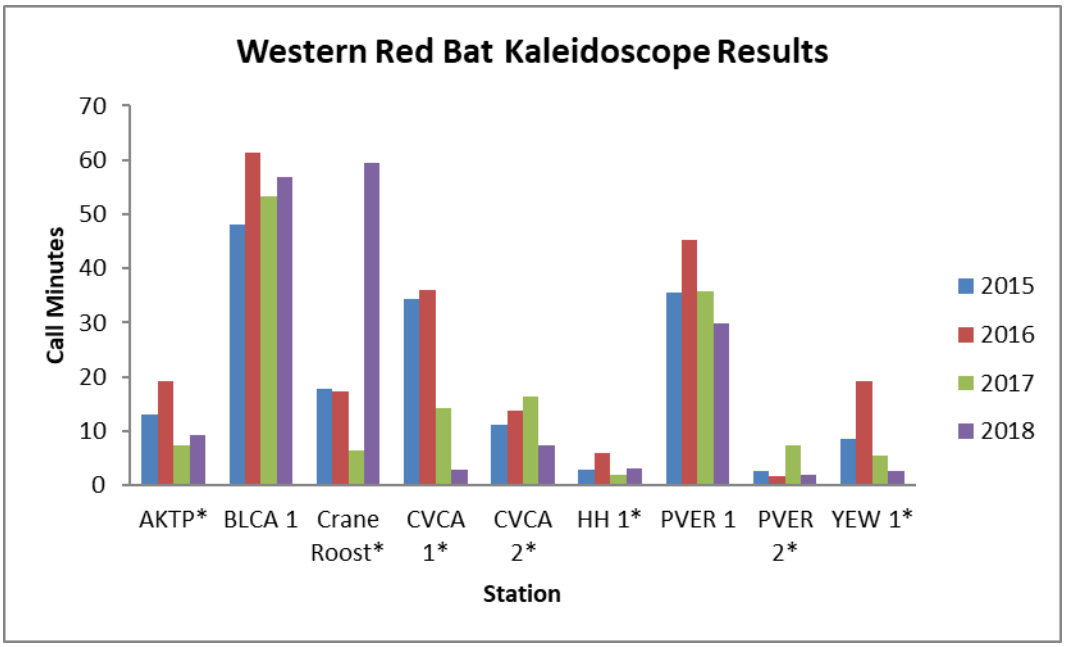

Figure 18.—Western red bat Kaleidoscope results station comparison.
* Station malfunction occurred at site.

Pale Townsend's Big-eared Bat

No pale Townsend's big-eared bat activity was detected through Analook visual verification methods at any site during the 2015, 2016, or 2018 seasons. One call was verified in August 2017 at CVCA 2. The Analook filters for this species flagged 74,663 calls as potential pale Townsend's big-eared bats across all sites, while the Kaleidoscope auto-classifier flagged a total of 514 calls (table 6).

Table 6.—Number of pale Townsend's big-eared bat calls detected by the Kaleidoscope auto-classifier, Analook filter, and visual verification

Station acronym	Kaleidoscope results	Analook filter results	Visual verification results
AKTP 1	42	6,482	0
BLCA 1	90	13,184	0
Crane Roost	50	10,263	0
CVCA 1	110	11,954	0
CVCA 2	37	15,917	1
HH 1	3	208	0
PVER 1	67	11,924	0
PVER 2	4	757	0
YEW 1	111	3,974	0
Total	514	74,663	1

Average nightly call minutes (activity) and proportion of nights occupied (occupancy) of pale Townsend's big-eared bats at each conservation area identified by the Kaleidoscope auto-classifier ranged widely across sites and years, with occupancy generally reflecting seasonal patterns of activity (figures 19 and 20). The greatest average nightly call minutes during the 2015 season were recorded at CVCA 1, followed by YEW 1, BLCA 1, AKTP 1, and Crane Roost (figure 19). The greatest average nightly call minutes during the 2016 season were recorded at YEW 1, followed by CVCA 1, PVER 1, and AKTP 1. The greatest average nightly call minutes recorded during the 2017 season were recorded at BLCA 1, followed by CVCA 1, YEW 1, and PVER 1. No activity for pale Townsend's big-eared bats was recorded at AKTP 1, CVCA 2, HH 1, or PVER 2 during the 2017 season. The greatest average nightly call minutes during the 2018 season were recorded at BLCA 1, followed by PVER 1, Crane Roost, AKTP, CVCA 2, and PVER 2. No activity was recorded at CVCA 1, HH 1, or YEW 1 in 2018. The greatest average nightly call minutes were recorded during the 2016 season for pale Townsend's big-eared bats and the least during 2018.

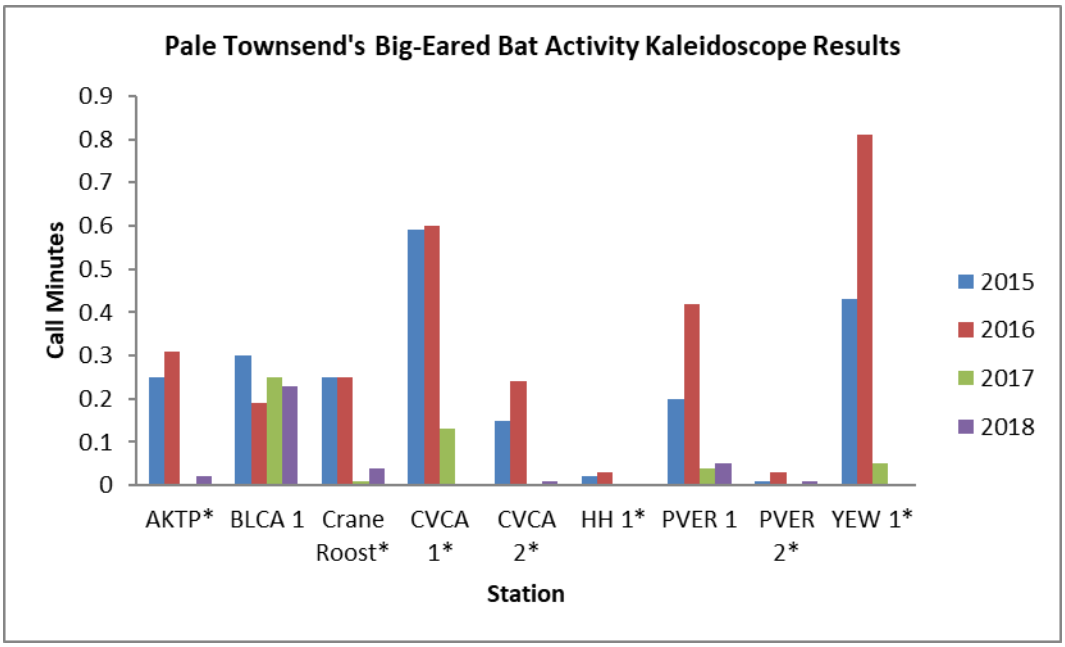

Figure 19.—Pale Townsend's big-eared bat activity Kaleidoscope results station comparison.
* Station malfunction occurred at station.

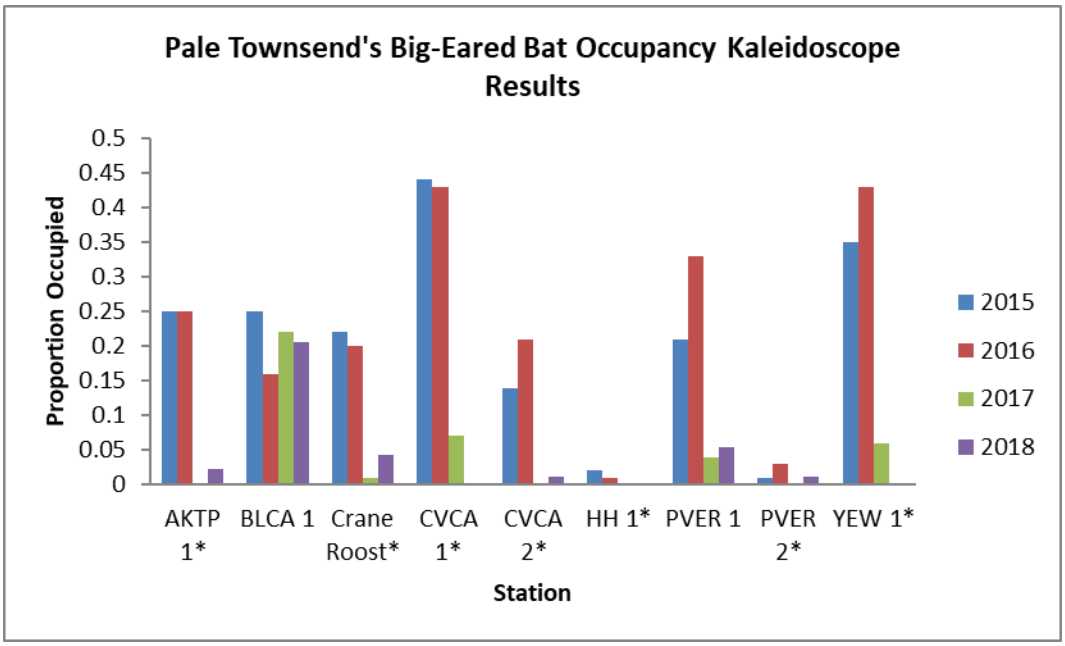

Figure 20.—Pale Townsend's big-eared bat occupancy Kaleidoscope results station comparison.
* Station malfunction occurred at station.

Other Species

The Kaleidoscope auto-classifier has 12 species classifiers for the study area: pallid bat (ANPA), pale Townsend's big-eared bat (PTBB), big brown bat (EPFU), spotted bat (EUMA), western mastiff bat (EUPE), western red bat (WRBA), hoary bat (LACI), California myotis (MYCA), Arizona myotis (MYOC), Yuma myotis (MYYU), canyon bat (PAHE), and Mexican free-tailed bat (TABR).

AKTP 1

TABR had the greatest 4-year average nightly call minutes (664.81) for any species at AKTP 1 detected by the Kaleidoscope auto-classifier from 2015 through 2018 (figure 21). This was largely driven by the station recording 1,066 average nightly call minutes for TABR during 2017 and 1,529 in 2018, which is the greatest yearly average nightly call minutes by far recorded for a single species. The station recorded poor-quality calls in 2017 and 2018, which may have led to numerous calls being misidentified as TABR. Conversely, if these are actual TABR calls, it would suggest that they may be utilizing a new, nearby roost. Other species with high 4-year average activity levels at AKTP 1 were MYOC and PAHE. MYOC activity rebounded from a low in 2017, while PAHE activity has decreased from the 2015 and 2016 seasons. The greatest yearly average nightly call minutes at AKTP 1 occurred during the 2018 season, due to the extremely large number of TABR calls recorded. The 2018 average nightly call minutes were followed by 2017, 2016, and 2015.

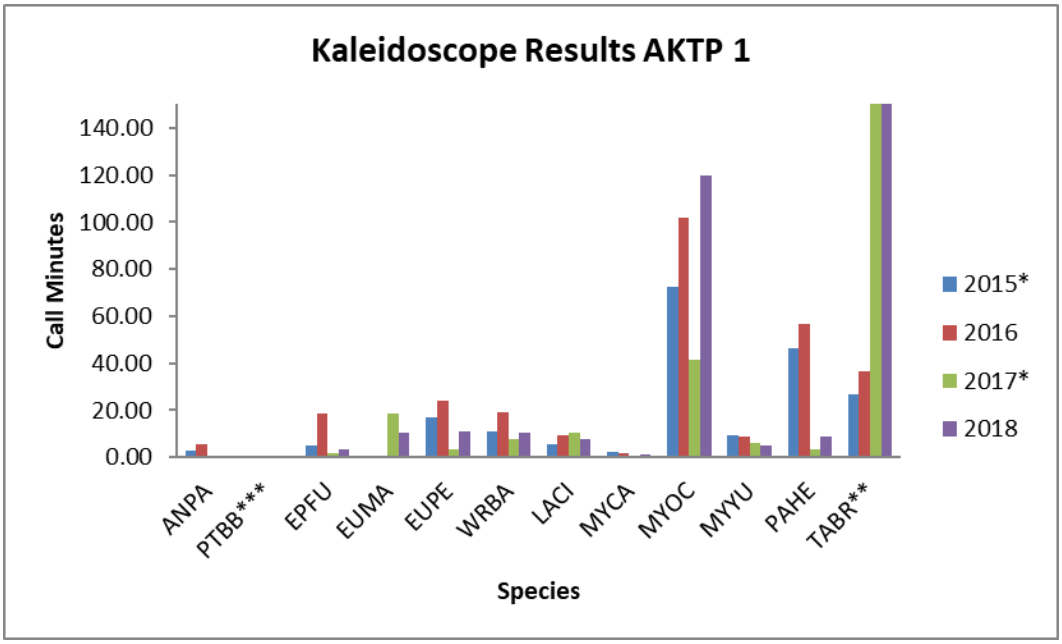

Figure 21.—Kaleidoscope results for 2015, 2016, 2017, and 2018 at AKTP 1.
* Station malfunction leading to partial monthly data collected in June and July of 2015 and 2017. ** TABR is actually 1,066 in 2017 and 1,529 in 2018. ***PTBB results that are too low to display on the figure were 0.18 in 2015, 0.32 in 2016, 0 in 2017, and 0.02 in 2018.

BLCA 1

PAHE had the greatest 4-year average nightly call minutes from 2015 through 2018 (134.28) for any species detected at BLCA 1 by the Kaleidoscope auto-classifier (figure 22). Other species with high 4-year average activity levels at BLCA 1 were MYOC, MYYU, and WRBA. The greatest yearly average nightly call minutes at BLCA 1 occurred during the 2016 season, followed by 2015, 2017, and 2018.

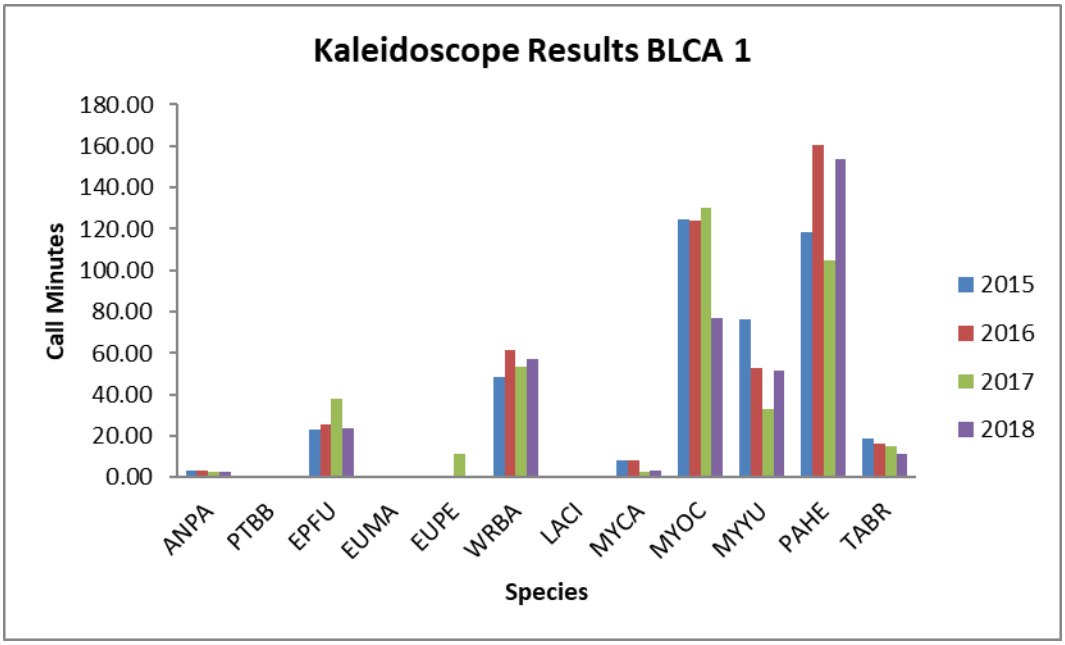

Figure 22.—Kaleidoscope results for 2015, 2016, 2017, and 2018 at BLCA 1.

Crane Roost

PAHE also had the greatest 4-year average nightly call minutes from 2015 through 2018 (100.23) for any species detected at Crane Roost by the Kaleidoscope auto-classifier (figure 23). Other species with high 4-year average activity levels at Crane Roost were MYYU and MYOC. EPFU, EUMA, EUPE, WRBA, and TABR all had substantial increases in yearly average activity during 2018 compared to 2015 through 2017. The greatest yearly average nightly call minutes at Crane Roost occurred during the 2018 season, followed by 2016, 2017, and 2015.

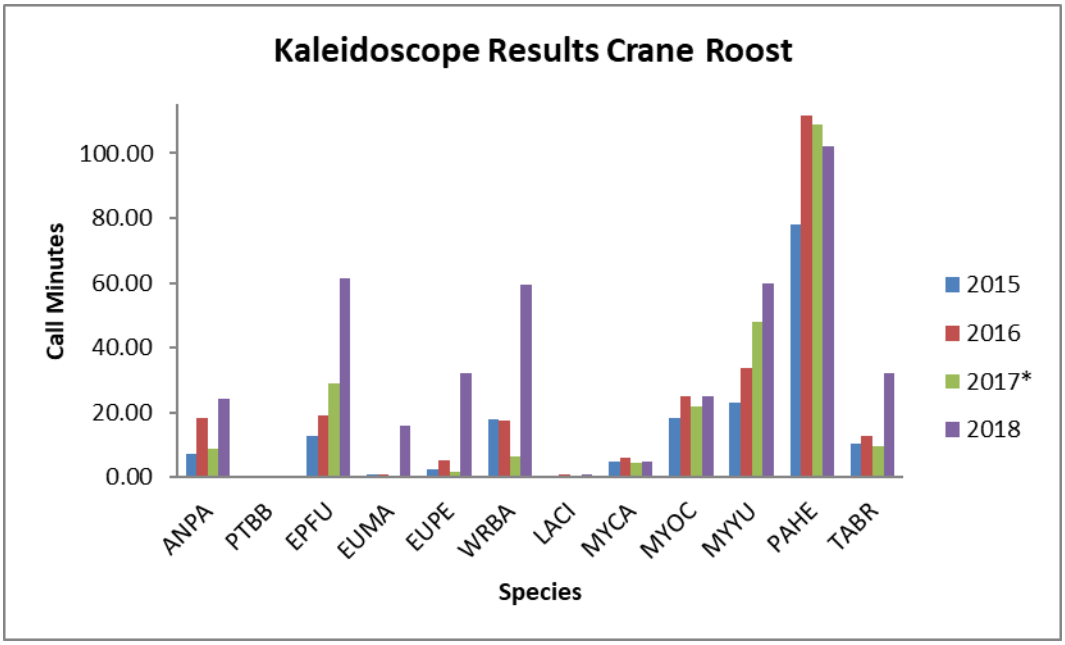

Figure 23.—Kaleidoscope results for 2015, 2016, 2017, and 2018 at Crane Roost.
* Station malfunction leading to partial monthly data collected in June 2016 and June and July of 2017.

CVCA 1

TABR had the greatest 4-year average nightly call minutes from 2015 through 2018 (198.60) for any species detected at CVCA 1 by the Kaleidoscope auto-classifier (figure 24). Other species with high 4-year average activity levels at CVCA 1 were EPFR and PAHE. The greatest yearly average nightly call minutes at CVCA 1 occurred during the 2016 season, followed by 2015. A sharp drop in acoustic activity at CVCA 1 for all species occurred in 2017 and 2018.

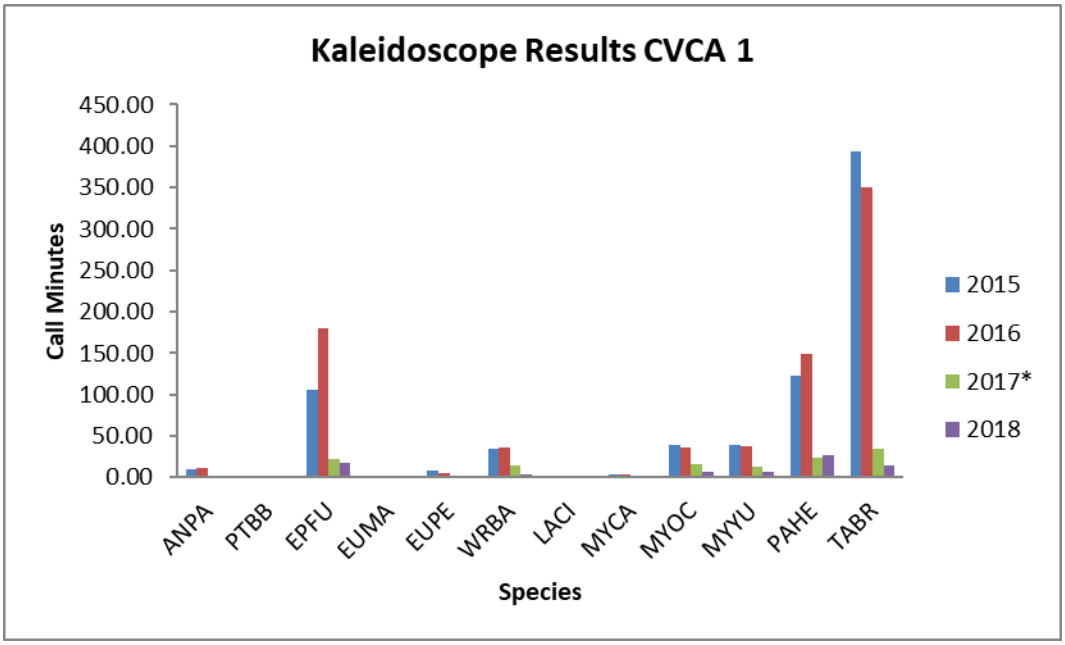

Figure 24.—Kaleidoscope results for 2015, 2016, 2017, and 2018 at CVCA 1.
* Station malfunction leading to no data collected in June 2017 and partial monthly data collected in July and August of 2017. Partial monthly data also collected in June 2018.

CVCA 2

MYYU had the greatest 4-year average nightly call minutes from 2015 through 2018 (98.22) for any species detected at CVCA 2 by the Kaleidoscope auto-classifier (figure 25). Other species with high 4-year average activity levels at CVCA 2 were PAHE, EPFU, MYOC, and TABR. The greatest yearly average nightly call minutes at CVCA 2 occurred during the 2018 season, followed by 2017, 2016, and 2015.

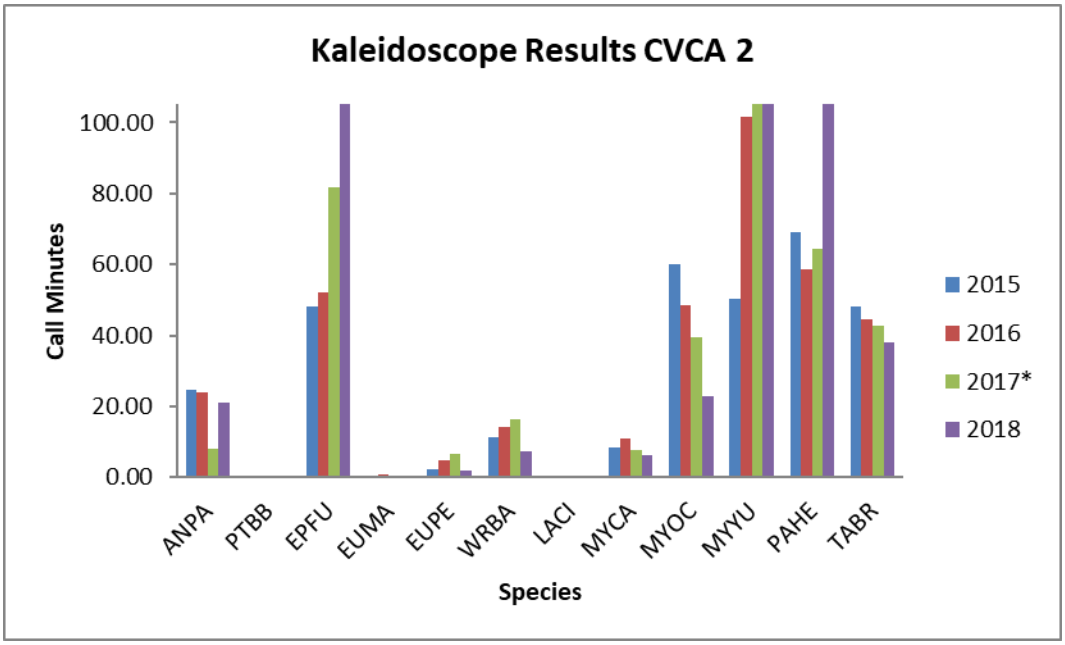

Figure 25.—Kaleidoscope results for 2015, 2016, 2017, and 2018 at CVCA 2.
* Station malfunction led to partial monthly data collected in June 2017.

HH 1

EUPE had the greatest 4-year average nightly call minutes from 2015 through 2018 (15.68) for any species detected at HH 1 by the Kaleidoscope auto-classifier (figure 26). Other species with high 4-year average activity levels at HH 1 were MYYU and TABR. The greatest yearly average nightly call minutes at HH 1 occurred during the 2018 season, followed by 2017, 2016, and 2015.

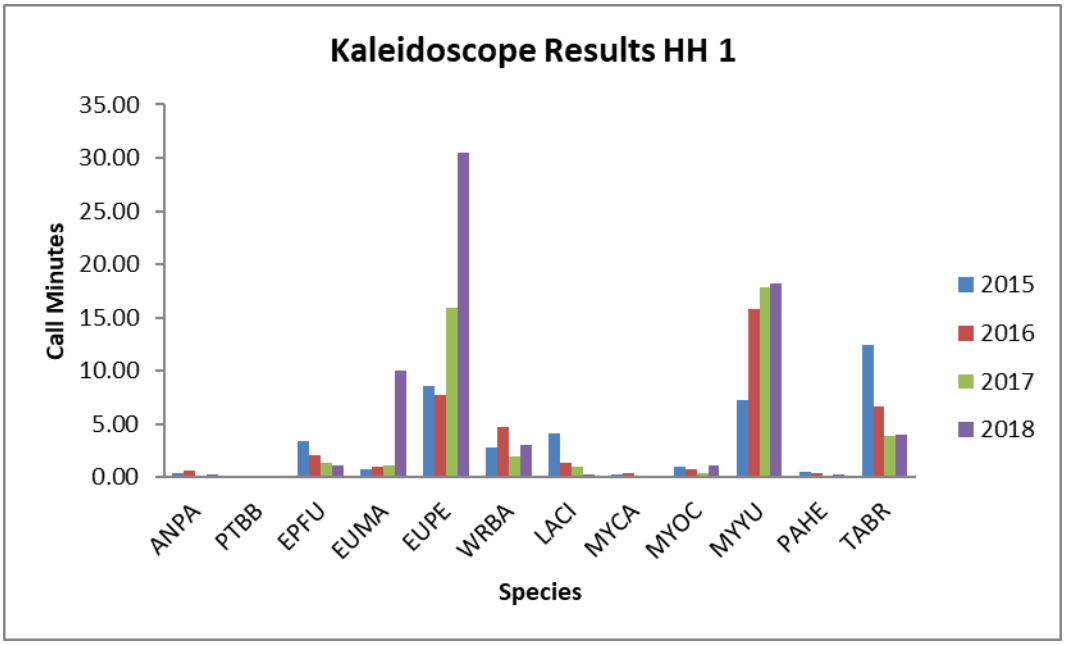

Figure 26.—Kaleidoscope results for 2015, 2016, 2017, and 2018 at HH 1.
* Station malfunction led to partial monthly data collected in June and July of 2017 and July and August of 2018.

PVER 1

TABR had the greatest 4-year average nightly call minutes from 2015 through 2018 (176.98) for any species detected at PVER 1 by the Kaleidoscope auto-classifier (figure 27). Other species with high 4-year average activity levels at PVER 1 were PAHE and EPFU. The greatest yearly average nightly call minutes at PVER 1 occurred during the 2016 season, followed by 2017, 2015, and 2018.

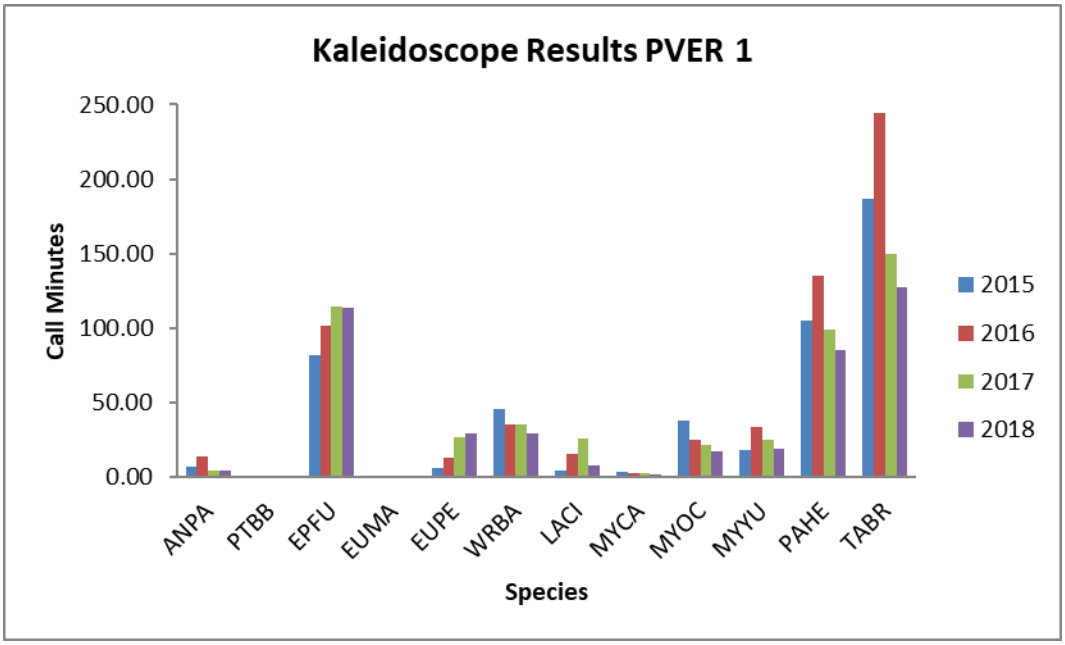

Figure 27.—Kaleidoscope results for 2015, 2016, 2017, and 2018 at PVER 1.

PVER 2

PAHE had the greatest 4-year average nightly call minutes from 2015 through 2018 (51.85) for any species detected at PVER 2 by the Kaleidoscope auto-classifier (figure 28). The other species with high 4-year average activity levels at PVER 2 were TABR and EPFU. ANPA, EPFU, EUPE, LACI, and PAHE all saw large increases in acoustic activity in 2018 compared to the 2015 through 2017 seasons. The greatest yearly average nightly call minutes at PVER 2 occurred during the 2018 season, followed by 2017, 2015, and 2016.

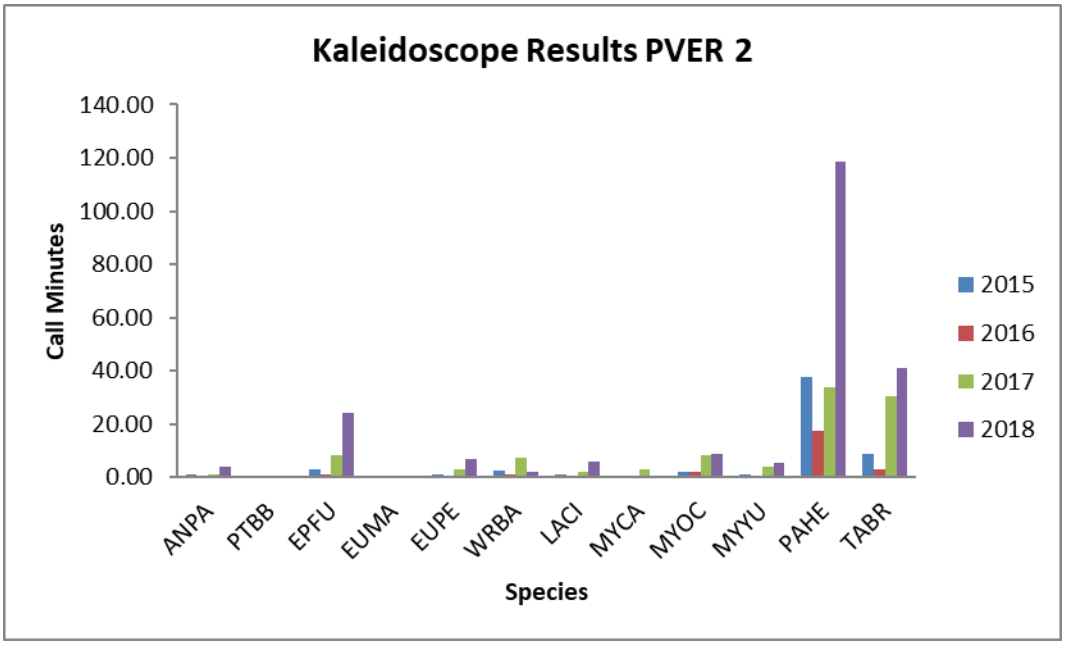

Figure 28.—Kaleidoscope results for 2015, 2016, 2017, and 2018 at PVER 2.
* Station malfunction leading to partial monthly data collected in June and August of 2015, June 2016, July 2017, and June 2018. No data collected in July 2015 or June 2017.

YEW 1

TABR had the greatest 4-year average nightly call minutes from 2015 through 2018 (74.05) for any species detected at YEW 1 by the Kaleidoscope auto-classifier (figure 29). The other species with high 4-year average activity levels at YEW 1 were EPFU, MYYU, ANPA, and PAHE. A spike in canyon bat calls was documented in 2016, and a spike in EUPE calls was recorded in 2017. The greatest yearly average nightly call minutes at YEW 1 occurred during the 2016 season, followed by 2015 and 2017, with a large drop in activity recorded in 2018.

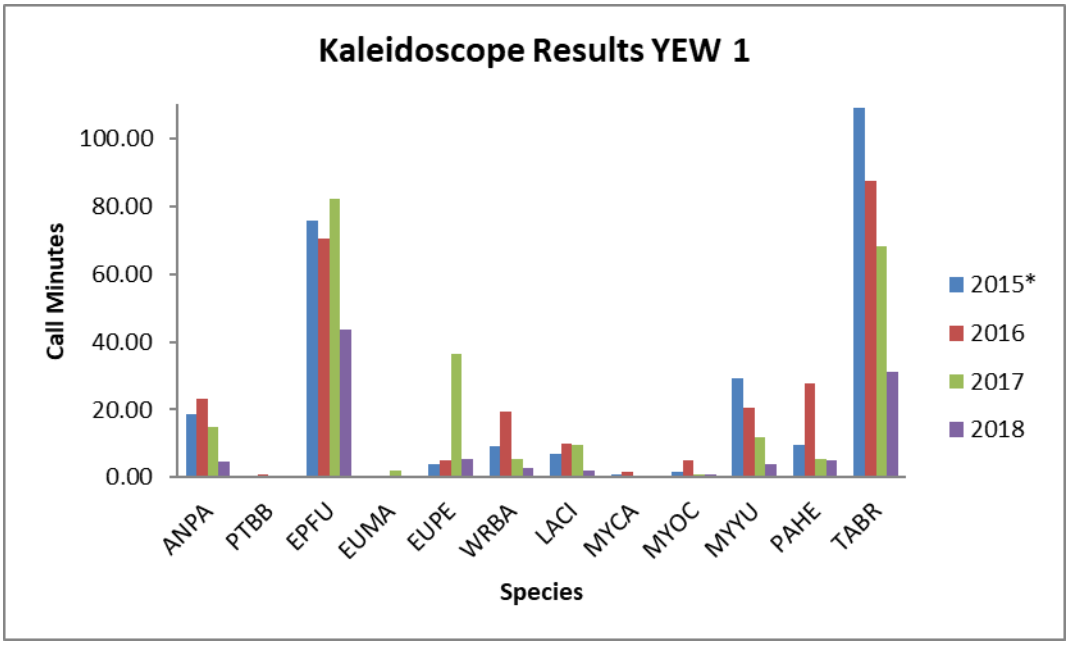

Figure 29.—Kaleidoscope results for 2015, 2016, 2017, and 2018 at YEW 1.
* Station malfunction leading to partial monthly data collected in June 2015 and July and August of 2018.

DISCUSSION

Through the Analook visual verification method, the greatest activity and occupancy for western red and yellow bats were detected at CVCA 1 and PVER 1, and at CVCA 2 and Crane Roost for California leaf-nosed bats. One pale Townsend's big-eared bat call was detected through the Analook visual verification methods at CVCA 2 in 2017, and they were recorded with the greatest activity and occupancy with the Kaleidoscope auto-classifier at YEW 1 and CVCA 1 from 2015 to 2016 and at BLCA 1 from 2017 to 2018. The Kaleidoscope auto-classifier appears to overestimated western red bat activity and occupancy but has the potential to be useful for pale Townsend's big-eared bat calls. The greatest activity across all species for the Kaleidoscope auto-classifier was detected at AKTP 1, followed by PVER 1 and CVCA 1. An extremely large number of calls were classified as Mexican free-

tailed bats in 2017 and 2018 at AKTP 1, leading to this location overtaking CVCA 1 and PVER 1 in recorded Kaleidoscope auto-classifier activity. The calls at AKTP 1 may be the result of insect noise, vegetation being too close to the microphone, or a problematic microphone. The Kaleidoscope auto-classifier results at this site should be viewed skeptically, as there has not been a full examination into what is causing this spike in activity.

Western Red Bat

Western red bat average nightly call minutes and proportion of nights occupied were recorded to be greatest at PVER 1 and CVCA 1 from 2015 through 2018. These stations are located in the most mature and complex vegetation of the conservation areas. The PVER and CVCA are also the largest continuous tracts of conservation area habitat and provide important foraging area and roosting locations for western red bats along the LCR. The greatest nightly call minutes and proportion of nights occupied at CVCA 1 occurred in July. The greatest nightly call minutes at PVER 1 occurred in July, but the greatest proportion of nights occupied occurred in August, which coincides with the time of year juvenile bats become volant. While CVCA 1 had the second greatest activity and occupancy from 2015 through 2018, a large decrease in activity and occupancy was documented from 2017 (0.83 and 0.37) to 2018 (0.25 and 0.16), making CVCA 1 the acoustic monitoring station with just the fifth greatest activity and sixth greatest occupancy in 2018. A station malfunction in June 2018 led to 10 nights of downtime for the recorder, but it does not explain the precipitous drop in activity at this site in 2018.

The greatest average nightly call minutes were recorded across all sites in 2015, but the 2017 season contained the greatest proportion of nights occupied for western red bats. Thus, activity was higher but concentrated over less nights in 2015 near the acoustic monitoring stations compared to 2017. The 2016 season contained the lowest proportion of nights occupied across all sites but had the third greatest activity. The 2018 season had the lowest activity recorded from 2015 to 2018 but had the second greatest occupancy. In assessing average nightly call minutes and proportion of nights occupied, it was found that average nightly call minutes fluctuate and display greater variations between years than proportion of nights occupied. In a given year, habitat near a detector may be optimal for a roost, maternity roost, or foraging, leading to an increase in average nightly call minutes but not necessarily nights occupied. The vegetation structure or prey base may change the following season, becoming less optimal near the detector but perhaps more optimal elsewhere in a conservation area. This leads to a decrease in average nightly call minutes near the detector site but does not reflect a true decrease in bat use across the entire conservation area. An example of this can be found at CVCA 1. If you relied solely on average nightly call minutes as an assessment of bat use, you would conclude that the 2016 season had a nearly twofold level of activity more than the 2015 season when, in fact, the 2015 season had a slightly higher proportion of

nights occupied. The alternative to this is comparing the 2016 and 2017 seasons. The 2017 season has roughly half the average nightly call minutes and proportion of nights occupied than the 2016 season; therefore, the proportion of nights occupied may be the best way to describe bat use through acoustic detectors at conservation areas.

While the Kaleidoscope auto-classifier results were similar to the visual call verification method (in that they generally identified the sites with the greatest and lowest activity levels), they considerably overestimated western red bat activity at the conservation areas. If only the Kaleidoscope results were relied upon to assess bat use, BLCA 1 would have been the acoustic monitoring station with the greatest western red bat activity from 2015 to 2017. Through the verification method, BLCA 1 had the third greatest activity and occupancy for western red bats, behind CVCA 1, CVCA 2, and PVER 1 from 2015 to 2017. Crane Roost would have the greatest activity in 2018 based on Kaleidoscope results. Through visual verification, Crane Roost had the fourth greatest activity and occupancy in 2018, behind PVER 1, CVCA 2, and BLCA 1. Previous capture surveys also support our verification methods, as captures for western red bats were greatest at the Palo Verde Ecological Reserve and Cibola Valley Conservation Area. The Kaleidoscope auto-classifier works much like the Analook filters but is considered to be more sophisticated in terms of analyzing call parameters for identification of each species. The Kaleidoscope auto-classifier identified more potential western red bat calls than the Analook filters overall, but differences between the results from these methods varied among monitoring sites, with the Analook filters identifying more potential calls at several locations. The greater potential western red bat calls identified by the Kaleidoscope auto-classifier likely represent misidentified calls from other species (canyon bat), but we cannot discount that the Kaleidoscope auto-classifier may have identified some western red bat calls the Analook filters did not detect. An indepth comparative analysis between these two methods was not an objective for this report, but it could prove to be useful as a management tool as its fit is improved in the future. Because these methods identify a different number of calls, which could potentially impact the verified results, it would be useful to determine which method identifies the greater number of verified calls.

Western Yellow Bat

Like western red bats, western yellow bats were recorded with the greatest average nightly call minutes and proportion of nights occupied at CVCA 1 and PVER 1. The CVAC and PVER are large, complex conservation areas that provide important edge habitat for foraging western yellow bats. The greatest average nightly call minutes and proportion of nights occupied occurred in July at CVCA 1 and August at PVER 1 from 2015 through 2018. Western yellow bats were also recorded with high average nightly call minutes and proportion of nights occupied at AKTP 1 in across the 2015 and 2016 seasons; however, they were not documented at AKTP 1

in 2017 and 2018. This is likely the result of insect/vegetation noise or a problematic microphone rather than a true absence, as they were consistently documented at AKTP 1 through capture surveys. Western yellow bats were recorded with high activity and occupancy at YEW 1 from 2015 through 2017, but detections decreased in 2018. This decrease is likely due to the detector being operable for only 37 nights and mostly during June, which typically sees the least amount of activity. Like western red bats, larger fluctuations and disparities among average nightly call minutes were noted versus proportion of nights occupied. The largest disparity occurred at CVCA 1, with 16.81 average nightly call minutes being recorded during the 2015 season versus 4.22 during the 2016 season. The difference in proportion of nights occupied between the two seasons was 0.97 in 2015 versus 0.91 in 2016, which equates to a difference of 5 nights. Another disparity to note is between YEW 1 and PVER 1 during the 2015 season. Average nightly call minutes at PVER 1 were 6.12 versus 2.55 at YEW 1, while YEW 1 actually had a slightly higher proportion of nights occupied (0.70 versus 0.68). PVER 1 also differed between years, with average nightly call minutes during 2015 (6.12) greatly surpassing 2016 (1.93) and 2017 (2.3). The proportion of nights occupied between 2015 (0.68), 2016 (0.63), and 2017 (0.58) did not show such a large disparity. Western yellow bat activity and occupancy decreased substantially after the 2015 season, remained stable from 2016 through 2017, then dropped again in 2018 across all sites. The reasons for this decrease are unknown at this time. Western yellow bat activity has not been recorded in greater magnitudes at the system-wide acoustic detectors from 2015 through 2018, so they have not shifted their activity to these areas. They may be foraging in different parts of the conservation areas as they mature, or it may be a true decrease in activity and occupancy along the LCR at conservation areas.

The majority of western yellow bat activity and occupancy occurs later in summer during the months of July and August, with no station documenting its greatest activity in June. Like western red bats, western yellow bat young typically become volant in July, which would lead to the increased activity observed in July and August. Western yellow bats are also believed to be migratory along the LCR. No Kaleidoscope auto-classifier exists for western yellow bats; however, developers are in the process of designing one (Agranat 2017, personal communication) that may be useful for future analysis.

California Leaf-nosed Bat

California leaf-nosed bats were recorded in low numbers across the 2015 and 2016 seasons in the nine conservation areas. These bats produce a low-amplitude call that is difficult to detect through acoustic methods. California leaf-nosed bats were not detected at PVER 2 from 2015 through 2018. The greatest average nightly call minutes and proportion of nights occupied occurred at CVCA 2, followed by Crane Roost and BLCA 1 from 2015 through 2018. The 2017 and 2018 seasons displayed a considerable increase in activity and occupancy over 2015 and 2016. This

increase is difficult to attribute to any one factor but may be that these conservation areas are maturing and harboring a favorable prey base for California leaf-nosed bats, and they are beginning to rely on these sites for a larger portion of their diet. No Kaleidoscope auto-classifier exists for California leaf-nosed bats; however developers are in the process of designing one (Agranat 2017, personal communication) that may be useful for future analysis.

Pale Townsend's Big-eared Bat

Pale Townsend's big-eared bats were not recorded at any conservation area with Analook visual verification methods during the 2015, 2016, or 2018 seasons; only a single call was verified at CVCA 2 in August 2017. These bats emit an extremely low-amplitude call that is difficult to detect using acoustic methods alone. The Kaleidoscope auto-classifier results recorded CVCA 1, YEW 1, and BLCA 1 as having the greatest average nightly call minutes and proportion of nights occupied from 2015 through 2018. The Kaleidoscope auto-classifier recorded pale Townsend's big-eared bat activity at every conservation area during 2015 and 2016. A lower number of calls were identified by the Kaleidoscope auto-classifier in 2017, with no activity recorded at ATKP 1, CVCA 2, HH 1, and PVER 2. The Kaleidoscope auto-classifier identified an even lower number of calls in 2018, with no activity recorded at CVCA 1, HH1, or YEW 1.

The Kaleidoscope auto-classifier identified an extremely low number of calls compared to the Analook filters. Where the Analook filters identified tens of thousands of calls as potential pale Townsend's big-eared bat calls, the Kaleidoscope auto-classifier identified hundreds. Given that a considerable amount of time is dedicated to visually verifying calls identified as potential pale Townsend's big-eared bat calls with little to no calls actually verified, the Kaleidoscope auto-classifier may be an efficient way to analyze these calls. A visual verification of the Kaleidoscope auto-classifier calls could be conducted to assess this method. Such a change in methods may not be warranted, as the continuity of data analysis for this long-term acoustic monitoring study could be compromised.

Other Species

The species with the second greatest average nightly call minutes at AKTP 1 was the Arizona myotis. The only known roost along the LCR for this species is located in a fan palm tree (*Washingtonia* sp.) less than 1km from AKTP 1. Previous capture results have confirmed that this species is present at AKTP 1 during the sampling period in considerable numbers. This species had the greatest average nightly call minutes at AKTP 1 until the 2017 season, which saw a drop in activity. Arizona myotis calls increased again in 2018 to the greatest recorded from 2015 through 2018.

A large number of calls during the 2017 and 2018 seasons at AKTP 1 were classified as Mexican free-tailed bats. The calls recorded at AKTP 1 during 2017 and 2018 were not the best quality calls due to a failing microphone, an object close to the microphone, and/or insect noise. This may have impacted the calls, which led to a large number being misidentified as Mexican free-tailed bat. Conversely, if these are actual Mexican free-tailed bat calls, it may be the result of a behavioral change due to a possible roost disturbance and/or a new roost being utilized nearby. Mexican free-tailed bat roost in extremely large numbers and have the ability to overwhelm an acoustic detector if they are roosting nearby and foraging in the vicinity of a detector. Average nightly call minutes for Mexican free-tailed bat in 2017 were comparable in June (1,246 per night) and August (1,323 per night), but July (254 per night) had much less activity. Mexican free-tailed bat activity was reduced (but still substantial) in 2018. with a different pattern emerging. Comparable activity was recorded in June (617 per night) and July (645 per night), with much less recorded in August (323 per night).

The species identified by the Kaleidoscope auto-classifier across all monitoring sites as having the greatest average nightly call minutes are Mexican free-tailed bats, canyon bats, big brown bats, and Yuma myotis. The greatest total average nightly call minutes identified by the auto-classifier for all species combined from 2015 through 2018 were recorded at AKTP 1, followed by PVER 1, CVCA 1, BLCA 1, CVCA 2, Crane Roost, YEW 1, PVER 2, and HH 1. These results for CVCA 1 and PVER 1 give support to the assertion that these large, mature, and complex conservation areas are providing important foraging and roosting habitat for not only LCR MSCP covered species but other species as well along the LCR. The activity at AKTP 1 in 2017 and 2018, which led to this site having the greatest activity identified by the Kaleidoscope auto-classifier for 2015–18, may be an anomaly (discussed above). Potential microphone, insect, and vegetation problems need to be addressed in order to clarify if this is a true influx of Mexican free-tailed bat activity or if these calls are being misidentified.

Assessing the four LCR MSCP bat species, it was found that western yellow bats were most prevalent, with the greatest activity and occupancy recorded across all conservation areas from 2015 through 2018. This is true even with the substantial decrease in activity starting in 2016. Western yellow bats are highly dependent on non-native palms for use as roosts, and as the acoustic data seem to indicate, planted conservation areas for foraging along the LCR. Western red bats are dependent on conservation areas for roosting, foraging, and maternity roosts. Their activity and occupancy fluctuates a bit between years and sites but overall has remained stable from 2015 through 2018. California leaf-nosed bats increased in verified activity in 2017 and 2018 and are foraging at conservation areas. Although pale Townsend's big-eared bats are difficult to detect acoustically, they are most likely relying on conservation areas as foraging sites. The majority of activity and occupancy for all species occurred during July and August, with larger, more mature, and complex vegetation seeing the greatest average nightly call minutes and proportion of nights occupied.

It is important to note that average nightly call minutes and proportion of nights occupied are two indexes of bat activity and do not translate to population estimates. A correlation of the acoustic and capture data being collected by Reclamation biologists at LCR MSCP conservation areas would further inform natural resource managers on bat activity and diversity at these sites, as it has been recorded that a combination of the methods was more successful in detecting bat species than either method alone (O'Farrell and Gannon 1999). Examining the capture data would be especially informative for California leaf-nosed bats and pale Townsend's big-eared bats, which emit low-intensity calls and are difficult to detect acoustically. Acoustic activity and occupancy are also being collected at system-wide sites along the LCR, which are located in habitat that has not been restored. A comparison between these sites and the conservation area sites would inform land managers on broader trends of bat activity and occupancy along the LCR.

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ATTACHMENT 1

Monthly Activity and Occupancy

MONTHLY ACTIVITY AND OCCUPANCY (USING THE ANALOOK VISUAL VERIFICATION METHODS)

Western Red Bat

AKTP 1

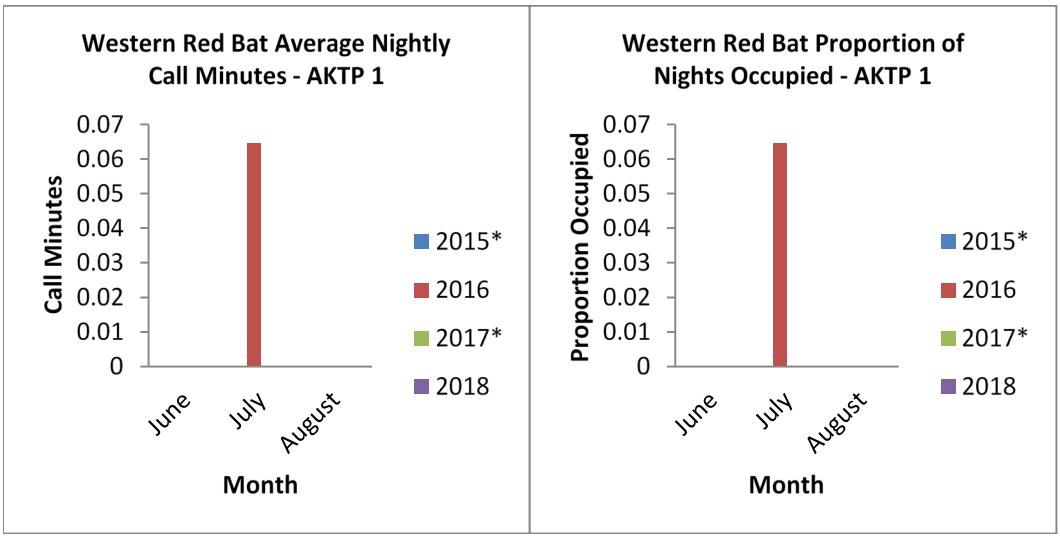

Figure 1-1.—Western red bat average nightly call minutes and proportion of nights occupied at AKTP 1, using Analook.

* Station malfunction leading to partial monthly data collected in June and July of 2015 and June and July 2017.

BLCA 1

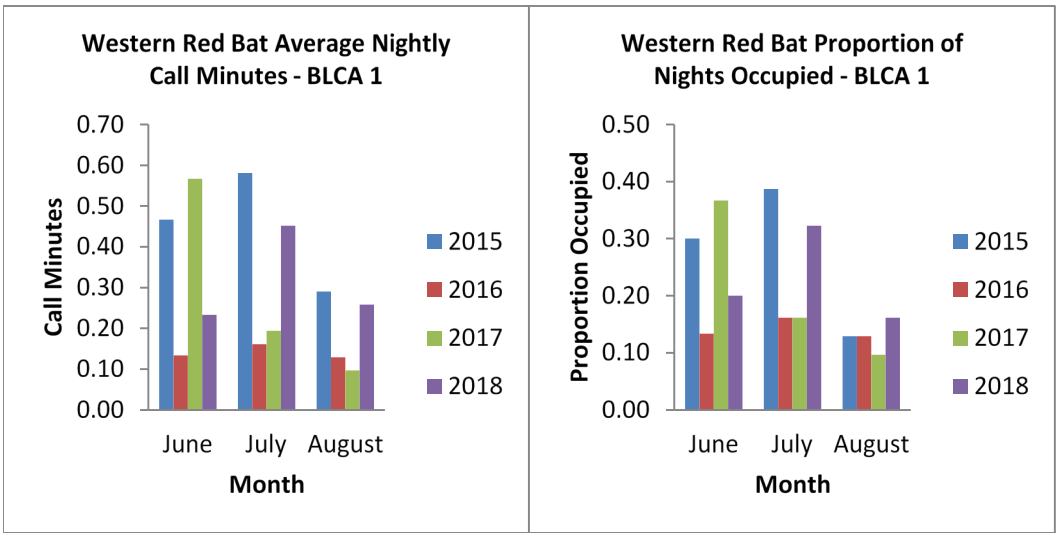

Figure 1-2.—Western red bat average nightly call minutes and proportion of nights occupied at BLCA 1.

Crane Roost

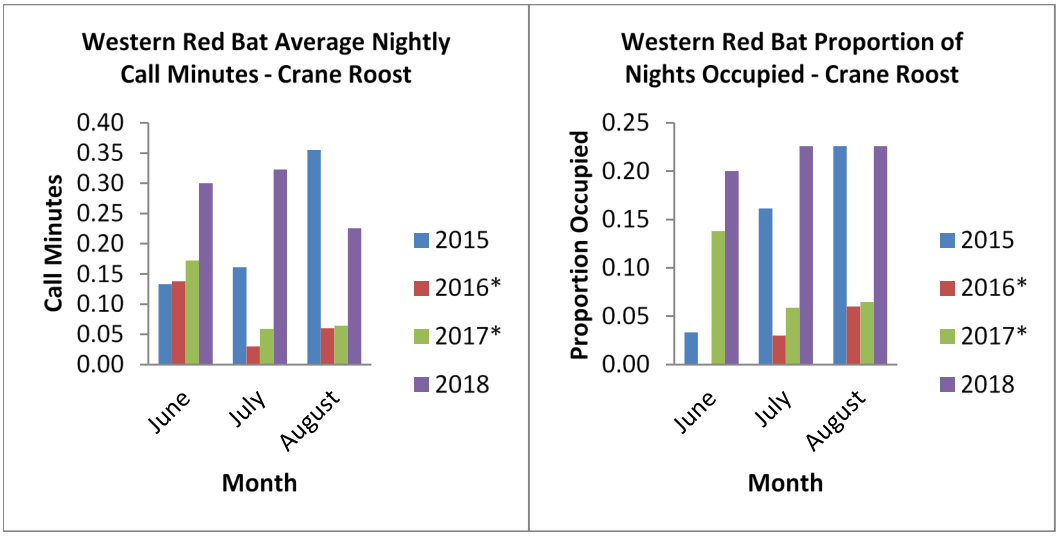

Figure 1-3.—Western red bat average nightly call minutes and proportion of nights occupied at Crane Roost, using Analook.

* Station malfunction leading to partial monthly data collected in June 2016 and June and July of 2017.

CVCA 1

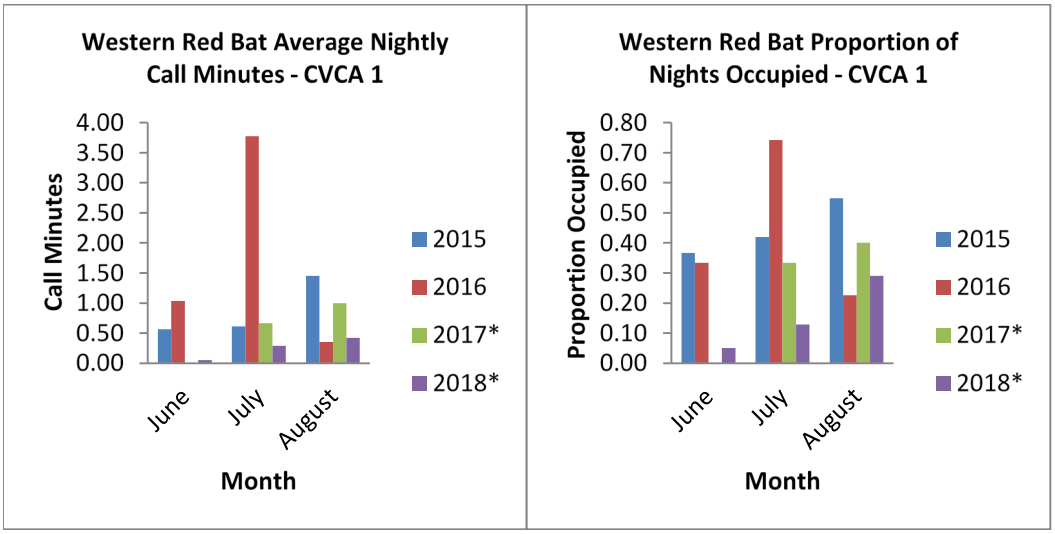

Figure 1-4.—Western red bat average nightly call minutes and proportion of nights occupied at CVCA 1, using Analook.

* Station malfunction leading to no data collected in June 2017 and partial monthly data collected in July and August of 2017 and June 2018.

CVCA 2

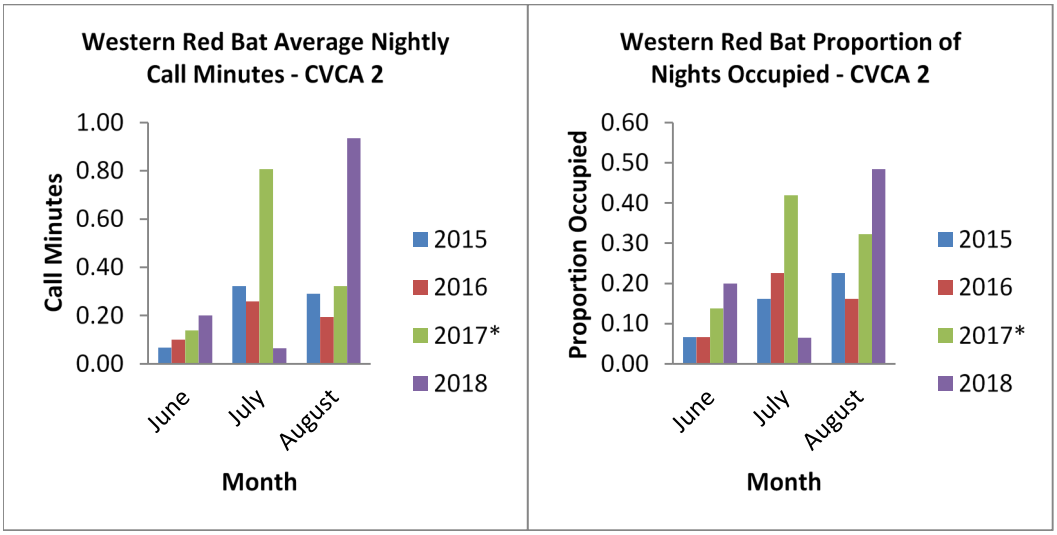

Figure 1-5.—Western red bat average nightly call minutes and proportion of nights occupied at CVCA 2, using Analook.

* Station malfunction led to partial monthly data collected in June 2017.

HH 1

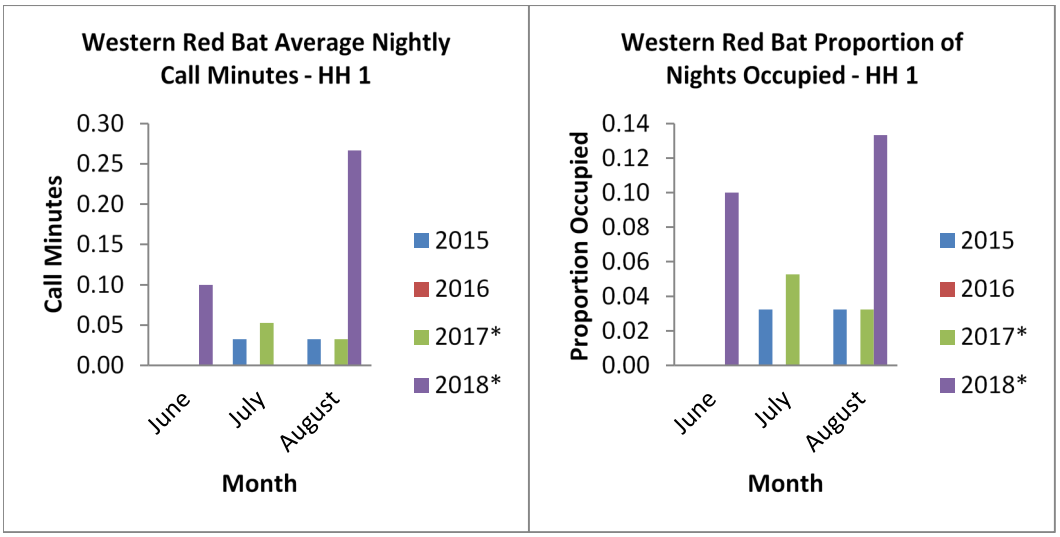

Figure 1-6.—Western red bat average nightly call minutes and proportion of nights occupied at HH 1, using Analook.

* Station malfunction led to partial monthly data collected in June and July of 2017 and only 2 nights of data in July 2018.

PVER 1

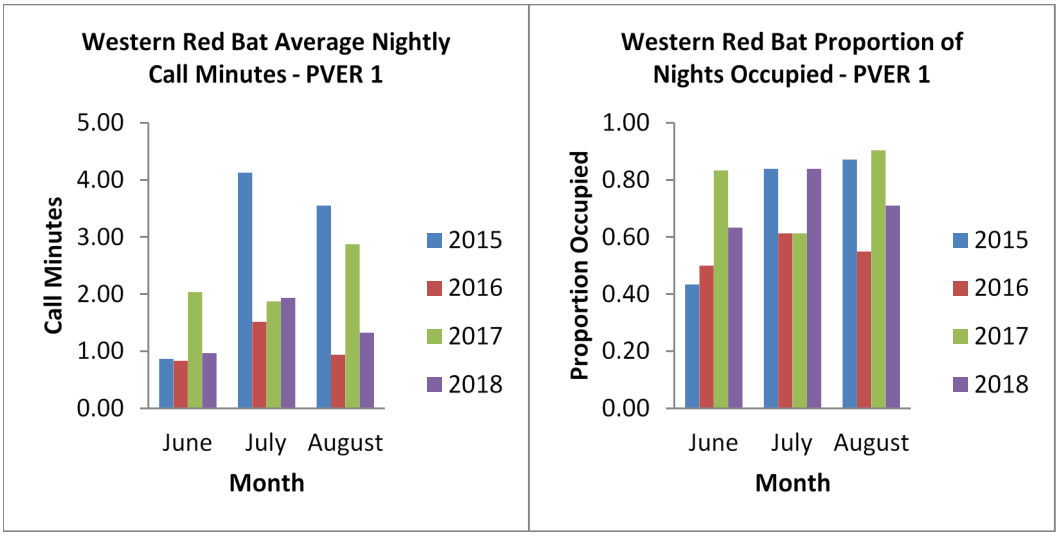

Figure 1-7.—Western red bat average nightly call minutes and proportion of nights occupied at PVER 1, using Analook.

PVER 2

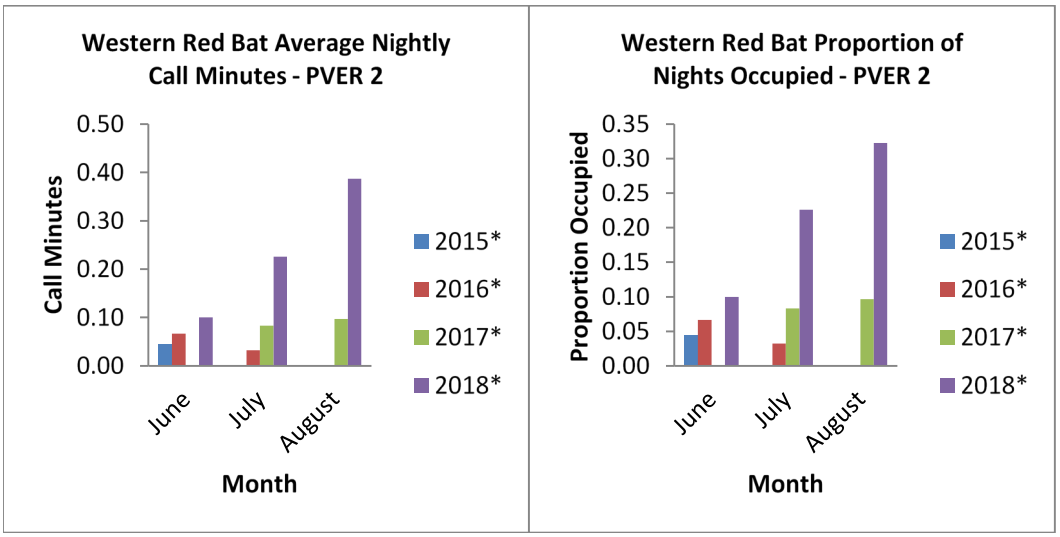

Figure 1-8.—Western red bat average nightly call minutes and proportion of nights occupied at PVER 2, using Analook.

* Station malfunction leading to partial monthly data collected in June and August of 2015, June 2016, July 2017, and June 2018. No data were collected in July 2015 or June 2017.

YEW 1

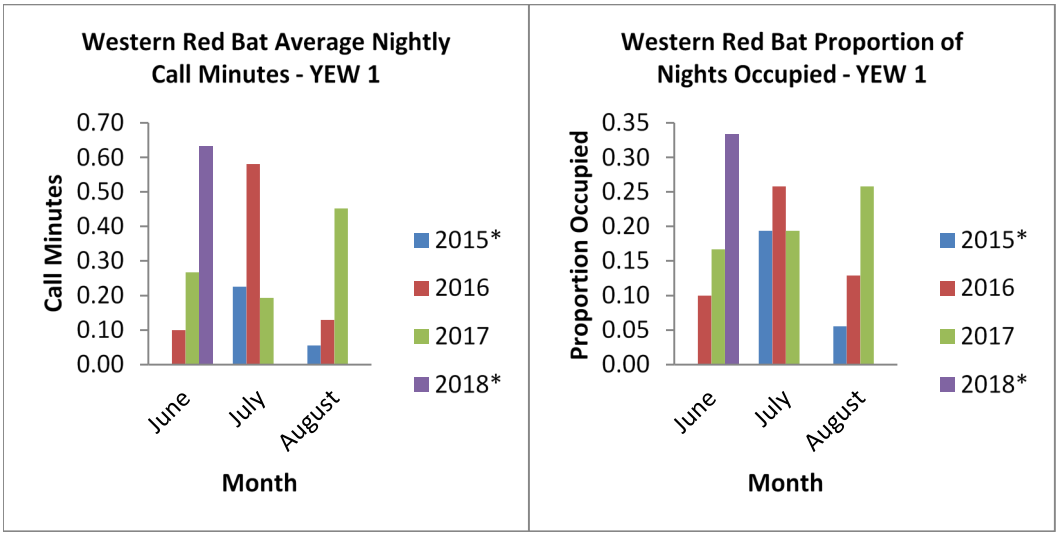

Figure 1-9.—Western red bat average nightly call minutes and proportion of nights occupied at YEW 1, using Analook.
* Station malfunction leading to partial monthly data collected in June 2015, July 2018, and August 2018.

Western Yellow Bat

AKTP 1

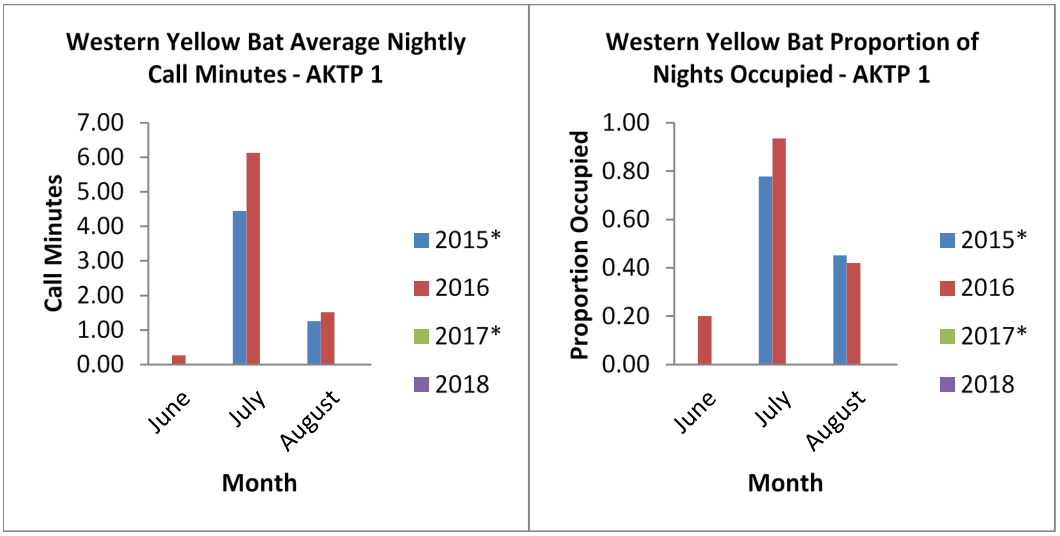

Figure 1-10.—Western yellow bat average nightly call minutes and proportion of nights occupied AKTP 1, using Analook.
* Station malfunction leading to partial monthly data collected in June and July of 2015 and June and July of 2017.

BLCA 1

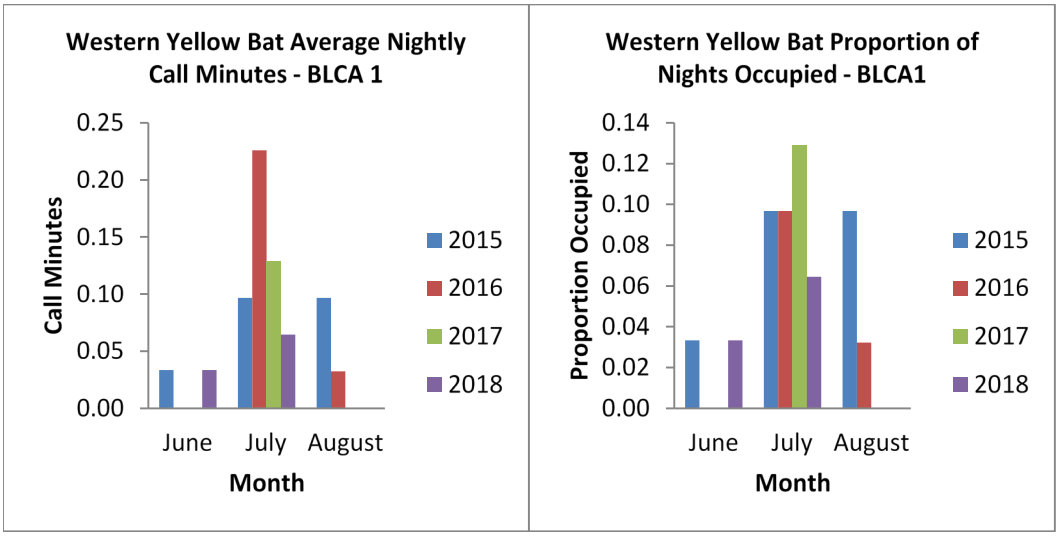

Figure 1-11.—Western yellow bat average nightly call minutes and proportion of nights occupied BLCA 1, using Analook.

Crane Roost

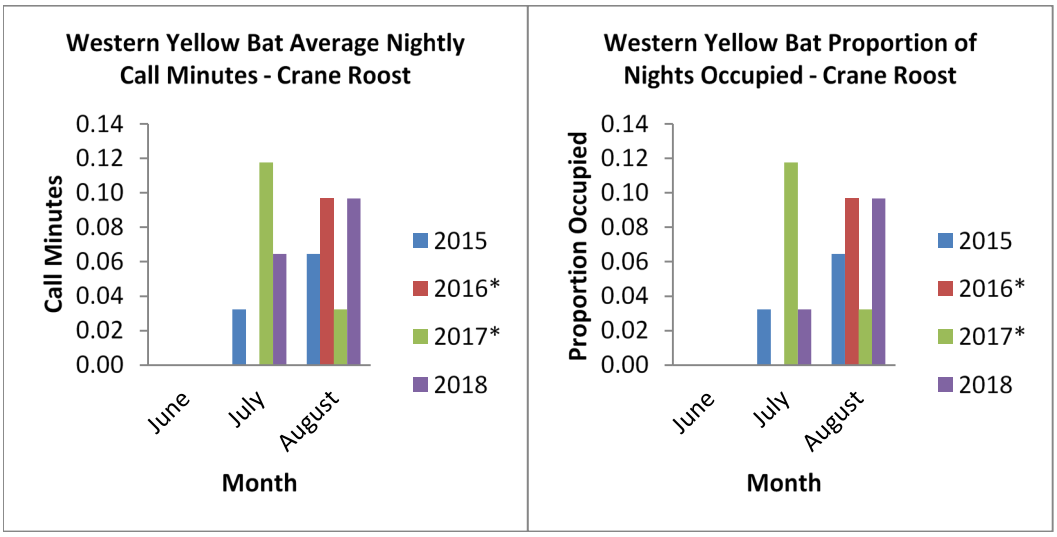

Figure 1-12.—Western yellow bat average nightly call minutes and proportion of nights occupied Crane Roost, using Analook.

* Station malfunction leading to partial monthly data collected in June 2016 and June and July of 2017.

CVCA 1

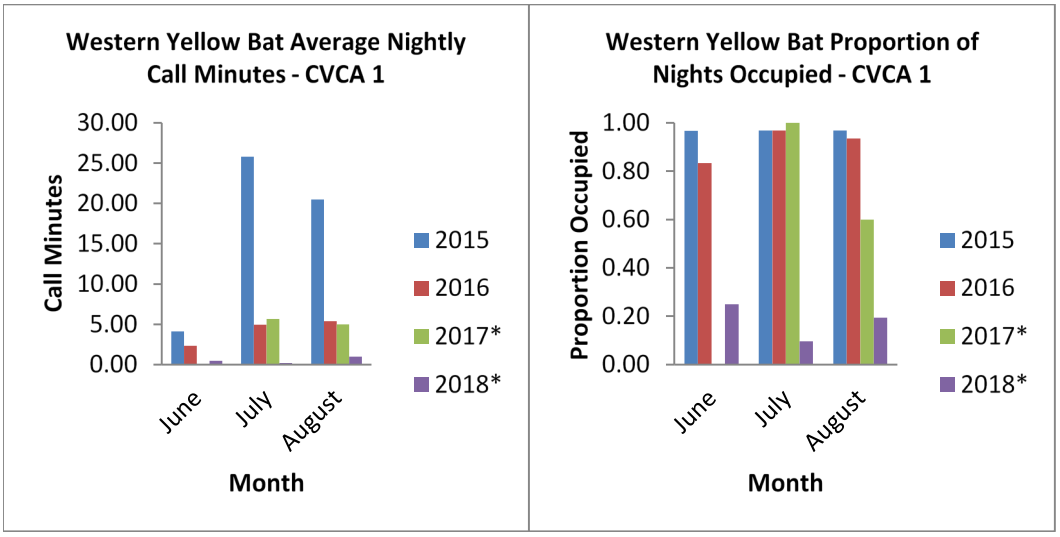

Figure 1-13.—Western yellow bat average nightly call minutes and proportion of nights occupied CVCA 1, using Analook.

* Station malfunction leading to no data collected in June 2017 and partial monthly data collected in July and August of 2017 and June 2018.

CVCA 2

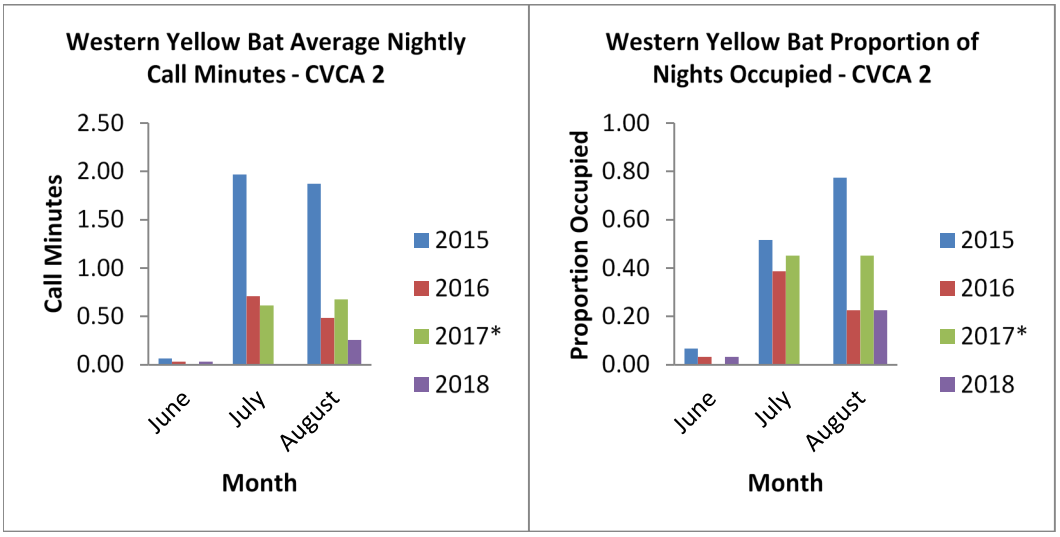

Figure 1-14.—Western yellow bat average nightly call minutes and proportion of nights occupied CVCA 2, using Analook.

* Station malfunction led to partial monthly data collected in June 2017.

HH 1

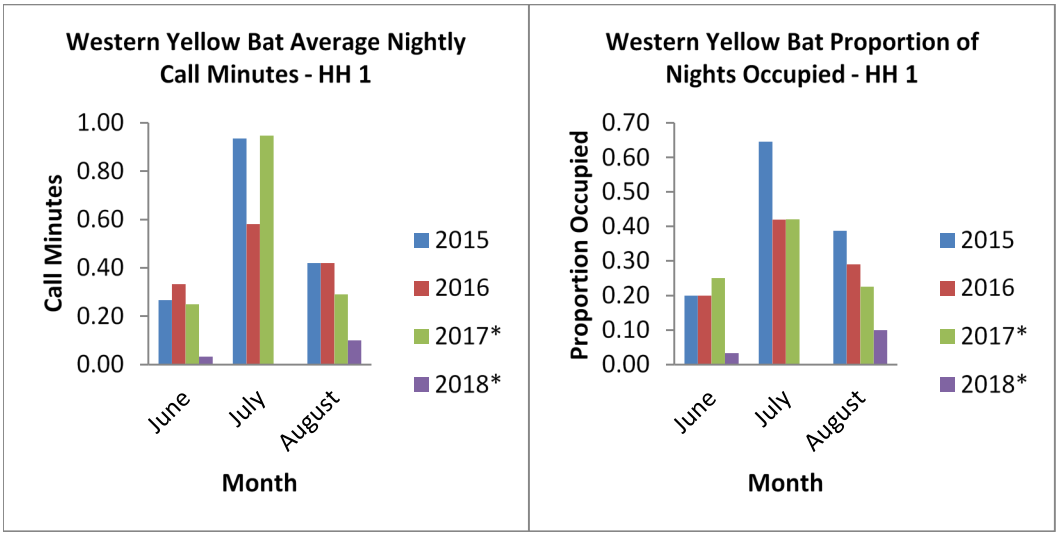

Figure 1-15.—Western yellow bat average nightly call minutes and proportion of nights occupied HH 1, using Analook.

* Station malfunction led to partial monthly data collected in June and July of 2017 and only 2 nights of data in July 2018.

PVER 1

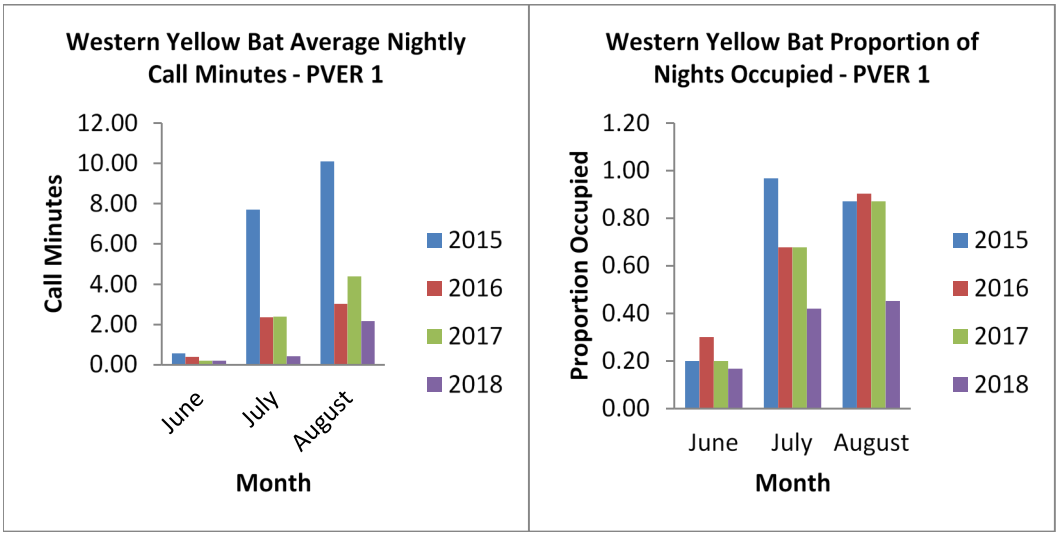

Figure 1-16.—Western yellow bat average nightly call minutes and proportion of nights occupied PVER 1, using Analook.

PVER 2

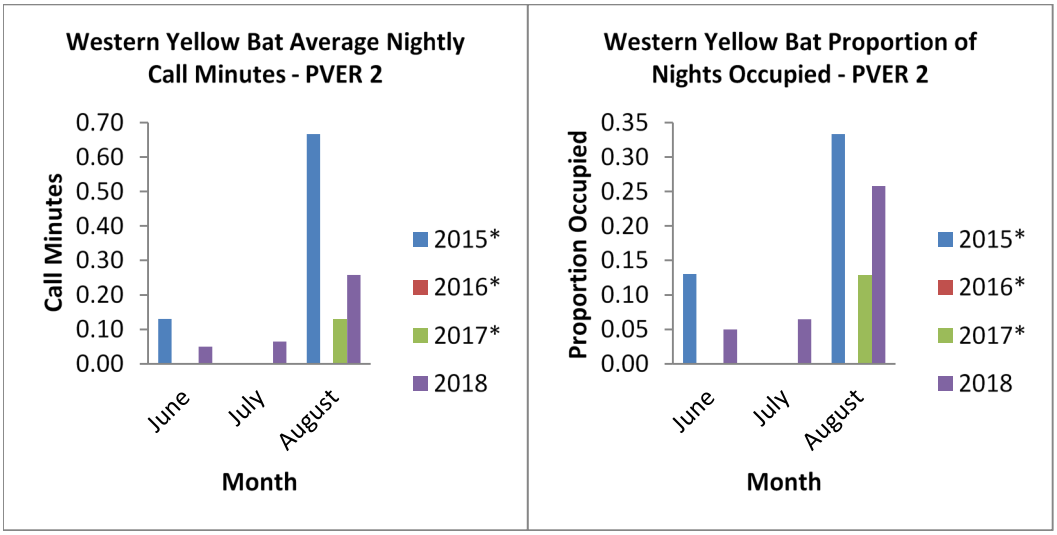

Figure 1-17.—Western yellow bat average nightly call minutes and proportion of nights occupied PVER 2, using Analook.

* Station malfunction leading to partial monthly data collected in June and August of 2015, June 2016, July 2017, and June 2018. No data were collected in July 2015 or June 2017.

YEW 1

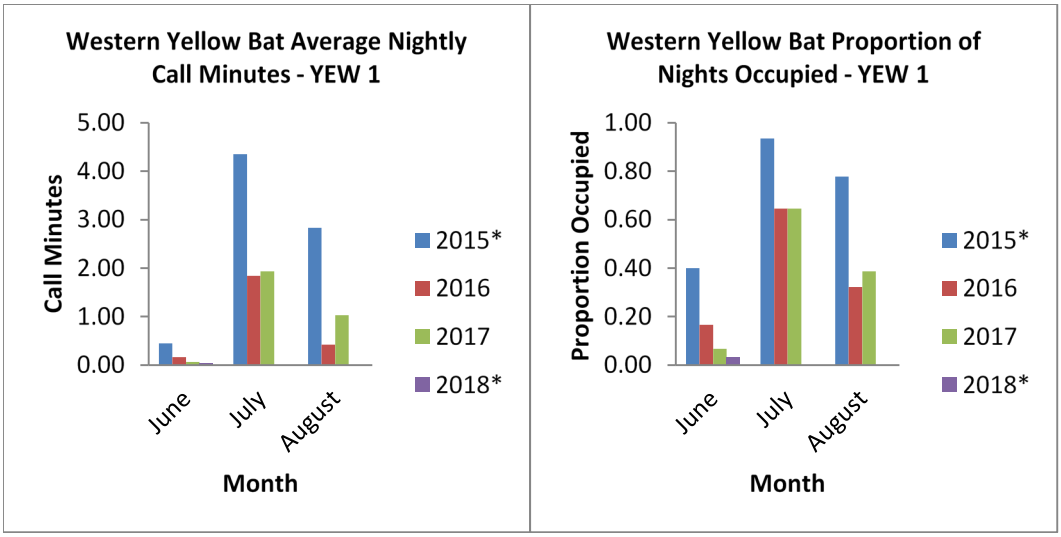

Figure 1-18.—Western yellow bat average nightly call minutes and proportion of nights occupied YEW 1, using Analook.

* Station malfunction leading to partial monthly data collected in June 2015 , July 2018, and August 2018.

California Leaf-nosed Bat

AKTP 1

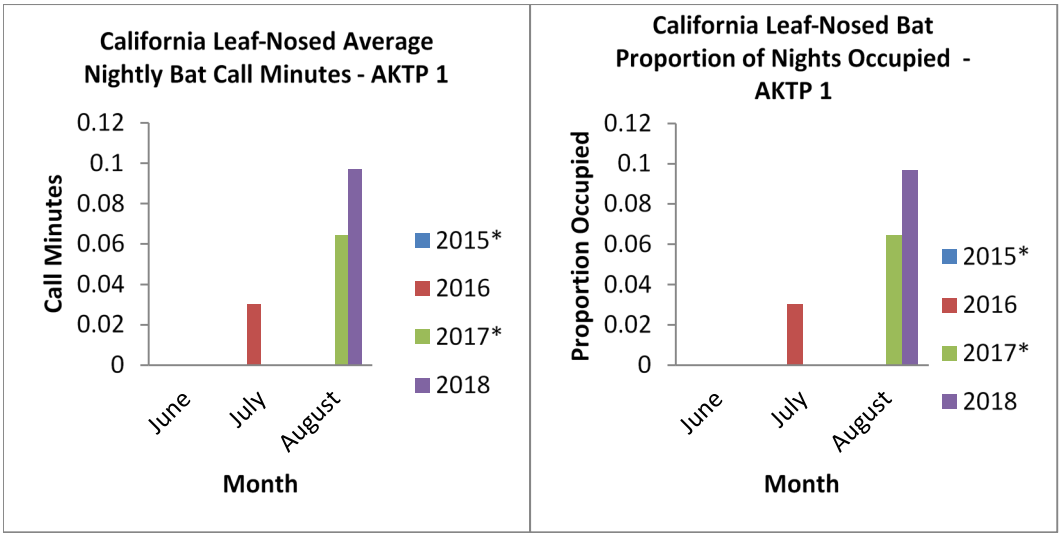

Figure 1-19.—California leaf-nosed bat average nightly call minutes and proportion of nights occupied AKTP 1, using Analook.

* Station malfunction leading to partial monthly data collected in June and July of 2015 and June and July of 2017.

BLCA 1

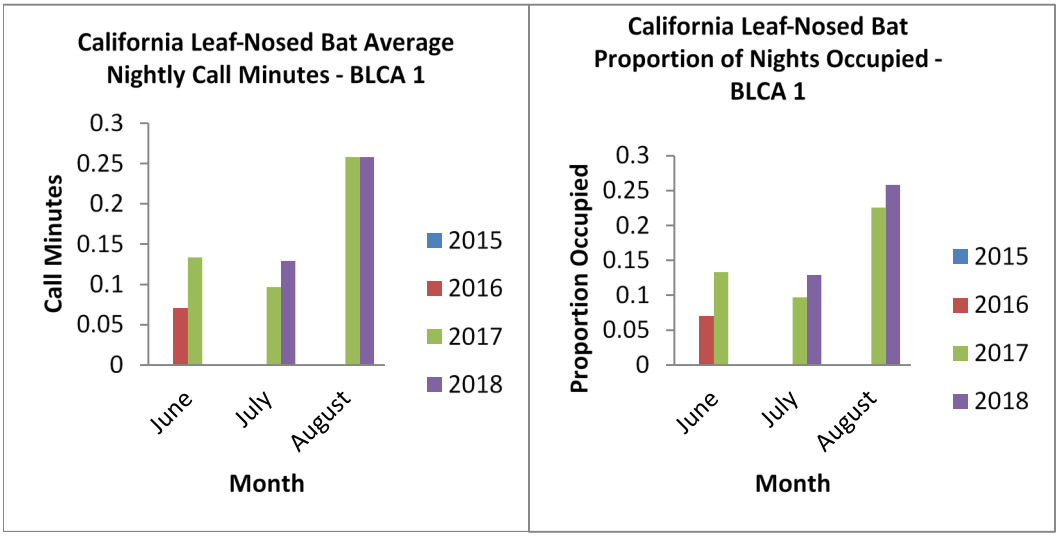

Figure 1-20.—California leaf-nosed bat average nightly call minutes and proportion of nights occupied BLCA 1, using Analook.

Crane Roost

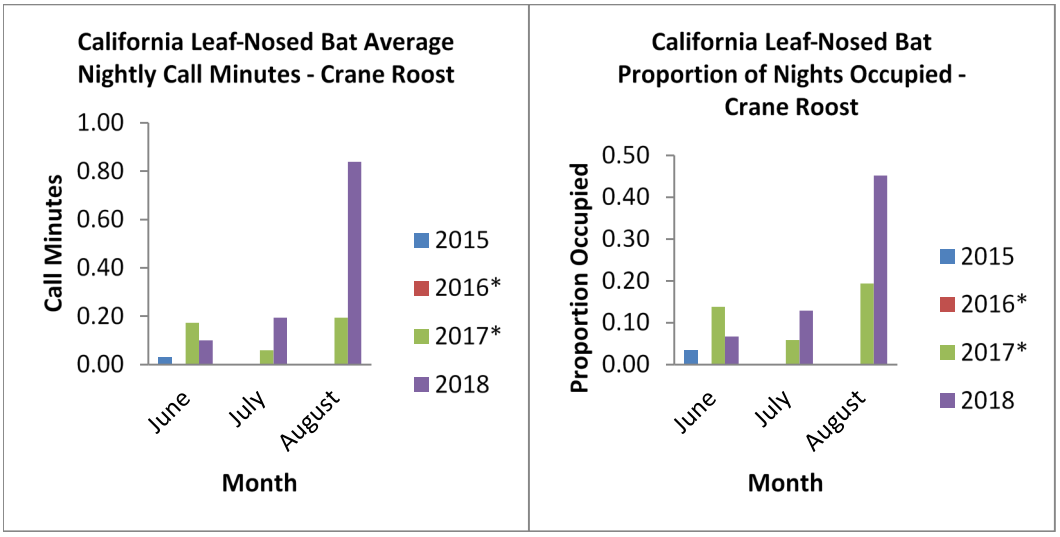

Figure 1-21.—California leaf-nosed bat average nightly call minutes and proportion of nights occupied Crane Roost, using Analook.

* Station malfunction leading to partial monthly data collected in June 2016 and June and July of 2017.

CVCA 1

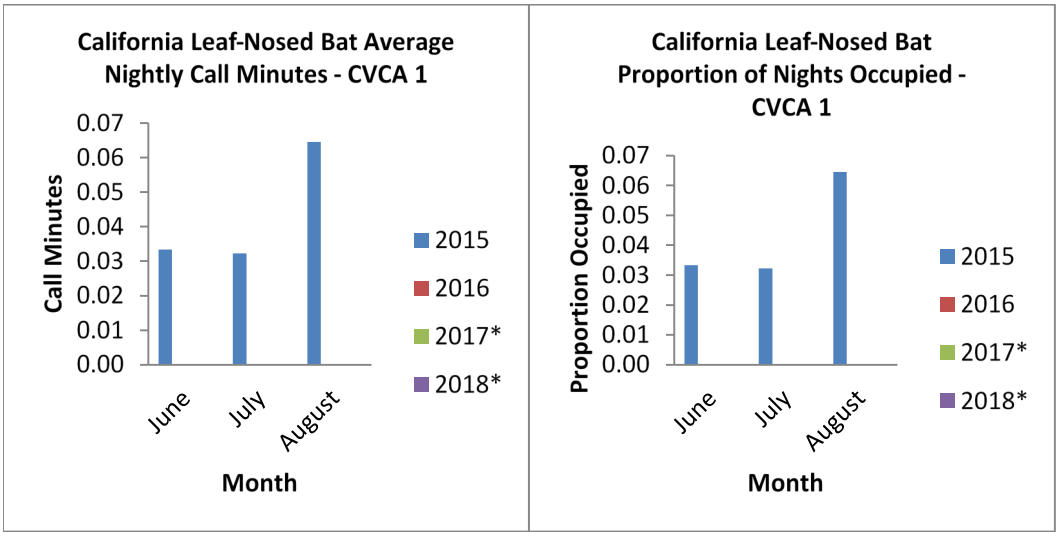

Figure 1-22.—California leaf-nosed bat average nightly call minutes and proportion of nights occupied CVCA 1, using Analook.

* Station malfunction leading to no data collected in June 2017 and partial monthly data collected in July and August of 2017 and June 2018.

CVCA 2

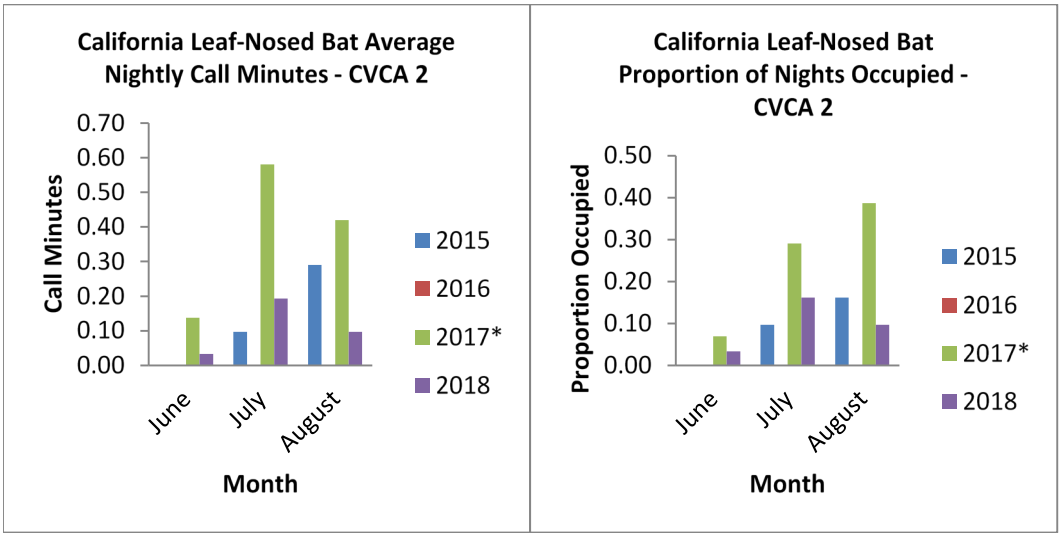

Figure 1-23.—California leaf-nosed bat average nightly call minutes and proportion of nights occupied CVCA 2, using Analook.

* Station malfunction led to partial monthly data collected in June 2017.

HH 1

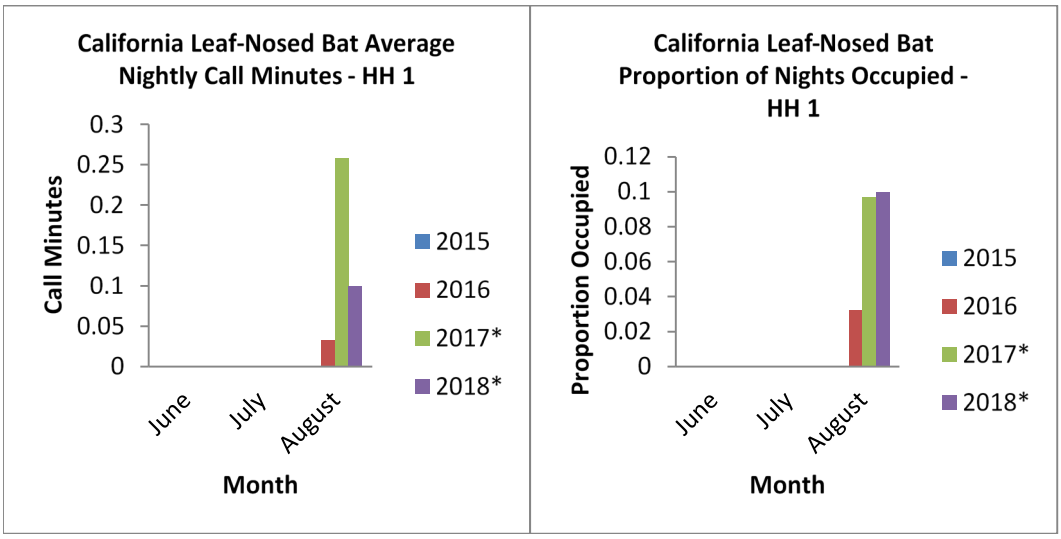

Figure 1-24.—California leaf-nosed bat average nightly call minutes and proportion of nights occupied HH 1, using Analook.

* Station malfunction led to partial monthly data collected in June and July of 2017 and only 2 nights of data in July 2018.

PVER 1

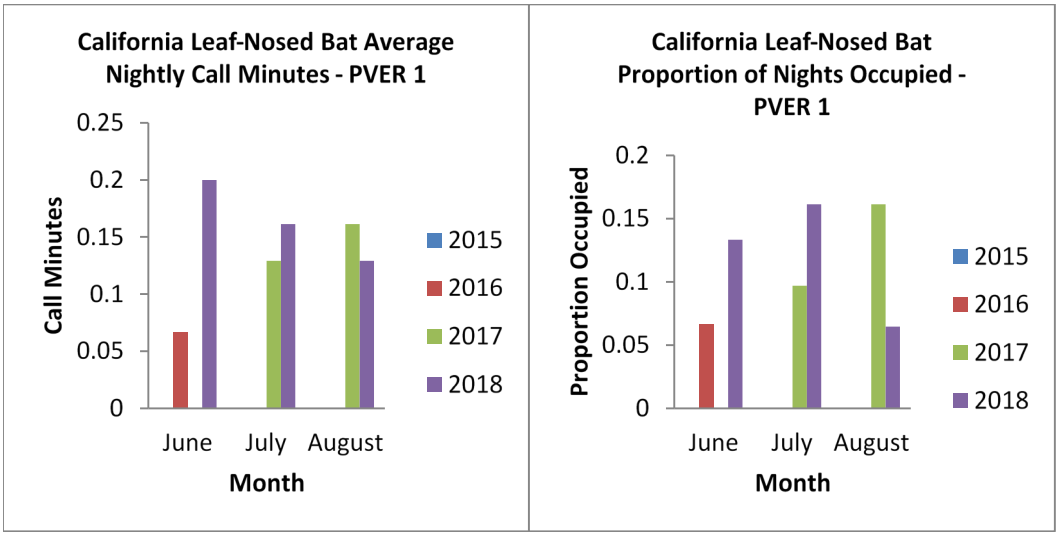

Figure 1-25.—California leaf-nosed bat average nightly call minutes and proportion of nights occupied at PVER 1, using Analook.

PVER 2

No California leaf-nosed bat activity or occupancy was recorded at PVER 2 during the 2015, 2016, 2017, or 2018 seasons. Malfunctions at this station may be responsible for the lack of activity and occupancy.

YEW 1

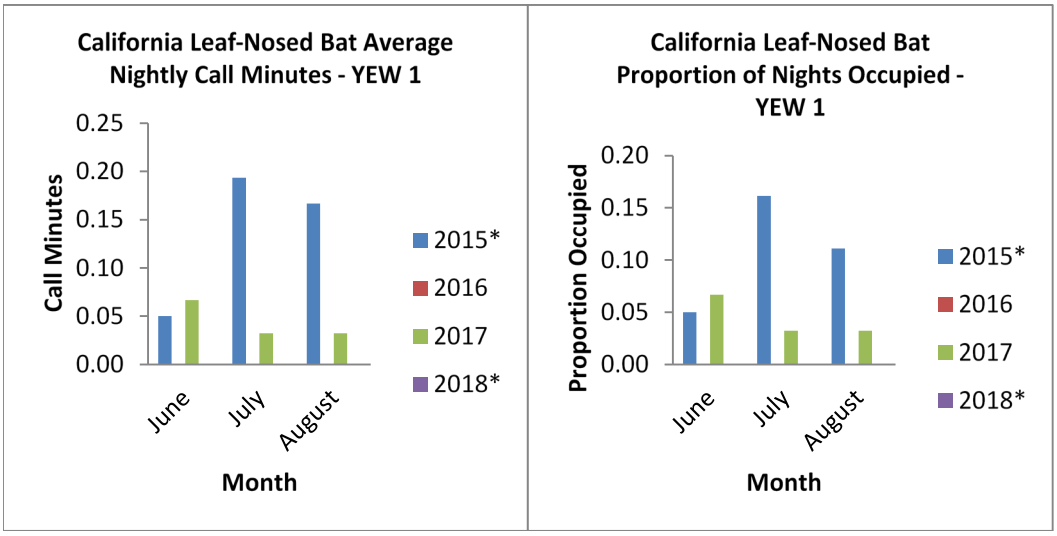

Figure 1-26.—California leaf-nosed bat average nightly call minutes and proportion of nights occupied YEW 1, using Analook.

* Station malfunction leading to partial monthly data collected in June 2015 , July 2018, and August 2018.

ATTACHMENT 2

Station Malfunctions

STATION MALFUNCTIONS

During the 2015, 2016, 2017, and 2018 sampling seasons, several equipment malfunctions resulted in periods of data loss (attachment 2). The Anabat™ units were checked the day after they were installed for the season; the day after, the data on each flashcard were downloaded and the flashcards replaced, if necessary, to ensure they collected data the first night. The units cannot be checked remotely to ensure they are functioning between site visits.

- AKTP 1 malfunctioned in 2015 (June 22 – July 22) due to a faulty battery connection and the time required to properly charge after the connection had been fixed. AKTP 1 did record acoustic activity for the remaining 61 days. AKTP 1 again malfunctioned during the 2017 season (June 14 – July 17). This was likely in part due to the trees growing densely around the station throughout summer and thereby reducing the effectiveness of the solar battery charger.

- PVER 2 had multiple issues during the 2015 season (June 24 – August 12, August 16–31), and the Anabat™ unit had to be replaced. PVER 2 also malfunctioned during the 2016 season (June 1–15). It was determined the issue was corrupted compact flashcards. The station also had a kinked microphone cable, which may have led to a reduced amount of calls being detected for the recording period. PVER 2 malfunctioned during the 2017 season as well (June 1 – July 19) due what was first thought to be a malfunctioning unit but ultimately was determined to be a broken microphone cable. The Anabat™ unit used in this station in 2016 had burn marks, and it is possible that the tower and equipment was damaged by a lightning strike. PVER 2 was also inoperable from June 1 to June 10, 2018.

- The Crane Roost station malfunctioned during the 2016 season (June 1–16) also due to corrupted compact flashcards. The station also malfunctioned during the 2017 season (June 1, July 4–17). The battery had to be replaced on June 2, 2017. No reason could be determined for the data loss in July 2017; the unit functioned properly through August.

- CVCA 1 malfunctioned during 2017, resulting in only 8 nights of recorded data (June 1 – July 28, August 6–31). Equipment was swapped out, but the cause of the malfunction could not be determined. CVCA 1 was inoperable from June 1–10, 2018.

- CVCA 2 malfunctioned during 2017 (no data on June 1). A different compact flash card was installed on June 2, and no further issues were encountered.

- YEW 1 could not be deployed at the beginning of the 2015 season (June 1–10) because the road had been washed out and was impassable. The station operated properly the remainder of 2015, June – August 2016, and all of 2017. YEW 1 was damaged in a fire on May 20, 2018. The equipment was operational until July 2, when the cables, microphone, and solar panel were replaced. The new equipment malfunctioned throughout summer, resulting in no data collection from July 4 to August 2, 2018, and again from August 7 to August 31, 2018. The cause is unknown.

- HH 1 malfunctioned during 2017 (June 1, June 14 – July 12). The compact flash card was replaced on June 2, 2017, and operated correctly. The battery cables were found to be corroded in July, which affected the Anabat™ unit's power. The cables were cleaned on July 12, 2017; the unit then functioned properly through August 2017. HH 1 also malfunctioned in July 2018 and only collected data for 2 nights.

- BLCA 1 and PVER 1 functioned properly throughout the recording period.