Chapter 4. Bat Surveys of the Baldwin Hills, Los Angeles County, California, 2014–2015

Stephanie Remington
P.O. Box 12383, Costa Mesa, California 92627 (stremington@earthlink.net)

Introduction

The Baldwin Hills comprise over 1,200 acres of fragmented open space, surrounded and intersected by urbanization, in the Los Angeles Basin. The territory of the Baldwin Hills Conservancy, a state agency, includes three major parks [Kenneth Hahn State Recreation Area (KHSRA), Culver City Park (CCP), Baldwin Hills Scenic Overlook (BHSO)], the Holy Cross Cemetery, privately owned oil fields, 'stringers' of vegetation along Stocker Street and La Brea Avenue, and the major drainage, Ballona Creek, which is channelized and concrete-lined.

The terrain ranges from just above sea level a few miles upstream of the mouth Ballona Creek to over 500 feet in elevation near the former site of the Baldwin Hills Dam at Kenneth Hahn State Recreation Area. The area is bounded by Ballona Creek and Culver City to the northwest, Inglewood to the south, and Los Angeles to the east and northeast. The main native habitats remaining in the Baldwin Hills are variants of scrub habitat, although there are areas of willow and mulefat riparian in some drainages, as well as a few native bunch grasses and annual flowering plants (Anderson, 2001). Molina et al. (2001) considered the majority of the native plant habitat to be degraded and in "disclimax" – with non-natives having replaced important components of plant communities and urban runoff having replaced significant natural watercourses. For these reasons, the authors felt that the patches of riparian vegetation were best described as 'urban riparian.' Due to the rarity of *Salvia* and *Eriogonum* species, they felt that 'coastal scrub' more accurately described the habitat dominated by *Artemesia californica*, *Baccharis pilularis*, and *Encelia californica*.

Non-native vegetation in the Baldwin Hills is prevalent. Non-native annual grasses are predominant over the native bunch grasses, and ornamental trees and shrubs, as well as lawns and pond vegetation, are prevalent in the local parks.

Despite this, there are areas of the Baldwin Hills where efforts are being made to improve the quality of native habitat. Although recent in its inception, habitat restoration is ongoing and an integral part of park planning at the Baldwin Hills Scenic Overlook (T. Longcore and S. Campbell, pers. comm.).

Remington, S.. 2016. Bat Surveys of the Baldwin Hills, Los Angeles County, California, 2014–2015. Pp. 72–101 in *Urban Biodiversity Assessment: Baldwin Hills Biota Update* (T. Longcore, ed.). Los Angeles: University of Southern California for Baldwin Hills Conservancy (Proposition 84) and Baldwin Hills Regional Conservation Authority (Proposition A).

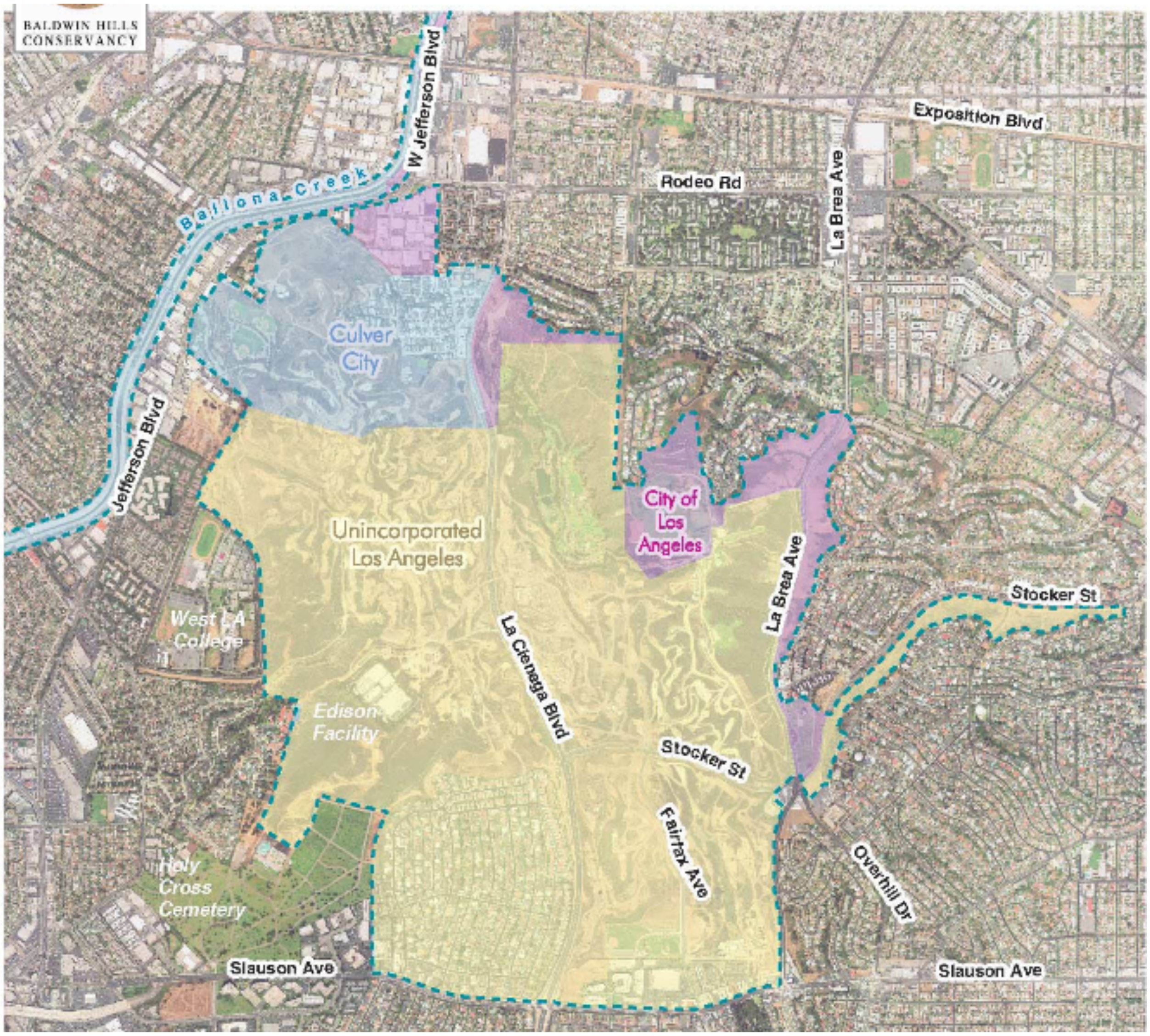

Figure 4-1. Territory of the Baldwin Hills Conservancy and surrounding areas.

There have been two previous inventories of the Baldwin Hills. 1) *The Baldwin Hills Project*, conducted in 1975 and 1978 with the goal of thoroughly cataloguing the natural, cultural, aesthetic, and recreational resources of the area, focused on terrestrial vertebrates for the faunal component of the surveys. 2) *The Biota of the Baldwin Hills: An Ecological Assessment* (Molina et al., 2001) described the effort in 2000 to provide updated data on biological resources, including plant communities, terrestrial vertebrates and arthropods.

Since some ecologically significant taxa were not included in either study, and technological advances since 2000 have enabled new survey techniques, a third project focusing on the Baldwin Hills was initiated in 2014–2015 to update information from the earlier studies and address some remaining gaps. Neither of the past studies included bat surveys. This report focuses on the bat fauna of the Baldwin Hills.

State and federal land management agencies officially recognize over two-thirds of the south coast ecoregion's 24 bat species as sensitive, including one endangered species, a state candidate for threatened status, and nearly half listed as California Species of Special Concern (CSSC). All 24 have been documented in Los Angeles County (Table 4-1).

Hilda Grinnell (1918) conducted the first focused surveys of bats in California, including detailed localities that were lacking in previous work, and compiling the results of previous survey efforts that had included bats. She found 13 bat species in Los Angeles County (one of which she found only on Catalina Island), and four others that occurred in adjacent counties, often very close to the L.A. County border, indicating they probably occurred there, too (Table 4-1).

Vaughn (1954) documented eight bat species in the San Gabriel Mountains, including one that Grinnell (1918) had only found outside the Los Angeles County border. With modern acoustic and capture equipment, Remington (2011) documented sixteen species in the San Gabriel Mountains, including four species that had not been captured by either Vaughn or Grinnell in Los Angeles County.

Four studies of the Santa Monica Mountain Range, from the Channel Islands to Griffith Park [(Brown, 1980; Brown, pers. comm.; Remington and Cooper (2014)] added several new species to the L.A. County list.

One species, the California leaf-nosed bat (*Macrotus californicus*), that had been documented in Ventura, Los Angeles, and San Diego Counties in the early 20th century has not been observed in either of the two former counties for decades (Constantine 1998), and is considered extirpated from both counties (Brown, pers. comm.). Both known roosts (one in each county) were cave roosts; the loss of this bat from the area is most likely due to human disturbance and/or actual destruction of the roost combined with the loss of foraging habitat. Within California, its primary range is the Mojave Desert, where it roosts predominantly in geothermally heated abandoned mines and forages extensively in desert wash vegetation.

Museum and Public Health Records

Twenty-one bat species are represented in museum records from Los Angeles County, primarily from the early 20th century (**Error! Reference source not found.**). Of over 1,100 individuals epresented in the collections of 28 institutions (Appendix 1), 30 specimens comprising five species were collected from the vicinity of the Baldwin Hills – Culver City and Palms. The seven locations of these species are found northwest of the Baldwin Hills (Figure 4-2).

Table 4-1. Bat species documented in and near Los Angeles County, including during the current study.

Latin Name	Common Name	Grinnell (1918)	Channel Islands (1979-2015)	Santa Monica Mts (2002-2004)	Griffith Park (2008)	Pt. Mugu (2014-2015)	San Gabriel Mts (1954)	San Gabriel Mts (2010)	Baldwin Hills (2014-15)
Family Phyllostomidae	**Leaf-nosed bats**								
Choeronycteris mexicana [1]	Mexican long-tongued bat								
Leptonycteris yerbabuenae [4]	Lesser long-nosed bat								
Macrotus californicus [1,2,6]	California leaf-nosed bat	*		E					
Family Molossidae	**Free-tailed bats**								
Eumops perotis [1,2,6]	Western mastiff bat	X		X		X			
Nyctinomops femorosaccus [1]	Pocketed free-tailed bat	X				X		X	
Nyctinomops macrotis [1,2]	Big free-tailed bat					X			
Tadarida brasiliensis	Mexican free-tailed bat	X	X	X	X	X		X	X
Family Vespertilionidae	**Mouse-eared bats**								
Antrozous pallidus [1,5,6]	Pallid bat	X	X	X		X		X	
Corynorhinus townsendii [1,2,3,5,6]	Townsend's big-eared bat	X†	X						
Eptesicus fuscus	Big brown bat	X	X	X	X	X	X	X	
Euderma maculatum [1,2,6]	Spotted bat	X		X					
Lasionycteris noctivagans	Silver haired bat		X					X	
Lasiurus blossevillii [1]	Western red bat	X	X	X	X	X	X	X	X
Lasiurus cinereus	Hoary bat	X	X	X	X	X	X	X	X
Lasiurus xanthinus [1]	Western yellow bat							X	
Myotis californicus	California myotis	X	X	X	X	X	X	X	
Myotis ciliolabrum [2,6]	Small-footed myotis	*		X		X		X	
Myotis evotis [2,6]	Long-eared myotis	X	X				X	X	
Myotis lucifugus	Little brown myotis							X	
Myotis thysanodes [2,5,6]	Fringed myotis	*	X					X	
Myotis velifer [1,6]	Cave Myotis								
Myotis volans [2]	Long-legged myotis	X					X	X	
Myotis yumanensis [2]	Yuma myotis	*	X	X	X	X	X	X	X
Parastrellus hesperus	Canyon bat	X		X	X		X	X	

Key to the Symbols

[1] California Mammal Species of Special Concern
[2] Former Candidate (Category 2) for listing under U.S. Endangered Species Act; Species of Concern
[3] Candidate for Threatened Status in California
[4] Listed under the ESA as Threatened/Endangered
[5] USFS: Sensitive
[6] BLM: Sensitive

* Documented in an adjacent county
† Catalina Island
E Extirpated

Table 4-2. Museum records of bats in Los Angeles County, including the Baldwin Hills area (with dates), and acoustic records of the current study.

Latin Name	Common Name	Museum Records	Constantine (1998)	Baldwin Hills (2014–2015)
Family Phyllostomidae	**Leaf-nosed bats**			
Choeronycteris mexicana [1]	Mexican long-tongued bat	LA County	X	
Leptonycteris yerbabuenae [4]	Lesser long-nosed bat			
Macrotus californicus [1, 2, 6]	California leaf-nosed bat	LA County		
Family Molossidae	**Free-tailed bats**			
Eumops perotis [1, 2, 6]	Western mastiff bat	1939	X	
Nyctinomops femorosaccus [1]	Pocketed free-tailed bat	1994	X	
Nyctinomops macrotis [1, 2]	Big free-tailed bat	LA County	X	
Tadarida brasiliensis	Mexican free-tailed bat	1939		X
Family Vespertilionidae	**Mouse-eared bats**			
Antrozous pallidus [1, 5, 6]	Pallid bat	1971		
Corynorhinus townsendii [1, 2, 3, 5, 6]	Townsend's big-eared bat	LA County		
Eptesicus fuscus	Big brown bat	2005		unconfirmed
Euderma maculatum [1, 2, 6]	Spotted bat			
Lasionycteris noctivagans	Silver haired bat	LA County	X	
Lasiurus blossevillii [1]	Western red bat	1939	X	X
Lasiurus cinereus	Hoary bat	1904		X
Lasiurus xanthinus [1]	Western yellow bat	LA County	X	unconfirmed
Myotis californicus	California myotis	LA County		
Myotis ciliolabrum [2, 6]	Small-footed myotis	LA County		
Myotis evotis [2, 6]	Long-eared myotis	LA County		
Myotis lucifugus	Little brown myotis			
Myotis thysanodes [2, 5, 6]	Fringed myotis	LA County		
Myotis velifer [1, 6]	Cave myotis	LA County	X	
Myotis volans [2]	Long-legged myotis	LA County		
Myotis yumanensis [2]	Yuma myotis	LA County		X
Parastrellus hesperus	Canyon bat	2005		

[1] California Mammal Species of Special Concern

[2] Former Candidate (Category 2) for listing under U.S. Endangered Species Act; Species of Concern

[3] Candidate for Threatened Status in California

[4] Listed under the ESA as Threatened/Endangered

[5] U.S. Forest Service: Sensitive

[6] U.S. Bureau of Land Management: Sensitive

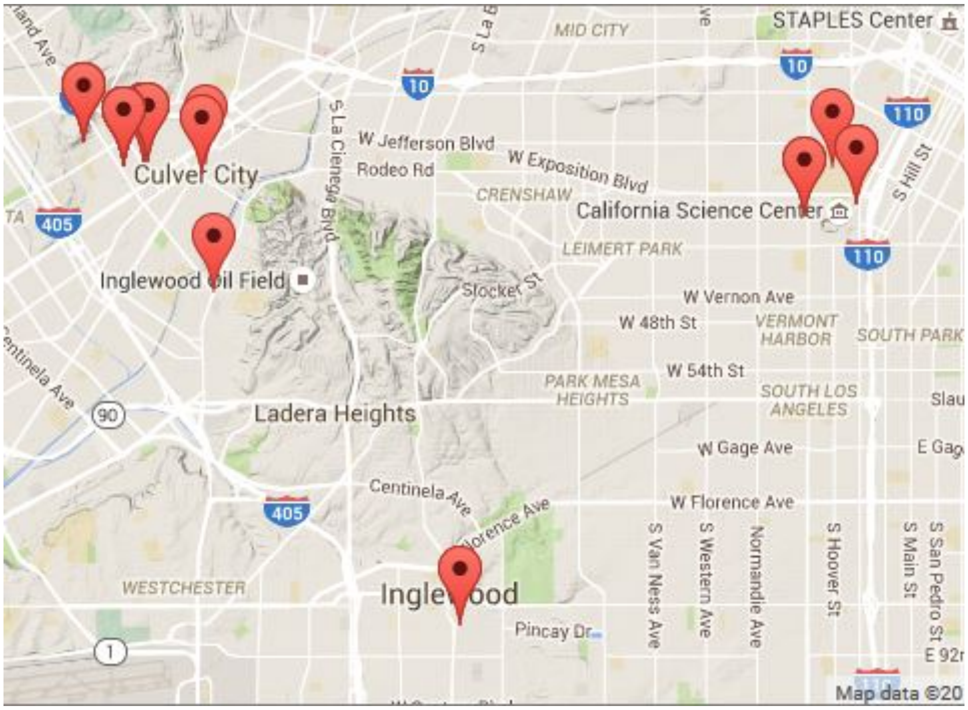

Figure 4-2. **Locations of** *museum records of the 35 bats collected near the Baldwin Hills. Basemap from Google Maps.*

The majority of the museum specimens (21) were Mexican free-tailed bats (*Tadarida brasiliensis*). The second most common species in these records was the pallid bat (*Antrozous pallidus*), with five individuals. There were two big brown bats (*Eptesicus fuscus*) and one each of the western mastiff bat (*Eumops perotis*) and hoary bat (*Lasiurus cinereus*). All were collected from 1925–1939. Most of these collection sites represent multiple individuals – some from the same date, others from repeat visits to the site over months or years – indicating that *T. brasiliensis* and *A. pallidus* probably had maternity colonies in the area.

Four specimens were collected at three sites east of the Baldwin Hills – at or near the USC campus [*L. cinereus* (1904), *L. blossevillii* (western red bat; 1939), *A. pallidus* (1971), and *Parastrellus hesperus* (canyon bat; 2005). A single pocketed free-tailed bat (*Nyctinomops femorosaccus*) was collected in Inglewood, to the south of the Baldwin Hills, in 1994, bringing the total number of species in museum collections from the Culver City/Palms, Exposition Park, and Inglewood areas to eight (see museum records with dates in Table 4-2).

Public Health Records of bats (generated by calls from the public reporting an encounter with, or find of, a bat that resulted in collection and rabies testing) for Los Angeles County included species identification, gender and age designation, biometrics of forearm and other anatomical features, as well as notes about the condition of each specimen, meticulously kept and updated by Denny Constantine (former California State Veterinarian) – beginning in 1955, and regularly from 1977 through the late 1990s when he retired. Unfortunately, he died without publishing the majority of these data and county officials are unsure of whether they retained the records he shared with them. His only publication of these records related to range extensions of several species (Constantine 1998) (**Error! Reference source not found.**). The closest of the records from this paper to the aldwin Hills are a silver-haired bat (*Lasionycteris noctivagans*) from Brentwood in 1977, a big free-tailed bat (*Nyctinomops macrotis*) from downtown Los Angeles in 1985, and a cave myotis (*Myotis velifer*) from Florence in 1992. These three species are considered rare migrants and/or vagrants in the area. *L. noctivagans* is associated primarily with forest habitat. This species is migratory and has been documented in places that are considered atypical, such as the Mojave Desert (pers. obs.) and other xeric habitats, particularly in winter and during migration (Perkins, 1998). Given the total number of specimens of this species in Los Angeles County, its occurrence in the area is more likely related to migratory patterns than accidental occurrences. The Brentwood specimen was collected in November. *N. macrotis* is considered a rare cliff-roosting, long-distance migrant that shows up regularly, but relatively infrequently, in coastal southern California (Navo, 1998; pers. obs.; D. Stokes, pers. comm). The current known range of *M. velifer* in California is along the Colorado River.

Given the age of the majority of bat species records in the vicinity of the Baldwin Hills, the main survey goals of the Baldwin Hills bat surveys were: 1) to develop a current species list for the area (including seasonal variations) and 2) to identify areas of habitat use (roosting and foraging locations).

The behavioral and ecological diversity among bat species precludes the use of a universal sampling method that is adequate for detecting all species (Pierson 1993, Pierson 1998). A combination of techniques – acoustic sampling, mist netting and roost monitoring – generally yields a more complete overall picture of diversity and distribution. However, some sampling techniques are more intrusive than others, and bat populations in southern California have been declining in recent years due to multiple human-induced pressures, particularly on the coast where bat species lose both roosting and foraging habitat regularly to urban development. Roosts of species that can adapt to human presence are frequently disturbed (deliberately or inadvertently) and colonies are often eradicated.

Additional impacts faced by local bat populations are pesticide poisoning (from eating insect prey); severe and extensive light pollution that exposes bats to diurnal predators that otherwise would not be active and disperses insect prey, rather than concentrating it; water pollution and mosquito abatement that also affect prey quality and availability; and increasingly frequent wildfires that reduce the prey base and may kill bats directly.

Bats typically have one pup a year. Their low reproductive rate, high juvenile mortality, and long generational turnover make them even more likely to experience population declines in the face of multiple human-induced pressures.

To minimize the impacts of our study on bats, acoustic techniques — the least intrusive of the above-mentioned sampling techniques — were the primary method used in these surveys.

These surveys were originally intended to include both active and passive (remote) monitoring. However, it was not possible to gain access to rooftops, which are the best locations in highly urban areas with extensive human visitation to place detectors to avoid vandalism and theft of acoustic equipment. The lack of all-night monitoring, which can be extended for days, or weeks, at a time, means that some species were likely missed in our survey (for example, rare species and those that arrive later in the evening, such as those that roost farther away but forage on site).

Four main areas were the focus of these bat surveys (Figure 4-1):

1. Kenneth Hahn State Recreation Area (KHSRA)
2. Culver City Park (CCP)
3. Baldwin Hills Scenic Overlook (BHSO)
4. Ballona Creek (BC)

A portion of the active oil field that is publicly owned was surveyed once in October 2014.

Sites were chosen based on area, potential to provide roosting and foraging opportunities for bats, accessibility, and availability of volunteer observers. Holy Cross Cemetery contains good quality coastal sage scrub in the northeast portion of the property. This habitat is known to support foraging bats (pers. obs.; D. Stokes, pers. comm.), and roosting, as well (pers. obs.). However, getting permission for regular access after dark was not possible at this site. The oil fields contain highly degraded habitat, but cover a large portion of the Baldwin Hills. Regular access was not possible at this site, either.

KHSRA is a large park with a variety of native and non-native tree and shrub habitats, and some water features. CCP contains ball fields and a variety of ornamental trees, shrubs, and grasses. The BHSO contains varied terrain and native habitat restoration is ongoing there. Personnel at all three of these sites were very cooperative in allowing access. As the major waterway in the area, BC was also considered a high value site.

This report summarizes the methods and results of these initial bat surveys of the Baldwin Hills and provides baseline data to support future studies of the bat fauna of this area.

Methods

Bat surveys were conducted once a month between April and October in 2014 at one or more sites each month, and once a month between March and June at three or more sites per month in 2015. All field sites except the oil fields were surveyed at least twice in each year. Surveys were conducted by teams of two or more observers, walking transects while watching for bats and recording ultrasonic calls with an ultrasonic detector – usually an Anabat, but SM2 detectors were also used on one night (Table 4-4 Table 4-5). Here, the term 'transect' refers to a pathway, not necessarily a straight line.

Light pollution is extreme in and around the Baldwin Hills (over much of the area, visibility at night is similar or only slightly darker than on an overcast day), so it was unknown how much effect moon phase would have on bat activity. However, because bat activity is often lower on nights with a full or near-full moon, all but two surveys were conducted on nights when moon phase was at less than half. The April 2014 survey at Ballona Creek was conducted two nights after a full moon, but on that night the moon did not rise until 20 minutes before the end of the survey. In June 2014, another near-full moon rose approximately 1.5 hour after sunset.

Table 4-3. Sampling effort by site and year.

2014	KHSRA	CCP	BHSO	BC	OF
April	X			X	
May		X	X	X	
June	X	X	X		
July		X	X	X	
August	X				
September		X	X		
October	X				X
TOTAL	**4**	**4**	**4**	**3**	**1**

2015	KHSRA	CCP	BHSO	BC	OF
March	X	X	X	X	
April		X	X	X	
May	X	X	X		
June	X	X	X		
TOTAL	**3**	**4**	**4**	**2**	**0**
Grand Total	**7**	**8**	**8**	**5**	**1**

Table 4-4 shows which sites were sampled each month during 2014 and 2015. The totals indicate how many bat surveys were done at each site that year, and the grand total is the number of surveys over both years done at that site. Table 4-5 shows sampling effort in terms of the numbers of observers and ultrasonic detectors deployed at each site.

For example, in April 2014 at Kenneth Hahn State Recreation Area (KHSRA), eight observers divided into three teams to survey the park. Ballona Creek was surveyed by one team of two observers. In this case, the April survey of Ballona Creek was conducted on a separate night, but usually, when multiple sites were surveyed in a particular month, they were done by separate teams of observers on the same night.

Table 4-4. Number of observers and detectors at each site during each month of surveys during 2014–2015.

2014	KHSRA		CCP		BHSO		BC		OF	
	# Obs	# Det	# Obs	# Det	# Obs	# Det	# Obs	# Det	# Obs	# Det
April	8	3					2	1		
May			5	2	2	1	2	1		
June	6	2	3	1	3	1				
July			4	2	4	2	14	3		
August	7	3								
September			6	2	3	1				
October	5	2							2	1
TOTAL	**26**	**10**	**18**	**7**	**12**	**5**	**18**	**5**	**2**	**1**

2015	KHSRA		CCP		BHSO		BC		OF	
	# Obs	# Det	# Obs	# Det	# Obs	# Det	# Obs	# Det	# Obs	# Det
March	3	1	4	1	4	1	4	1		
April			4	2	4	2	4	1		
May	3	1	3	2	2	1				
June	4	1	3	2	3	1				
TOTAL	**10**	**3**	**14**	**7**	**13**	**5**	**8**	**2**		

Grand Total	**36**	**13**	**32**	**14**	**25**	**10**	**26**	**7**	**2**	**1**

Kenneth Hanh State Recreation Area	KHSRA
Culver City Park	CCP
Baldwin Hills Scenic Overlook	BHSO
Ballona Creek	BC
Oil Fields	OF

There were two other exceptions to this rule. In October 2014, the KHSRA survey was conducted on a separate night from the oil fields. And Culver City Park (CCP) and Baldwin Hills Scenic Overlook (BHSO) were surveyed along the same transect line by a single team of observers. An example of a CCP/BHSO transect line is shown in Figure 4-3.

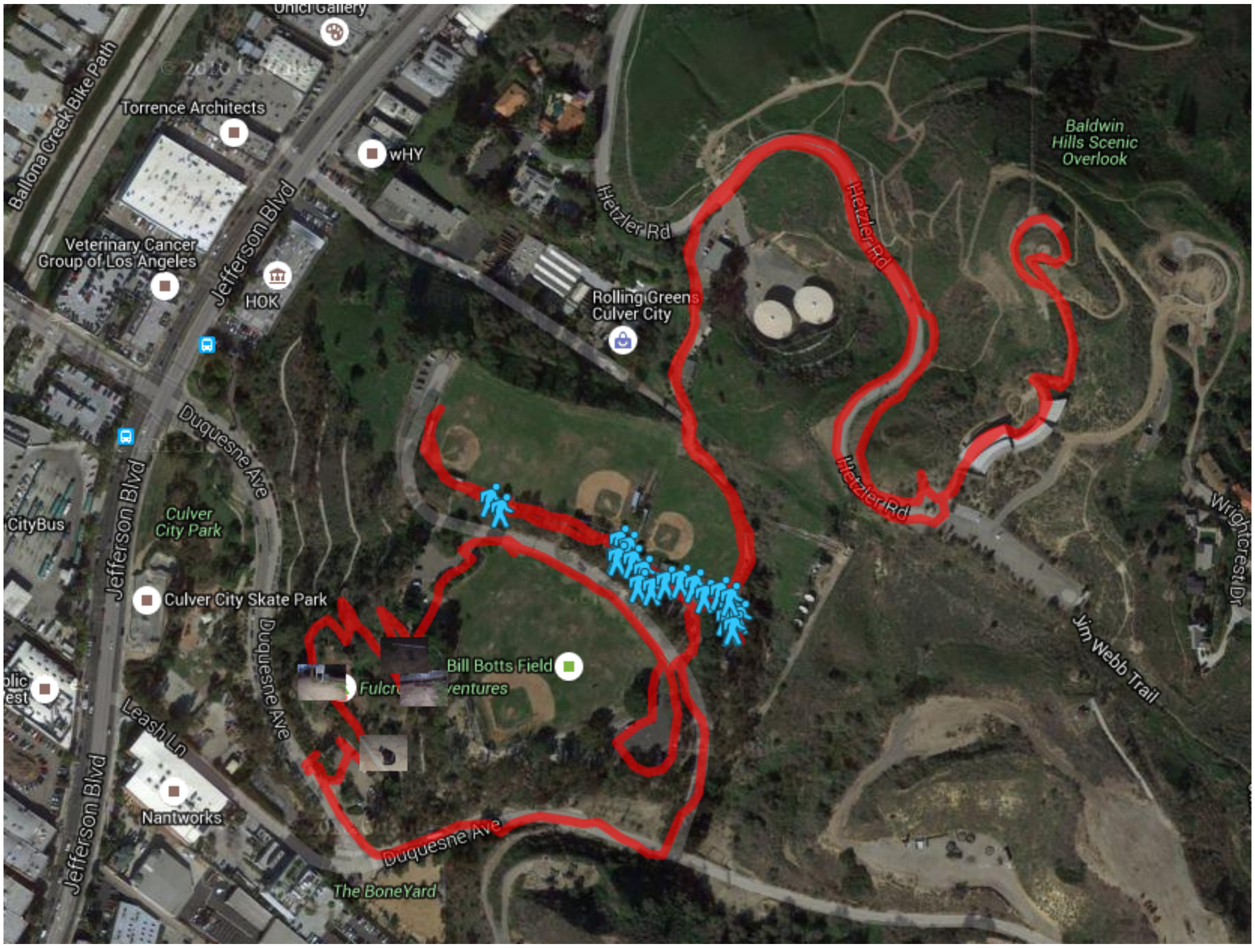

Figure 4-3. An example of a transect (pathway) walked by a team surveying CCP/BHSO.

The tracker app used here takes waypoints every approximately 100 feet (depicted as blue walking figures in Figure 4-3), which can be converted to a record of the path taken that night.

The optimum number of observers per team was three to four – one deploying a detector, one recording data in real time into the ArcGIS Collector App (which was downloaded onto the cell phone of one observer in each group), one taking data on paper (as a backup), and – if present – a fourth observer to help look for flying bats. One or more of the observers frequently had a second duty, such as one of the above tasks (for smaller teams) or of recording GPS points on a hand-held unit for comparison with the GPS readings on the phone app. Some teams had the tracker app, described above, and it was used regularly by one team, but its use was not part of official protocol.

Transect Protocol

After recording the site name, location, and description, as well as sunset time, weather, observer names, and detector identification, transect protocol was to walk until a bat was observed visually and/or detected on an Anabat, then to stop and wait for at least a minute to see if any other bats were seen or recorded. If no bats were seen or recorded, the team resumed walking. If more bats were observed or recorded, then the team stayed at the site for a maximum of ten minutes. During the time stopped, data were entered on the time, location, species (if known), habitat, and behavior (if observed).

All calls were entered into the Collector App (except for occasions when the app was not working or when a last-minute personnel change precluded use of the app for one group) and on paper datasheets.

The detectors were programmed to begin monitoring ½ hour before sunset and were turned off approximately three hours after sunset. 'Bat activity' was measured by the total number of call files recorded on one or more Anabats deployed at a particular site, for a given species or for all species recorded in a night.

Calls were identified to species whenever possible. Timing of calls was used to infer the location of nearby roosts. Calls recorded within an hour of sunset were considered indicators of bats roosting nearby.

Bat Detectors

Because bats are very vocal animals, producing anywhere from one to more than 200 calls per second, often at frequencies inaudible to humans (>20 kHz), ultrasonic detectors are valuable tools for passively monitoring presence-absence and general activity (Fenton 1988, Thomas and LaVal 1988, Pierson 1993).

The microphone of the Anabat detects sounds in both the upper range of human hearing and the ultrasonic range (4-200 kHz). Calls recorded on Anabats are stored on a compact flash card or PDA for later retrieval and download onto a laptop computer, where they can be viewed and analyzed as sonograms. The SM2 detector picks up calls up to 100 kHz. All local bat species can be detected within the frequency range of both detectors. The detection range of the detectors depends on a variety of factors, including the frequency range and intensity of the bat call, air temperature, habitat, relative humidity, and altitude. The SM2 is more sensitive than the Anabat.

Species identification using Anabat recordings is made by comparison with "voucher" calls from known hand-released bats. Interpretation of acoustic data is affected by biases and limitations of the equipment used to collect it. Not all bat species are equally detectable by this method. Its effectiveness depends on the frequency and intensity of a call (Pierson 1993), the habitat and weather conditions in which a bat is foraging (Fenton 1984, Livengood et al, 2001), whether or not a bat is echolocating, and the detector used (Rainey 1995).

The louder bats will be over-represented; Mexican free-tailed bats (*Tadarida brasiliensis*) and western mastiff bats (*Eumops perotis*) emit such loud, low frequency calls that they can be recorded from hundreds of feet away, while "whispering" bats such as Townsend's big-eared bats (*Corynorhinus townsendii)* emit such faint calls, they may not be recorded at all. Pallid bats *(Antrozous pallidus)* also tend to produce lower intensity calls and often hunt without echolocating – detecting prey either visually, by passively listening, or olfactorily (D. Johnston, pers. comm.).

The number of calls recorded can be used as an index of relative bat activity – it is not possible to determine the number of bats from the number of calls recorded.

Although certain calls are diagnostic for a particular species, no "key" to the calls of California bats is available and not all call sequences are identifiable. Different bat species can sometimes use similar signals, and members of the same species can vary the calls they use based on the perceptual task and the surrounding habitat. Calls can also vary regionally. The ability to identify species varies with the experience of the person using the equipment; knowing which bats occur in the area and which are common are important considerations.

Anabat identification in this study follows Stokes' protocol (D. Stokes, pers. comm.). There are similarities and overlap among the calls of several groups of bat species (Table 4-6). To standardize Anabat identifications, a confidence level (high, medium, or low) is assigned to call sequences based on the known range of call characteristics for the group of species occurring in an area (Table 4-7). (See Table 4-8 for the key to species acronyms.)

Table 4-5. Challenges in identifying bat species with similar calls.

Species producing similar calls	Possible additional diagnostic factors
LACI/NYFE	season, elevation
NYFE/TABR	NYFE is audible to some people
TABR/EPFU	visual observation; season (TABR is more likely to be active in the winter)
EPFU/ANPA	visual observation of behavior; ANPA sometimes emits distinctive social calls
ANPA/MYEV	ANPA sometimes emits distinctive social calls
MYCA/MYYU	observe MYYU foraging over water when call is recorded
MYYU/LABL	visual observation of behavior; red bats easily recognized visually with spot-lighting

Table 4-6. Criteria for assigning confidence levels to call sequences.

Criteria	Confidence Level			
	High	**Medium**	**Low**	**Reject Call**
Call is diagnostic of a particular species	X			
Call is diagnostic but fragmented		X		
Call is in a species repertoire but is not diagnostic; ID is made in combination with other evidence		X		
Call is not diagnostic and equally likely to be made by 2 or more species; habitat/season/altitude, etc., suggest candidate species			X	
Call is fragmented; no evidence suggests one species over another				X

A high confidence level is assigned only to those calls that appear diagnostic of the species (Table 4-7). A medium confidence level is assigned to calls for either of two reasons: 1) a call is known from the repertoire of two species but there is other evidence (such as habitat, time of year, elevation, etc.) supporting a tentative identification; 2) a call is diagnostic but fragmented. A low confidence rating is given when a call appears equally likely to be from two or more species, but when considered with other evidence, one species is more likely to have produced it than the others.

Table 4-7. Bat species in southern California producing diagnostic calls

Species Producing Diagnostic Calls	Usually	Often	Sometimes
LABL		x	
LACI			x
LAXA			x
PAHE	x		
EPFU			x
ANPA			x
TABR			x
NYFE			x
NYMA			x
EUPE	x		

In this report, bat calls that were identified with a high degree of confidence were used to create the species list. Those that were assigned a medium confidence level are used to indicate species that potentially exist in the area, but are unconfirmed. Bat calls that are fragmentary — and therefore unidentifiable or equally likely to be one of several species — and there is no additional evidence to indicate one over the others, are used only to measure activity levels, and not for identification.

Results and Discussion

On 13 survey nights over both years, 1,208 call files were recorded, 1,072 of which were identifiable to species. Four species were confirmed from the call files [Mexican free-tailed bat (*Tadarida brasiliensis*), Yuma bat (*Myotis yumanensis*), western red bat (*Lasiurus blossevillii*), and hoary bat (*L. cinereus*)] (Figure 4-4, Table 4-8).

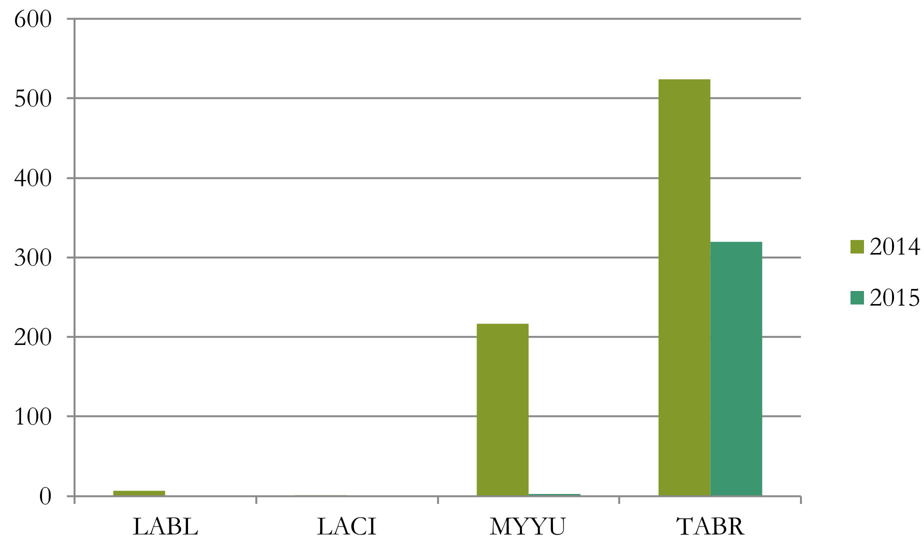

Figure 4-4. Number of bat call files by species in the Baldwin Hills, 2014–2015.

Several call files recorded in May 2015 at KHSRA were possibly made by the western yellow bat (*L. xanthinus*), but identification was not confirmed.

Table 4-8. Species composition in the Baldwin Hills, 2014–2015, with number of call identified per species.

	2014	2015	Total
LABL	7		7
LACI	1		1
MYYU	217	3	220
TABR	524	320	844
Total	***749***	***323***	***1072***

Two species represented 99% of all identifiable call files in 2014: 70% Mexican free-tailed bat (*Tadarida brasiliensis*) and 29% Yuma bat (*Myotis yumanensis*); *T. brasiliensis* represented 99% of identifiable call files in 2015 (Figure 4-4 and Table 4-8), and 79% of total identifiable call files over both years.

The greater number of call files in 2014 is at least partly due to the greater survey effort that year, both in terms of the number of survey nights and number of teams per night (Table 4-3). When the data are standardized by taking an average at sites with multiple teams per night and dividing the resulting annual sum of call files by the total number of survey nights, the resulting ratios for 2014 and 2015 are very similar: 42.1 in 2014 and 41.9 in 2015 (Table 4-9).

Table 4-9. Total bat activity in the Baldwin Hills, 2014–2015, standardized for survey effort.

Month	Site	2014	2015
Mar	BC		2
	CCP		7
	KHSRA		6
Apr	BC	160	3
	KHSRA	6	
	CCP		1
May	BC	36	
	CCP	31	78
	KHSRA		275
Jun	CCP	2	0
	KHSRA	19	5
Jul	BC	27	
	CCP	0	
Aug	KHSRA	23	
Sep	CCP	201	
Oct	KHSRA	0	
	OF	0	
Adjusted Total		**505**	**377**
Total/# survey nights		**42.1**	**41.9**

Three surveys had no bat detections in 2014 (July at CCP and October at both KHSRA and the oil fields (OF). In two of these cases (CCP and KHSRA), the lack of detections was due to accidental changes in the detector sensitivity settings. At CCP, the team recorded bat calls in their datasheets and at KHSRA one of the two teams reported visual sightings of bats early in the evening. If the recording units had functioned properly, it is likely that the 2014 activity ratio from Table 4-9 would have been somewhat higher in 2014.

In April through June, the three months in which surveys were conducted in both years, there were more total calls in 2015 than in 2014, primarily due to *T. brasiliensis* activity in May 2015 (Figure 4-5 and Figure 4-6).

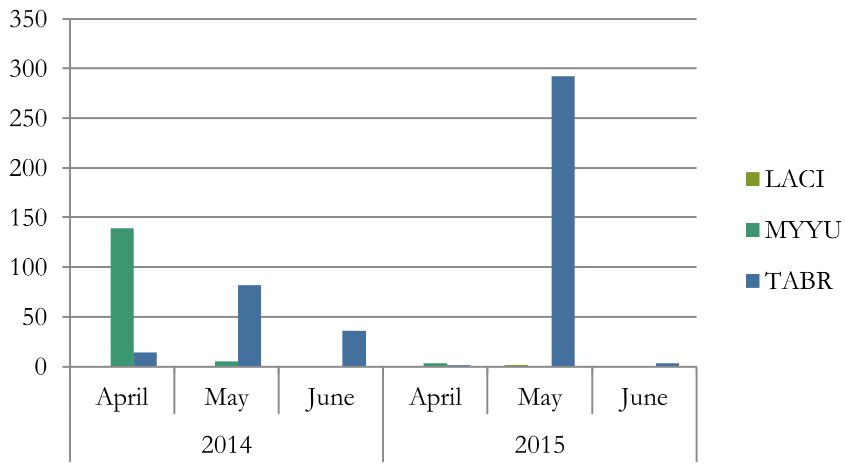

Figure 4-5. Bat activity by species (number of call files) in April–June 2014 and 2015.

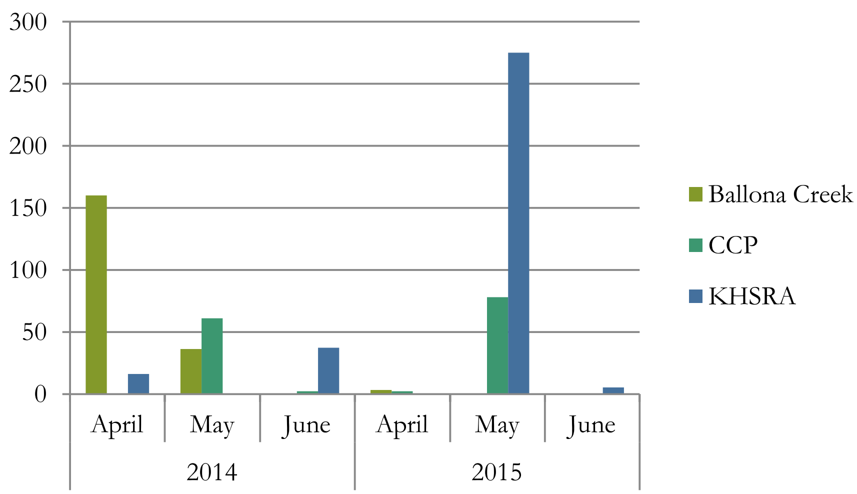

Figure 4-6. Bat activity by site in April–June 2014 and 2015.

In data for all months, *T. brasiliensis* was acoustically dominant at Kenneth Hahn State Recreation Area (KHSRA) and Culver City Park (CCP)(Figure 7) over both years. The bulk of the *T. brasiliensis* activity was recorded on two separate survey nights – one in September 2014 in CCP, and one in May 2015 at KHSRA (Figure 4-7).

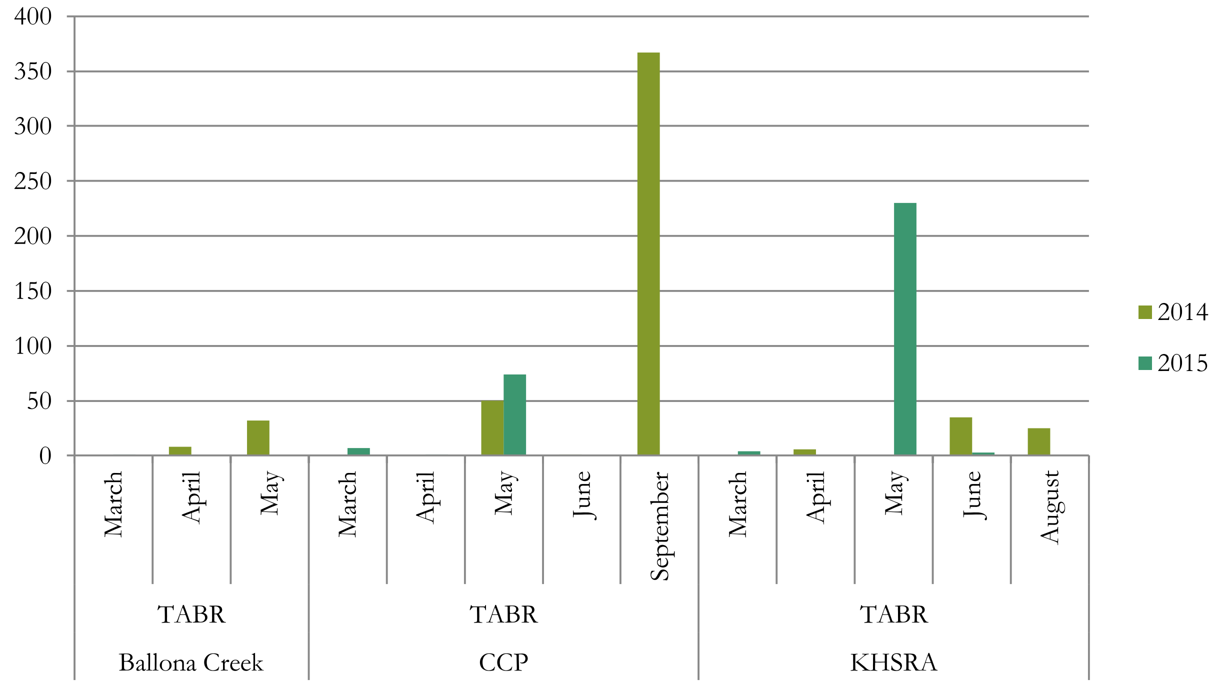

Figure 4-7. T. brasiliensis *activity by site, month, and year in 2014 and 2015.*

M. yumanensis was acoustically dominant at Ballona Creek (BC). There were more call files of this species than any other in both years, despite only three *M. yumanensis* calls being confirmed in 2015. The low number of *M. yumanensis* calls in 2015 was at least partly because there were only half the number of surveys done at this site as the others. The prevalence of *M. yumanensis* (a specialist in the capture of aquatic emergent insects whose geographic range is highly associated with the distribution of permanent water sources) at Ballona Creek was expected. It was not detected at any other sites, however, including KHSRA (Figure 4-8), which has three ponds of varying size. There are a few potential explanations, none of which are mutually exclusive, for the lack of *M. yumanensis* detections at KHSRA. It is possible that this species exists at the park in relatively low numbers and/or tends to arrive later in the night and would have been detected at KHSRA with long-term monitoring. It could also be related to an acoustic bias related to the physics of sound transmission. As mentioned previously, acoustic recording is biased in favor of species (like *T. brasiliensis*) that produce relatively low-frequency echolocation calls. *T. brasiliensis* can be recorded hundreds of feet away, while *M. yumanensis*, which produces calls more than an octave higher (and, therefore, attenuate more quickly in the atmosphere), can only be recorded when they are much closer to the detector.

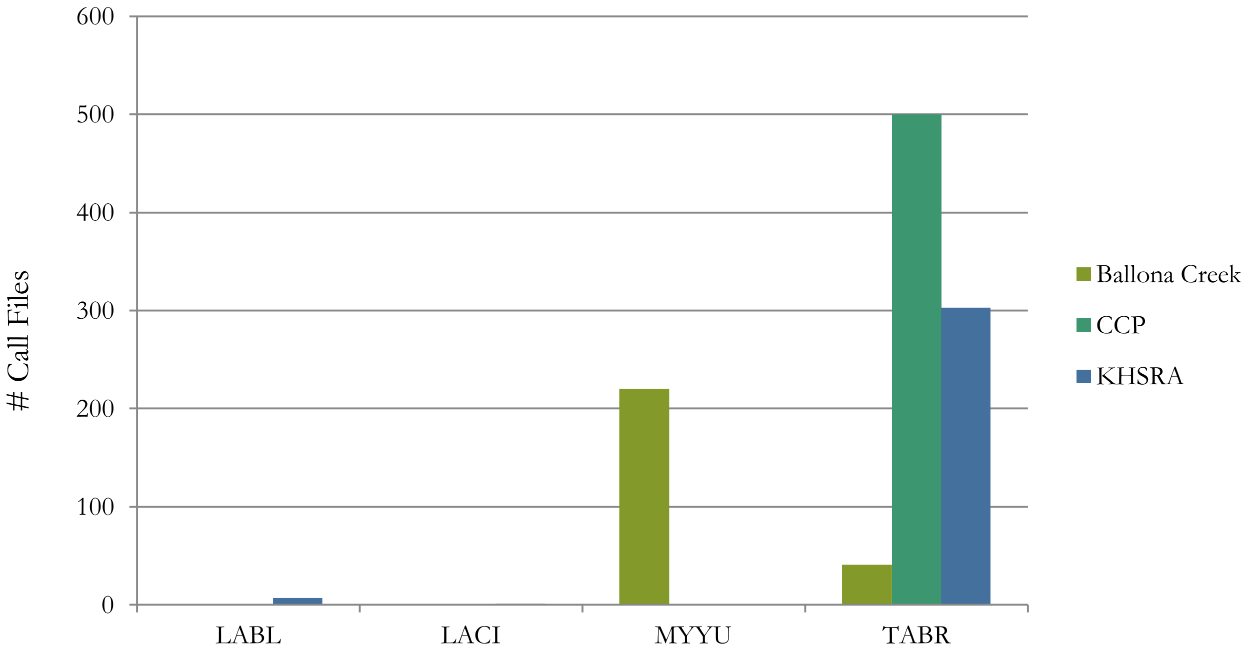

Figure 4-8. Bat activity at each site over both years (2014–2015).

It is also possible that an aggressive mosquito abatement program (at a park with very high human visitation) results in very low abundance of aquatic emergent insects. Flight and echolocation are each very energetically demanding; bats can eat a large proportion of their body weight in insects on a given night. Lactating females, with a particularly high-energy budget, may consume more than their body weight in a night. A suppressed prey base could result in an insufficient quantity of insects to support many *M. yumanensis* on a regular basis.

The highest species diversity was at KHSRA (3 species) – *M. yumanensis* was the only species not detected there (Figure 4-8). Both of the two other species detected were lasiurines (solitary, migratory foliage-roosting species in the genus *Lasiurus*: western red bat (*L. blossevillii*), and hoary bat (*L. cinereus*). All seven *L. blossevillii* detections were recorded on a single night by both teams surveying the park that night. *L. cinereus* was only confirmed once, in April 2014. Long-term monitoring would very likely result in higher rates of detection for both species.

L. blossevillii was the only California Species of Special Concern (CSSC) confirmed during the survey period. The western yellow bat (*L. xanthinus*) is also a CSSC, but – as mentioned before – was unconfirmed. *L. blossevillii* distribution is strongly associated with mature riparian vegetation for both roosting and foraging, which is mostly lacking throughout the Baldwin Hills. An exception is a small patch of native riparian vegetation near the north end of the park, and adjacent to the pond at KHSRA where they were recorded in August 2014. KHSRA was the only site where this species was recorded. Long-term monitoring may have resulted in detections along Ballona Creek, but given the degraded quality of riparian vegetation in and along most portions of the creek in the survey area, it is unlikely to support large numbers of *L. blossevillii*.

The only bat species confirmed at CCP was *T. brasiliensis*. This species foraged extensively over the ball fields – both lighted and unlit, but more heavily toward the lights during the surveys. No bats were detected at the Baldwin Hills Scenic Overlook (BHSO). This may be partly due to the large proportion of the site that is sparsely vegetated or un-vegetated. Although native habitat restoration is ongoing there, work on restoring vegetation at this site is relatively recent in its inception. It may also be due to the paucity of physical or biological features that would funnel or concentrate bat activity (e.g. trees, riparian areas, drainages). It may also have resulted from surveys of the BHSO being combined with surveys of CCP. So, as with previously mentioned scenarios, if activity was already low due to low vegetation biomass (and the resulting low insect prey base), and few features were present to concentrate existing activity, and survey effort was only half (at most) of what it was at KHSRA, these factors could all have contributed to the lack of detections at this site. There are very likely bats at this site that we did not detect. As the habitat restoration continues and the vegetation matures, bat activity will very likely increase at this site.

The timing of call files indicates that bats roosted relatively nearby at KHSRA, CCP, and BC. *M. yumanensis* were recorded within an hour of sunset at the creek in April and July 2014. *T. brasiliensis* were recorded foraging over the lights at the CCP ballfields within a half hour of sunset in September 2014. Two bats were observed foraging below the canopy (about 15 feet off the ground) for approximately 10 minutes at KHSRA, on the City View Trail near Autumn's Peak, a little over a half hour after sunset. Unfortunately, in the last case there was a detector malfunction and none of the bats there were recorded. These bats almost certainly were roosting in KHSRA, but it is unknown which species they were. Given the description of the location and flight, it was unlikely to have been *T. brasiliensis* – a species with high aspect ratio wings, better designed for speed in open air than extended flight in high clutter.

The *T. brasiliensis* calls recorded early at CCP were search phase calls and feeding buzzes (i.e. made by bats that were already foraging relatively high in the air). They were probably roosting relatively nearby, but this species is a fast flyer, so the roost was not necessarily in the immediate vicinity.

Bright moonlight from a full or near-full moon can have an inhibiting effect on bat activity (Lang et al. 2005). Bats may delay their emergence from their roosts, especially if a potential predator is nearby (pers. obs.). As mentioned previously, nights with bright moonlight were avoided in all but two occasions during the current study. However, extensive light pollution in urban areas has been noted to have a similar effect to bright moonlight (pers. obs.), and this was largely unavoidable. Artificial night lighting in the Baldwin Hills area is extreme, especially along Ballona Creek, where visibility throughout the survey period was similar to that of an overcast day.

The consequences of permanently bright night lighting can be severe (Rydell 2006). Azam et al. (2016) found that artificial night lighting negatively influenced bat activity and occurrence in the four most common bats species in France. The authors attributed this effect to the fact that artificial night lighting affects a range of bat behaviors, including roosting, foraging, commuting, and reproduction. Delayed emergence can cause bats to miss the peak in prey abundance (Downs et al.

2003, Boldogh et al. 2007), which can reduce juvenile growth rates and decrease survivorship of adult females in maternity colonies, as well. Bats may avoid lit areas or even abandon roosts altogether due to lighting (Boldogh et al. 2007). This can cause bats to take sub-optimal roosts and foraging and commuting routes.

The effects of artificial night lighting on high, fast-flying species like *T. brasiliensis* may be different from those on slower species that forage closer to the ground and vegetation (e.g. *M. yumanensis*), but landscape level artificial night lighting may act as barriers to bat movements regardless of foraging strategy (Azam et al. 2016). These two are the most common species in highly urban areas of southern California. This indicates that they may be more light-tolerant than other species formerly recorded more frequently in the area. Stone et al. (2015) postulated that more light-tolerant species could be outcompeting less light tolerant species. Schoeman (2016) found results supporting that conclusion at stadium lights. Stone et al. (2015) also describe attraction of insects away from dark areas, reducing the prey base for bat species that do not forage in lit areas.

Comparison with Historical Records and Species Accounts

Of 21 species documented in museum records for Los Angeles County, eight were collected in the Baldwin Hills area (Table 4-2).

Three of these eight species were detected during the current study: a colonial, crevice and cavity-dwelling species [Mexican free-tailed bat (*Tadarida brasiliensis*) and two solitary, foliage-roosting lasiurines [western red bat (*Lasiurus blossevillii*) and hoary bat (*L. cinereus*). A fourth species, of these eight, the big brown bat (*Eptesicus fuscus*), is a habitat generalist that was possibly detected at KHSRA, but its identification was not confirmed. Two species detected in the current study – one confirmed and one unconfirmed – are not among museum records for the Baldwin Hills: a specialist in the capture of aquatic emergent insects [Yuma myotis (*Myotis yumanensis*)] and another foliage-roosting lasiurine [western yellow bat (*Lasiurus xanthinus*)].

T. brasiliensis is the most common species among museum records from the Baldwin Hills area, comprising 21 of 35 specimens, and it was recorded most often in the current study (Figure 4-9). This species is known to roost in a variety of artificial and natural roost types throughout the region. It tends to congregate in large numbers in suitable roosts, and is known to adapt very well to urban structures, such as roof tiles and highway structures.

T. brasiliensis is a fast-flying species that typically forages over long distances, high above the ground, for moths and other insects, including a variety of pest species. It is considered a year-round resident in southern California, but there is some anecdotal evidence that migratory populations from other locations may arrive in fall and stay for some period of time before leaving again, with spikes in colony sizes observed in both fall and spring (pers. obs.).

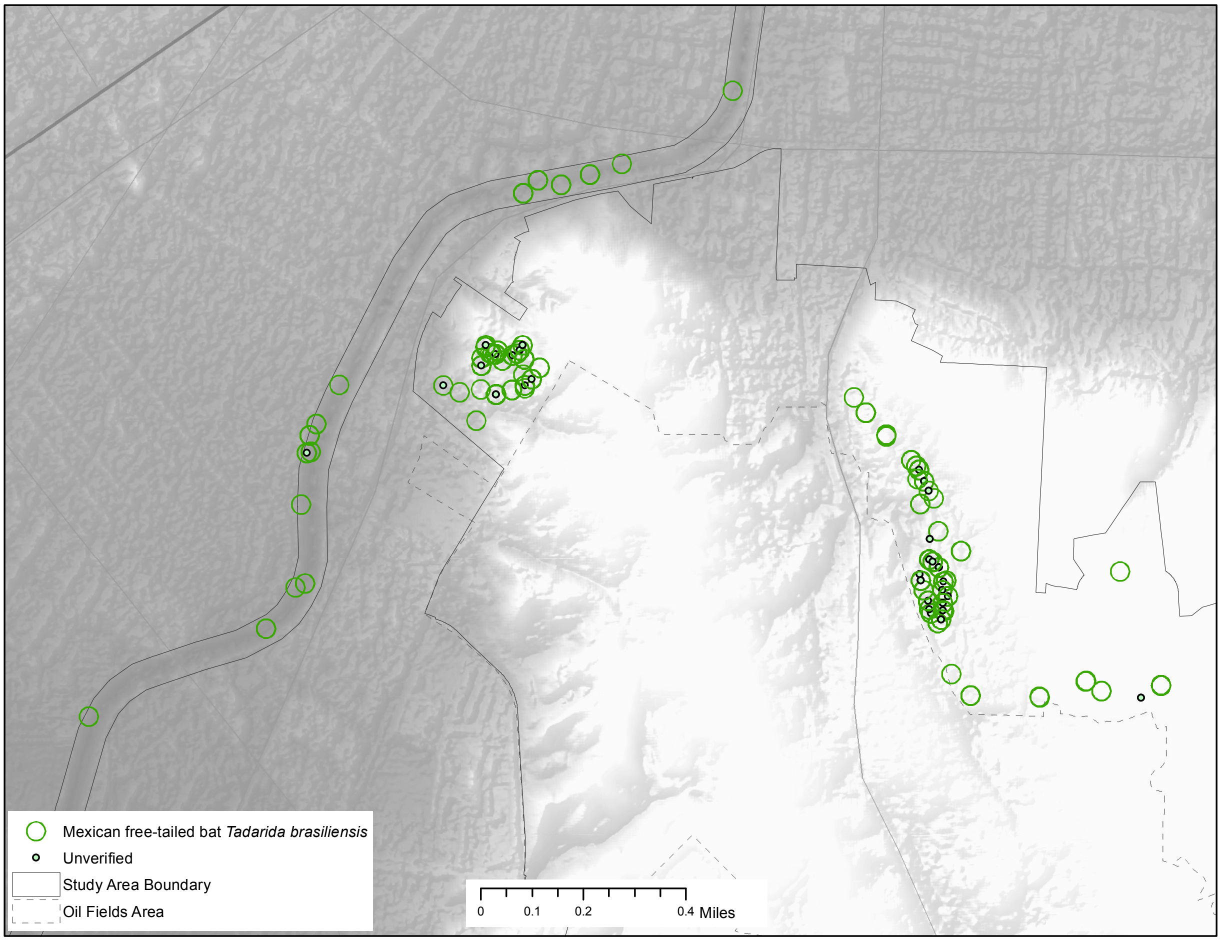

Figure 4-9. Distribution of observations of Mexican free-tailed bat.

This species was recorded within an hour of sunset on five of the 11 survey nights, including two nights in which it was detected early in the evening at two sites. In most cases recordings were of search phase calls, indicating that the individuals producing them were already high in the sky when they were detected. In areas without substantial light pollution, bats sometimes exit the roost within a few minutes of sunset (pers. obs). In areas were light pollution is more extreme, bats may exit the roost a half an hour or more after sunset (pers. obs.), especially when moon phase is full or nearly full. Given the types of call recorded and the speed of this species, individuals recorded within an hour of sunset most likely roosted relatively nearby, but not in the immediate vicinity. There may be one or more roost structures onsite, or they may be located in areas adjacent to survey sites.

When bats are observed early in the evening, it is sometimes possible to find the roost by looking for appropriate structures in the direction from which they came. Although several calls were recorded during this period, none were seen in flight early in the evening.

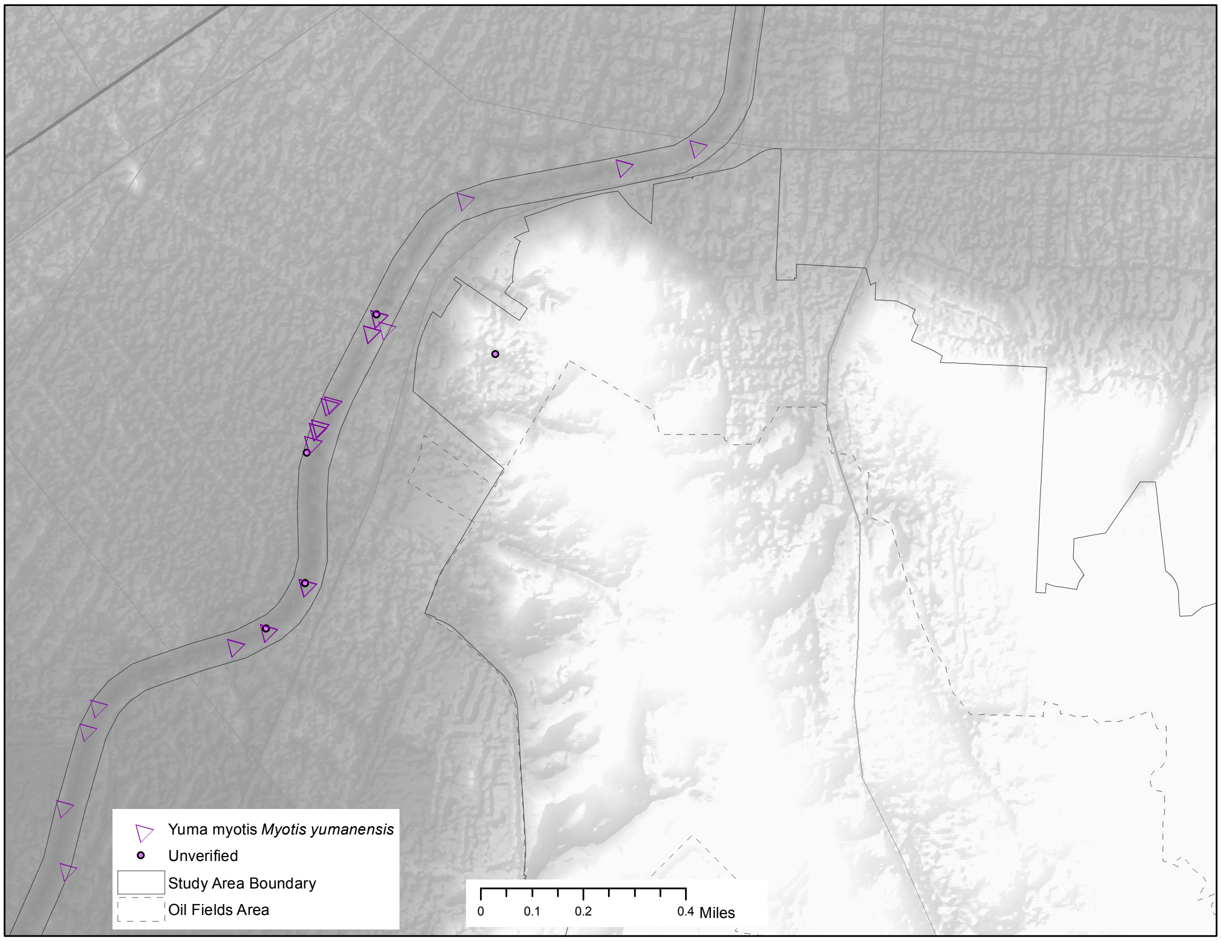

Figure 4-10. Distribution of Yuma myotis observations.

The second most commonly recorded species (Figure 4-10), Yuma myotis (*M. yumanensis*), is not among museum records from the Baldwin Hills area. Of 39 specimens collected in Los Angeles County, between 1906 and 2006, two were collected from within 5 miles of the Baldwin Hills limits – one, collected in 1968 at the Franklin Canyon Reservoir and another collected in 2005 in a residential area in the city of Hawthorne. The next closest specimens, in Downey (2005) and Lakewood (no year recorded), are over 10 miles away, both in commercial areas. Neither distance is insurmountable for a bat to travel, but nightly foraging commutes of this species are usually much shorter than those of *T. brasiliensis*. Typically, when bats commute several miles from a roost to a foraging area, either the roost is high quality, the foraging area is very productive, or both. Highly urban areas often lack diversity in insect populations and small species, such as midges, often dominate the insect fauna along urban creeks and rivers. Although species that forage over long distances, such as molossids (e.g *T. brasiliensis*) and lasiurines (e.g. *L. cinereus*), often include urban areas on their foraging routes (pers. obs.), it would be more likely for highly urban insect populations to support local bat populations of the smaller species, than to draw them in from a long distance.

M. yumanensis is considered a specialist in the capture of aquatic emergent insects whose geographic distribution is strongly associated with the presence of permanent water sources (Bogan, et al., 1998). Its occurrence along Ballona Creek and at the Franklin Canyon Reservoir would be expected. The location noted for the Downy specimen was collected within a mile of the San Gabriel River, where this species was detected within the last three years (pers. obs.), but since the same latitude and longitude is listed for a big brown bat (*E. fuscus*) from the same collector in the same year, this may not be the exact location where either specimen was obtained. The Hawthorne specimen, also listed as collected in a residential area, is located within a couple of miles of a golf course, but may or may not be the actual site of collection.

During the survey period, there was no evidence of bats roosting in the Sawtelle Boulevard, Sepulveda Boulevard, or Overland Avenue bridges over Ballona Creek. It is likely that individuals detected along the creek roosted in the surrounding residential or commercial areas.

The second most common species in museum records, the pallid bat (*Antrozous pallidus*) – 5 records, was undetected in the current study. *A. pallidus* is a CSSC that is sensitive to human disturbance. Individuals of this species can be difficult to detect acoustically because they tend to produce relatively low-intensity calls and sometimes forage without echolocating at all. This species is known to roost in a wide variety of natural and artificial structures including trees, rock crevices, and transportation structures and is known to forage, often for large prey items, in a wide variety of habitats, including grassland, woodland, orchards, and over gravel roads. Despite this species' use of relatively diverse roosting situations, local populations have declined substantially throughout southern California due to habitat loss, sensitivity to disturbance, and a variety of other factors, such as extermination and pesticide poisoning. This species may still occur in the Baldwin Hills, and – if so – would be more likely to be detected by long-term, all-night acoustic sampling than monthly surveys conducted within a few hours of sunset. Locating and protecting local populations is vital to protecting this species (Sherwin 1998, Rambaldini 2005).

Of 127 museum records of *E. fuscus* in Los Angeles County from 1890–2005, there are two from the Baldwin Hills area, both collected in 1935. There is a museum record from 1939 from Exposition Park and another from downtown Los Angeles in 1952. But the most recent museum record from relatively near the Baldwin Hills is the 2005 Downey record. There are recent field records to the north of the Baldwin Hills [Griffith Park (Remington and Cooper, 2014), other sites in the Santa Monica Mountains (Brown, pers. comm., pers. obs.)], but this species was not confirmed acoustically during the current study. It may still occur in the Baldwin Hills at sites such as KHSRA and the Holy Cross Cemetery.

In urban Orange County, *E. fuscus* is occasionally detected in relatively large parks, primarily those near larger tracts of open space, and along Santiago Creek where the vegetation supports relatively high insect populations. However, despite being a relatively adaptable generalist, it is primarily detected in the Santa Ana Mountains and San Joaquin Hills and along their margins (pers. obs.). Recent records in San Diego County show a similar pattern, with occurrences primarily in large open space, but also in suburban areas, housing tracts adjacent to open space (e.g. Camp Pendleton), or in old neighborhoods with a lot of large, old (albeit non-native) trees (D. Stokes, pers. comm.).

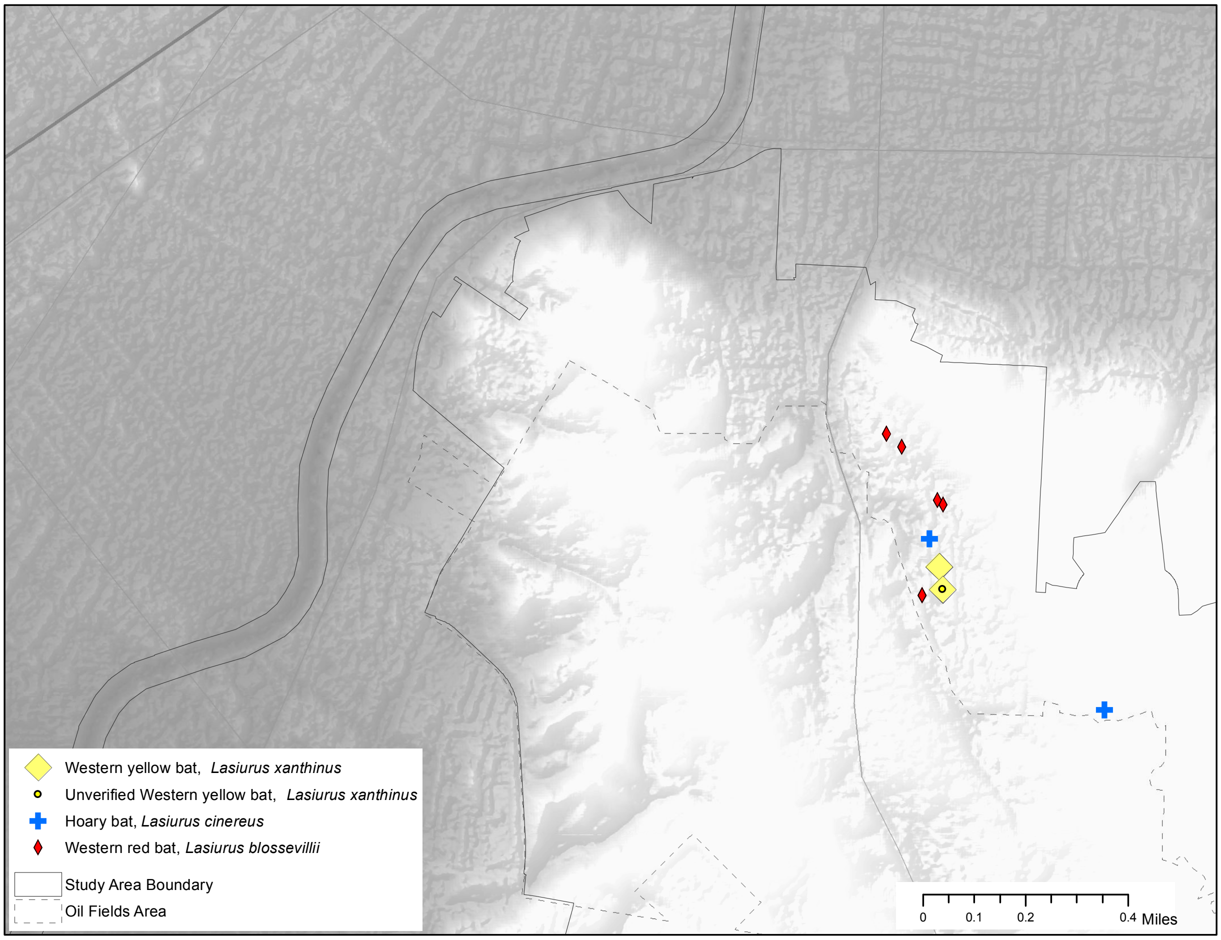

Figure 4-11. Location of Western red bat detections, possible detection of western yellow bat and hoary bats.

Twelve records of *L. blossevillii* exist in Museum records for Los Angeles County (eight are identified as *L. borealis*) between 1889 and 1954. The location closest to the Baldwin Hills was a specimen collected in Exposition Park in 1939. Two others were collected in downtown Los Angeles in 1938 and 1944. Two were collected in the summer, one was collected in spring, and the rest were collected in fall and winter. In Griffith Park, acoustic detections of this species were primarily in the spring and fall. *L. blossevillii* is a solitary foliage-roosting species whose distribution is associated with riparian corridors, particularly areas with mature, intact riparian vegetation, which it uses for both roosting and foraging (Bolster 1998, Pierson and Rainey, 1998). In areas where riparian habitat is less extensive and more fragmented, this species (the only CSSC confirmed during the survey period) also roosts in other trees and shrubs, including orchards – often adjacent to streams, open fields, and urban areas. Roosts are commonly found in edge habitat.

Pierson and Rainey (1998) identified several threats to this species, including conversion or loss of riparian areas, pesticide use (e.g. orchards and golf courses), and fire (in winter it has been observed roosting in leaf litter). This species was considered common in San Diego County from the coastal plain to the foothills of San Diego County in the 1930s and 1940s (Krutzsch 1948). Currently, it is not considered common anywhere in coastal southern California.

There is a small stand of relatively mature native riparian vegetation north of the ponds at KHSRA. *L. blossevillii* was recorded at the pond adjacent to this stand (Figure 4-11). It was only recorded at KHSRA and only on a single night in August. All detections that night were near ponds (including the Japanese garden) and riparian vegetation.

Of 47 *L. cinereus* museum records from Los Angeles County, collected from 1890–1992, there is a single specimen from the Baldwin Hills area (Palms), collected in 1939. The next nearest locations of this species in museum records were Exposition Park (1904), downtown Los Angeles (1942), Hollywood (1928, 1962), and Beverly Hills (1957). Over 80% were collected in spring and fall. As with *L. blossevillii*, *L. cinereus* was detected in Griffith Park most often in spring and fall (Remington and Cooper, 2015) and at other sites in the Santa Monica Mountains (P. Brown, pers. comm., pers. obs.). In Griffith Park, *L. cinereus* was detected more often than *L. blossevillii*. It was the reverse in the current study. Both species were detected on a single night in the current study, but *L. blossevillii* was detected several times on 23 August 2014. There were several call files recorded that could have been *L. cinereus* at all three main sites, but the only call file confirmed as this species was recorded in April 2014 at KHSRA. It very likely occurs at least occasionally throughout the Baldwin Hills area, but This species showed signs of substantial population decline in Orange County from the 1980s through 2000 (Remington, 2000), most likely due in large part to habitat loss. *L. cinereus* is a solitary, migratory, foliage-roosting species that is detected most often in the fall, winter, and spring months in southern California.

Management Recommendations

Based on the observations in the Baldwin Hills and extensive experience with bats and bat conservation in southern California, the following recommendations for management of the Baldwin Hills to promote bat diversity are offered:

- Restore native habitats wherever possible.
- If large scale removal of non-native vegetation is undertaken, conducting the removal in phases, rather than all at once, can prevent total loss of insect fauna over a large area. At the San Joaquin Reserve in Orange County, non-native vegetation was removed all at once from the entire 250-acre property in the mid-1990s. Bat activity had been extensive at the reserve prior to the removal, but dropped to nearly nothing afterwards (non-natives support some insect populations; bare ground does not). The quality of the restoration was excellent, but it took nearly 20 years for bat activity to approach pre-restoration levels.
- Initiate a volunteer program to continue collecting acoustic data on bats. More data are necessary to identify trends.

- Whenever possible, collaborate with entomologists and vector control officials. Knowing when and where mosquito abatement is conducted and what types of compounds and/or organisms are used can help determine the best times to conduct bat surveys. It would be informative to collect and compare data before and after abatement to see if data at any sites indicate the potential for mosquito control by bats.
- Locate, monitor, and protect day (particularly maternity) and night roosts in natural and anthropogenic roosts;
- Engage in outreach (local organizations and individuals, including homeowners) to locate, monitor, and protect local bat colonies.
- Promote adoption of energy-efficient community lighting (similar to the changes made in Tucson, Arizona) or any of the variations described by Stone et al. (2015). In addition to the non-biological benefits of such a program, darker night skies would potentially help increase bat populations by decreasing predation pressures on bats and increasing the amount of dark time available for foraging bats.
- Promote a multi-disciplinary approach, including studies across trophic levels (Stone et al. 2015), to assess the effects of artificial night lighting on ecological communities in the Baldwin Hills.

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APPENDIX

A1. Collections with bat specimens from Los Angeles County.

Institution	Acronym
American Museum of Natural History	AMNH
Barcelona Natural History Museum	MCNB
California Academy of Sciences	CAS
Charles R. Connor Museum, Washington State University	CRCM
Cheadle Center for Biodiversity and Ecological Restoration, Santa Barbara	CCBER
Chicago Academy of Sciences	CHAS
Donald R. Dickey Bird and Mammal Collection	UCLA
Humboldt State University Vertebrate Museum	HSU
Kansas University Biodiversity Institute and Natural History Museum	KU
Los Angeles County Museum of Natural History	LACMNH
Louisiana State Museum of Natural Science	LSUMZ
Michigan State University	MSU
Moore Laboratory of Zoology	MLZ
Museum of Comparative Zoology, Harvard	MCZ
Museum of Southwestern Biology, New Mexico	MSB
Museum of Vertebrate Zoology, Berkeley	MVZ
North Carolina Museum of Natural Sciences	NCSM
Puget Sound Museum	PSM
Royal Ontario Museum	ROM
Santa Barbara Museum of Natural History	SBMNH
Smithsonian National Museum of Natural History	USNM
Texas Tech University	TTU
The Field Museum of Natural History, Chicago	FMNH
University of Arizona Museum of Natural History	UAZ
University of Colorado Museum of Natural History	UCM
University of Connecticut	UCONN
University of Florida Museum of Natural History	UF
University of Michigan Museum of Zoology	UMMZ