Lower Colorado River Multi-Species Conservation Program

Balancing Resource Use and Conservation

Post-Development Bat Monitoring of Conservation Areas and the ‘Ahakhav Tribal Preserve Along the Lower Colorado River – 2013–2014 Capture Surveys

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

October 2016

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Lower Colorado River
Multi-Species Conservation Program

Post-Development Bat Monitoring of Conservation Areas and the ‘Ahakhav Tribal Preserve Along the Lower Colorado River – 2013–2014 Capture Surveys

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ACRONYMS AND ABBREVIATIONS

AKTP	‘Ahakhav Tribal Preserve
BCI	Bat Conservation International
BLCA	Beal Lake Conservation Area
Cibola NWR Unit #1	Cibola National Wildlife Refuge Unit #1 Conservation Area
CRIT	Colorado River Indian Tribes
CVCA	Cibola Valley Conservation Area
ft	foot/feet
GPS	Global Positioning System
ha	hectare(s)
in	inch(es)
km	kilometer(s)
LCR	lower Colorado River
LCR MSCP	Lower Colorado River Multi-Species Conservation Program
m	meter(s)
mi	mile(s)
mm	millimeter(s)
PC	personal computer
PIT	passive integrated transponder
PVER	Palo Verde Ecological Reserve
Reclamation	Bureau of Reclamation
YEW	Yuma East Wetlands

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ABSTRACT

This report summarizes the results of bat capture surveys conducted within conservation areas and the ʻAhakhav Tribal Preserve for the Lower Colorado River Multi-Species Conservation Program (LCR MSCP) in 2013 and 2014. There are two bat species covered under the program and two evaluation bat species. The two covered species are the western red bat (*Lasiurus blossevillii*) and western yellow bat (*L. xanthinus*), which are tree-roosting species. The two evaluation species are the California leaf-nosed bat (*Macrotus californicus*) and pale Townsend's big-eared bat (*Corynorhinus townsendii* also known as *Plecotus townsendii pallescens and C. townsendii townsendii*), which are mine- and cave-roosting species that utilize riparian areas as foraging habitat. Six sites were surveyed in 2013 and 2014. All of the sites were surveyed once a month from May through September. A total of 613 individual bats representing 12 species were captured in 2013, and a total of 778 individual bats representing 15 species were captured in 2014. All four LCR MSCP species were captured within the study areas. Western red bats were captured more often at the Cibola Valley Conservation Area than at any of the other sites. The pale Townsend's big-eared bat was captured for the first time at the Beal Lake Conservation Area in 2013 and was again captured in 2014. Renyi diversity profiles were used to compare sites and years. Most of the sites showed little variation in diversity between years. The only site that showed a lower species diversity compared to other sites in 2014 was Yuma East Wetlands, one of the most recently developed conservation areas being monitored using capture surveys.

INTRODUCTION

The Lower Colorado River Multi-Species Conservation Program (LCR MSCP) is a partnership of Federal and non-Federal stakeholders that was created to respond to the need to balance the use of lower Colorado River (LCR) water resources and the conservation of native species and their habitats in compliance with the Endangered Species Act. This is a long-term (50-year) plan to conserve at least 26 species along the LCR from Lake Mead to the Southerly International Boundary with Mexico through implementation of a Habitat Conservation Plan. The LCR MSCP was implemented in October 2005. Implementing the LCR MSCP will create at least 8,132 acres of new habitat: (1) 5,940 acres (2,404 hectares [ha]) of cottonwood-willow (*Populus fremontii* and *Salix* spp.), (2) 1,320 acres (534 ha) of honey mesquite (*Prosopis glandulosa*), (3) 512 acres (207 ha) of marsh, and (4) 360 acres (146 ha) of backwaters (Bureau of Reclamation [Reclamation] 2004).

This report summarizes the results of bat capture surveys conducted within LCR MSCP conservation areas and the Colorado River Indian Tribes' (CRIT) 'Ahakhav Tribal Preserve (AKTP) in 2013 and 2014. The western red bat (*Lasiurus blossevillii*) and western yellow bat (*L. xanthinus*) are covered species under the program. The California leaf-nosed bat (*Macrotus californicus*) and pale Townsend's big-eared bat (*Corynorhinus townsendii* also known as *Plecotus townsendii pallescens and C. townsendii townsendii*) are evaluation species under the program. 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 (*C. townsendii townsendii)* rather than the pale Townsend's big-eared bat (Piaggio and Perkins 2005). Herein, these four species will be known as LCR MSCP species. The LCR MSCP uses a variety of methods to monitor LCR MSCP bat species and monitors at varying intensities to address specific hypotheses about where and how these covered species are utilizing created habitat. Conservation areas containing riparian habitat along the LCR were surveyed for bats minimally prior to 2006 (Brown 2006). In fall 2006, a post-development bat survey using acoustic bat detectors was initiated by Reclamation (Broderick 2008). In 2007, acoustic surveys and capture surveys were conducted at the Beal Lake Conservation Area (BLCA), the Cibola National Wildlife Refuge Unit #1 Conservation Area (Cibola NWR Unit #1) Nature Trail site, the AKTP, and the Pratt Restoration Demonstration Area (Calvert 2009). In 2008, a full-season capture survey was conducted at all four sites. The survey protocol was refined in 2009, and surveys following that protocol have continued since.

Pairing acoustic and capture techniques provides benefits over using a single method. Each method has limitations that can affect the ability to detect the presence of species at a site (O'Farrell and Gannon 1999). Species such as pale Townsend's big-eared bats and California leaf-nosed bats are known to echolocate at low intensities, so their presence is often missed using acoustic detectors. Capturing bats may confirm the presence of a species when acoustic calls cannot be definitively identified to species on the recordings. This method also allows for acoustic reference calls to be recorded when releasing bats near a bat detector so

that additional calls can be included in the reference call library, which allows easier identification of species using bat detectors. Capturing bats adds additional information such as age, gender, breeding status, and health of individuals.

STUDY AREAS

Palo Verde Ecological Reserve

The Palo Verde Ecological Reserve (PVER) is a large-scale LCR MSCP conservation area approximately 6 miles (mi) (10 kilometers [km]) north of Blythe, California (figure 1). The PVER is managed under a partnership between the landowner (California Department of Fish and Wildlife) and Reclamation. Habitat is being created by replacing cultivated crops with native riparian plant species on agricultural fields, utilizing existing irrigation infrastructure. In the last 7 years, over 1,000 acres (405 ha) of habitat were created. The species planted included Fremont cottonwood *(Populus fremontii),* Goodding's willow (*Salix gooddingii*), coyote willow (*Salix exigua*), honey mesquite, willow baccharis (*Baccharis salicina*), desert broom (*Baccharis sarothroides*), and quailbush (*Atriplex lentiformis*). Most of the habitat is dominated by cottonwood and willow trees, including the area where the surveys were conducted (figure 2). Two net sets were within an area planted in 2006, and the other area was planted in 2009 (figure 2).

Cibola Valley Conservation Area

The Cibola Valley Conservation Area (CVCA) is approximately 2 mi (3 km) north of Cibola, Arizona, and is also a large-scale LCR MSCP restoration project (figure 1). The CVCA is managed under a partnership between the landowner (Arizona Game and Fish Department) and Reclamation. The habitat is being developed in the same manner and planted with the same species as the PVER. In the last 7 years, over 600 acres (243 ha) of habitat were created. Once all phases have been planted, there will be over 1,000 acres (405 ha) of riparian habitat within the CVCA. The capture survey area was an 86-acre (35-ha) section with cottonwood and willow that was planted in 2006 (figure 3).

Cibola National Wildlife Refuge Unit #1 Conservation Area

Cibola NWR Unit #1 is over 800 acres (323.7 ha) on the northern end of the refuge that includes several phases of habitat development (figure 1). Capture

Figure 1.—Bat capture survey areas.

Figure 2.—Net locations (in red) at the PVER.

Figure 3.—Net locations (in red) at the CVCA.

surveys were conducted within two of these phases: the Nature Trail (planted in 1999) and Mass Planting (planted in 2005). Capture surveys took place in areas where tall cottonwood lined the trail (figure 4). Goodding's willow, desert broom, screwbean mesquite (*Prosopis pubescens*), and honey mesquite are additional species found within the site.

Figure 4.—Net locations (in red) at Cibola NWR Unit #1.

'Ahakhav Tribal Preserve

The AKTP is a 150-acre (61-ha) site located 3 mi (5 km) southwest of Parker, Arizona, on CRIT land (see figure 1). This site consists of fields of cottonwood, willow, and honey mesquite planted as part of an agreement between the CRIT and Reclamation. The capture survey area was planted in 2001 and has the largest trees of the site (figure 5). Cottonwoods, Goodding's willows, and coyote willows were planted in the area. This site is not a LCR MSCP conservation area, but it continues to be monitored not only because it was planted by Reclamation and serves as an example of an older restoration site but also because of its high bat diversity.

Figure 5.—Net locations (in red) at the AKTP.

Beal Lake Conservation Area

The BLCA is a 100-acre (61-ha) site located 6 mi (10 km) southwest of Needles, California, within the Havasu National Wildlife Refuge (see figure 1). This site consists of fields of cottonwood, willow, and honey mesquite planted as part of an agreement between the U.S. Fish and Wildlife Service and Reclamation. The capture survey area was planted between 2003 and 2006, and the nets were set along the center road of the site (figure 6). Cottonwoods, Goodding's willows, and coyote willows were planted in the area.

Figure 6.—Net locations (in red) at the BLCA.

Yuma East Wetlands

Yuma East Wetlands (YEW) is a 1,400-acre (566-ha) (approximately 350 acres (61 ha) have been restored and are being managed) site within the city of Yuma and Quechan Tribal land (see figure 1). It is a multi-partner project including the city of Yuma, the Quechan Tribe, the Arizona Game and Fish Department, and Reclamation. This site consists of cottonwood, willow, honey mesquite, and marsh habitat. The capture survey area (known as the "North Channel" area) was planted in 2010; nets were placed along a road that bisected two areas dominated by cottonwood plantings (figure 7).

METHODS

Mist netting was the technique used to capture bats during surveys (attachment 2). Depending on net locations, five different net lengths were used, including 6-meter (m) (19.7-foot [ft]), 9-m (29.5-ft), 12-m (39.4-ft), 15-m (49.2-ft) and 18-m (60-ft) Avinet, Inc., nets, which were all 2.6 m (8.5 ft) tall with a 38-millimeter (mm) (1.5-inch [in]) mesh size. High net setups were used at all of the sites. These high nets were constructed by stacking regular nets (8.5 ft [2.6 m] tall) on top of each other using poles in which a pulley system had been made to reach the higher stacked nets. The three nets were stacked on top of each other

Figure 7.—Net locations (in red) at YEW.

known hereafter as a triple net set) (figure 8). The triple net set was used to capture bats that fly higher and where single nets were easily avoided. In general, a different length net was used for each triple net set within each site. Of the five different net lengths used, three different net lengths were used at each site, and the combination changed depending on the width of the corridors where the nets were set, which allowed for a diversity of foraging areas to be included in each survey. It was assumed that different net lengths for a given net height did not substantially affect survey efforts (see below).

Nets were set up at a site in areas where bats may be easily captured below the canopy, such as corridors within the site where a space such as a road or trail was found between two planting areas. Netting perpendicular to an edge was also implemented at two sites (the PVER and CVCA). The length of the net was determined by the width of the corridor in order to maximize the area where bats could be captured. In some areas where it appeared that one triple net set may be easily avoided by a bat, two net sets were placed together to make avoidance less likely. Nets were set up in a "V" or "L" formation so that a bat might be funneled from one net to the other (see figure 8). These techniques have been used successfully by Bat Conservation International (J. Tyburec 2007, personal communication).

Figure 8.—Two triple net sets in an "L" formation at the CVCA.

During netting, two types of bat detectors were used to obtain reference calls of captured bats when released as well as to determine whether bat activity in the area was changing over the course of the evening. Bat detectors record the calls, which are above the audible range of humans. Software is later used to analyze each call for species-specific characteristics such as frequency, length, and slope. The detectors used were an Anabat SD2 bat detector (Titley Electronics) connected to an HP iPAQ pocket personal computer (PC) running AnaPocket software and an AR-125 bat detector (Binary Acoustics Technology) connected to a Mobile Demand xTablet T7000 tablet PC running SPECTR Mobile software.

Once a bat was captured, its species, age, gender, and reproductive status were determined. Measurements such as forearm and ear length were taken, if necessary, to identify the species. If acoustic reference calls were needed for that species, a small 1-in (2.5-centimeter) long glow stick was glued (using a non-toxic glue stick) onto the ventral fur to be used as a light tag (Kunz and Weise 2009). Once the bat was released, it was followed by a person holding a bat detector until it flew too far away to be recorded. These light tags either fall off or are groomed off by the bat within 2–3 hours after release. All acoustic file names saved on the HP iPAQ or the tablet PC were written on the data sheet for species confirmation and later added to the acoustic reference library.

Wing tissue was collected from captured bats if needed for genetic-based species identification or genetic studies (such as LCR MSCP Work Task C43, which is

studying the genetics of California leaf-nosed bats, and an outside request from a researcher in 2014 for samples from Yuma myotis (*Myotis yumanensis*) to fill in distribution gaps of his samples). Genetic samples were taken from the wing using a 2- or 3-mm biopsy punch. All tissues were stored in 95-percent ethanol.

Surveys began a half hour after sunset and continued for 4 hours (weather permitting). Each site was surveyed once a month from May to September, for a total of five survey sessions. If covered species were recorded acoustically during other times of the year, an exploratory survey was conducted. Three triple net sets were used at each site. It was assumed that each triple net set had an equal chance of capturing bats regardless of net length. For example, a 12-m triple net set within a corridor at one site would not necessarily increase the survey effort compared to a 9-m triple net set within a corridor at a different site. In this manner, it was assumed that the survey effort was equal at each site. These standardizations were derived from a protocol that was created using data from the 2007 and 2008 LCR MSCP bat surveys and has been updated periodically since then (attachment s).

Total captures per species, reproductive status, age, and gender ratios were summarized for each site. Species diversity statistics were used to compare the diversity of the bat community among sites in and between years at a single site. For the sake of brevity, an among-site analysis was only done for the 2014 data, being the most recent year of data collection. There are multiple indices that are used to compare species diversity. Most of these indices are biased differently based on the evenness or dominance of a species within the dataset. Parametric families of diversity indices that reflect varying sensitivity to rare and abundant species have been developed to provide a more comprehensive comparison of communities. The Renyi index family is among the most useful and robust of these (Tóthmérész 1995). Renyi diversity profiles were used to compare diversity among sites and years within sites. Renyi indices are presented as a line graph, with each profile being represented by a single line on the graph. If the profile (line) for one site is everywhere above the profile for another site, then this means the site with the highest profile is the more diverse of the two. If the profiles (lines) intersect, it is not possible to order the sites from lowest to highest diversity.

Multiple sites or years can be compared in this manner within one graph. The shape of each profile represents the species evenness of each site or year. A horizontal profile indicates that all species have the same evenness, and the farther from horizontal the shape of the profile is, the less evenness there is among species. The horizontal axis of the graph represents the diversity of each site or year, and each point represents the sensitivity to rare versus abundant species for the diversity value at each point. Point 0 represents species richness since there is no sensitivity to rare or abundant species. The point represented by the infinity symbol at the other end of the horizontal axis represents the proportion of the most abundant species, with the lower value reflecting a higher

proportion (i.e., less evenness). In between, point 1 represents the Shannon Index, which is more sensitive to species richness, and point 2 represents the logarithm of the reciprocal of the Simpson Index, which is more sensitive to species evenness. All other points represent a gradient between these values (Kindt and Coe 2005). Renyi diversity profiles were calculated using the BiodiversityR package in Program R (v. 2.15.2).

RESULTS

See attachment 1 for a list of common and scientific names of all species captured (tables 1–31.)

Palo Verde Ecological Reserve

A total of 146 bats from 10 species were captured in 2013 at the PVER (table 1). The big brown bat (*Eptesicus fuscus*) was the most commonly captured species (106). Three LCR MSCP bat species were captured: the California leaf-nosed bat, western red bat, and western yellow bat. The highest capture rates were found during the July survey (75), and the highest species richness was found during the June survey (table 1).

Table 1.—Species captured at the PVER during each survey month in 2013

Species	May	June	July	August	September	Total
Big brown bat	23	6	62	9	6	106
California leaf-nosed bat*	1	1	0	0	0	2
California myotis	0	1	0	0	0	1
Canyon bat	0	0	1	0	0	1
Cave myotis	1	3	3	1	0	8
Mexican free-tailed bat	1	0	0	0	0	1
Pallid bat	2	1	4	2	1	10
Western red bat	0	1	0	0	0	1
Western yellow bat	0	1	2	9	0	12
Yuma myotis	0	0	3	1	0	4
Total bats captured	**28**	**14**	**75**	**22**	**7**	**146**
Total species (richness)	**5**	**7**	**6**	**5**	**3**	**10**

Note: Species in bold are LCR MSCP covered species; * indicates an evaluation species.

Four species had a higher capture ratio of females versus males (table 2) in 2013. Juveniles were captured from six species (table 2). Reproductive male western red bats and reproductive female western yellow bats were confirmed.

Table 2.—Gender and age ratios for all species at the PVER in 2013

Species	Gender (male:female)	Age (adult:juvenile)
Big brown bat[1]	38:67	52:52
California leaf-nosed bat*	1:1	2:0
California myotis[1]	0:0	0:1
Canyon bat	1:0	0:1
Cave myotis	4:4	6:2
Mexican free-tailed bat	1:0	1:0
Pallid bat	2:8	10:0
Western red bat	**1:0**	**1:0**
Western yellow bat[1]	**5:6**	**9:2**
Yuma myotis	1:3	2:2

[1] One big brown bat and one western yellow bat escaped before the age and gender was determined. One big brown bat was released before the age was determined. The California myotis was released before the gender was determined.

Note: Species in bold are LCR MSCP covered species; * indicates an evaluation species.

A total of 159 bats from 12 species were captured in 2014 at the PVER (table 3). The big brown bat was the most commonly captured species (96). Three LCR MSCP bat species were captured: the California leaf-nosed bat, western red bat, and western yellow bat. The highest capture rates were found during the July survey (69), and the highest species richness was found during the June survey (table 3). An exploratory survey was conducted in February, which resulted in the capture of four California leaf-nosed bats.

Table 3.—Species captured at the PVER during each survey month in 2014

Species	February	May	June	July	August	September	Total
Big brown bat	0	3	37	50	4	2	96
California leaf-nosed bat*	4	0	2	0	0	0	6
California myotis	0	0	1	0	0	0	1
Canyon bat	0	0	1	0	0	0	1
Cave myotis	0	1	1	0	0	0	2
Mexican free-tailed bat	0	0	0	0	4	0	4
Pallid bat	0	3	11	8	2	0	24
Pocketed free-tailed bat	0	0	0	1	0	0	1
Western mastiff bat	0	0	0	1	0	0	1
Western red bat	**0**	**0**	**0**	**0**	**1**	**0**	**1**
Western yellow bat	**0**	**1**	**2**	**8**	**4**	**0**	**15**
Yuma myotis	0	1	1	1	4	0	7
Total bats captured	**4**	**9**	**56**	**69**	**19**	**2**	**159**
Total species (richness)	**1**	**4**	**8**	**6**	**5**	**1**	**12**

Note: Species in bold are LCR MSCP covered species; * indicates an evaluation species.

Eight species had a higher capture ratio of females versus males (table 4) in 2014. Juveniles were captured from five species (table 4). One reproductive female western yellow bat was confirmed.

Table 4.—Gender and age ratios for all species at the PVER in 2014

Species	Gender (male:female)	Age (adult:juvenile)
Big brown bat[1]	28:66	61:33
California leaf-nosed bat*	4:2	6:0
California myotis	0:1	1:0
Canyon bat	0:1	1:0
Cave myotis	1:1	2:0
Mexican free-tailed bat	2:2	4:0
Pallid bat	6:18	22:2
Pocketed free-tailed bat	0:1	1:0
Western mastiff bat	0:1	0:1
Western red bat	0:1	1:0
Western yellow bat[1]	6:6	7:5
Yuma myotis	2:5	6:1

[1] Two big brown bats and three western yellow bats escaped before the age and gender could be determined.

Note: Species in bold are LCR MSCP covered species; * indicates an evaluation species.

Capture rates from 2010–14 were fairly consistent, except for in 2010 when there was a very high capture rate. A total of 12 species have been captured at the site, with 2014 being the only year when all 12 species were captured in a single year (table 5). Big brown bats were the most common species captured. Of the LCR MSCP species, western red bats were captured every year; however, only one individual was captured in each of the past 2 years. Western yellow bat captures have been consistent each year from 2012–14. California leaf-nosed bats have been captured each year from 2011–14. No pale Townsend's big-eared bats have been captured at the PVER during this monitoring effort (2010–14).

Table 5.—All species captured across all years at the PVER

Species	2010	2011	2012	2013	2014	All years
Big brown bat	154	75	70	106	96	501
California leaf-nosed bat*	0	5	1	2	6	14
California myotis	3	2	1	1	1	8
Canyon bat	0	0	0	1	1	2
Cave myotis	31	10	14	8	2	65
Mexican free-tailed bat	2	2	5	1	4	14
Pallid bat	7	23	10	10	24	74
Pocketed free-tailed bat	4	0	0	0	1	5
Western mastiff bat	0	1	0	0	1	2
Western red bat	**3**	**5**	**6**	**1**	**1**	**16**
Western yellow bat	**12**	**9**	**10**	**12**	**15**	**58**
Yuma myotis	16	4	7	4	7	38
Total bats captured	**232**	**136**	**124**	**146**	**159**	**797**
Total species (richness)	**9**	**10**	**9**	**10**	**12**	

Note: Species in bold are LCR MSCP covered species; * indicates an evaluation species.

The Renyi species diversity profiles that start higher on the Y axis have higher species richness. Figure 9 indicates that the species are not evenly distributed.

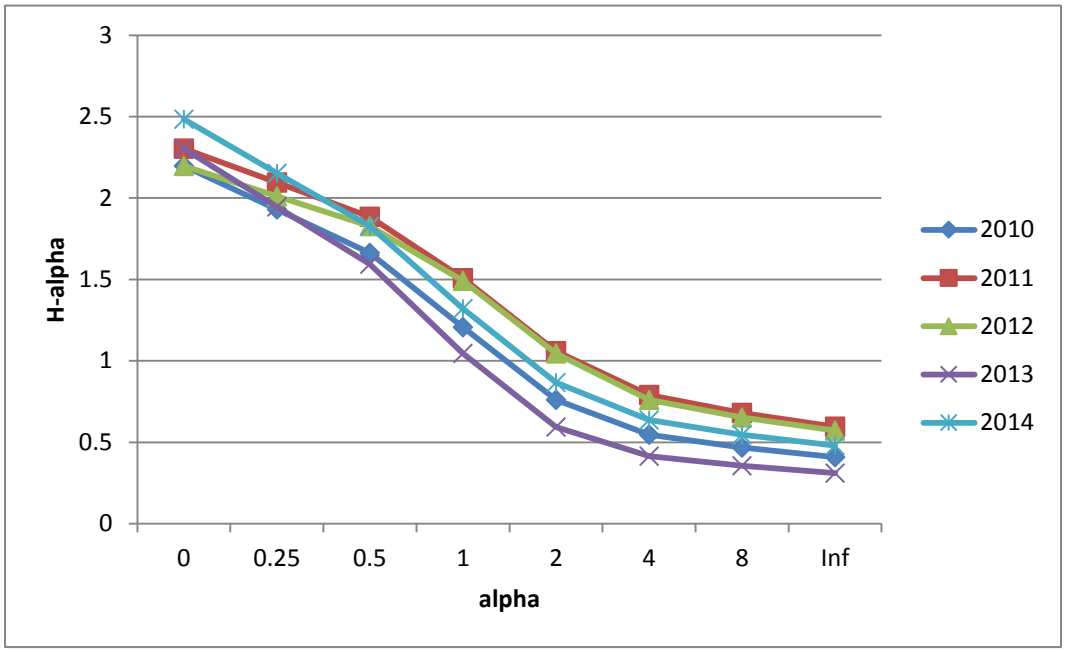

Figure 9.—Renyi diversity profiles for all years at the PVER.

Cibola Valley Conservation Area

A total of 128 bats from 8 species were captured in 2013 at the CVCA (table 6). The big brown bat was the most commonly captured species (63). Two LCR MSCP bat species were captured: the western red bat and western yellow bat. The highest capture rates were found during the July survey (73), and the highest species richness was found during the July survey (table 6).

Table 6.—Species captured at the CVCA during each month in 2013

Species	May	June	July	August	September	Total
Big brown bat	4	3	39	17	0	63
California myotis	0	2	0	0	0	2
Cave myotis	1	0	9	2	1	13
Mexican free-tailed bat	0	0	2	0	0	2
Pallid bat	4	1	9	4	3	21
Western red bat	**1**	**1**	**4**	**1**	**3**	**10**
Western yellow bat	**0**	**0**	**4**	**1**	**0**	**5**
Yuma myotis	4	1	6	1	0	12
Total bats captured	**14**	**8**	**73**	**26**	**7**	**128**
Total species (richness)	**5**	**5**	**7**	**6**	**4**	**8**

Note: Species in bold are LCR MSCP covered species.

Five species had a higher capture ratio of females versus males (table 7) in 2013. Juveniles were captured from seven species. There were higher capture rates of juvenile big brown bats and California myotis compared to adults, whereas all other species had more adults captured (table 7). Reproductive male and female western yellow bats were confirmed. One reproductive female western red bat was also confirmed.

Table 7.—Gender and age ratios for all species at the CVCA in 2013

Species	Gender (male:female)	Age (adult:juvenile)
Big brown bat[1]	25:37	29:33
California myotis[2]	1:0	0:2
Cave myotis	6:7	8:5
Pallid bat	9:12	19:2
Yuma myotis	3:9	8:4
Western yellow bat	**2:3**	**3:2**
Western red bat[1]	**7:2**	**6:3**
Mexican free-tailed bat	2:0	2:0

[1] One big brown bat and one western red bat escaped before the age and gender could be determined.
[2] One California myotis escaped before the gender could be determined.
Note: Species in bold are LCR MSCP covered species.

A total of 172 bats of 11 species were captured in 2014 at the CVCA (table 8). The pallid bat (*Antrozous pallidus*) was the most commonly captured species (58). Three LCR MSCP bat species were captured: the California leaf-nosed bat, western red bat, and western yellow bat. The highest capture rates were found during the July survey (98), and the highest species richness was found during the July survey (table 8).

Seven species had a higher capture ratio of females versus males (table 9) in 2014. The western red bat and California leaf-nosed bat had equal gender ratios. Juveniles were captured from seven species. Adults had a higher capture rate for all but two species. The canyon bat (*Paratrellus hesperus*) was the only species with a similar ratio of adults to juveniles captured, and big brown bats had the greater number of juveniles captured. Of the LCR MSCP species, one reproductive female western yellow bat was confirmed. No reproductive western red bats were confirmed; however, the presence of juveniles indicates reproductive success in the area.

Table 8.—Species captured at the CVCA during each month in 2014

Species	February	May	June	July	August	September	Total
Big brown bat	0	1	1	26	8	2	38
California myotis	0	0	0	1	0	1	2
California leaf-nosed bat*	0	1	0	0	0	1	2
Canyon bat	0	0	0	2	0	0	2
Cave myotis	0	0	2	9	10	1	22
Mexican free-tailed bat	0	1	0	0	0	0	1
Pallid bat	0	4	5	31	13	5	58
Pocketed free-tailed bat	0	0	0	0	0	5	5
Western red bat	**1**	**1**	**0**	**4**	**0**	**2**	**8**
Western yellow bat	**0**	**0**	**0**	**9**	**3**	**0**	**12**
Yuma myotis	1	0	2	16	3	0	22
Total bats captured	**2**	**8**	**10**	**98**	**37**	**17**	**172**
Total species (richness)	**2**	**5**	**4**	**8**	**5**	**7**	**11**

Note: Species in bold are LCR MSCP covered species; * indicates an evaluation species.

Table 9.—Gender and age ratios for all species at the CVCA in 2014

Species	Gender (male:female)	Age (adult:juvenile)
Big brown bat	10:28	27:11
California leaf-nosed bat*	1:1	2:0
California myotis	1:1	2:0
Canyon bat	0:2	1:1
Cave myotis	6:16	19:3
Mexican free-tailed bat	1:0	1:0
Pallid bat[1]	24:33	51:6
Pocketed free-tailed bat	1:4	5:0
Western red bat[1]	**3:3**	**4:2**
Western yellow bat[1]	**4:7**	**3:8**
Yuma myotis	7:15	16:6

[1] One pallid bat, one western yellow bat, and two western red bats escaped before the age and gender could be determined.

Note: Species in bold are LCR MSCP covered species; * indicates an evaluation species

Capture rates across all species combined have varied across years, but there is no apparent decline in captures of any of the 13 species at the site (table 10). The big brown bat consistently had the highest captures until 2014, when the pallid bat had a higher capture rate. Of the LCR MSCP species, western red bat and western yellow bat captures have been fairly consistent among years. California leaf-nosed bats had not been captured in 2012 and 2013, but they were detected again in 2014. No pale Townsend's big-eared bats have been captured.

Table 10.—All species captured across all years at the CVCA

Species	2009	2010	2011	2012	2013	2014	Total
Arizona myotis	0	2	0	0	0	0	2
Big brown bat	86	101	139	76	63	38	503
California leaf-nosed bat*	1	4	3	0	0	2	10
California myotis	2	10	9	8	2	2	33
Canyon bat	1	3	0	0	0	2	6
Cave myotis	4	16	17	17	13	22	89
Hoary bat	1	0	0	3	0	0	4
Mexican free-tailed bat	2	0	2	1	2	1	8
Pallid bat	9	8	35	35	21	58	166
Pocketed free-tailed bat	0	0	0	0	0	5	5
Western red bat	**3**	**2**	**7**	**4**	**10**	**8**	**34**
Western yellow bat	**5**	**4**	**14**	**7**	**5**	**12**	**47**
Yuma myotis	7	37	34	37	12	22	149
Total bats captured	**121**	**187**	**260**	**188**	**128**	**172**	**1,056**
Total species (richness)	**11**	**10**	**9**	**9**	**8**	**11**	**13**

Note: Species in bold are LCR MSCP covered species; * indicates an evaluation species.

The Renyi species diversity profiles show that 2014 tied 2009 for the highest species richness (species richness is designated by 0 on the X axis), but the rest of the profile for 2014 was higher than any other year, indicating that species diversity was higher in 2014 than all years except 2009, which had the same species richness but much less even distribution of species (figure 10).

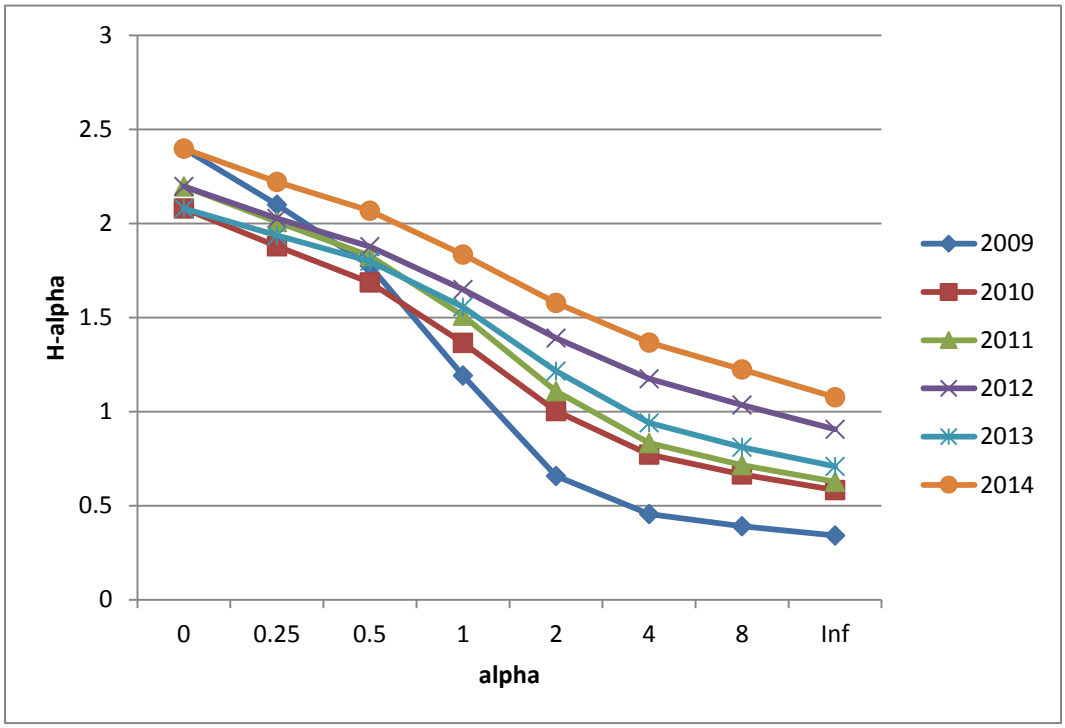

Figure 10.—Renyi diversity profiles for all years at the CVCA.

Cibola National Wildlife Refuge Unit #1 Conservation Area

A total of 55 bats from 6 species were captured in 2013 at Cibola NWR Unit #1 (table 11). No survey was conducted in August due to high winds. The big brown bat was the most commonly captured species (28). Only one LCR MSCP bat species was captured: the western red bat. The highest capture rates were found during the July survey (29), and the highest species richness was found during the September survey (table 11).

Table 11.—Species captured at Cibola NWR Unit #1 during each month in 2013

Species	May	June	July	September	Total
Big brown bat	4	1	22	1	28
California myotis	0	3	4	0	7
Mexican free-tailed bat	0	0	0	1	1
Pallid bat	11	1	0	1	13
Western red bat[1]	**0**	**0**	**0**	**3[1]**	**3**
Yuma myotis	0	0	3	0	3
Total bats captured	**15**	**5**	**29**	**6**	**55**
Total species (richness)	**2**	**3**	**3**	**4**	**6**

[1] There were three western red bat captures, but one western red bat was captured twice during the September survey.

Note: Species in bold is a LCR MSCP covered species.

Three species in 2013 had a higher capture ratio of females versus males (table 12), and juveniles were captured from three species. Of the LCR MSCP species, two adult male reproductive western red bats were confirmed.

Table 12.—Gender and age ratios for all species at Cibola NWR Unit #1 in 2013

Species	Gender (male:female)	Age (adult:juvenile)
Big brown bat	12:15[1]	10:17[1]
California myotis	4:3	5:2
Mexican free-tailed bat	1:0	1:0
Pallid bat	4:9	13:0
Western red bat	**2:0[2]**	**2:0[2]**
Yuma myotis	1:2	1:2

[1] One big brown bat escaped before the age and gender could be determined.

[2] There were three western red bats captured (see table 11), but one adult male western red bat was captured twice during the September survey.

Note: Species in bold is a LCR MSCP covered species.

A total of 68 bats of 10 species were captured in 2014 at Cibola NWR Unit #1 (table 13). The big brown bat was the most commonly captured species. Two LCR MSCP bat species were captured: the California leaf-nosed bat and western yellow bat. The highest capture rates were found during the July survey (23), and the highest species richness was found during the August survey (table 13).

Table 13.—Species captured at Cibola NWR Unit #1 during each month in 2014

Species	May	June	July	August	September	Total
Big brown bat	3	1	10	6	3	23
California leaf-nosed bat*	0	0	1	0	0	1
California myotis	1	3	3	0	3	10
Canyon bat	0	0	0	0	1	1
Cave myotis	0	0	0	4	0	4
Hoary bat	0	0	0	1	1	2
Mexican free-tailed bat	0	0	0	1	0	1
Pallid bat	3	6	8	3	2	22
Western yellow bat	**0**	**0**	**0**	**3**	**0**	**3**
Yuma myotis	0	0	1	0	0	1
Total bats captured	**7**	**10**	**23**	**18**	**10**	**68**
Total species (richness)	**3**	**3**	**5**	**6**	**5**	**10**

Note: Species in bold is a LCR MSCP covered species; * indicates an evaluation species.

Four species had a higher capture ratio of females versus males in 2014 (table 14). Juvenile bats were captured for three species, and all species had adults captured (table 14). The California leaf-nosed bat that was captured in July was found lactating, confirming reproduction.

Table 14.—Gender and age ratios for all species at Cibola NWR Unit #1 in 2014

Species[1]	Gender (male:female)	Age (adult:juvenile)
Big brown bat	6:17	18:5
California leaf-nosed bat*	0:1	1:0
California myotis	4:6	7:3
Canyon bat	0:1	1:0
Cave myotis	2:2	4:0
Hoary bat	1:1	2:0
Mexican free-tailed bat	1:0	1:0
Pallid bat	8:13	17:4
Western yellow bat	**1:2**	**3:0**
Yuma myotis	1:0	1:0

Note: Species in bold is a LCR MSCP covered species; * indicates an evaluation species.

[1] One pallid bat escaped before the age and gender could be determined.

Since capture surveys began in 2007, a total of 603 bats of 11 species have been captured at Cibola NWR Unit #1. The big brown bat was the most commonly captured species (table 15). Of the LCR MSCP species, western red bats were only captured in 2012 and 2013. Western yellow bats were captured in 2008, 2012 and 2014. California leaf-nosed bats were captured every year except for 2013. No pale Townsend's big-eared bats have been captured at Cibola NWR Unit #1 during this monitoring effort (2007–14).

The Renyi species diversity profiles show that 2012 and 2014 were equal for the highest species richness (0 on the X axis), but the rest of the profile for 2014 was higher than any other year except for 2011, indicating that 2014 had a higher species diversity than 2009, 2010, and 2013 (figure 11).

Table 15.—All species captured across all years at Cibola NWR Unit #1

Species	2007	2008	2009	2010	2011	2012	2013	2014	All years
Big brown bat	2	13	121	37	28	73	28	23	325
California leaf-nosed bat*	14	4	4	5	8	6	0	1	42
California myotis	0	3	27	6	13	13	7	10	79
Canyon bat	0	0	0	1	2	3	0	1	7
Cave myotis	0	0	0	3	1	2	0	4	10
Hoary bat	1	2	0	0	0	0	0	2	5
Mexican free-tailed bat	0	0	1	0	0	1	1	1	4
Myotis species	0	0	1	0	0	0	0	0	1
Pallid bat	1	13	8	7	11	17	13	22	92
Western red bat	**0**	**0**	**0**	**0**	**0**	**1**	**3**	**0**	**4**
Western yellow bat	**0**	**2**	**0**	**0**	**0**	**1**	**0**	**3**	**6**
Yuma myotis	1	0	4	4	7	8	3	1	28
Total bats captured	**19**	**37**	**166**	**63**	**70**	**125**	**55**	**68**	**603**
Total species (richness)	**5**	**6**	**7**	**7**	**7**	**10**	**6**	**10**	**12**

Note: Species in bold are LCR MSCP covered species; * indicates an evaluation species.

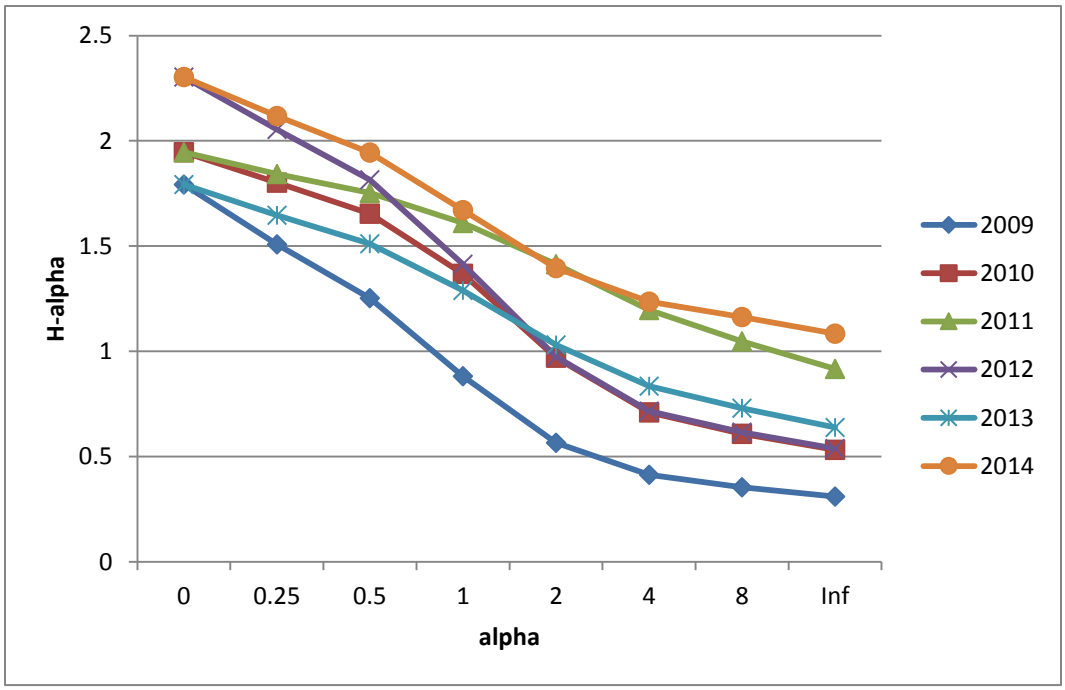

Figure 11.—Renyi diversity profiles for all years at Cibola NWR Unit #1.

'Ahakhav Tribal Preserve

A total of 189 bats from 10 species were captured in 2013 at the AKTP (table 16). The pallid bat was the most commonly captured species (56). Two LCR MSCP bat species were captured: the California leaf-nosed bat and western yellow bat. The highest capture rates were found during the July survey (102), and the highest species richness was found during the May, July, August, and September surveys (table 16).

Table 16.—Species captured at the AKTP during each month in 2013

Species	May	June	July	August	September	Total
Pallid bat	0	10	36	9	1	56
Big brown bat	4	5	31	9	1	50
Arizona myotis	16	1	20	5	3	45
California leaf-nosed bat*	2	0	1	0	1	4
Cave myotis	1	1	10	3	1	16
Western yellow bat	**2**	**0**	**0**	**0**	**0**	**2**
Yuma myotis	2	0	3	2	0	7
California myotis	0	0	0	1	1	2
Mexican free-tailed bat	3	0	0	0	2	5
Canyon bat	0	0	1	1	0	2
Total bats captured	**30**	**17**	**102**	**30**	**10**	**189**
Total species (richness)	**7**	**4**	**7**	**7**	**7**	**10**

Note: Species in bold is a LCR MSCP covered species; * indicates an evaluation species.

Five species had a higher capture ratio of females versus males (table 17) in 2013. Juveniles were captured from six species (table 17).

Table 17.—Gender and age ratios for all species at the AKTP in 2013

Species[1]	Gender (male:female)	Age (adult:juvenile)
Arizona myotis	8:37	38:7
Big brown bat	24:25	42:7
California leaf-nosed bat*	3:1	4:0
California myotis	1:1	2:0
Canyon bat	1:1	1:1
Cave myotis	7:9	13:3
Mexican free-tailed bat	3:2	5:0
Pallid bat	38:17	47:8
Western yellow bat	**0:2**	**2:0**
Yuma myotis	2:5	5:2

Note: Species in bold is a LCR MSCP covered species; * indicates an evaluation species.

[1] One big brown bat and one pallid bat escaped before age and gender could be determined.

A total of 223 bats from 9 species were captured in 2014 at the AKTP (table 18). Big brown bats were the most commonly captured species (82). Two LCR MSCP bat species were captured: the California leaf-nosed bat and western yellow bat. The highest capture rates were found during the July survey (76), and the highest species richness was found during the July survey (table 18). Of the LCR MSCP species, seven California leaf-nosed bats were captured during February, and western yellow bats were captured in four different survey sessions (table 18).

Table 18.—Species captured at the AKTP during each month in 2014

Species	February	May	June	July	August	September	Total
Arizona myotis	0	31	0	3	3	0	37
Big brown bat	0	12	19	49	0	2	82
California leaf-nosed bat*	7	1	1	2	0	5[1]	16
California myotis	0	0	1	0	0	0	1
Cave myotis	0	4	4	1	1	0	10
Mexican free-tailed bat	0	0	0	1	0	12	13
Pallid bat	1	3	14	16	6	5	45
Western yellow bat	**0**	**0**	**1**	**2**	**1**	**2**	**6**
Yuma myotis	0	3	4	2	2	2	13
Total bats captured	**8**	**54**	**44**	**76**	**13**	**28**	**223**
Total species (richness)	**2**	**6**	**7**	**8**	**5**	**6**	**9**

[1] One of the California leaf-nosed bats captured in September was a recapture of a bat that had been banded at its winter roost in January 2010.

Note: Species in bold is a LCR MSCP covered species; * indicates an evaluation species.

Six species had a higher capture ratio of females versus males, and six species had juveniles captured (table 19) in 2014. No reproductive bats were confirmed.

Table 19.—Gender and age ratios for all species at the AKTP in 2014

Species	Gender (male:female)	Age (adult:juvenile)
Arizona myotis[1]	1:35	35:1
Big brown bat[1]	29:49	68:10
California leaf-nosed bat*	4:12	16:0
California myotis	1:0	1:0
Cave myotis	1:9	9:1
Mexican free-tailed bat[1]	8:4	12:0
Pallid bat[1]	20:21	40:1
Western yellow bat	**4:2**	**5:1**
Yuma myotis	5:8	11:2

[1] Four big brown bats, four pallid bats, one Arizona myotis, and one Mexican free-tailed bat escaped before the age and gender could be determined.

Note: Species in bold is a LCR MSCP covered species; * indicates an evaluation species.

Since surveys began in 2007, a total of 1,126 bats of 14 species have been captured at the AKTP (table 20). Over one-half of these captures were big brown bats and pallid bats. Only five species have been detected every year, including the covered western yellow bat and the evaluation species California leaf-nosed bat. A pale Townsend's big-eared bat was captured in 2011, and western red bats were captured in 2009 and 2011.

Table 20.—All species captured across all years at the AKTP

Species	2007	2008	2009	2011	2012	2013	2014	All years
Arizona myotis	5	0	12	36	32	45	37	167
Big brown bat	0	9	35	82	57	50	82	315
California leaf-nosed bat*	1	4	13	19	8	4	16	65
California myotis	1	1	1	1	1	2	1	8
Canyon bat	0	0	0	0	7	2	0	9
Cave myotis	6	0	5	15	14	16	10	66
Hoary bat	0	0	1	0	1	0	0	2
Mexican free-tailed bat	1	0	0	0	1	5	13	20
Pale Townsend's big-eared bat*	0	0	0	1	0	0	0	1
Pallid bat	4	35	52	98	60	56	45	350
Pocketed free-tailed bat	0	0	0	0	1	0	0	1
Western red bat	**0**	**0**	**1**	**0**	**1**	**0**	**0**	**2**
Western yellow bat	**4**	**4**	**6**	**11**	**4**	**2**	**6**	**37**
Yuma myotis	4	12	23	8	16	7	13	83
Total bats captured	**26**	**65**	**149**	**271**	**203**	**189**	**223**	**1,126**
Total species (richness)	**8**	**6**	**10**	**8**	**13**	**10**	**9**	**14**

Note: Species in bold are LCR MSCP covered species; * indicates an evaluation species.

The Renyi species diversity profiles show that 2014 roughly fit within the average species diversity compared to other years (figure 12).

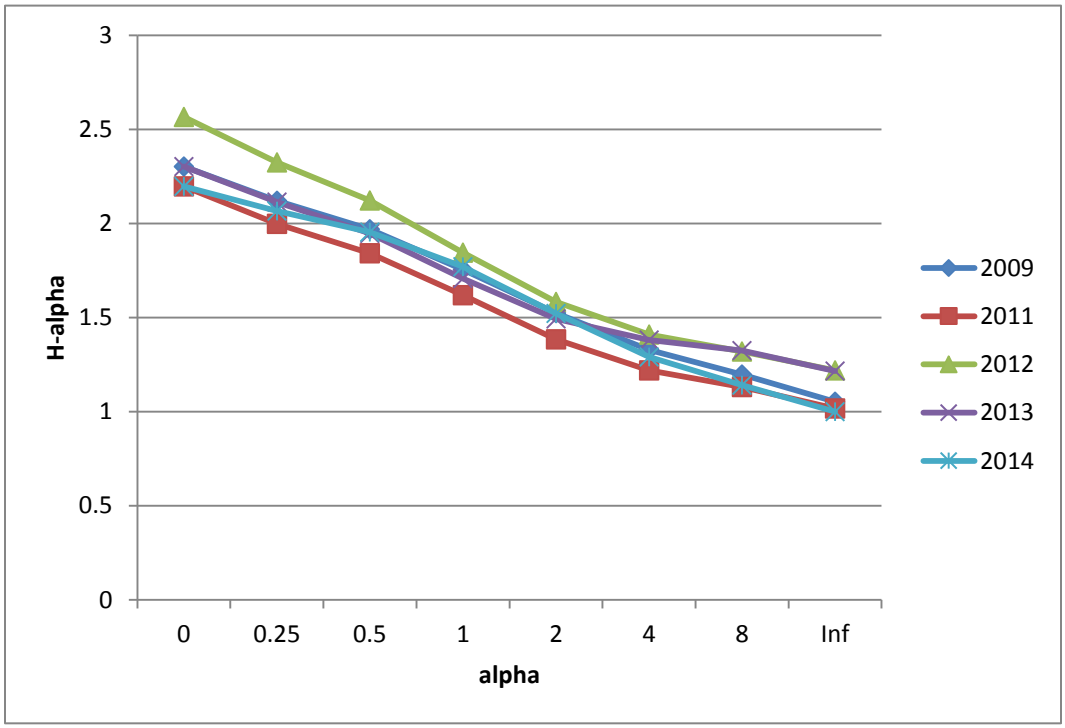

Figure 12.—Renyi diversity profiles at the AKTP.

Beal Lake Conservation Area

A total of 40 bats from 6 species were captured in 2013 at the BLCA (table 21). The big brown bat had the highest capture frequency (16). Two LCR MSCP species were captured: the California leaf-nosed bat and pale Townsend's big-eared bat. The highest capture rates were found during the August survey (18), and the highest species richness was found during the August survey (table 21).

Table 21.—Species captured at the BLCA during each month in 2013

Species	May	June	July	August	September	Total
Big brown bat	0	1	5	9	1	16
California myotis	0	1	1	3	0	5
Cave myotis	1	9	0	1	1	12
Pale Townsend's big-eared bat*	0	0	0	2	0	2
Pallid bat	0	0	2	2	0	4
Yuma myotis	0	0	0	1	0	1
Total bats captured	**1**	**11**	**8**	**18**	**2**	**40**
Total species (richness)	**1**	**3**	**3**	**6**	**2**	**6**

Note: * indicates an evaluation species.

All species except for the pallid bat had a higher capture ratio of females (table 22) in 2013. Juvenile bats were only captured for the big brown bat (table 22). The big brown bat and cave myotis were the only species captured with reproductive individuals.

Table 22.—Gender and age ratios for all species at the BLCA in 2013

Species	Gender (male:female)	Age (adult:juvenile)
Big brown bat	4:12	11:5
Cave myotis	2:10	12:0
California myotis	0:5	5:0
Pale Townsend's big-eared bat*	0:2	2:0
Pallid bat	3:1	4:0
Yuma myotis	0:1	1:0

Note: * indicates an evaluation species.

A total of 75 bats of nine species were captured in 2014 at the BLCA (table 23). The big brown bat was the most commonly captured species (27). Two LCR MSCP species were captured: the California leaf-nosed bat and pale Townsend's big-eared bat. The highest capture rates were found during the July survey (39), and the highest species richness was found during the July survey (table 23).

Table 23.—Species captured at the BLCA during each month in 2014

Species	May	June	July	August	September	Total
Big brown bat	1	0	25	1	0	27
California leaf-nosed bat*	0	1	1	0	0	2
California myotis	0	1	2	0	0	3
Cave myotis	3	10	1	3	0	17
Hoary bat	0	0	0	0	1	1
Mexican free-tailed bat	0	0	0	0	2	2
Pale Townsend's big-eared bat*	0	1	0	0	0	1
Pallid bat	2	0	9	1	1	13
Yuma myotis	0	1	1	6	1	9
Total bats captured	**6**	**14**	**39**	**11**	**5**	**75**
Total species (richness)	**3**	**5**	**6**	**4**	**4**	**9**

Note: * indicates an evaluation species.

Four species had a higher ratio of females versus males (table 24) in 2014. Juvenile bats were detected for four species (table 24). Reproductive activity was found for all but two species captured (big brown bat and Mexican free-tailed bat), including a lactating pale Townsend's big-eared bat.

Table 24.—Gender and age ratios for all species at the BLCA in 2014

Species	Gender (male:female)	Age (adult:juvenile)
Big brown bat[1]	8:17	5:19
California leaf-nosed bat*	1:1	2:0
California myotis	0:3	3:0
Cave myotis	7:10	15:2
Hoary bat	1:0	1:0
Mexican free-tailed bat	1:1	2:0
Pale Townsend's big-eared bat*	0:1	1:0
Pallid bat[1]	8:4	11:1
Yuma myotis	6:3	8:1

[1] One pallid bat and two big brown bats escaped before the age and gender could be determined.

Note: * indicates an evaluation species.

Over the last 3 years of surveys, 185 bats of 10 species have been captured (table 25). Big brown bats were the most common species captured. Five species have been captured over all 3 years. Of the evaluation species, the pale Townsend's big-eared bat has been captured the last 2 years.

Table 25.—All species captured across all years at the BLCA

Species	2012	2013	2014	All years
Big brown bat	23	16	27	66
California leaf-nosed bat*	1	0	2	3
California myotis	5	5	3	13
Canyon bat	19	0	0	19
Cave myotis	6	12	17	35
Pallid bat	8	4	13	25
Mexican free-tailed bat	2	0	2	4
Hoary bat	1	0	1	2
Pale Townsend's big-eared bat*	0	2	1	3
Yuma myotis	5	1	9	15
Total bats captured	**70**	**40**	**75**	**185**
Total species (richness)	**9**	**6**	**9**	**10**

Note: * indicates an evaluation species.

The Renyi species diversity profiles show that species diversity was greater in 2012 and 2014 compared to 2013 (figure 13).

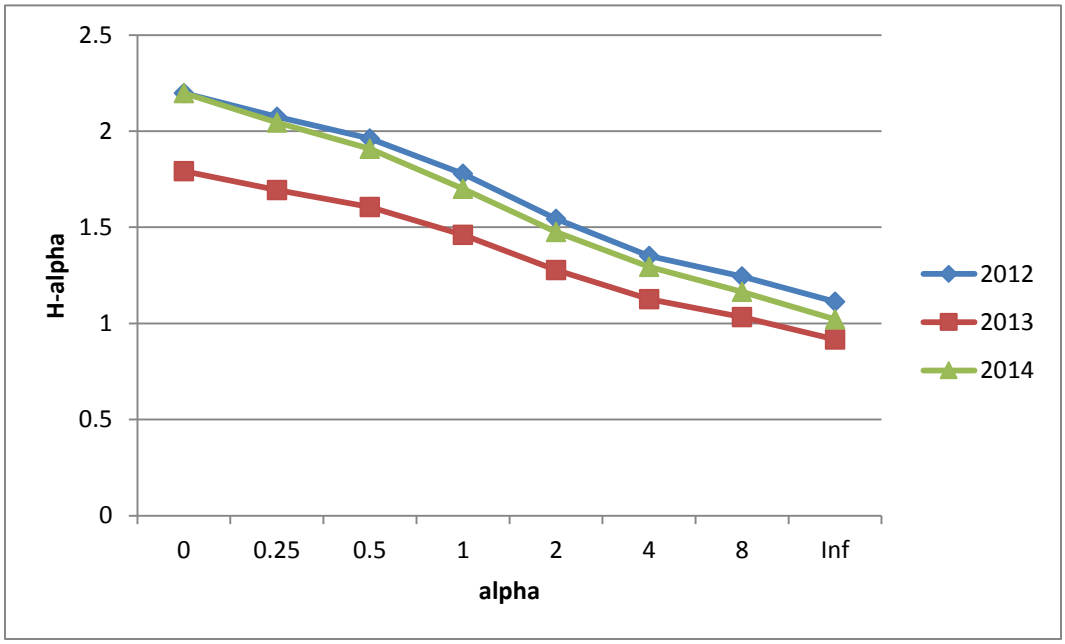

Figure 13.—Renyi diversity profiles at the BLCA.

Yuma East Wetlands

A total of 55 bats from 8 species were captured in 2013 at YEW (table 26). The big brown bat was the most commonly captured species (46). Two LCR MSCP species were captured: the California leaf-nosed bat and western yellow bat. The highest capture rates were found during the May survey (22), and the highest species richness was found during the May survey (table 26).

Table 26.—Species captured at YEW during each month in 2013

Species	May	June	July	August	September	Total
Big brown bat	19	9	13	3	2	46
California leaf-nosed bat*	0	0	0	0	1	1
California myotis	0	0	0	0	1	1
Cave myotis	0	0	1	0	0	1
Mexican free-tailed bat	1	0	0	0	0	1
Pallid bat	1	0	0	0	1	2
Western yellow bat	**1**	**0**	**1**	**0**	**0**	**2**
Yuma myotis	0	1	0	0	0	1
Total bats captured	**22**	**10**	**15**	**3**	**5**	**55**
Total species (richness)	**4**	**2**	**3**	**1**	**4**	**8**

Note: Species in bold is a LCR MSCP covered species; * indicates an evaluation species.

The big brown bat had a much higher ratio of females, and most were adults (table 27) in 2013. The big brown bat, Mexican free-tailed bat, and California myotis had individuals showing signs of reproduction. The May, June, July, and August surveys were conducted by Arizona Game and Fish Department personnel for a western red and western yellow bat roosting study (LCR MSCP Work Task C35). Reclamation conducted the September survey.

Table 27.—Gender and age ratios for all species at YEW in 2013

Species	Gender (male:female)	Age (adult:juvenile)
Big brown bat	5:39	36:8
California leaf-nosed bat*	0:1	1:0
California myotis	1:0	1:0
Cave myotis	0:1	0:1
Mexican free-tailed bat	0:1	1:0
Pallid bat	1:1	2:0
Western yellow bat	**1:1**	**2:0**
Yuma myotis	1:0	1:0

Note: Species in bold is a LCR MSCP covered species; * indicates an evaluation species.

A total of 83 bats of 6 species were captured in 2014 at YEW (table 28). The big brown bat was the most commonly captured species (69). Two LCR MSCP species were captured: the California leaf-nosed bat and western yellow bat. The highest capture rates were found during the July survey (57), and the highest species richness was found during the July survey (table 28).

Table 28.—Species captured at YEW during each month in 2014

Species	May	June	July	August	September	Total
Big brown bat	8	3	48	6	4	69
California leaf-nosed bat*	0	0	1	0	0	1
Canyon bat	1	1	0	0	0	2
Pallid bat	0	0	4	1	0	5
Western yellow bat	**0**	**0**	**2**	**1**	**0**	**3**
Yuma myotis	1	0	2	0	0	3
Total bats captured	**10**	**4**	**57**	**8**	**4**	**83**
Total species (richness)	**3**	**2**	**5**	**3**	**1**	**6**

Note: Species in bold is a LCR MSCP covered species; * indicates an evaluation species.

All but one species had a higher capture ratio of females versus males (table 29) in 2014. Juvenile bats were captured for four species. Reproductive individuals were captured from three species, including the big brown bat, pallid bat, and canyon bat.

Table 29.—Gender and age ratios for all species at YEW in 2014

Species[1]	Gender (male:female)	Age (adult:juvenile)
Big brown bat	20:48	35:33
California leaf-nosed bat*	1:0	0:1
Canyon bat	0:2	2:0
Pallid bat	1:4	5:0
Western yellow bat	**0:3**	**1:2**
Yuma myotis	0:3	2:1

[1] One big brown bat escaped before age and gender could be determined.

Note: Species in bold is a LCR MSCP covered species; * indicates an evaluation species.

Across all 3 years, a total of 223 bats of 10 species were captured at YEW (table 30). Big brown bats were the most common species captured. Three species have been captured every year. Of the LCR MSCP species, the western yellow bat has been captured every year. The western red bat has only been captured once in 2012. The California leaf-nosed bat has been captured during the last 2 years. No pale Townsend's big-eared bats have been captured.

Table 30.—All species captured across all years at YEW

Species	2012	2013	2014	Total
Big brown bat	77	46	69	192
California leaf-nosed bat*	0	1	1	2
California myotis	0	1	0	1
Canyon bat	0	0	2	2
Cave myotis	1	1	0	2
Mexican free-tailed bat	1	1	0	2
Pallid bat	0	2	5	7
Western red bat	**1**	**0**	**0**	**1**
Western yellow bat	**3**	**2**	**3**	**8**
Yuma myotis	2	1	3	6
Total bats captured	**85**	**55**	**83**	**223**
Total species (richness)	**6**	**8**	**6**	**10**

Note: Species in bold are LCR MSCP covered species; * indicates an evaluation species.

The Renyi diversity profiles show that the 2013 species diversity was lower than 2012. Species diversity in 2014 overlapped with both 2013 and 2012, meaning there was no consistent difference in diversity among these years (figure 14).

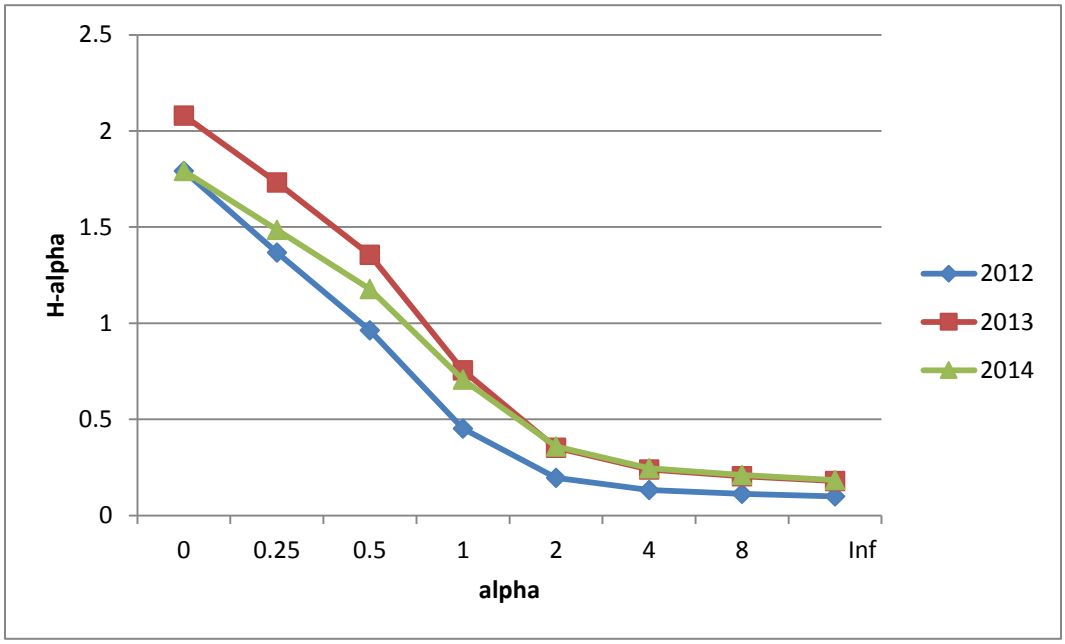

Figure 14.—Renyi diversity profiles at YEW.

Site Comparisons

Site comparisons were only done for data collected in 2014. A total of 778 bats of 15 species were captured in 2014 (table 31). The big brown bat made up 43% of all captures. All four LCR MSCP species were captured. Species composition varied at each site, with only four species (California leaf-nosed bat, big brown bat, pallid bat, and Yuma myotis) overlapping across all sites surveyed. Capture rates were highest at the AKTP and lowest at Cibola NWR Unit #1 (table 31 and figure 15). According to the Renyi diversity profiles, YEW had a lower species diversity compared to the other five sites (figure 16).

Table 31.—All species captured across all sites in 2014

Species	AKTP	BLCA	CVCA	Cibola NWR Unit #1	PVER	YEW	Total
Arizona myotis	37	0	0	0	0	0	37
Big brown bat	82	27	38	23	96	69	335
California leaf-nosed bat*	16	2	2	1	6	1	28
California myotis	1	3	2	10	1	0	17
Canyon bat	0	0	2	1	1	2	4
Cave myotis	10	17	22	4	2	0	55
Hoary bat	0	1	0	2	0	0	3
Mexican free-tailed bat	13	2	1	1	4	0	21
Pale Townsend's big-eared bat*	0	1	0	0	0	0	1
Pallid bat	45	13	58	22	24	5	167
Pocketed free-tailed bat	0	0	5	0	1	0	6
Western mastiff bat	0	0	0	0	1	0	1
Western red bat	**0**	**0**	**8**	**0**	**1**	**0**	**9**
Western yellow bat	**6**	**0**	**12**	**3**	**15**	**3**	**39**
Yuma myotis	13	9	22	1	7	3	55
Total bats captured	**223**	**75**	**172**	**68**	**159**	**81**	**778**
Total species (richness)	**9**	**9**	**11**	**10**	**12**	**6**	**15**

Note: Species in bold are LCR MSCP covered species; * indicates an evaluation species.

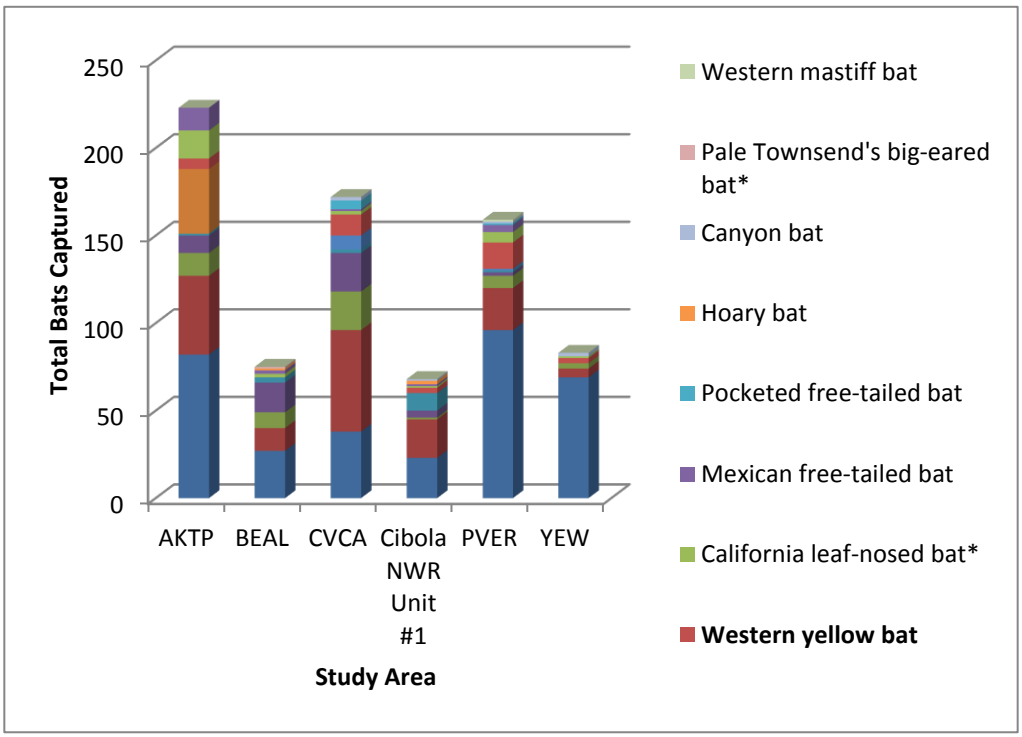

Figure 15.—Species composition at all sites in 2014.
Species in bold is a LCR MSCP covered species; * indicates an evaluation species.

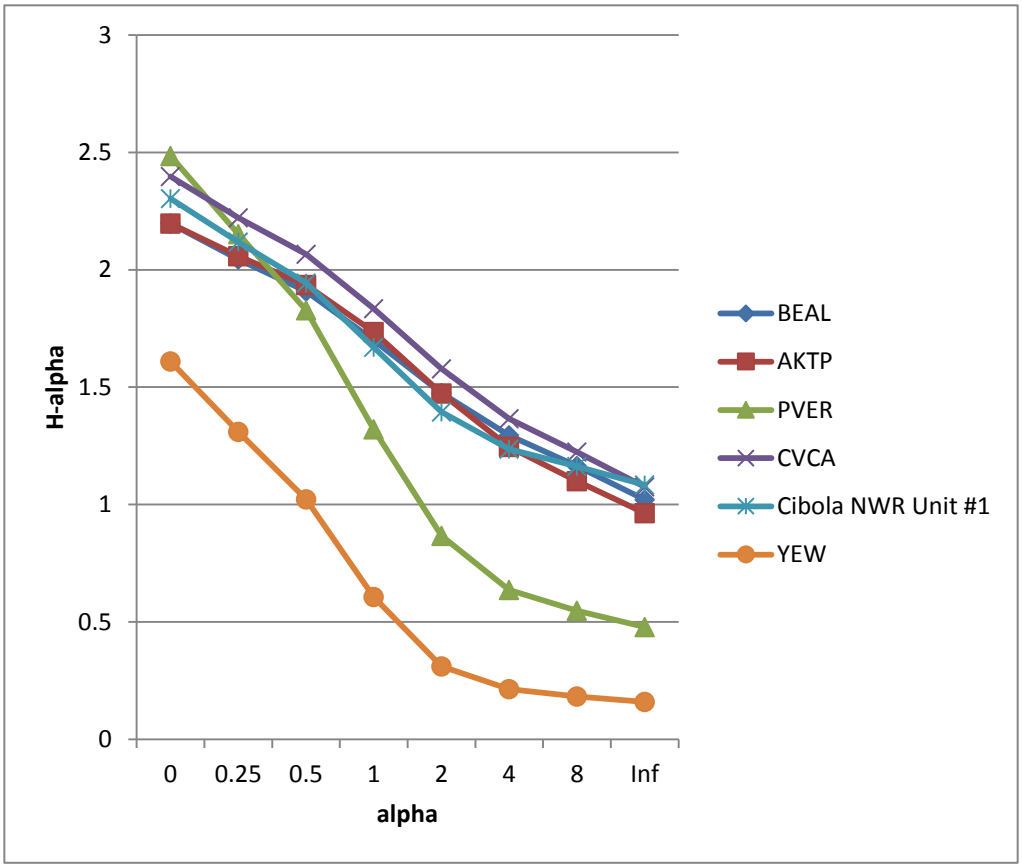

Figure 16.—Renyi diversity profiles for 2014 data.

DISCUSSION

In 2013 and 2014, five conservation areas and the AKTP were surveyed in the summer season. In 2014, three sites also had an exploratory winter survey conducted in preparation for a new study that is assessing the foraging distances of the California leaf-nosed bat and pale Townsend's big-eared bat (LCR MSCP Work Task D9). At least one LCR MSCP species was captured at all sites in 2014, and all had at least six species captured.

Palo Verde Ecological Reserve

Four California leaf-nosed bats were captured during the exploratory winter survey at the PVER, which was twice the number captured during the entire summer season. This could indicate that winter may be a successful period to capture bats for tracking studies. There was an increase in pallid bat captures in 2014, compared to the previous 2 years, but a decrease in cave myotis and western red bat captures. Overall, 2014 had the second highest total capture rate

since surveys at the PVER began in 2010 and the highest species richness of any other year. The PVER is also the only site where a western mastiff bat was captured – one in 2014 and the other in 2011. Western mastiff bats normally fly hundreds of feet in the air and rarely fly low enough to be captured in nets except when the nets are set over water where bats come down to drink.

Cibola Valley Conservation Area

At the CVCA, the capture rate of big brown bats was low compared to other years, and there was a large increase in captures of pallid bats. Western red bats were captured in three of the six total survey sessions in 2014. Based on previous telemetry data, red bats are roosting onsite and are detected across enough months to be considered a resident species. It is unknown if the western red bats residing at the CVCA in the winter are non-migratory and stay year round or if the winter resident western red bats migrate north in the summer and summer resident western red bats migrate south in the winter. Both western red and yellow bats are being passive integrated transponder (PIT) tagged, and California leaf-nosed bats are being banded in an attempt to determine the seasonal use of the CVCA and other sites during the summer and winter seasons. Banding is the preferred method because it is immediately visible by anyone when a bat is recaptured. Red and yellow bats were PIT tagged instead because there is evidence that there is increased wing damage caused by bands (P. Brown 2013, personal communication). PIT tags must be read with a PIT tag reader device.

Cibola National Wildlife Refuge Unit #1 Conservation Area

The Cibola NWR Unit #1 netting area at the Nature Trail had the lowest capture rate in 2014; however, species richness was high, with 10 of the 11 total species that have been detected at the site being captured in 2014. This included an increase in western yellow bat captures; all occurred during the August survey, indicating migratory use of the site. One California leaf-nosed bat was captured in 2014, and none were captured in 2013 – the first year that none had been captured. Hoary bats were captured during both the August and September surveys in 2014. Hoary bats, which use the LCR as a migratory corridor, had not been captured at Cibola NWR Unit #1 since 2008.

'Ahakhav Tribal Preserve

Similar to other years, the AKTP has consistently had high capture rates as compared to other sites along the LCR. Western red bats have only been captured

in August or September during the summer survey season, indicating that the AKTP may be used as a migration stopover site during the summer months. Winter capture surveys in previous years, as well as acoustic data, show that the AKTP has winter resident habitat for western red bats (Calvert 2012). Western red bats may not be summer residents due to the lower canopy cover at the site compared to the more densely planted younger sites. Both western yellow bats and California leaf-nosed bats are captured every year and over multiple months, indicating they are residents of the area.

During the September 2014 survey at the AKTP a California leaf-nosed bat was captured that had been previously banded by Dr. Patricia Brown (Brown 2014, personal communication) at the California Mine in January 2010. This mine is more than 12 miles (19 km) from the AKTP. This bat was captured from a winter roost, and it is unknown where this bat roosts during the summer season.

It is important to note that the AKTP is the only location along the LCR where the Arizona myotis is regularly captured (Calvert and Neiswenter 2012). Arizona Game and Fish personnel (J. Diamond 2013, personal communication) radio tracked a single Arizona myotis back to its roost and found a maternity colony (over 100 bats) within the dead fronds of two large Mexican fan palm trees (*Washingtonia robusta*) adjacent to a mobile home within 1 mile of the site. With the increase of habitat creation areas along the LCR, this species may begin to use other areas. While the Arizona myotis is not an LCR MSCP species, it may be a good indicator of foraging and potentially roosting habitat quality, as it is a tree-roosting species that in other areas of its range roosts under the exfoliating bark of various trees, including mature cottonwoods (Chung-MacCoubrey 1999) and was historically found along most of the LCR and captured regularly by Grinnell (1914).

Beal Lake Conservation Area

The BLCA had its highest capture rate in 2014 since surveys we reinitiated. While overall capture rates are low compared to most other sites, they are much higher than during the first 2 years monitored (5 captures in 2007 and 12 in 2008). It is likely that the capture rate increased in part due to the use of three triple high net sets. The vegetation within the site has also matured in some areas greatly since 2008.

California leaf-nosed bats were captured during two different months in 2014. The most important information gathered in 2013 and 2014 was the capture of female pale Townsend's big-eared bats at the BLCA, including a lactating female during the June 2014 survey. This likely means that a maternity colony is somewhere within foraging distance of the site. The site of the maternity colony is not known. It is hoped that at least one individual can be captured during the

foraging distance study (LCR MSCP Work Task D9) to determine where this colony may be located. The AKTP is the only other site where this species has been captured in the past.

Yuma East Wetlands

YEW has the youngest vegetation of any of the sites surveyed, which probably played a role in its lower species richness and diversity. Western yellow bats appear to be a resident at YEW, with at least two captures in two different months every year and juvenile bats being detected. Only one western red bat has ever been captured at YEW (in 2012), which suggests that they may not be residents of the site and may only use the site during migration.

All Sites

All sites will be evaluated during 2015 to determine future monitoring needs. Data show captures and species diversity generally increase over the first 5–8 years of vegetation growth after planting. It is therefore recommended that all sites be surveyed using capture techniques for a period of at least 5 years, generally starting during the third growing season of the trees at the site.

By reducing the timing of surveys and rotating out older sites for capture surveys, the post-development bat monitoring program for the LCR MSCP may be able to continue providing adequate monitoring to detect LCR MSCP species while preparing for future budget reductions. With new sites like the Laguna Division Conservation Area having been recently planted, some sites may need to be discontinued or reduced to surveys only every 3–5 years to stay within anticipated budget reductions. All four LCR MSCP species are residents along the LCR between the months of June, July, and August. While residents may arrive earlier than June or stay later than August, these time periods are when the majority of individuals using LCR MSCP conservation areas are residents. Based on this information, LCR MSCP acoustic surveys will be reduced to the months of June – August. In future years, capture surveys may also be reduced to these same time periods to focus strictly on summer resident time periods.

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ATTACHMENT 1

Common and Scientific Names of All Species Captured

Common name	Scientific name
Arizona myotis	*Myotis occultus*
Big brown bat	*Eptesicus fuscus*
California leaf-nosed bat	*Macrotus californicus*
California myotis	*Myotis californicus*
Canyon bat[1]	*Parastrellus hesperus*
Cave myotis	*Myotis velifer*
Hoary bat	*Lasiurus cinereus*
Mexican free-tailed bat	*Tadarida brasiliensis mexicanus*
Pallid bat	*Antrozous pallidus*
Pocketed free-tailed bat	*Nyctinomops femorosaccus*
Pale Townsend's big-eared bat	*Corynorhinus townsendii* also known as *Plecotus townsendii pallescens and Corynorhinus townsendii*
Unknown myotis	*Myotis* spp.
Western mastiff bat	*Eumops perotis*
Western red bat	*Lasiurus blossevillii*
Western yellow bat	*Lasiurus xanthinus*
Yuma myotis	*Myotis yumanensis*

[1] *Parastrellus hesperus* is formerly known as *Pipistrellus hesperus*, the western pipistrelle.

ATTACHMENT 2

Bat Capture Survey Protocol for Post-Development Monitoring of Lower Colorado River Multi-Species Conservation Program Habitat Creation Areas

INTRODUCTION

The western red bat (*Lasiurus blossevillii*) and western yellow bat (*L. xanthinus*) are covered species, and the California leaf-nosed bat (*Macrotus californicus*) and pale Townsend's big-eared bat (*Corynorhinus townsendii* also known as *Plecotus townsendii pallescens and Corynorhinus townsendii townsendii*) are evaluation species under the Lower Colorado River Multi-Species Conservation Program (LCR MSCP). Bat capture surveys are conducted at habitat creation areas for both general monitoring purposes as well as to provide confirmation of covered species recorded using acoustic monitoring. When covered species are captured, acoustic calls are obtained to augment call reference libraries for these species that will aid future species identification from acoustic data. A minimum of four habitat creation areas, herein known as sites, are chosen each year so that the maximum number of sites can be surveyed in a given workweek. Additional sites may be added as exploratory sites if acoustic data show the possibility of an LCR MSCP species (e.g., red or yellow bat) with high activity levels. This protocol is based on adaptations of similar protocols, lessons learned during training courses with Bat Conservation International (BCI), and past experience conducting bat capture surveys in 2007 and 2008 (Calvert 2009).

METHODS

Timing of Surveys

The summer months have generally been found to have the highest bat capture rates (Manley et al. 2006). Surveys are to be conducted at each site once per month from May – September, for a total of five survey sessions for each of the four sites. Multiple surveys are important because bats can and will forage at a variety of areas within a site and may not necessarily use all areas every night (Manley et al. 2006). Surveys from month to month should be spaced 3–4 weeks apart. If the third week of May is selected as the start week for that year, then each subsequent monthly survey should also stick to that same week each month. Due to winter active western red bats and California leaf-nosed bats, winter season surveys are also conducted on an exploratory basis. Winter surveys should be conducted in January or February when the daily high temperature is forecasted to exceed 18 degrees Celsius (65 degrees Fahrenheit). These temperatures have been found to provide nighttime temperatures that are warm enough for moderate bat foraging activity (unpublished data). The week before a full moon should be avoided if possible, as California leaf-nosed bats have been found to be lunar phobic (Brown 2010). Surveys are to begin a half hour after sunset and continue for 4 hours (adapted from an Arizona Game and Fish Department, unpublished protocol). Nets should be checked every 10–20 minutes depending on activity. Netting will be cancelled if the average windspeed exceeds 16 kilometers per hour (10 miles per hour) and/or precipitation is more

than a light sprinkle. Netting will also be cancelled if a thunderstorm is approaching the area regardless of precipitation due to the potential for lightning strikes. If a weather system appears to be temporary (less than 2 hours), the survey can be stopped and then restarted after conditions improve.

Capture Techniques

A minimum of three triple high net sets should be used at each site. Pole sets that use a pulley system to raise and lower the stacked nets will be used to accomplish this. The size of the nets used for each triple will vary depending on the area being netted. A minimum field crew of two people is mandatory, and it is highly recommended to use a crew of at least three during the July survey due to high capture rates. Five net lengths are currently being used, including 6-meter (m) (19.7-foot [ft]), 9-m (29.5-ft), 12-m (39.4-ft), 15-m (49.2-ft), and 18-m (59.1-ft) Avinet, Inc., nets, which were all 7.8 m (25.6 ft) tall with a 38-millimeter (mm) (1.5-inch [in]) mesh size. Additional "single" high (2.6-m) (8.5-ft) tall net sets can be added to the survey if areas of pooled water are found within the site that may attract bats for drinking.

The field crew must arrive at the site at least 1.5 hours before sunset to set the nets. The nets are set up at a site where bats are most likely to be using an area as a flyway (Manley et al. 2006) – usually natural corridors within a site or roadways and trails that divide areas of habitat creating artificial corridors. The size of the net used is determined by the width of the corridor, maximizing the area where bats can be captured. Corridors where a triple stacked net set can be used will be the focus for net placement because this allows for bats to be sampled higher in the canopy. Some sites may not have enough corridors for three triple high nets. When this is the case, a triple high set can be used on the edge of a row of plantings so that any bats foraging near the edge will be captured. It is recommended that the longest net possible be used for an edge set. Some corridors may have an area that fits a triple high nicely but has an open area that bats could use as an escape route. Two triple highs can then be used together in an "L" formation, which will allow bats to be funneled into one of the nets (BCI 2007). Every attempt should be made to set nets and traps the same way during every survey session for the entire year. The number of nets and traps can be increased from a previous survey as long as the original net sets are used and the additional effort can be focused on a different area of the site that was not included in the original setup.

Data Collection

A bat capture data sheet and a Trimble Global Positioning System (GPS) unit with a data dictionary will be used for every survey. This data sheet includes the following general information categories: location, date, start time, end time,

recorder, GPS Universal Transverse Mercators (UTMs), GPS datum, start temperature, end temperature, percent clouds, habitat, weather/wind, capture technique, and set over/near water. All of these categories should be filled out for every survey. As long as a GPS UTM was entered for the first survey of the year, this category does not need to be repeated for future surveys. Use a Kestrel weather station to obtain temperature and humidity data. An area is given to describe the net set. Be sure to do this on the first survey of the year.

Bats must be handled only by persons that have received rabies vaccinations. Leather gloves must be worn at all times; the thickness of glove will depend on the size/species of bat being handled. If the bat was captured in one of the triple high stacked nets, the net location will correspond with which triple setup and which net in the stack. Stacked nets will be numbered from the ground so that the lowest net is # 1 and the highest net is # 3. Each triple net set will be named numerically starting with #1 for the closest net set to the processing area. So, if a bat was captured in the net that was second closest to the processing area in the highest net, it would be labeled 2-3.

Bats should be processed as soon as possible after capture, if multiple bats are caught during a single net check, and pregnant and lactating females should be processed first (Manley et al. 2006). Species that do not need to be kept for marking or genetic sampling can be processed immediately after being removed from the net and released without being placed in a bag. Gender, age, and reproductive status will be determined for each bat captured. Age is determined by shining a headlamp on the knuckle of the third and fourth finger bones for full (adult) or partial (juvenile) ossification (Manley et al. 2006). Reproductive status for females includes: pregnant (P), lactating (L), or post-lactating (PL). Reproductive males are those for which the testes have descended, known as scrotal (S) on the data sheet. If the bat does not have these characteristics, it is considered non-reproductive (NR). If a bat escapes before it can be processed fully, write down as much information as possible and explain in the "Notes" section of the data form that the bat escaped. The data form includes various measurements for each bat, including forearm size, ear size, tragus size, hind foot size, and weight. For our purposes, only forearm measurements will be recorded unless additional measurements are needed for identification purposes. Bats will be identified using a key to the bats of Arizona provided by BCI. Once a bat has been processed, it will be immediately released unless reference acoustic calls are needed.

Genetic Sampling

If a bat either cannot be identified to species or is a species that genetic information is lacking (e.g., red bats), then a genetic sample can be taken from each wing using a biopsy punch. These directions are adapted from a protocol by the American Museum of Natural History (American Museum of Natural

History 2009.) and on-the-ground training by Dr. Patricia Brown of Brown-Berry Consulting.[1] For small bats (forearm size 40 mm [1.6 in] or less), use the 2-mm (0.08-in] punch. Samples from larger bats can be taken using a 3-mm (0.12-in] punch. The wing punch kit contains everything needed to obtain a genetic sample. The wing punch is done right before the bat is released. Fill one of the small NUNC tubes about half way with 95-percent ethanol using a sterile pipette. Keep the tube somewhere it can be left open and not be tipped over. Using an alcohol wipe, wipe off the top of the plastic lid that is found in the kit and also wipe off the area of the wing where the punch will be taken, which is usually the area of the wing in between the fingers where the least amount of blood vessels can be seen. Once the wing has been wiped, lay the wing flat on top of the lid. Then, open up the correct biopsy punch and be careful not to touch the end of the punch anywhere before the samples are taken. Place the punch in the area chosen and twist the handle of the punch back and forth a couple times to ensure the punch has cut all the way around. Remove the punch from the wing and determine if the genetic sample is lying on the lid or still attached to the punch. If still attached, gently tap the punch over the tube until the sample drops into the tube. If it is still on the lid, use a pair of tweezers that have been sterilized using the alcohol wipe to pick up the sample and place it into the tube. Then, repeat the process on the other wing using the same biopsy punch. Place the cap back on and shake the tube to make sure both pieces of skin are within the ethanol solution. Label the sample tube with the initials of the survey crew lead and the corresponding number based on how many samples that person has collected. If the person's initials were AWC and this was the 14th sample taken by that person, the ID code would be AWC-14. The date, species code, and site code are also written on the tube. The tube ID is written on the data sheet, and the other information is written down in the crew lead's field notebook where all other genetic samples are being recorded.

Marking Individuals

Western red and yellow bats may be marked using a passive integrated transponder (PIT) tag. PIT tags allow for individuals to be determined between survey seasons and years. While one person holds the bat, another takes their fingers and lifts up the skin of the bat between the shoulder blades, making sure that you have skin and not just hair so that you make a "tent" with the skin. It may be necessary to clip off hair in the insertion area. Place the needle of the injection syringe into the skin toward the head of the bat in a horizontal manner, making sure to not inject it into the deep tissue. Quickly depress the plunger of the syringe, making sure the tag has been completely ejected into the skin, and then pull the needle out. Apply antibiotic ointment onto the injection site and

[1] Dr. Patricia Brown can be contacted at patbobbat@aol.com

massage the area to make sure the tag does not back out. Scan the bat with the PIT tag reader to make sure the tag can be scanned easily. Once the PIT tag ID has been recorded, the bat may be released (Kunz and Weise 2009).

All California leaf-nosed bats will be marked using a numbered wing band. They are marked with a band instead of a PIT tag because they are far less prone to injury from a band compared to red bats and other tree-roosting species, and it is easy to spot a banded bat while doing mine surveys, enabling individuals to potentially be recaptured at both roosting and foraging sites. Only lipped bands should be used. Once a bat is in hand, one wing is pulled out and the band is placed over the forearm of the bat. Using your thumb and forefinger, gently close the band so that it cannot be pulled off the arm but can still slide up and down the arm freely. Write down both the band number and which wing was banded on the data sheet (Kunz and Weise 2009).

Collecting Acoustic Calls

Acoustic calls are collected using a bat detector such as an Anabat (Titley Electronics) or an AR 125 (Binary Acoustic Technology). To allow for longer call files once a bat is released, a small (1-in long) cyalume light tag is attached using a non-toxic glue stick to the ventral side of the bat. Light tags and glue sticks can be found inside the small, yellow tool box labeled "wing punch kit." The directions below are taken from how BCI personnel light tag bats at their acoustic monitoring workshop. Light tagging is done by rubbing the light tag onto the glue stick until a small dollop of glue is on one end of the light tag. The fur on the underside of the bat is then spread apart, and the light tag is placed vertical against the bat's body, and the fur is spread over the area of the light tag where the glue is. Once the light tag appears to be attached firmly, the bat can then be released. One person should be holding the bat detector a short distance away from the person holding the bat in the direction where the bat is most likely to fly away. All lights and head lamps should be turned off so that the light tag can be easily seen. Once the person holding the bat releases it, the person(s) with the detector(s) will aim the detector at the bat and follow it until it can no longer be seen or is too far away. The file names of the calls that were collected should be written on the data form in the "Notes" section for that bat as well as the color of light tag used. The same color light tag should be used for the same species so that if a bat returns to the area and more calls are collected, they can be written down as the correct species. If more species need to be light tagged than the number of colors available on a given night, then the same color can be used on a different species as long as the two species have very few, if any, overlapping calls.

Data Entry

The data can be entered into an Excel spreadsheet either in the field (during downtime in the hotel room) or after returning to the office. Each site will have its own spreadsheet, with each survey month on a separate tab of the worksheet. A new spreadsheet will be used at the beginning of each year. Everything written on the data form will be transferred onto the spreadsheet. The spreadsheets should then be posted onto the F-4 SharePoint site.

Utilizing the Trimble GPS units, data will also be transferred onto a computer using the program Pathfinder. The process for transferring, quality assurance/ quality control, and database management can be found in the Mobile Electronic Field Forms documentation for bat capture surveys (Reclamation 2013).

EQUIPMENT CHECKLIST

- Nets:
  - Triple 6-m
  - Triple 9-m
  - Triple 12-m
  - Triple 15-m
  - Triple 18-m
- 3 triple high pole sets
- Sledge hammer, rubber mallet
- Hand pruners
- Long-arm branch pruner
- 3–5 chairs
- 2 tables
- Kestrel weather station
- Spotlight
- Headlamps
- Ziplock bags
- Weigh scale
- Data sheets
- AA and AAA batteries
- Clipboard
- PIT tag kit:
  - PIT tags
  - Injection syringes
  - Antibiotic ointment
  - PIT tag reader
  - Alcohol
- Bat species keys
- Rulers
- Bat bags
- Gloves
- Camera
- Light sticks
- Glue stick
- Wing punch kit:
  - Biopsy punches
  - Tissue tubes
  - Ethanol
  - Tweezers
  - Cutting board/lid
  - Plastic pipettes
  - Alcohol swabs
- Anabat detectors and iPAQ with GPS
- AR 125 and tablet
- Field laptop
- Extra rope
- Arizona permit
- California permit
- U.S. Fish and Wildlife Service permit
- Protocol

LCR MSCP Bat Capture Data Sheet

Location (site name): Trimble file name:

Date: Start Time: End Time: Observers:

Start Temp: End Temp: % clouds: Start Wind: End Wind: Start Humidty: End Humidty:

Habitat Type:

Set over/Near water: YES / NO If yes; pool or stream if pool; size W x L Winds gusty? YES / NO

Capture Technique (length of set): Triple: Triple: Triple: Double: Single: Single: Single: Other:

Description of set-up:

Net location UTM's:

BAT #	TIME	NET #	SPECIES	SEX (M/F)	AGE (J/A)	REPRO	FOREARM	WING	TISSUE ID	Other (PIT tag, band #, ref calls, measurements)

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