Lower Colorado River Multi-Species Conservation Program

Balancing Resource Use and Conservation

Post-Development Bat Monitoring of Habitat Creation Areas along the Lower Colorado River – 2012 Capture Surveys

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

July 2013

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Lower Colorado River
Multi-Species Conservation Program

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ACRONYMS AND ABBREVIATIONS

AKTP	‘Ahakhav Tribal Preserve
BEAL	Beal Lake Conservation Area
CIBO	Cibola National Wildlife Refuge Unit 1 Conservation Area
CRIT	Colorado River Indian Tribe
CVCA	Cibola Valley Conservation Area
ft	foot/feet
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
YEWE	Yuma East Wetlands

CONTENTS

Tables

Tables (continued)

Figures

Attachments

Attachment

ABSTRACT

This was the sixth year of bat capture surveys within habitat creation areas for the Lower Colorado River Multi-Species Conservation Program (LCR MSCP). There are two covered and two evaluation bat species listed under the program. The western red bat (*Lasiurus blossevillii*) and western yellow bat (*Lasiurus xanthinus*) are both tree roosting species, and the California leaf-nosed bat (*Macrotus californicus*) and Townsend's big-eared bat (*Corynorhinus townsendii*) are both mine and cave roosting species that utilize riparian areas as foraging habitat. Six sites were surveyed in 2012. Four sites were surveyed once a month from May through September. Two sites were surveyed on an exploratory basis. A total of 795 bats of 13 species were captured during the survey period. Three of the four LCR MSCP species were captured within habitat creation areas. Renyi diversity profiles were used to compare sites and years. The ʻAhakhav Tribal Preserve had the highest species diversity in 2012. Exploratory sites will have full surveys in 2013.

INTRODUCTION

The Bureau of Reclamation (Reclamation) is the lead implementing agency for the Lower Colorado River Multi-Species Conservation Program (LCR MSCP). The LCR MSCP is a 50-year cooperative Federal-State-Tribal-County-Private effort to manage the natural resources of the lower Colorado River (LCR) watershed, provide regulatory relief for the use of water resources of the river, and create native habitat types along the LCR. The LCR MSCP was implemented in October 2005. To restore native habitats, the LCR MSCP will create the following land cover types: (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 (Reclamation 2004).

The western red bat (*Lasiurus blossevillii*) and western yellow bat (*Lasiurus xanthinus*) are covered species under the program. The California leaf-nosed bat (*Macrotus californicus*) and Townsend's big-eared bat (*Corynorhinus townsendii*) are evaluation species under the program. Herein, these four species will be known as LCR MSCP species. The LCR MSCP uses a variety of methods to monitor covered bat species in these habitat creation areas. Riparian habitat creation areas along the LCR have only minimally been surveyed for bats in the past (Brown 2006). In the fall of 2006, a post-development bat survey using acoustic bat detectors was initiated by Reclamation, Technical Service Center, in Denver, Colorado (Broderick 2008). During these acoustic surveys in July and October 2007, a preliminary capture survey began at three of the locations in which acoustic data had been collected (Calvert 2009). In September 2007, a fourth site was surveyed in which only exploratory acoustic work had been done. In 2008, a full season capture survey was conducted. The survey protocol was refined in 2009, and surveys following that protocol have continued since. This new survey intensity is an attempt to increase effort and thus increase bat captures to determine whether LCR MSCP covered species are utilizing habitat creation areas.

There are a variety of reasons why bat surveys should include both acoustic and capture techniques. Not all species are successfully surveyed using only one of the two methods (O'Farrell and Gannon 1999). Species such as Townsend's big-eared bats and California leaf-nosed bats are known to echolocate at low intensities, which are often missed using acoustic detectors. If there is a species identification question using acoustic data, then captures may confirm the presence of a species. Capturing bats allows for acoustic reference calls to be made 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 recorded using bat detectors. The design of future habitat creation areas may also be aided by capturing bats. The location of mist nets at current sites may allow a better understanding of how bats use riparian areas. Acoustic data show that most bats avoid cluttered areas where dense vegetation is difficult to navigate and

forage along edges of riparian forests, in corridors, and openings in forest canopies that create "flyways" for bats (Broderick 2008). Capture techniques may allow for more refined specifications (width and length of flyways) on how to create corridors and flyways at future sites, which would allow bats to use a larger area as well as allow biologists to more easily find locations to capture bats during future surveys.

STUDY AREAS

Palo Verde Ecological Reserve

The Palo Verde Ecological Reserve (PVER) is a large-scale LCR MSCP restoration project approximately 6 miles (mi) (10 kilometers [km]) north of Blythe, California (figure 1). The PVER site is a partnership between the landowner (California Fish and Wildlife Department) 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 6 years, over 700 acres (283 ha) of habitat were created. Species that were planted include Fremont cottonwood, Goodding's willow (*Salix gooddingii*), coyote willow (*Salix exigua*), honey mesquite, willow baccharis (*Baccharis salicifolia*), desertbroom (*Baccharis sarothroides*), and big saltbush (*Atriplex lentiformis*). Most of the habitat is dominated by cottonwood and willow trees, including the area where surveys were conducted (figure 2). Two net sets were within an area planted in 2007, and the other area was planted in 2008 (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). CVCA is 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 PVER. In the last 6 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 CVCA. The capture survey area was an 86-acre (35-ha) section with cottonwood and willow that was planted in 2006 (figure 3).

Cibola NWR Unit 1 Conservation Area

The Cibola National Wildlife Refuge Unit 1 Conservation Area (CIBO) is an over 800-acre (323.7-ha) area on the northern end of the refuge that includes several phases of habitat development (figure 1). Capture surveys were conducted

Figure 1.—Bat capture survey areas.

Figure 2.—Netting areas (in red) at PVER.

Figure 3.—Netting area (in red) at CVCA.

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, desertbroom, screwbean mesquite (*Prosopis pubescens*), and honey mesquite are additional species found within the site.

Figure 4.—Netting areas (in red) at CIBO.

‘Ahakhav Tribal Preserve

The ‘Ahakhav Tribal Preserve (AKTP) is a 150-acre (61-ha) site located 3 mi (5 km) southwest of Parker, Arizona, on Colorado River Indian Tribe (CRIT) land (see figure 1). This site consists of fields of cottonwood, willow, and mesquite planted as part of an agreement between CRIT and Reclamation. The capture survey area was planted in 2001 and has the largest trees of the site (figure 5). Cottonwood, Goodding’s willow, and coyote willow were planted in the area.

Beal Lake Conservation Area

The Beal Lake Conservation Area (BEAL) 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 mesquite planted as part of an agreement between the refuge and Reclamation. The capture survey area was planted between 2003 and 2006 (figure 6). Cottonwood, Goodding’s willow, and coyote willow were planted in the area.

Figure 5.—Netting areas (in red) at AKTP.

Figure 6.—Netting areas (in red) at BEAL.

Yuma East Wetlands

The Yuma East Wetlands (YEWE) 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, Quechan Tribe, Arizona Game and Fish Department, and Reclamation. This site consists of cottonwood, willow, mesquite, and marsh habitat. The capture survey area (known as the "North Channel" area) was planted in 2010 and was dominated by cottonwoods (figure 7).

Figure 7.—Netting areas (in red) at YEWE.

METHODS

Mist netting was the only technique used to capture bats during the 2012 surveys. 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 setup used three nets stacked on top of each other (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

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

different net lengths used, three different net lengths were used at each site, and the combination changed depending on site conditions, which allowed for a diversity of foraging areas to be included in each survey.

Nets were set up at a site in an area such as a flyway where bats would be more concentrated. These flyways were usually corridors within the site where a space such as a road or trail was created between two planting areas. Netting perpendicular to an edge was also implemented at two sites (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, personal communication).

During netting, two types of bat detectors were used in order 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 high frequency calls of bats, 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 Anabat SD2 bat detector (Titley Electronics) was connected to an HP iPAQ pocket personal computer (PC) running AnaPocket

software. The AR-125 bat detector (Binary Acoustics Technology) was also used, which records bat calls as full spectrum .wav files. It was connected to a Samsung Q1 Ultra tablet PC running SPECTR Mobile software.

Once a bat was captured, species, age, sex, and reproductive status were determined. Measurements such as forearm and ear length were also taken, if necessary, to identify the species. If the species was one for which acoustic reference calls were needed, a small 1-in (2.5-centimeter) long glow stick was glued (using a nontoxic 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 with the bat detector until it flew too far to be recorded. All acoustic file names saved on the HP iPAQ or the Samsung Q1 Ultra were written on the data sheet for species confirmation and later added to the acoustic reference library.

Genetic sampling was conducted on captured bats if needed for future genetic studies or species identification. If a species was found in a new locality, a voucher specimen may have been taken and deposited into an accredited museum. 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 at sunset and continued for 4.5 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. These standardizations were taken from an unpublished protocol (available upon request) that was created using data from the 2007 and 2008 LCR MSCP bat surveys. In the past, survey effort was determined by calculating total net hours depending on the length of each triple net set used at each site. Based on previous years' data, it was determined that bats use corridors equally regardless of width (with 6 m being the minimum corridor width used), so the actual length of the net is not important as long as the entire corridor was covered. Because each site had three triple net sets, 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, we assumed that survey effort was equal at each site.

Data from each site were used to calculate total captures per species, reproductive status, age and sex ratios, and LCR MSCP species naïve occupancy (number of surveys in which at least one individual of a species was detected). Naïve occupancy was calculated for each LCR MSCP species per survey so that an occupancy rate (proportion of survey sessions where at least one individual of a species was detected) for the whole survey season could be calculated. This was not an attempt to statistically model occupancy for each site, as detectability is not

known and sample size is small (MacKenzie et al. 2002). This method allows for a better representation of potential residency of a species at a particular site. Residency is determined by the number of survey sessions a species is detected or if reproductive status confirms it is occupying the site during breeding or while caring for young. Sometimes, a high number of captures in a single survey session (such as during migration) misrepresents the use of that site by a species.

Species diversity statistics were used to compare the overall bat community between sites and between years at a single site. There are multiple diversity indices that are used to compare datasets. Most of these indices are biased differently based on the evenness or dominance of a species within the dataset. Renyi diversity profiles were used to better compare any statistical differences between sites. A Renyi diversity profile compares multiple diversity indices (such as richness, dominance, Simpson, and Shannon) in a graphical representation using 100 permutations of the data. When one dataset's profile curve is completely above another (no overlap), it is considered to be statistically more diverse than the other (Kindt and Coe 2005). Renyi diversity profiles were calculated using Program R (v. 2.15.2), BiodiversityR package.

RESULTS

See attachment 1 for a list of common and scientific names of all species captured.

Palo Verde Ecological Reserve

Capture surveys were conducted at PVER for the third year in 2012. A total of 124 bats from 9 species were captured. The big brown bat (*Eptesicus fuscus*) was the most commonly captured species. All LCR MSCP listed bat species were captured at PVER except Townsend's big-eared bat. The highest captures and species richness were found during the July survey (table 1).

All captured species had a higher female to male sex ratio, except for western red bats, where only males were captured (table 2). The big brown bat was the only species with a similar ratio of adults to juveniles captured, and most species had only a few juveniles captured (table 2). More adult females were found to be reproductively active compared to adult males (figure 9). Three species had captures of individuals with no signs of reproduction.

Table 1.—Species captured at PVER for each survey month in 2011

Species	May	June	July	August	September	Totals
Big brown bat	3	17	37	10	3	70
Pallid bat	0	5	3	1	1	10
Cave myotis	6	0	4	2	2	14
Yuma myotis	1	2	3	1	0	7
California myotis	0	0	1	0	0	1
Western yellow bat	**1**	**5**	**3**	**1**	**0**	**10**
Western red bat	**0**	**2**	**2**	**0**	**2**	**6**
California leaf-nosed bat*	0	0	0	1	0	1
Mexican free-tailed bat	0	0	0	0	5	5
Totals	11	31	53	16	13	124

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

Table 2.—Sex and age ratios for all species at PVER in 2011

Species[1]	Sex (male:female)	Age (adult:juvenile)
Pallid bat	2:7	7:2
Big brown bat	16:51	33:34
Cave myotis	6:8	12:2
Yuma myotis	3:4	6:1
California myotis	0:1	1:0
Western yellow bat	**1:9**	**8:2**
Western red bat	**5:0**	**5:0**
California leaf-nosed bat*	0:1	1:0
Mexican free-tailed bat	3:2	5:0

[1] Five individuals escaped before age and sex could be determined. Species in bold are LCR MSCP covered species; * indicates an evaluation species.

The pocketed free-tailed bat (*Nyctinomops femorosaccus*) and western mastiff bat (*Eumops perotis*) were not captured in 2012 (table 3). While 2010 had the highest capture rate, the big brown bat was less dominant in 2011 and 2012 (figure 10). For LCR MSCP species, naïve occupancy was highest for western yellow bats in 2012 (figure 11). The Renyi diversity profiles indicate that species diversity was slightly lower in 2010 compared to 2011 and 2012 (figure 12).

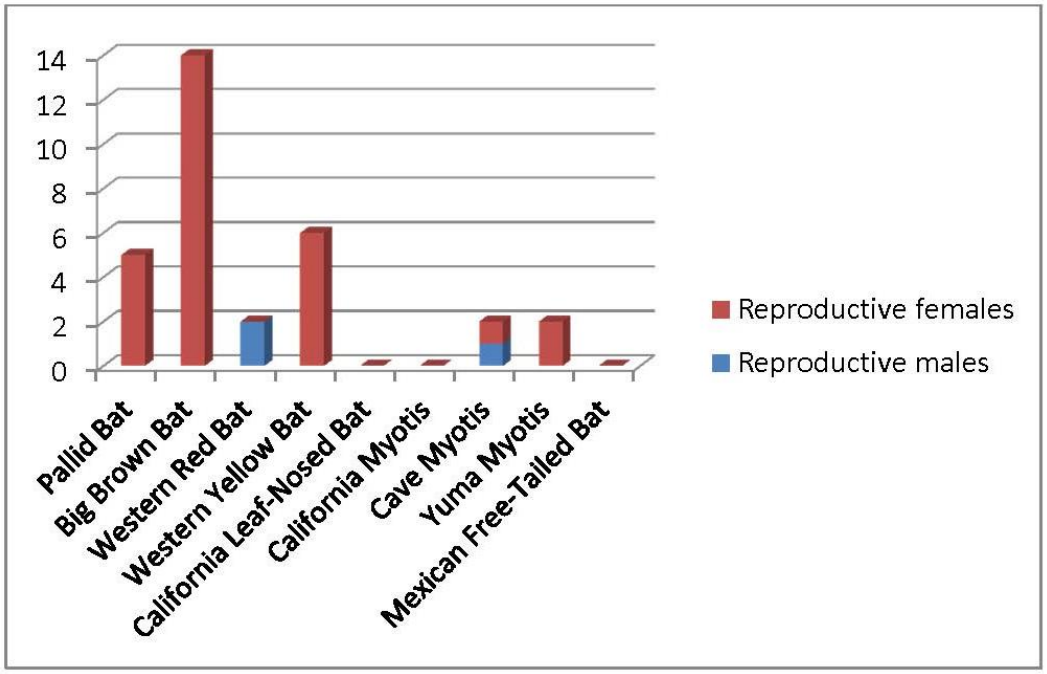

Figure 9.—Ratio of reproductive adults by sex at PVER in 2011.

Table 3.—All species captured across all years at PVER

Species	2010	2011	2012	All years
Big brown bat	154	75	70	299
Cave myotis	31	10	14	55
Pallid bat	7	23	10	40
Western yellow bat	**12**	**9**	**10**	**31**
Yuma myotis	16	4	7	27
Western red bat	**3**	**5**	**6**	**14**
Mexican free-tailed bat	2	2	5	9
California leaf-nosed bat*	0	5	1	6
California myotis	3	2	1	6
Pocketed free-tailed bat	4	0	0	4
Western mastiff bat	0	1	0	1
Totals	232	136	124	492

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

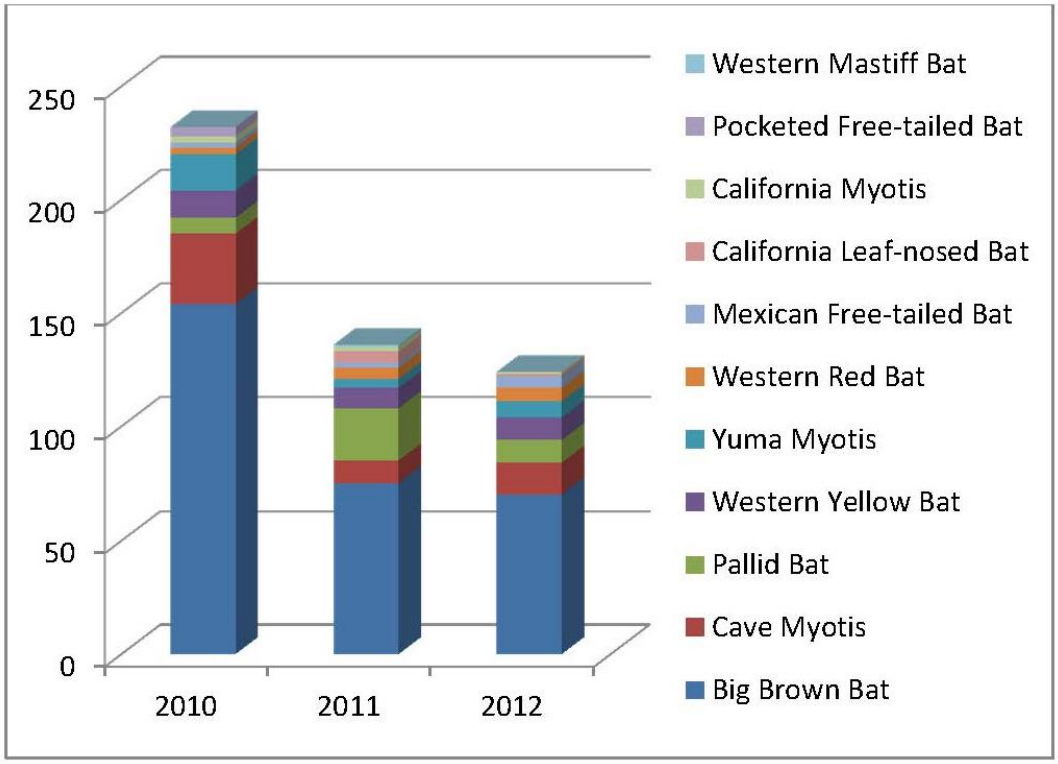

Figure 10.—Species composition for all years at PVER.

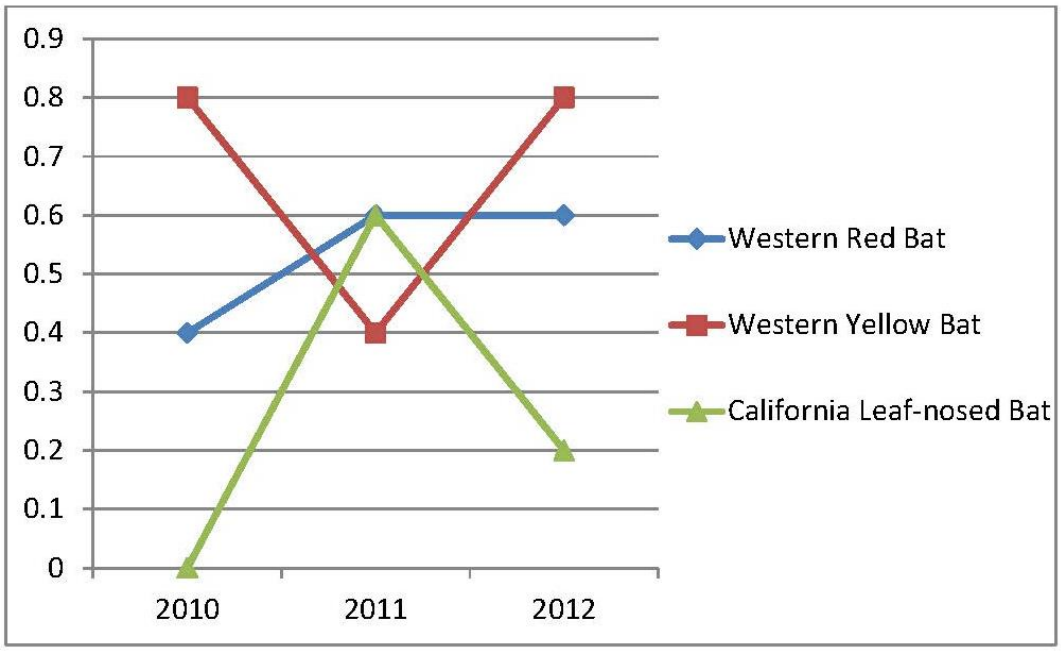

Figure 11.—Naïve occupancy rates for LCR MSCP species at PVER.

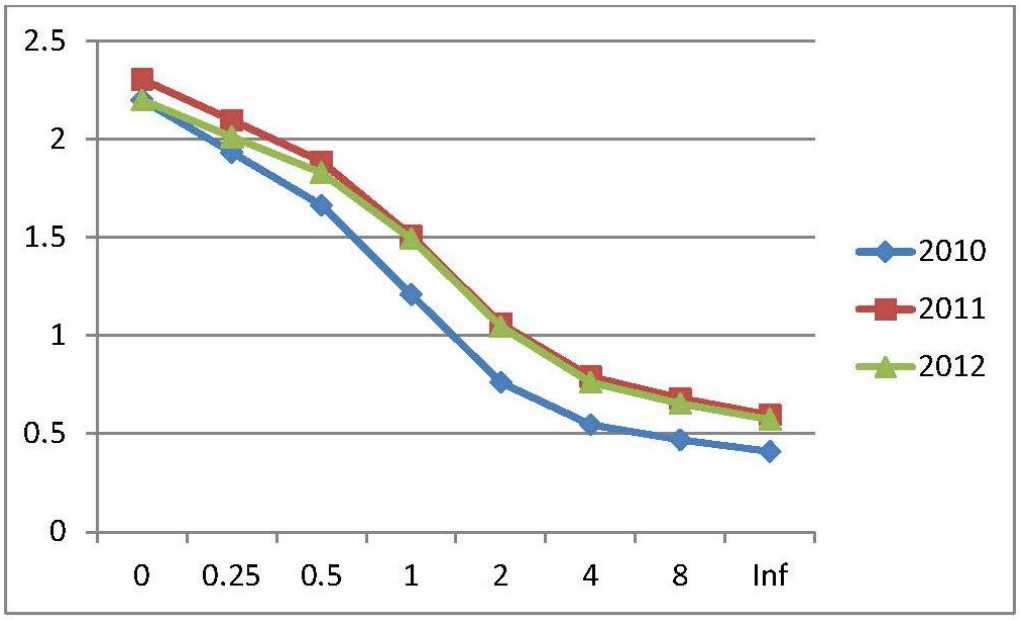

Figure 12.—Renyi diversity profiles for all years at PVER.

Cibola Valley Conservation Area

This was the fourth year that capture surveys were conducted at CVCA. A total of 188 bats from nine species were captured (table 4). The big brown bat was the most commonly captured species. All LCR MSCP listed bat species were captured at CVCA except the California leaf-nosed bat and Townsend's big-eared bat. August had the highest capture rate, and both June and August had the highest species richness.

Table 4.—Species captured at CVCA for each month

Species	May	June	July	August	September	Totals
Big brown bat	13	18	19	21	5	76
Yuma myotis	4	5	4	21	3	37
Pallid bat	8	9	7	6	5	35
Cave myotis	2	3	5	6	1	17
California myotis	2	1	0	5	0	8
Western yellow bat	**0**	**1**	**3**	**2**	**1**	**7**
Western red bat	**1**	**1**	**2**	**0**	**0**	**4**
Hoary bat	0	0	0	1	2	3
Mexican free-tailed bat	1	0	0	0	0	1
Totals	31	38	40	62	17	188

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

Most species had higher capture rates of females, though western red bats had an equal sex ratio, and three species had higher capture rates of males (table 5). There were higher capture rates of adults for all species; seven of the nine species also had captures of juveniles (table 5). The Mexican free-tailed bat was the only species with no signs of reproductive activity, and most species had a higher proportion of reproductive females, though the western yellow bat had an equal ratio, and the hoary bat (*Lasiurus cinereus*) had only reproductive males (figure 13).

Table 5.—Sex and age ratios for all species at CVCA in 2012

Species[1]	Sex (male:female)	Age (adult:juvenile)
Big brown bat	25:48	58:15
Yuma myotis	5:31	31:5
Pallid bat	8:21	26:3
Cave myotis	8:9	15:2
California myotis	2:6	8:0
Western yellow bat	**4:3**	**4:3**
Western red bat	**2:2**	**3:1**
Hoary bat	2:1	3:0
Mexican free-tailed bat	1:0	1:0

[1] Ten individual bats escaped before age and sex could be determined. Species in bold are LCR MSCP covered species; * indicates an evaluation species.

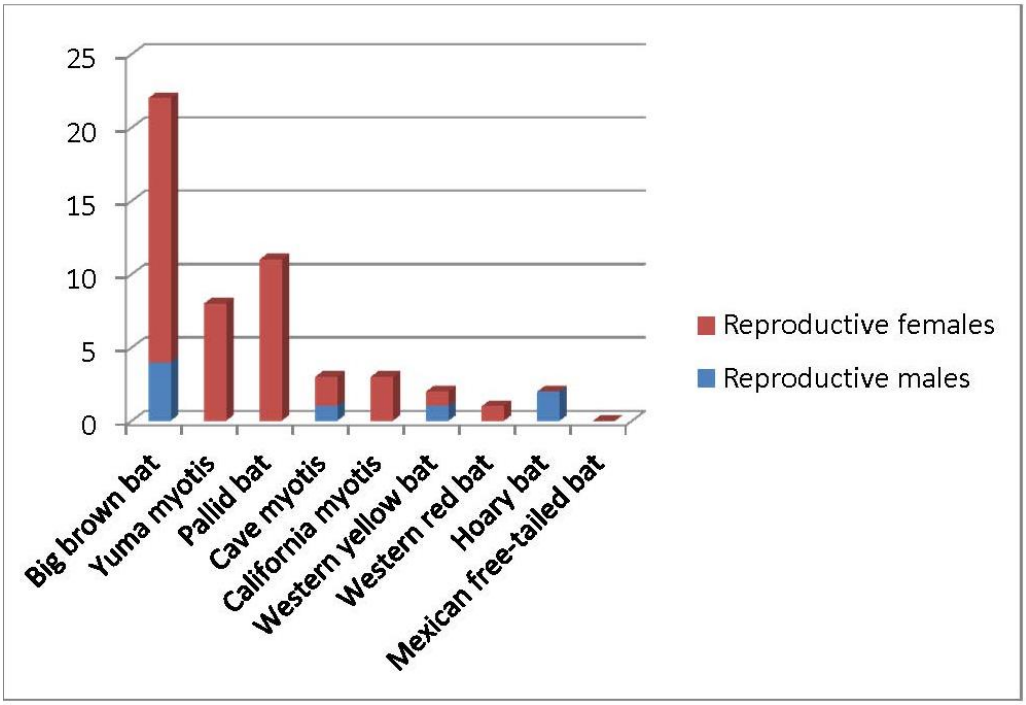

Figure 13.—Ratio of reproductive adults by sex at CVCA in 2012.

Three species that had been captured in previous years were not captured in 2012, including the California leaf-nosed bat, canyon bat (*Parastrellus hesperus*), and Arizona myotis (*Myotis occultus*) (table 6). The capture rate in 2012 was lower than in 2011, but higher than 2009 and 2010 (figure 14). For LCR MSCP species, naïve occupancy was highest for western yellow bats in 2012 (figure 15). The Renyi diversity profiles indicate that there is no statistical difference in species diversity between years (figure 16).

Table 6.—All species captured across all years at CVCA

Species	2009	2010	2011	2012	Totals
Big brown bat	86	101	139	76	402
Yuma myotis	7	37	34	37	115
Pallid bat	9	8	35	35	87
Cave myotis	4	16	17	17	54
Western yellow bat	**5**	**4**	**14**	**7**	**30**
California myotis	2	10	9	8	29
Western red bat	**3**	**0**	**7**	**4**	**14**
Mexican free-tailed bat	2	0	2	1	5
California leaf-nosed bat*	1	0	3	0	4
Hoary bat	1	0	0	3	4
Canyon bat	1	3	0	0	4
Arizona myotis	0	2	0	0	2
Totals	121	181	260	188	750

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

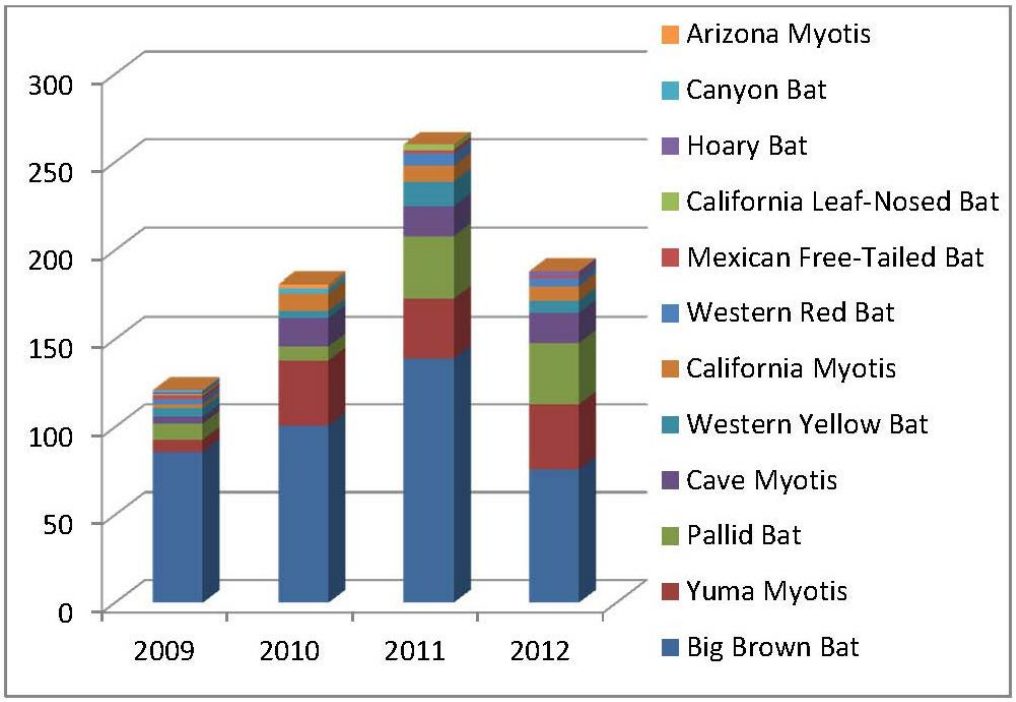

Figure 14.—Species composition for all years at CVCA.

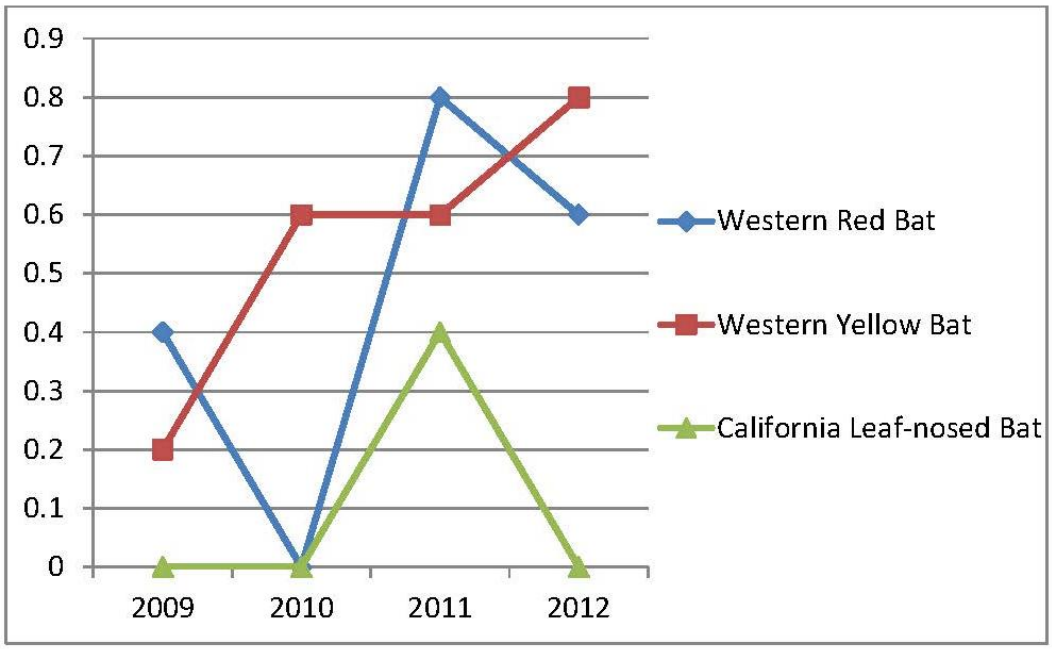

Figure 15.—Naïve occupancy rates for LCR MSCP species at CVCA.

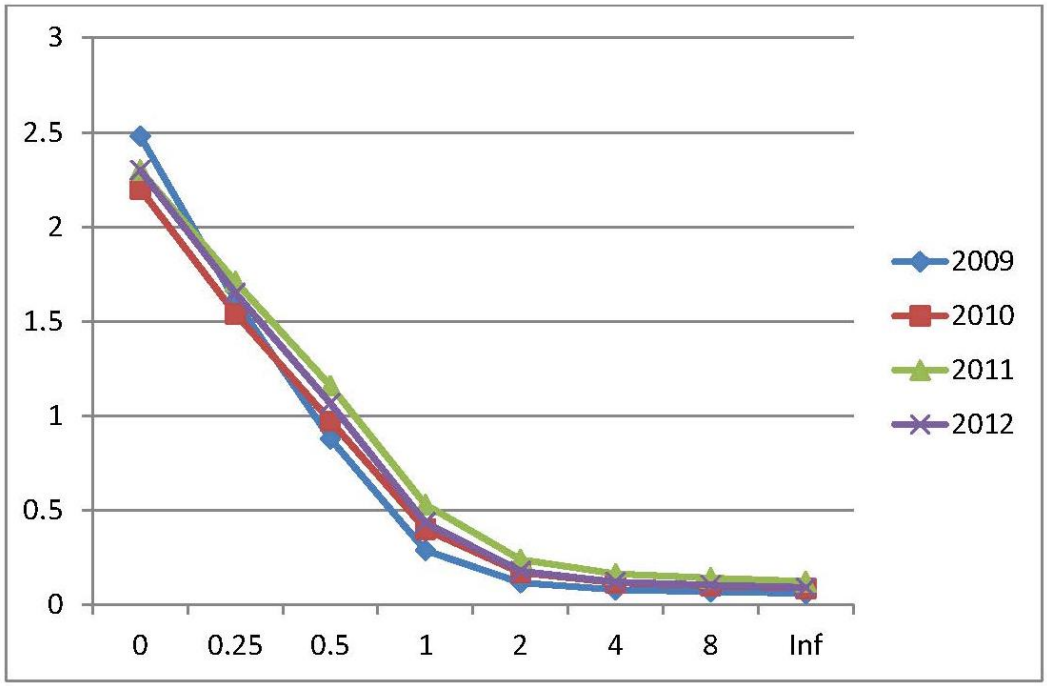

Figure 16.—Renyi diversity profiles for all years at CVCA.

Cibola NWR Unit 1 Conservation Area

This was the sixth year (fourth year following revised protocol) that capture surveys were conducted at CIBO. This was the first year that not all triple net sets were within the Nature Trail. One triple net set was used in a corridor within the Mass Planting phase adjacent to the Nature Trail. A total of 125 bats of 10 species were captured in 2012. The big brown bat was the most commonly captured species. Three LCR MSCP species were captured at CIBO (table 7). Females outnumbered males in only four species at CIBO (table 7). Adults dominated captures, though age ratios were close to even for the big brown bat (table 8). Only four species showed signs of reproduction (figure 17).

Table 7.—Species captured at CIBO for each month

Species	May	June	July	August	September	Totals
Big brown bat	4	3	31	33	2	73
Pallid bat	8	3	3	2	1	17
California myotis	2	1	5	3	2	13
Yuma myotis	1	0	2	3	2	8
California leaf-nosed bat*	0	1	0	1	4	6
Canyon bat	0	0	0	3	0	3
Cave myotis	0	0	1	1	0	2
Mexican free-tailed bat	0	0	0	0	1	1
Western yellow bat	**0**	**0**	**0**	**1**	**0**	**1**
Western red bat	**0**	**0**	**0**	**0**	**1**	**1**
Totals	15	8	42	47	13	125

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

Table 8.—Sex and age ratios for all species at CIBO in 2012

Species[1]	Sex (male:female)	Age (adult:juvenile)
Big brown bat	23:47	38:32
Pallid bat	4:13	15:2
California myotis	5:8	12:1
Yuma myotis	2:6	7:1
California leaf-nosed bat*	5:0	5:0
Canyon bat	2:1	3:0
Cave myotis	1:1	1:1
Mexican free-tailed bat	1:0	1:0
Western yellow bat	**0:1**	**0:1**
Western red bat	**0:0**	**0:0**

[1] Five individual bats escaped before age and sex could be determined, including the western red bat. Species in bold are LCR MSCP covered species; * indicates an evaluation species.

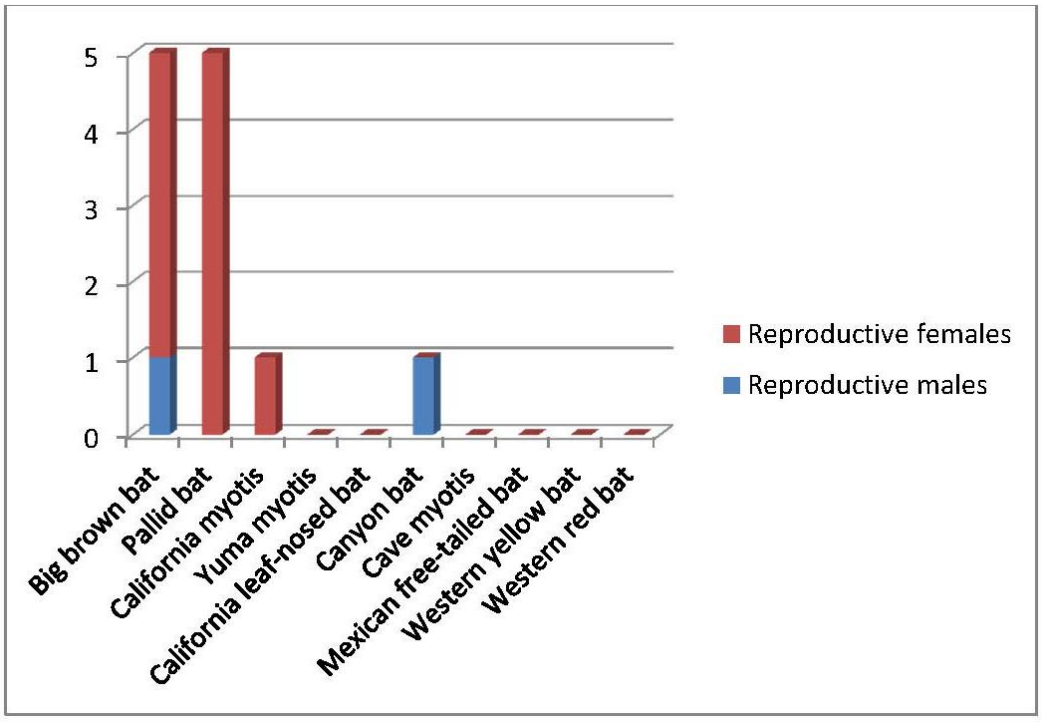

Figure 17.—Ratio of reproductive adults by sex at CIBO in 2012.

Species richness increased to 10 for the first time in any year (table 9). The western red bat was captured for the first time at CIBO, and the western yellow bat was captured for the first time since 2008. Capture rates increased compared to 2010 and 2011, though they were not as high as 2009 when a high number of big brown bats were captured (figure 18). It should be noted that prior to 2009, surveys at CIBO were not conducted during all of the same months and effort varied, so any comparisons with those previous years should be made with caution. Naïve occupancy was highest for California leaf-nosed bats (figure 19). Renyi profiles indicate that 2009 had the lowest species diversity, but there was no statistical difference between other years (figure 20).

Table 9.—All species captured across all years at CIBO

Species	2007	2008	2009	2010	2011	2012	Totals
Big brown bat	2	13	121	37	28	73	274
Pallid bat	1	13	8	7	11	17	57
California myotis	0	3	27	6	13	13	62
Yuma myotis	1	0	4	4	7	8	24
California leaf-nosed bat*	14	4	4	5	8	6	41
Canyon bat	0	0	0	1	2	3	6
Cave myotis	0	0	0	3	1	2	6
Mexican free-tailed bat	0	0	1	0	0	1	2
Western yellow bat	**0**	**2**	**0**	**0**	**0**	**1**	**3**
Western red bat	**0**	**0**	**0**	**0**	**0**	**1**	**1**
Hoary bat	1	2	0	0	0	0	3
Myotis species	0	0	1	0	0	0	1
Totals	19	37	166	63	70	125	480

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

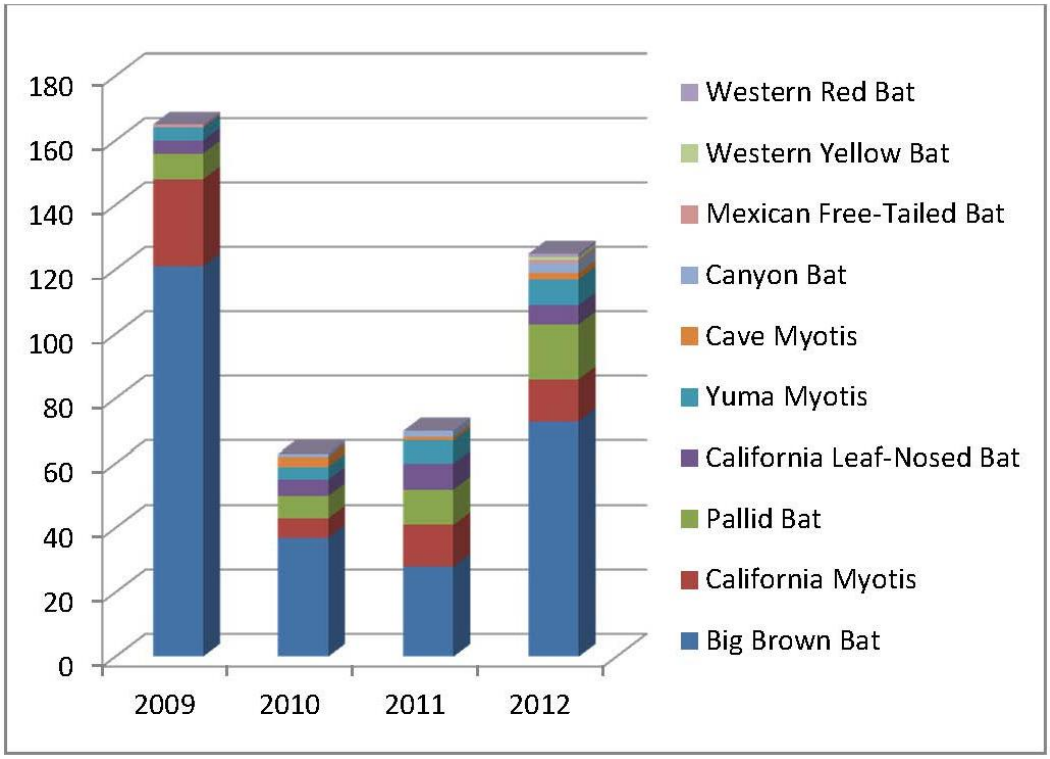

Figure 18.—Species composition for all years at CIBO.

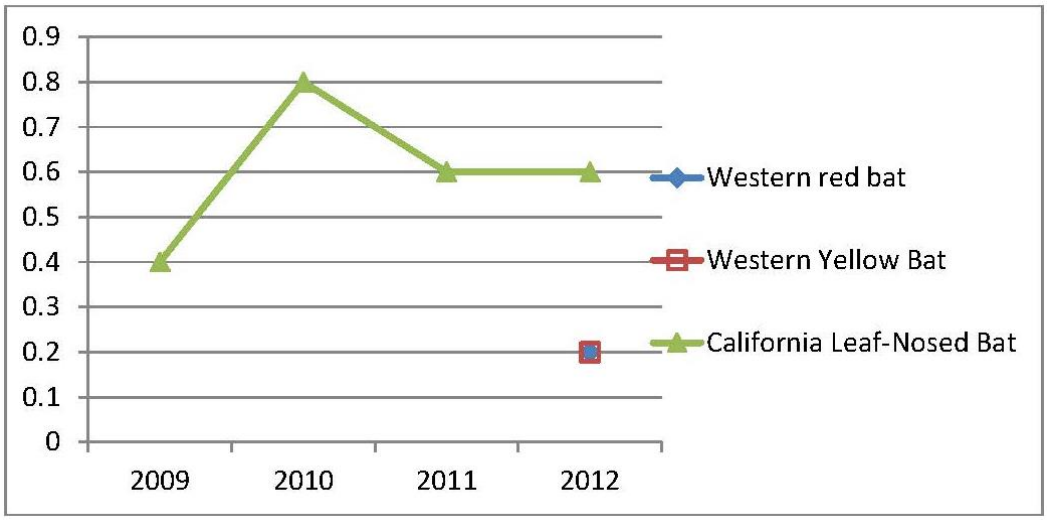

Figure 19.—Naïve occupancy rates for LCR MSCP species at CIBO.

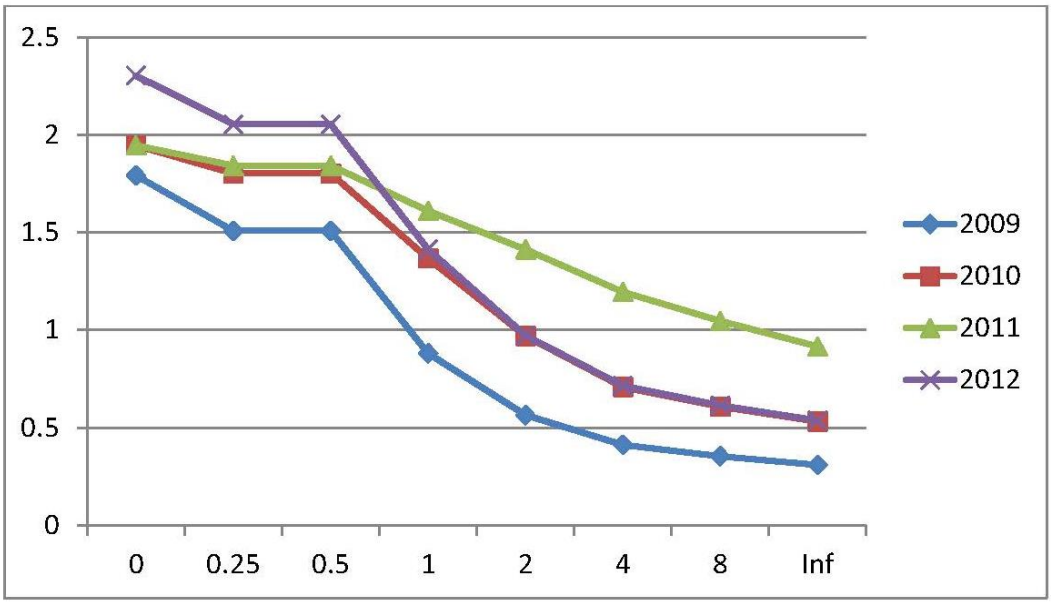

Figure 20.—Renyi diversity profiles for all years at CIBO.

‘Ahakhav Tribal Preserve

This was the sixth year that capture surveys were conducted at AKTP. Only a single survey was conducted in 2010 during the month of February to determine winter use of the site by western red bats. No summer surveys were conducted in 2010 due to a delay in permitting; permits were granted prior to the 2011 summer survey season. Summer capture data are compared in the tables 10–11 and figures 21–24 below. Winter season surveys were conducted in both 2009 and 2010, and each resulted in the capture of a western red bat.

A total of 203 bats from 13 species were captured in 2012 at AKTP, including three LCR MSCP species (table 10). More pallid bats were captured at this site than big brown bats, and the pallid bat was the only species with more captures of males versus females. Only male western red bats were captured, and western yellow bats had an equal sex ratio (table 11). Very few juveniles were captured overall; juveniles were captured from eight species.

All but two species showed reproductive activity (figure 21). Total captures were lower in 2012 than in 2011, but species richness was higher (table 12). Species composition was similar to previous years, with the big brown bat and pallid bat, making up greater than 50 percent of all captures (figure 22). Like CIBO, surveys prior to 2009 at AKTP were not consistent with time and net effort, so any comparisons made across years should be made with caution. Naïve occupancy was highest for California leaf-nosed bats (figure 23). Renyi profiles indicate that 2012 had a slightly higher species diversity compared to 2009 and 2011 (figure 24).

Table 10.—Species captured at AKTP for each month

Species	May	June	July	August	September	Totals
Big brown bat	8	8	30	11	0	57
Pallid bat	2	26	27	4	1	60
Cave myotis	0	5	2	7	0	14
Western yellow bat	**0**	**0**	**2**	**2**	**0**	**4**
Yuma myotis	5	3	1	5	2	16
California myotis	0	0	1	0	0	1
Western red bat	**0**	**0**	**0**	**1**	**0**	**1**
California leaf-nosed bat*	**1**	**2**	**3**	**0**	**2**	**8**
Mexican free-tailed bat	0	0	0	1	0	1
Arizona myotis	22	0	10	0	0	32
Pocketed free-tailed bat	0	1	0	0	0	1
Canyon bat	0	6	0	0	1	7
Hoary bat	0	0	0	0	1	1
Totals	38	51	76	31	7	203

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

Table 11.—Sex and age ratios for all species at AKTP in 2012

Species[1]	Sex (male:female)	Age (adult:juvenile)
Big brown bat	23:33	44:12
Pallid bat	35:23	48:10
Cave myotis	3:11	12:2
Western yellow bat	**2:2**	**3:1**
Yuma myotis	3:13	14:2
California myotis	0:1	0:1
Western red bat	**1:0**	**1:0**
California leaf-nosed bat*	**1:7**	**8:0**
Mexican free-tailed bat	1:0	0:1
Arizona myotis	2:30	26:6
Pocketed free-tailed bat	0:1	1:0
Canyon bat	*1:6*	*7:0*

[1] Six individual bats escaped before age and sex could be determined. Species in bold are LCR MSCP covered species; * indicates an evaluation species.

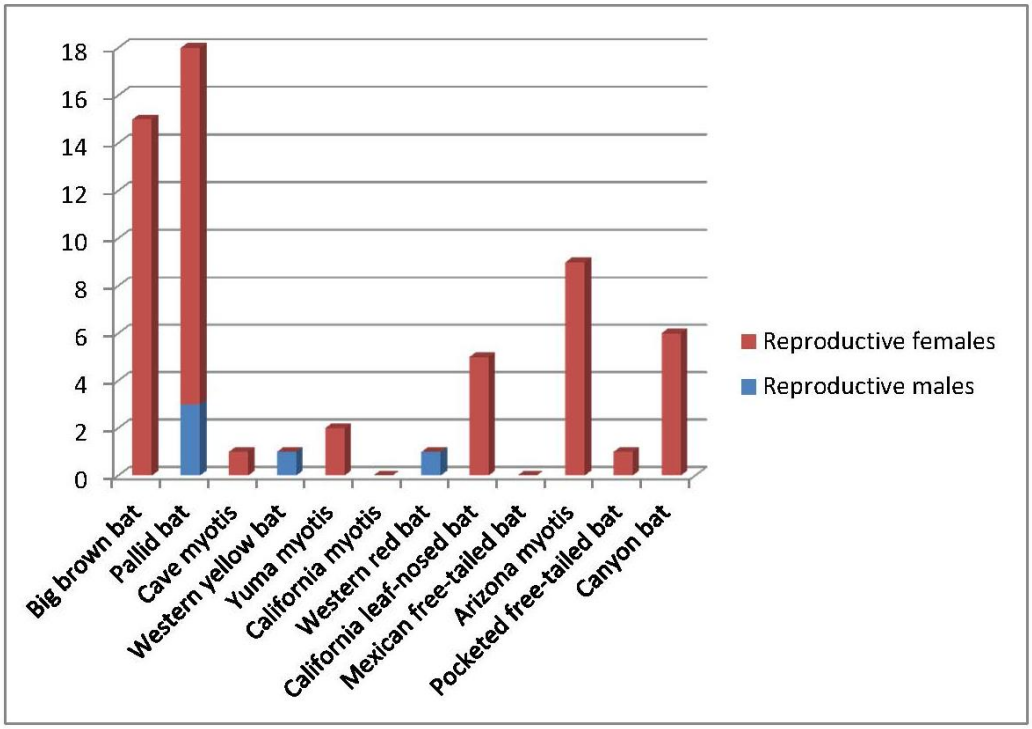

Figure 21.—Ratio of reproductive adults by sex at AKTP in 2012.

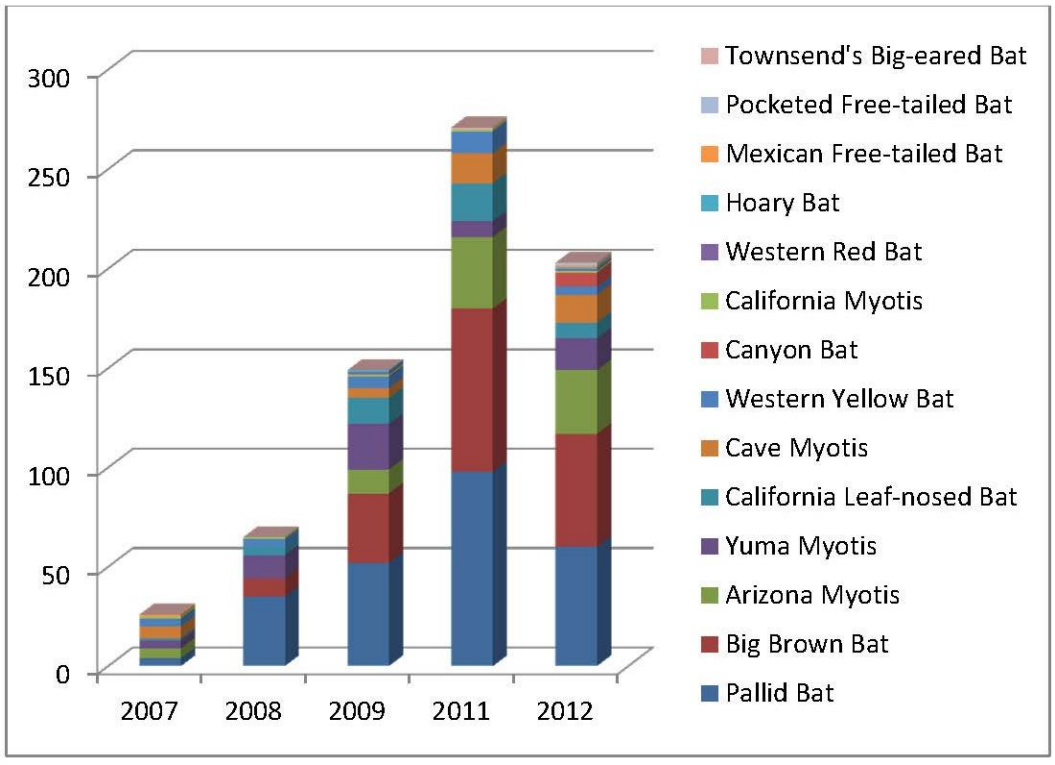

Figure 22.—Species composition for all years at AKTP.

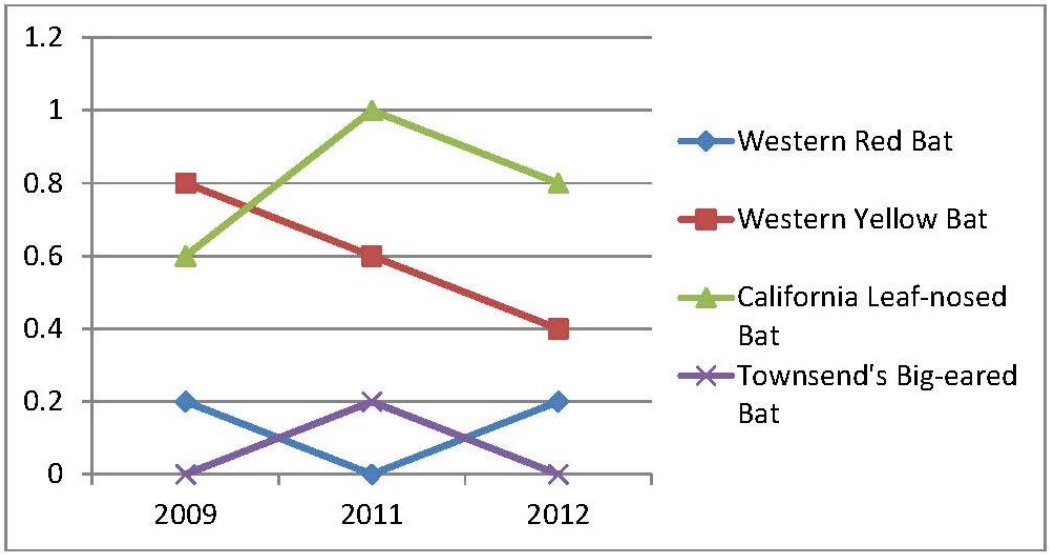

Figure 23.—Naïve occupancy rates for LCR MSCP species at AKTP.

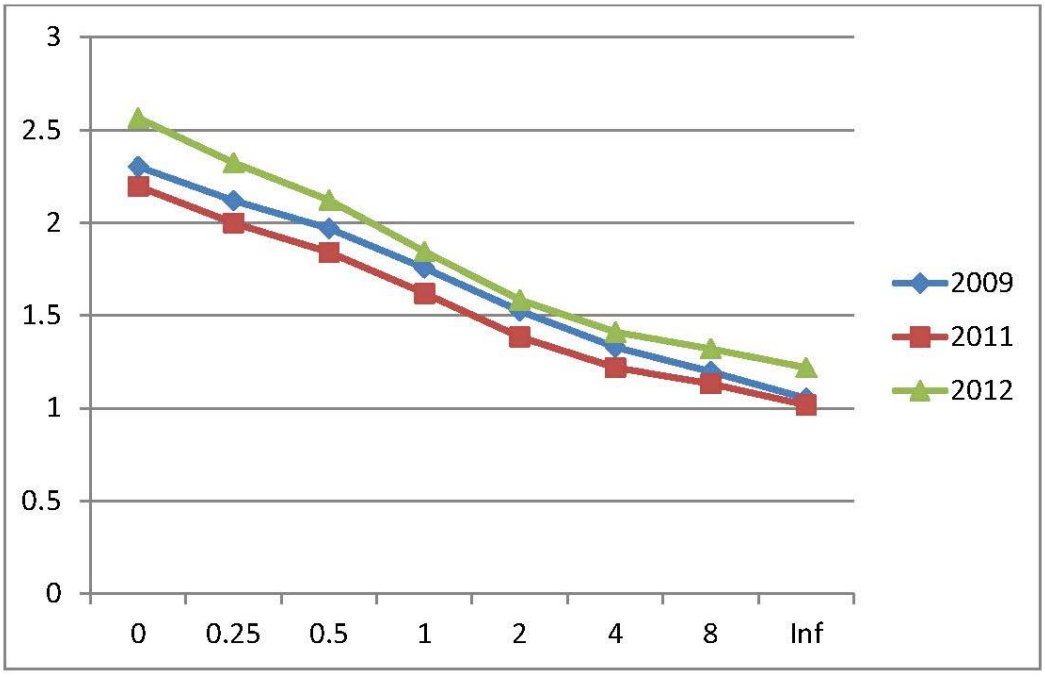

Figure 24.—Renyi diversity profiles at AKTP.

Table 12.—All species captured across all years (summer season only) at AKTP

Species	2007	2008	2009	2011	2012	Totals
Pallid bat	4	35	52	98	60	249
Big brown bat	0	9	35	82	57	183
Arizona myotis	5	0	12	36	32	85
Yuma myotis	4	12	23	8	16	63
California leaf-nosed bat*	**1**	**4**	**13**	**19**	**8**	**45**
Cave myotis	6	0	5	15	14	40
Western yellow bat	**4**	**4**	**6**	**11**	**4**	**29**
Canyon bat	0	0	0	0	7	7
California myotis	1	1	1	1	1	5
Western red bat	**0**	**0**	**1**	**0**	**1**	**2**
Hoary bat	0	0	1	0	1	2
Mexican free-tailed bat	1	0	0	0	1	2
Pocketed free-tailed bat	0	0	0	0	1	1
Townsend's big-eared bat	0	0	0	1	0	1
Totals	26	65	149	271	203	714

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

Beal Lake Conservation Area

This was the third year (first since 2008) that capture surveys were conducted at BEAL. A total of 70 bats from 9 species were captured in 2012 (table 13). The big brown bat has the highest capture frequency; one LCR MSCP species, the California leaf-nosed bat, was captured at BEAL. Five species had a higher ratio of males captured, while all but the big brown bat had higher ratios of adults (table 14). Five species showed signs of reproduction (figure 25). Capture rates and species richness in 2012 were much higher than previous years, though it should be noted that only one triple net set accompanied with some single, double net, or harp trap sets were used in previous years (figure 26). Because these surveys were exploratory and not conducted across all survey months, no diversity profiles were calculated.

Table 13.—Species captured at BEAL for each month

Species	May	July	September	Totals
Big brown bat	6	17	0	23
Canyon bat	9	10	0	19
Pallid bat	2	4	2	8
Cave myotis	4	2	0	6
Yuma myotis	1	3	1	5
California myotis	5	0	0	5
Mexican free-tailed bat	0	0	2	2
Hoary bat	0	0	1	1
California leaf-nosed bat*	0	1	0	1
Totals	27	37	6	70

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

Table 14.—Sex and age ratios for all species at BEAL in 2012

Species[1]	Sex (male:female)	Age (adult:juvenile)
Big brown bat	14:8	7:15
Canyon bat	5:12	15:2
Pallid bat	1:7	6:2
Cave myotis	4:2	4:2
Yuma myotis	3:2	4:1
California myotis	1:4	5:0
Mexican free-tailed bat	1:1	1:1
Hoary bat	1:0	1:0
California leaf-nosed bat*	**1:0**	**1:0**

[1] Three individual bats escaped before age and sex could be determined. Species in bold are LCR MSCP covered species; * indicates an evaluation species.

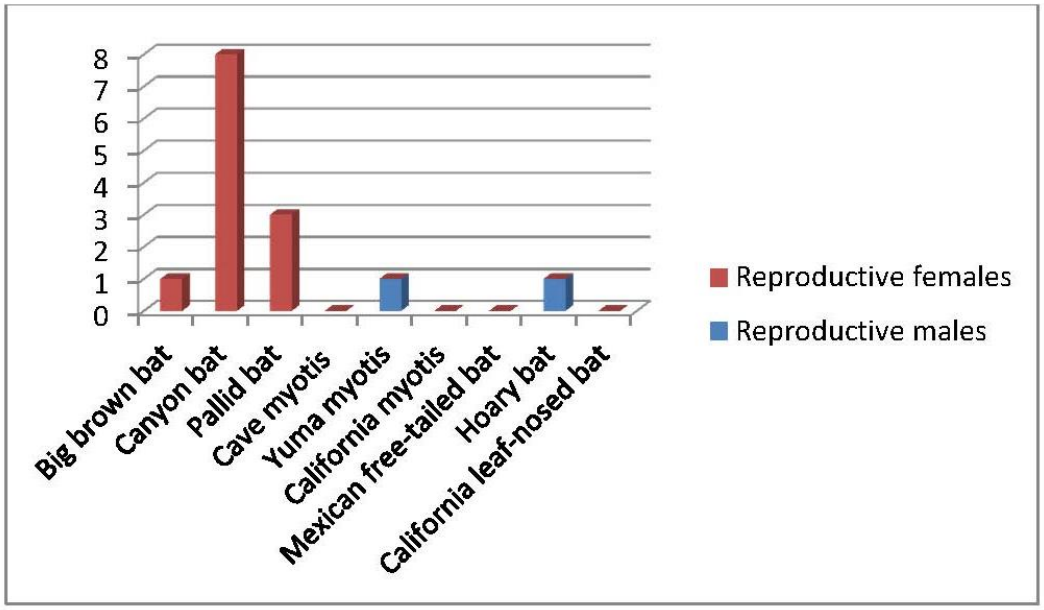

Figure 25.—Ratio of reproductive adults by sex at BEAL in 2012.

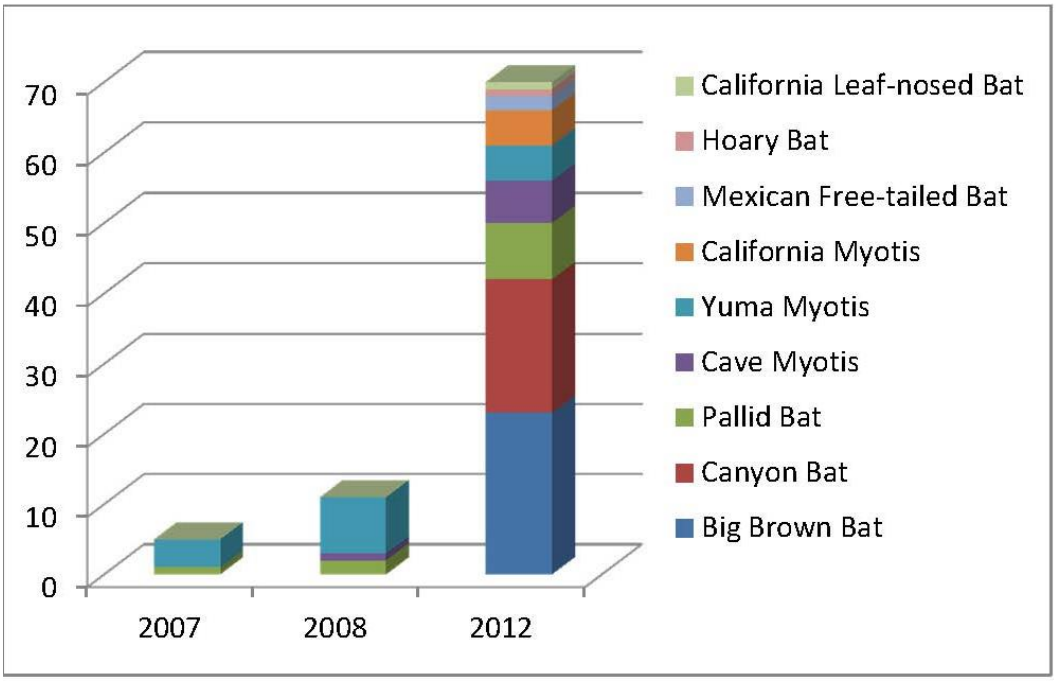

Figure 26.—Species composition for all years at BEAL.

Yuma East Wetlands

This was the first year that capture surveys were conducted at YEWE. A total of 85 bats from 6 species were captured in 2012 (table 15). The big brown bat has the highest capture frequency; one LCR MSCP species, the California leaf-nosed bat, was captured at YEWE. The big brown bat had a much higher ratio of females compared to males, and most were adults (table 16). The big brown bat and western yellow bat both had males and females showing signs of reproduction (figure 27). Because only one season of data was collected and surveys were not conducted every month, no diversity profile was calculated. The May 16 and September 12 surveys were conducted by Reclamation, and the other three surveys were conducted by Arizona Game and Fish Personnel for the western red and yellow bat roosting study.

Table 15.—Species captured at YEWE for each survey

Species	May 16	May 21	June 18	July 16	September 12	Totals
Big brown bat	16	13	7	35	6	77
Western yellow bat	**1**	**1**	**0**	**1**	**0**	**3**
Yuma myotis	0	0	0	2	0	2
Cave myotis	0	0	0	1	0	1
Western red bat	**1**	**0**	**0**	**0**	**0**	**1**
Mexican free-tailed bat	0	1	0	0	0	1
Totals	18	15	7	39	6	85

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

Table 16.—Sex and age ratios for all species at YEWE in 2012

Species[1]	Sex (male:female)	Age (adult:juvenile)
Big brown bat	16:61	62:6
Western yellow bat	**1:2**	**3:0**
Cave myotis	1:0	0:1
Western red bat	**1:0**	**1:0**
Mexican free-tailed bat	1:0	1:0

[1] Two Yuma myotis were released before age and sex could be determined, and nine big brown bats were released before age could be determined. Species in bold are LCR MSCP covered species; * indicates an evaluation species.

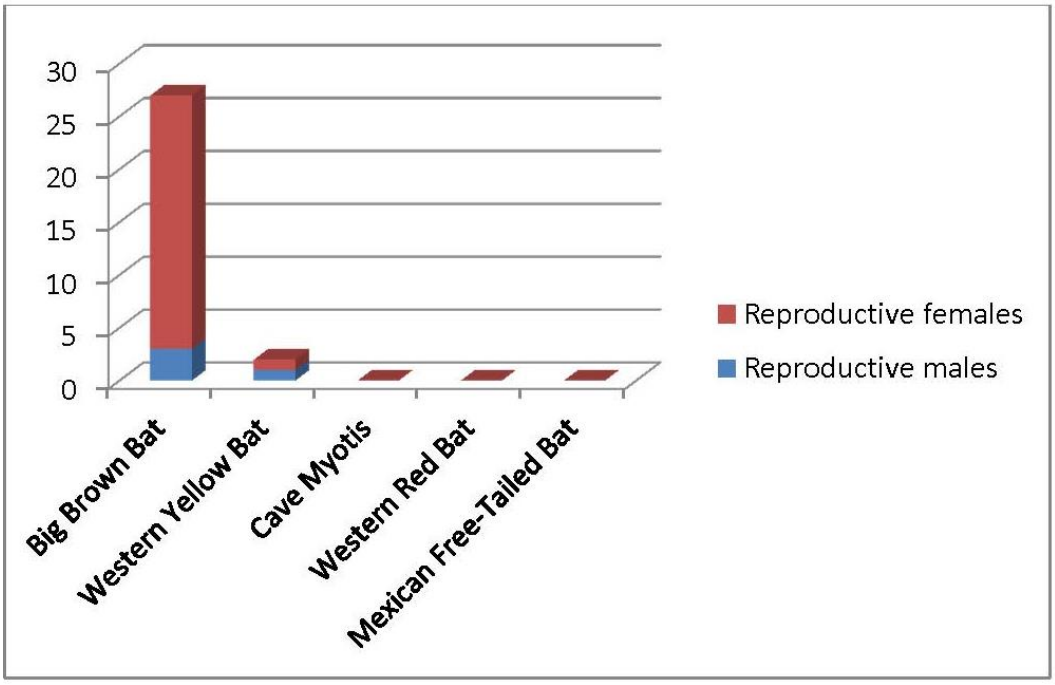

Figure 27.—Ratio of reproductive adults by sex at YEWE in 2012.

Site Comparisons

A total of 795 bats were captured from 13 species in 2012 (table 17). Three of the four LCR MSCP species were captured. Species composition varied at each site, with only five species overlapping across all sites surveyed. Capture rates were highest at AKTP and lowest at BEAL (figure 28). Species richness was highest at AKTP and lowest at YEWE (figure 28). Western red bat and western yellow bat

Table 17.—All species captured across all sites in 2012

Species	AKTP	PVER	CVCA	CIBO	BEAL	YEWE	Totals
Big brown bat	57	70	76	73	23	77	376
Pallid bat	60	10	35	17	8	0	130
Yuma myotis	16	7	37	8	5	2	75
Cave myotis	14	14	17	2	6	1	54
Arizona myotis	32	0	0	0	0	0	32
Canyon bat	7	0	0	3	19	0	29
California myotis	1	1	8	13	5	0	28
Western yellow bat	**4**	**10**	**7**	**1**	**0**	**3**	**25**
California leaf-nosed bat*	**8**	**1**	**0**	**6**	**1**	**0**	**16**
Western red bat	**1**	**6**	**4**	**1**	**0**	**1**	**13**
Mexican free-tailed bat	1	5	1	1	2	1	11
Hoary bat	1	0	3	0	1	0	5
Pocketed free-tailed bat	1	0	0	0	0	0	1
Totals	203	124	188	125	70	85	795

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

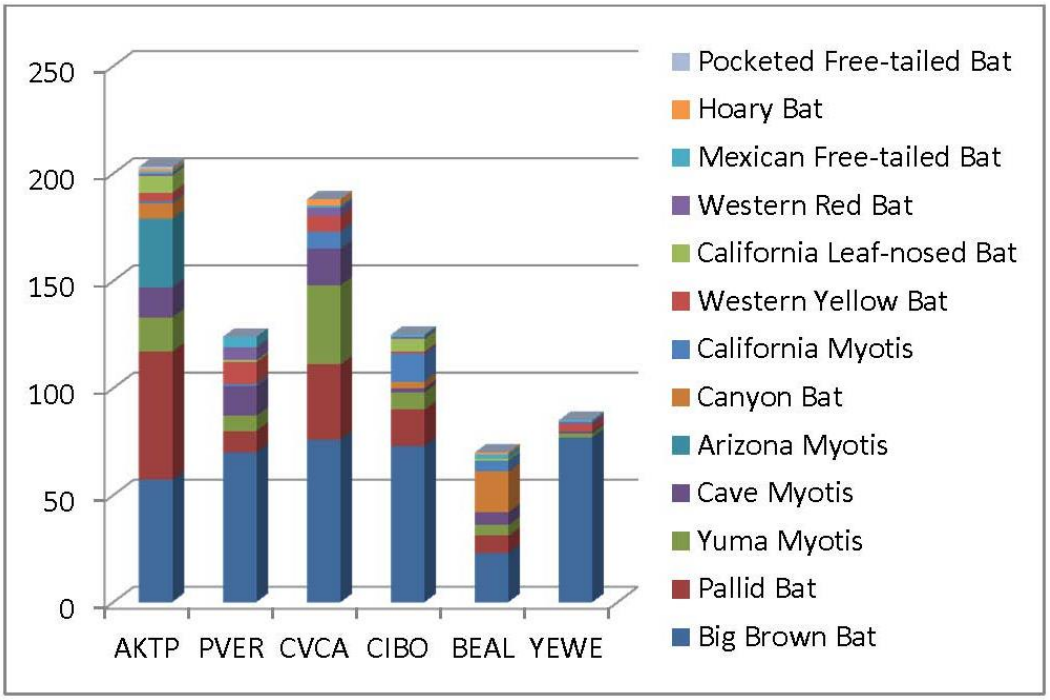

Figure 28.—Species composition at all sites in 2012.

naïve occupancy was highest at CVCA and PVER, while California leaf-nosed bat naïve occupancy was highest at AKTP (figure 29). Renyi diversity profiles showed that AKTP had the highest species diversity, while there was no statistical difference in species diversity between the other sites (figure 30).

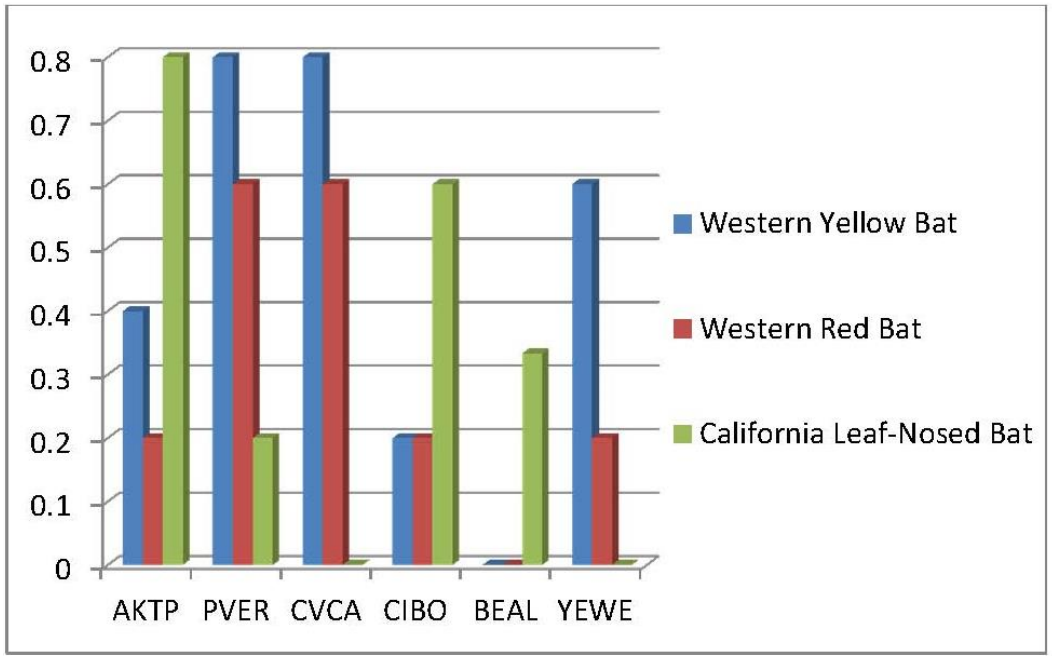

Figure 29.—LCR MSCP covered species naïve occupancy at all sites in 2012.

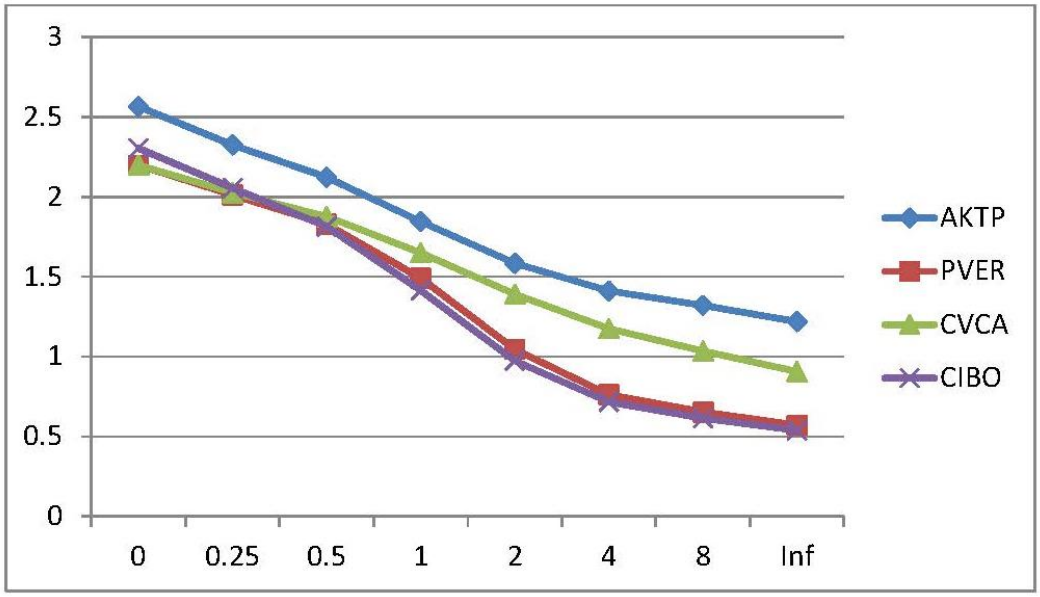

Figure 30.—Renyi diversity profiles for 2012 data.

DISCUSSION

This year, six different habitat creation areas were surveyed in the summer season. The surveys were all successful this year due to high species richness and the presence of at least one LCR MSCP species at each site. At least one LCR MSCP species was captured at all sites, and all but one site (YEWE) had at least nine species captured. Yuma East Wetlands was the youngest site, which probably played a role in its lower species richness. Western yellow bats appear to be a resident at YEWE, with one pregnant female and one juvenile captured. Because only one red bat was captured early in the season at YEWE, it was likely a migrant.

Similar to other years, AKTP has consistently had both high species richness and diversity (and statistically higher in 2012), though western red bats have only been captured in August or September, indicating that AKTP is used as a summer migration stopover site (Calvert 2012). Winter capture surveys in previous years, as well as preliminary acoustic data, show that AKTP has been winter resident habitat for western red bats. One potential reason this site has higher species diversity may be a combination of its age and patch size. While newer sites such as CVCA and PVER have large patch sizes, the older trees at these sites are still 5 years younger than most of the trees at AKTP. Red bats may not be summer residents due to the lower canopy cover at the site compared to the more densely planted younger sites.

Most net locations across all sites were productive, all producing at least moderate capture rates. In the past, CIBO captures and species richness were lower, and one of the three triple net sets was usually much less productive. Moving that net to the Mass Planting field may have helped increase captures at CIBO this year.

The PVER netting location was moved this year due to the combined surveys with Arizona Game and Fish personnel working on the western red and western yellow bat roosting study. In 2011, we had all nets within the same planting phase. Because we wanted to spread the nets out, we moved our nets to Phases 2 and 3. There was no apparent change in species richness or diversity compared to 2011, though Arizona Game and Fish personnel who left their nets in the same locations both years did capture more western red bats than we did on the same survey nights.

Captures at CVCA were down in 2012, but overall richness and diversity remained relatively unchanged from previous years. California leaf-nosed bats were not captured in 2012, similar to 2009 and 2010. Either CVCA is not providing the necessary foraging habitat, or the site is located on the limits of how far they will forage from a roost. This species is commonly captured at CIBO, which is approximately 3 mi (4.8 km) away from CVCA. CIBO is a more mature site, and the walking trails may provide greater opportunity for foraging than the roads at CVCA.

The Beal Lake Conservation Area site proved much more successful than in years past due to both higher captures and diversity. The cottonwoods onsite had grown considerably and had created more defined corridors and edges that provided better netting areas. This also increased the structural heterogeneity of BEAL, which is known to increase bat activity (Broderick 2012). It is anticipated that BEAL will have a full survey season in 2013.

While AKTP had the highest species richness and diversity, PVER and CVCA had higher occupancy rates of western red and yellow bats. For western red bats, this is most likely due to the planting design of these newer habitat creation areas. Both CVCA and PVER were developed using a dense planting plan. This has created large areas of high canopy cover, which preliminary data indicate is an important component for western red bat roosting. Western yellow bat occupancy has decreased from previous years at AKTP. Because they roost in nearby fan palm trees (*Washingtonia* spp.), these habitat creation areas are primarily used by western yellow bats as foraging habitat. If the dead palm fronds that create a "skirt" around the palm are trimmed, it may reduce the number of roosts available for the western yellow bat.

It is unknown how bat use of these sites changes over time. Younger sites like PVER and CVCA will continue to mature. Continued monitoring is necessary to determine if bat use changes at these sites, especially for the LCR MSCP species. Capture surveys will continue at all six sites to collect data on age, sex, and reproductive status of bats using each site. Start times may also be delayed in 2013. It was observed that western red bats were usually captured at the start of surveys or later on in the evening. Acoustic data collected during the surveys usually showed consistent activity during this "down" time when few western red bats were captured. It is hypothesized that western red bats that are roosting onsite, will leave their roost soon after sunset to start foraging. If they encounter and successfully avoid the nets during their early foraging, they may continue to avoid them or leave the area to forage elsewhere. If net start time is delayed until 30 minutes after sunset, this may give western red bats some time to begin their foraging route with no nets in their way. Once the nets are opened, they may be more likely to be captured, not expecting to run into a net that was not present during a previous flight through the corridor.

Reference acoustic files will also continue to be collected in order to make each species acoustic reference library as robust as possible. Mark re-capture studies are also being investigated. California leaf-nosed bats are now being banded when captured at each site to confirm site fidelity and possibly determine what roost they are coming from. Western red and yellow bats do not accept bands as well, and they may be passive integrated transponder (PIT) tagged in the future. Because the roosting study will continue in 2013, western red and yellow bats will not be PIT tagged as to not add stress to the individuals that will have radio

transmitters attached. If all individuals cannot be marked, then it is not advised to start PIT tagging until after the roosting study is complete. Because there are no data on site fidelity for these species, once implemented, PIT tagging will fill in important research gaps.

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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*
Townsend's big-eared bat	*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.