

Bat Surveys at Pinnacles National Monument

August 2004 Through July 2005

PAUL A. HEADY III

Central Coast Bat Research Group

P.O. Box 1352 Aptos, CA 95001
 (831) 662-1338 tel/fax
 pheady3@earthlink.net

Bat surveys were conducted at Pinnacles National Monument August 2004 through July 2005. Surveys included eight acoustic sampling sites, four mist netting sites and one visual mine survey. The survey sites were chosen to best sample the diverse habitats and primary bat resources (water, foraging sites and roosting habitat). Seventeen species are known to occur in the Central California region. Nine of these species have Special status. Thirteen species were detected during the bat surveys, seven with Special status.

Table 1 Species Known to Occur in the Central California Region

Family VESPERTILIONIDAE (Plain-nosed or mouse-eared bats)		
<i>Myotis lucifugus</i>	Little brown myotis	
<i>Myotis yumanensis</i>	Yuma myotis	
<i>Myotis evotis</i>	Long-eared myotis	FSC/BLMS
<i>Myotis thysanodes</i>	Fringed myotis	FSC/ BLMS/WBVG
<i>Myotis volans</i>	Long-legged myotis	FSC/ BLMS/WBVG
<i>Myotis californicus</i>	California myotis	
<i>Myotis ciliolabrum</i>	W. small-footed myotis	FSC/BLMS
<i>Lasionycteris noctivagans</i>	Silver-haired bat	
<i>Pipistrellus hesperus</i>	Western pipistrelle	
<i>Eptesicus fuscus</i>	Big brown bat	
<i>Lasiurus blossevillii</i>	Western red bat	FSS/WBVG
<i>Lasiurus cinereus</i>	Hoary bat	
<i>Corynorhinus townsendii</i>	Townsend's big-eared bat	FSC/CSC/FSS/BLMS/WBVG
<i>Antrozous pallidus</i>	Pallid bat	CSC/FSS/BLMS/WBVG
<i>Euderma maculatum</i>	Spotted bat	FSC/CSC/BLMS/WBVG
Family MOLOSSIDAE (Free-tailed bats)		
<i>Tadarida brasiliensis</i>	Mexican free-tailed bat	
<i>Eumops perotis</i>	Western mastiff bat	FSC/CSC/BLMS/WBVG
<p>FSC = Federal Special Concern species (former Category 2 candidates for ESA listing) CSC = California Department of Fish and Game's California Special Concern species FSS = Forest Service Sensitive species BLMS = Bureau of Land Management Sensitive species WBVG = Western Bat Working Group High Priority species</p>		
<p>For more information on the meaning of these listings, please visit the Calif. Depart. of Fish and Game's California Natural Diversity Database website at www.dfg.ca.gov/whdab/assess/docs/spanim2001_Jan.pdf</p>		

Multiple Survey Techniques

To characterize the general bat assemblage in the area, it is best use multiple survey techniques.

Each of the available survey methods (acoustic sampling, mist-net surveys, and roost surveys) has inherent biases and different detection likelihood for each bat species (Kalko et al. 1996, Pierson et al. 1996; Pierson and Rainey 1996, Simmons and Voss 1998).

Mist Netting

Mist-nets similar to those used to capture birds are set over water, trails, and in other known flyways. Bats are handled to collect the following data: reproductive condition, sex, age, and body measurements. After data are collected, the animal is released on-site. Mist-netting does not give an adequate indication of activity or abundance of bats in an area, but is used to gather data that can not be obtained without an animal in hand. Mist-netting sites are generally augmented by acoustic monitoring near the mist-nets to assess relative abundance/activity. All bats that are captured are recorded on release to confirm species identification and for future use in species call identification.

Roost Sampling

Pinnacles National Monument provides roosting habitat suitable for bats in the form of rock outcroppings, caves, mines, mature oak woodlands and riparian cottonwood stands. Townsend's big-eared bats prefer large cavernous spaces such as caves attics and barns. Pallid bats are crevice roosters as well as cavern roosters, and will use crevices in rocks. Bear Gulch Cave is well documented. An abandoned mine was surveyed to determine if it was being used as a roost by the local bat species.

Acoustic Sampling

Equipment

Acoustic sampling was conducted with an Anabat II bat detector system (Titley Electronics). The Anabat system uses a bat detector to detect bat ultrasonic echolocation calls in the field and uses a z-caim unit to convert the detected signals into time/frequency (kilohertz (kHz)) graphs on a computer. Acoustic units (Anabat bat detector and CF-Storage ZCAIM) were placed in appropriate settings to collect bat calls. Appropriate settings included reservoir edges, and riparian corridors. Acoustic units operated and collected data from sunset until sunrise. Detectors were placed at eight sites and operated between 19:30 and 06:30 throughout survey periods.

Identification of Species

Detecting and identifying bat species with acoustic sampling is bound by two constraints: 1) how easily a bat is detected in the field, and 2) how reliably it can be identified by its call parameters once detected. Detectability depends on call intensity, call frequency, and distance from the detector. In general, species with low frequency, high intensity calls are

detected at the greatest distance, and therefore are more frequently represented in acoustic sampling surveys (Pierson et al. 2001).

Identifying bat species by echolocation calls involves analyzing several call parameters such as base frequency, call shape, call pattern, call duration and interpulse time interval. Some bat species are more readily identifiable by their echolocation call features than other species. Knowledge of the local bat fauna and the ecology and biology of the bat species is necessary in analyzing acoustic data.

Nine of the bat species likely to occur in the region are readily identified using the Anabat system. These species are Townsend's big-eared bat, pallid bat, western red bat, hoary bat, long-eared myotis, fringed myotis, western pipistrelle, spotted bat, and the western mastiff bat. Although discernible, Townsend's big-eared bat is rarely detected by acoustic units because it has a low intensity, high frequency call, and the bat must fly in extremely close proximity to the detector unit in order to be recorded.

Three groups of bats are difficult to distinguish by Anabat call sequence. The first set, silver-haired bat (*Lasiorycteris noctivagans*), big brown bat (*Eptesicus fuscus*), and Mexican free-tailed bat (*Tadarida brasiliensis*), all share similar call characteristics in the 20 kHz to 30 kHz frequency range. Some calls can be diagnostic, but most calls are difficult to differentiate. These calls are identified as 25kHz group in the analysis.

California myotis (*Myotis californicus*) and Yuma myotis (*Myotis yumanensis*) both have call frequencies between 45 kHz and 50 kHz. Call shape can be diagnostic, although it is often difficult to discern. The two species are best differentiated by their foraging behavior and the location of the detector site. Yuma myotis flies close over water surfaces, foraging for emerging insects, while California myotis flies along vegetation edges, often at canopy height, in an erratic flight pattern. Calls that were indistinguishable between these two species were labeled 50K Myotis in the analysis.

Western small footed myotis (*Myotis ciliolabrum*), long-legged myotis (*Myotis volans*), and little brown myotis (*Myotis lucifugus*) comprise the third problematic group of taxa. These three species all have similar calls between 35-45 kHz and are very difficult to distinguish by call sequences.

Results

In all, thirteen bat species were detected at Pinnacles National Monument. An additional three species that belong to groups whose members cannot be distinguished acoustically were considered possible but not confirmed (Table 2).

Table 2. Species Detected or Possibly Detected in Pinnacles National Monument

Family VESPERTILIONIDAE (Plain-nosed or mouse-eared bats)			
<i>Myotis lucifugus</i>	Mylu	Little brown myotis	40kHz *****
<i>Myotis yumanensis</i>	Myyu	Yuma myotis	Ac, Mn, V, 50kHz,
<i>Myotis evotis</i>	Myev	Long-eared myotis	Ac
<i>Myotis thysanodes</i>	Myth	Fringed myotis	Ac, Mn
<i>Myotis volans</i>	Myvo	Long-legged myotis	40kHz *****
<i>Myotis californicus</i>	Myca	California myotis	Ac, Mn, V, 50kHz
<i>Myotis ciliolabrum</i>	Myci	W. small-footed myotis	Mn, 40kHz
<i>Lasionycteris noctivagans</i>	Lano	Silver-haired bat	Q25, *****
<i>Pipistrellus hesperus</i>	Pihe	Western pipistrelle	Ac, Mn, V
<i>Eptesicus fuscus</i>	Epfu	Big brown bat	Ac, Mn Q25, V
<i>Lasiurus blossevillii</i>	Labl	Western red bat	Ac, Mn
<i>Lasiurus cinereus</i>	Laci	Hoary bat	Ac, Mn
<i>Corynorhinus townsendii</i>	Coto	Townsend's big-eared bat	Ac, Mn, V
<i>Antrozous pallidus</i>	Anpa	Pallid bat	Ac, Mn, V
Family MOLOSSIDAE (Free-tailed bats)			
<i>Tadarida brasiliensis</i>	Tabr	Mexican free-tailed bat	Mn, V, Q25
<i>Eumops perotis</i>	Eupe	Western mastiff bat	Ac, V

Mn=Mist net capture, V= visual, 40kHz= possible in 40kHz group
 50kHz= possible in 50kHz group, Q25= possible in 25kHz group,
 *****= not detected but presence Possible

Mist Net and Visual Survey Results

Table 3. Bat capture results from mist-net surveys. *Italics indicate observed roosting bats in a mine.*

SITE	LAT	LONG	DATE	MYU	MYTH	MYCA	MYCI	PIHE	EPFU	LABL	LACI	COTO	ANPA	TABR	TOTAL
PNM01	36.48619	121.15224	05/13/05	-	1	-	1	-	-	-	-	1	1	-	4
PNM02	36.48604	121.16738	06/28/05	-	-	1	1	1	4	1	1	-	-	1	10
PNM03	36.48726	121.16864	08/12/04	-	-	-	-	-	-	-	-	-	-	-	0
PNM05	36.47843	121.18311	07/04/05	2	1	6	-	-	7	-	-	-	1	-	17
PNM08			10/21/04	-	-	-	-	-	1	-	-	>50	-	-	>50
TOTAL				2	2	7	2	1	12	1	1	>50	2	1	31

Table 4. Sex and reproductive condition of captured bats

Species	Date	Site Name	Latitude	Longitude	Males	Females			Unknown	Totals
						Lactating	Post-Lactating	Null		
Pallid bat (<i>Antrozous pallidus</i>)										
	13-May-05	PNM01	36.48619	121.15224	1	-	-	-	-	1
	4-Jul-05	PNM05	36.47843	121.18311	1	-	-	-	-	1
	Subtotal				2	0	0	0	0	2
Big brown bat (<i>Eptesicus fuscus</i>)										
	28-Jun-05	PNM02	36.48604	121.16738	4	-	-	-	-	4
	4-Jul-05	PNM05	36.47843	121.18311	7	-	-	-	-	7
	21-Oct-04	PNM08			-	-	-	-	1	1
	Subtotal				11	0	0	0	1	12
Western red bat (<i>Lasiurus blossevillii</i>)										
	28-Jun-05	PNM02	36.48604	121.16738	1	-	-	-	-	1
	Subtotal				1	0	0	0	0	1
Hoary bat (<i>Lasiurus cinereus</i>)										
	28-Jun-05	PNM02	36.48604	121.16738	1	-	-	-	-	1
	Subtotal				1	0	0	0	0	1
California myotis (<i>Myotis californicus</i>)										
	28-Jun-05	PNM02	36.48604	121.16738	1	-	-	-	-	1
	4-Jul-05	PNM05	36.47843	121.18311	4	1	1	-	-	6
	Subtotal				5	1	1	0	0	7
Western small-footed myotis (<i>Myotis ciliolabrum</i>)										
	13-May-05	PNM01	36.48619	121.15224	1	-	-	-	-	1
	28-Jun-05	PNM02	36.48604	121.16738	1	-	-	-	-	1
	Subtotal				2	0	0	0	0	2
Fringed myotis (<i>Myotis thysanodes</i>)										
	13-May-05	PNM01	36.48619	121.15224	1	-	-	-	-	1
	4-Jul-05	PNM05	36.47843	121.18311	1	-	-	-	-	1
	Subtotal				2	0	0	0	0	2
Yuma myotis (<i>Myotis yumanensis</i>)										
	4-Jul-05	PNM05	36.47843	121.18311	2	-	-	-	-	2
	Subtotal				2	0	0	0	0	2
Western pipistrelle (<i>Pipistrellus hesperus</i>)										
	28-Jun-05	PNM02	36.48604	121.16738	-	1	-	-	-	1
	Subtotal				0	1	0	0	0	1
Townsend's big-eared bat (<i>Corynorhinus townsendii</i>)										
	13-May-05	PNM01	36.48619	121.15224	1	-	-	-	-	1
	21-Oct-04	PNM08			-	-	-	-	50+	50+
	Subtotal				1	0	0	0	0	>50
Mexican free-tailed (<i>Tadarida brasiliensis</i>)										
	28-Jun-05	PNM02	36.48604	121.16738	-	1	-	-	-	1

Table 5. Number of bat call sequences per night at each survey site for species detectable using the Anabat echolocation software. * indicate probable detection. M40, M50, Q25 represent phonic groups (see text for more information).

Site	Latitude	Longitude	MYEV	MYTH	PIHE	EPFU	LABL	LACI	COTO	ANPA	EUPE	M40	M50	Q25
PNM01	36.48619	121.15224												
	21-Oct-05		14	1	1	*	1	23	8	1	1	12	4	35
	28-Jun-05		2	4	6	3	2	6	1	1	1	56	48	147
PNM02	36.48604	121.16738												
	21-Oct-05		-	-	0.40	*	-	0.20	-	0.40	-	0.80	1	0.80
	28-Jun-05		25	10	4	86	1	2	1	48	Obs	30	34	54
PNM03	36.48726	121.16864												
	12-Aug-04		1	-	4	*	-	-	-	1	Obs	3	2	11
PNM04	36.48146	121.17945												
	21-Oct-05		-	-	0.40	-	-	0.80	0.60	-	-	6	9	-
PNM06	36.47540	121.18510												
	28-Jun-05		1	3	-	*	-	1	6	1	4	2	33	2
PNM07	36.47219	121.18835												
	12-Aug-04		1	11	62	10	2	4	-	9	80	130	1016	39
	28-Jun-05		2	4	2	198	-	6	14	79	70	25	747	501
PNM08														
	21-Oct-05		0.25	-	-	-	-	0.25	-	0.75	-	0.25	0.50	-
SITE10	36.49217	121.14548												
	21-Oct-05		-	-	-	-	-	1	-	-	-	1	2	-

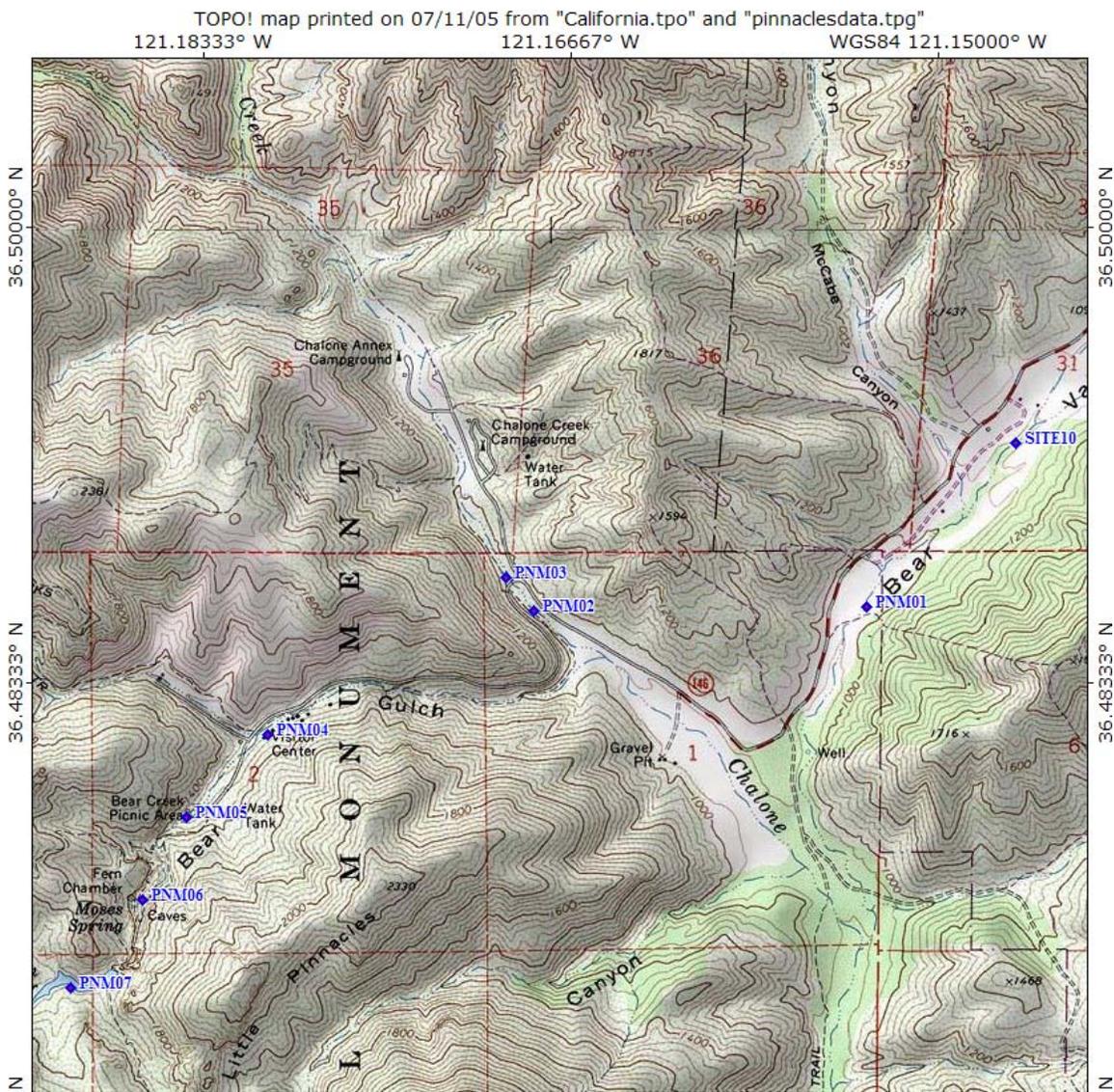


Figure 1. Map of bat survey sites at Pinnacles National Monument

Discussion of Results

Yuma myotis (*Myotis yumanensis*)

Yuma myotis were observed foraging over the reservoir in fairly high numbers. Acoustic monitoring at the reservoir detected 1,016 50Khz passes which were most likely to be *M. yumanensis*. Mist nets over pools near the Bear Gulch parking area captured *M. yumanensis*. The bats seem to be abundant where open water provides foraging for emergent insects. Yuma myotis have ample roosting habitat in the form of older growth trees and rock crevices.

Western long-eared myotis (*Myotis evotis*)

Forest Service Sensitive species Bureau of Land Management Sensitive species

Myotis evotis call sequences were detected at six of the eight acoustic sample sites although in low numbers. No captures of *M. evotis* occurred during the surveys. This species is not typically difficult to capture and the low number of call sequences indicates that *M. evotis* is not overly abundant. There is plenty of roosting habitat provided by the rock outcroppings this species is known to roost in rock piles and riprap.

Fringed Myotis (*Myotis thysanodes*)

Forest Service Sensitive species Bureau of Land Management Sensitive species Western Bat Working Group High Priority species
--

Myotis thysanodes call sequences were detected at five of the eight acoustic monitoring stations and captures occurred at two of the four mist netting sites. The rock features of the park provide excellent roosting habitat for this species.

California myotis (*Myotis californicus*)

50Khz call sequences were detected at all of the acoustic monitoring stations and could represent *M. californicus* activity. California myotis were captured at two of the four mist netting sites. The mixed oak and riparian forest provide excellent roosting habitat for this species.

Western small-footed myotis (*Myotis ciliolabrum*)

Forest Service Sensitive species Bureau of Land Management Sensitive species

40Khz call sequences were detected at all acoustic monitoring stations and could represent *M. ciliolabrum* activity. *M. ciliolabrum* was captured at two of the four mist netting sites. Rock formations in the park provide excellent roosting habitat.

Western Pipistrelle (*Pipistrellus hesperus*)

Pipistrelles were detected at five acoustic sites and captured at one mist netting site during the survey. These are abundant in the park. There is ample roosting habitat for pipistrelles in the form of rock crevices.

Big brown bat (*Eptesicus fuscus*)

Call sequences with distinct big brown bat characteristics were recorded at three acoustic monitoring stations and two other stations recorded calls in the Q25 category that may be indicative of this species. *E. fuscus* was captured at two of the mist netting sites a total of 11 individuals. *E. fuscus* was observed in the abandoned mine. This species appears to be abundant in the monument.

Western red bat (*Lasiurus blossevillii*)

Forest Service Sensitive species Western Bat Working Group High Priority species

Red bats call sequences were detected at three sites during the surveys. These bats are easily detected with acoustic monitoring and the low number of calls and few sites with detections suggests that red bats are not abundant in the area. One Western red bat was captured in the mist nets at PNM01; this site is cottonwood riparian. Western red bat have been observed roosting in cottonwood trees (Pierson and Heady 1997).

Hoary bat (*Lasiurus cinereus*)

Hoary bats call sequences were detected at 7 of the eight sites during the surveys and captured in mist nets. Although they were detected at seven sites there were not high numbers of call sequences. These bats are easily detected with acoustic monitoring and the low number of calls suggests that hoary bats are not abundant in the area. Hoary bats were detected in higher numbers during fall suggesting higher numbers during migrations.

Townsend’s big-eared bat (*Corynorhinus townsendii*)

Federal Special Concern species (former Category 2 candidates for ESA listing) California Department of Fish and Game’s California Special Concern species Forest Service Sensitive species Bureau of Land Management Sensitive species Western Bat Working Group High Priority species

Corynorhinus Townsendii is the high profile bat species in the park. The Bear Gulch Cave colony is a well known and monitored population. Five of the acoustic monitoring stations recorded *C. townsendii* calls which is rather remarkable given that this species has a very low-intensity echo location call. Bear Gulch Cave and several other sites provide excellent roosting habitat for this species.

Pallid Bat (*Antrozous pallidus*)

California Department of Fish and Game’s California Special Concern species Forest Service Sensitive species Bureau of Land Management Sensitive species Western Bat Working Group High Priority species

Pallid bat calls were detected at six of the eight acoustic sample sites. All of the acoustic sites seem to be foraging areas for pallid bats. Pallid bats were captured at two of the mist netting sites. There is abundant roosting habitat for pallid bats in the Park in the form of rock crevices and caves.

Mexican free-tailed bat (*Tadarida brasiliensis*)

Call sequences in the 25Khz range were recorded at five of the eight acoustic monitoring sites and. These calls were likely Mexican free-tailed bats. *T. brasiliensis* were captured at one mist netting site and appear to be abundant at Pinnacles National Monument. This species forages high and is difficult to capture except when drinking over open water. The rock features of Pinnacles National Monument provide excellent roosting habitat for Mexican free-tailed bats.

Western mastiff bat (*Eumops perotis*)

Federal Special Concern species (former Category 2 candidates for ESA listing) California Department of Fish and Game’s California Special Concern species Bureau of Land Management Sensitive species Western Bat Working Group High Priority species

The unique rock features that give Pinnacles National Monument its name provide some of the only suitable roosting habitat for the western mastiff bat in the region. Because of the abundant roosting habitat the audible calls of *Eumops perotis* can be heard throughout the park. The low frequency calls (15Khz and lower) are not easily recorded by the acoustic equipment because they are below the sensitivity threshold yet call sequences for *E. perotis* were recorded at three of the acoustic stations. The highest level of activity for this species was recorded at the Bear Gulch Reservoir where *E. perotis* is likely drinking.

50kHz Myotis

This group includes California myotis (*Myotis californicus*) and Yuma myotis (*Myotis yumanensis*). Neither of these species have any special status. They are common throughout California. Calls in the 50 Khz range were detected at all acoustic sites. Both species were captured in mist nets confirming their presence. Large numbers of 50 Khz bats were observed foraging low over the reservoir suggesting that high numbers of *Myotis yumanensis* are present at the reservoir.

40kHz Myotis

This group includes Little brown myotis (*Myotis lucifugus*), long-legged myotis (*Myotis volans*), and the small footed myotis (*Myotis ciliolabrum*). These calls were detected at all acoustic sites. The only 40khz species captured in mist nets was *Myotis ciliolabrum*.

Q25

This group includes silver-haired bat (*Lasionycteris noctivagans*), big brown bat (*Eptesicus fuscus*), and Mexican free-tailed bat (*Tadarida brasiliensis*). None of these species have any special status. The later two are common throughout California. These bats have high intensity and low frequency calls and are easily detected at long distances. Calls of this type were detected during the survey period at five of the eight acoustic sites. Calls with distinctive characteristics were detected for big brown bat and Mexican free-tailed bat.

Discussion of sites

PNM01 Is located near the east entrance kiosk in cottonwood and willow dominated riparian habitat surrounded by oak woodland and grassland. Acoustic monitoring and mist netting detected all species of bats recorded at the park during the inventory. This site has very high levels of activity as well as diversity.

PNM02 Is located along Chalone Creek 200 meters down stream of the entrance road bridge. This site is cottonwood dominated riparian. Open water in the creek bed provides drinking and foraging for bats. Bat activity and diversity are high at this site, acoustic monitoring and mist netting detected all species of bats recorded at the park during the inventory.

PNM03 Is located along Chalone Creek 50 meters up stream of the entrance road bridge. This site is cottonwood dominated riparian. Open water in the creek bed provides drinking and foraging for bats. Bat activity and diversity are moderate at this site. Acoustic monitoring and mist netting was conducted in August 2004 and the water was not easily accessible to bats because seasonal low levels and there were no mist net captures.

PNM04 is located in closed canopy oak dominated riparian in the Visitor center area. Bat activity and diversity were low in this site this may be due to the closed canopy.

PNM05 is located in Bear Gulch immediately up stream of the Bear Gulch parking area. Mist nets were set over open water and in fly ways. Four species and seventeen individuals were captured. Active acoustic monitoring detected high activity and diversity as well.

PNM06 is located in Bear Gulch 50 meters up stream of the trail closure gate. The habitat is oak woodland, chaparral and rock outcroppings. Activity levels were not high but diversity was with all but two species detected.

PNM07 is located on the East side of the Bear Gulch Reservoir. Activity and diversity are extremely high at this site most likely due to the open water providing drinking, and foraging for aquatic insects. Call sequences for all species detected during the inventory were recorded at this site. Notably 1,016 call sequences of 50Khz and 80 *E. perotis*.

PNM08 [*Information about the location of this site has been removed in order to protect the bats that use it.*] Visual surveys of the mine were conducted to determine if this site provided alternate roosting habitat for the *C. townsendii* of the area. The October 21 survey recorded 50+ *C. townsendii* day roosting as well as one *E. fuscus*. Acoustic monitoring at the mine entrance recorded very low activity calls of *A. pallidus*, *M. evotis*, and *L. cinerius*. 40Khz and 50Khz groups were recorded.

Site 10 is located in the public camp ground just outside the East park entrance. The acoustic monitoring took place in the riparian habitat. Activity and diversity were low.

Natural History of Species Detected at Pinnacles National Monument

*****species are possible but not confirmed. Acoustic monitoring detected calls in the frequency group but no distinct calls were recorded.**

*****Little Brown Myotis** (*Myotis lucifugus*) ranges over most of North America from the Yukon to Mexico. In California this bat is found at most elevations, from the coast to high alpine settings. Day roosts are in buildings, trees, under rocks and even in woodpiles. Maternity roosts are more commonly found in buildings although they can be found in hollow trees or in crevices with the appropriate temperature regimes. Night roosts are in buildings, bridges and other structures that have confined spaces. Congregating in confined areas for night roosting is most likely to facilitate energy conservation. Mating takes place in the fall and sperm is stored over winter. Ovulation and fertilization takes place in the spring and a single young is born after a 50-60 day gestation. Young are capable of flight after 3 weeks and are weaned shortly thereafter. Parturition for this species is typically earlier than species of other bats within its range (Fenton and Barclay 1980). Aquatic insects such as midges, caddisflies and mayflies are the major prey of *Myotis lucifugus*, although moths, beetles and other insects are taken. Foraging takes place over water along edges of vegetation and in open areas (Nagorsen and Brigham 1993).

Yuma Myotis (*Myotis yumanensis*) is a year-round resident in a wide variety of habitats from coast to mid-elevation. It is very tolerant of human habitation and survives in urbanized environments. Day roosts occur in buildings, trees, mines, caves, bridges, and rock crevices. Night roosts occur in buildings, bridges, and other man-made structures. The Yuma myotis is presumed to be non-migratory and hibernates in winter, but no large winter aggregations have been reported. A single young is born per year between June and July. Females form large maternity colonies from two hundred to several thousand individuals. Males tend to roost singly or in small groups. The Yuma myotis forages by trawling with its large feet on open water surfaces for emergent aquatic insects, such as caddisflies and midges. Foraging occurs directly over the surface of still water ponds, reservoirs, or pools in streams and rivers.

California Myotis (*Myotis californicus*) is common in most habitats throughout its range, which stretches from the Alaskan panhandle to Mexico (Simpson 1993). Although this bat is common and can be regularly encountered flying along trails at dusk, it is rarely an abundant species in any one area. Maternity colonies are usually small, generally less than 10 individuals. Day roosts are in rock crevices, peeling bark, tree hollows, and on buildings (Simpson 1993). This bat is very flexible in its choice of night roost and will use any natural or man-made shelter (Nagorsen and Brigham 1993). The California myotis is non-migratory and undergoes extended torpor during the winter months in most of its California range. It will arouse from torpor to forage during winter months and has been observed foraging in temperatures as low as -8°C (Simpson 1993). California myotis usually produces one young per year and has a potential reproductive life span of 15 years. In California, mating takes place in early spring and young are born in late May and early June. The California myotis feeds primarily on moths and flies,

with smaller amounts of beetles and bugs. Hunting takes place along edges of vegetation and the canopy, over water, and above open ground (Simpson 1993). This bat emerges in the evening and alternates foraging and roosting throughout the night.

*****Long-legged myotis** (*Myotis volans*) is a Federal Special Concern species. *Myotis volans* inhabits western North America from South-east Alaska to Central Mexico. It is found in an elevational range from sea level to 3,770 m. *Myotis volans* is primarily a coniferous forest bat although it may also be found in riparian and desert habitats (Warner and Czaplewski 1984). Maternity colonies can be up to 300 individuals. Maternity roosts are found in buildings, rock crevices, and under exfoliating bark. Males roost singly or in small numbers in rock crevices, buildings and under tree bark. Night roosts are known to be found under bridges, in caves and mines, and in buildings (Nagorsen and Brigham 1993). In the northern portion of their range, *M. volans* commonly hibernates. It is unknown whether this bat migrates in the portion of its range where winters are less severe. Mating takes place in the fall and sperm is stored over winter. Ovulation and fertilization takes place from March to May and parturition occurs from May to August. There is extensive variation in the timing of reproductive activity in this species. *M. volans* is known to live 21 years in the wild (Warner and Czaplewski 1984). *M. volans* feeds primarily on moths, it is also known to feed on other soft bodied prey such as flies, termites, lacewings, wasps, bugs, leafhoppers, and small beetles. *M. volans* is a rapid, direct flier pursuing its prey over relatively long distances through, around, under and over forest canopy (Warner and Czaplewski 1984).

Western small-footed myotis (*Myotis ciliolabrum*) is a federal species of special concern. It occurs mainly in arid habitats across the western United States and appears to be uncommon throughout most of California (pers. obs.). This species is known to roost in rock crevices in rock faces and is associated with cliffs and talus fields. It has also been found roosting under bark crevices as well as in barns. Western small-footed myotis emerge at dusk and are most active between 2200 and 2300 and again between 0100 and 0200 (Harvey et al. 1999). It forages between 1 and 3 meters along cliffs, feeding on small insects, such as moths, beetles, and flies. One young, although twins may occur, is born in June.

Western pipistrelle (*Pipistrellus hesperus*) occurs throughout the southwestern United States and is associated with desert habitats. It generally day roosts in rock crevices, but can be found underneath rocks, in burrows, in mines, or in buildings (Harvey et al. 1999). It roosts in small groups or individually. The Western pipistrelle begins foraging before sunset and can often be identified by its slow, fluttery flight in the evening light. It is one of the smallest bats in North America. Most of the foraging activity takes place during evening and ceases 1-2 hours after sunset. Foraging takes place 2-25 meters above ground on swarming insects – and a single bat can consume 20% of its body weight per foraging bout (.6-.12 grams of insects) (Harvey et al. 1999). Prey includes a variety of insects, such as, mosquitos, flies, ants, wasps, caddisflies, stoneflies, moths, and small beetles. Western pipistrelles generally give birth to twins in June or July. Juveniles become volant after approximately one month.

*****Silver-haired bat** (*Lasionycteris noctivagans*) occurs throughout most of North America and is associated with forest habitats (Kunz 1982). In California, the silver haired bat is most common in the northwestern portions of the state and the Sierra Nevada. The California population appears to be sexually segregated, with breeding females found in the interior mountains. In coastal regions, only males have been observed. In California, maternity roosts have been documented in trees, such as ponderosa pine, Douglas fir, black oak, and big leaf maple (Rainey et al. 1994). Males have been documented roosting in bark fissures in coastal redwoods (Heady and Frick 2001). This species have also been known to hibernate in mines, caves, trees and buildings in colder portions of their range. The species is primarily a tree roosting bat and forestry practices have the potential to greatly affect its status (Nagorsen and Brigham 1993). Mating takes place in the fall and sperm is stored until ovulation in the late spring. Gestation lasts 50-60 days and lactation is estimated at roughly 36 days (Kunz 1982). Twins are most common. Studies of relative seasonal abundance of the silver-haired bat suggest that this species migrates over most of its range, although the British Columbia population seems to be resident (Nagorsen and Brigham 1993). The silver-haired bat is a generalist forager, taking a wide variety of prey, including moths, midges, leafhoppers, caddisflies, flies, beetles, ants, and termites. It is particularly adept at exploiting large swarms of insects. Foraging typically occurs in or near coniferous and or mixed deciduous forest, adjacent to ponds, streams and other bodies of water (Kunz 1982).

Big Brown Bat (*Eptesicus fuscus*) occurs throughout most of North and Central America and reaches its southern limit in northwestern South America. Specimens are known from all the Canadian provinces bordering the US and from all the United States with the exception of Hawaii. This species decreases in numbers as one moves from a deciduous biome to a coniferous forest biome (Kurta and Baker 1990). Maternity colonies vary in size from small (ca. 5 individuals) to quite large (ca. 700 individuals) and are found in buildings, bridges, rocks and trees. The name *Eptesicus fuscus* means dusky house flier and refers to the species' preference for man-made structures. Males roost singly or in small bachelor groups in similar structures. In colder climates hibernacula are common in buildings and caves. In climates with less severe winters like California, migrations and/or periods of extended torpor take place (Nagorsen and Brigham 1993). In the west, big brown bat usually produce one offspring per year. Copulation occurs between September and March and sperm is stored until spring. Gestation is 60 days and young are born from May to July. Young become volant 18 to 35 days after birth. Recorded longevity in the wild is 19 years for a banded individual (Kurta and Baker 1990). Foraging occurs through the night with most of the activity in the first two hours after sunset. In terms of foraging, big brown bat is a generalist, showing no preference for over-water versus over-land sites, edge versus non-edge habitats, canopy versus open, and urban versus rural environments. Diet consists primarily of beetles. Other prey include moths, termites, carpenter ants, lacewings and various flies (Nagorsen and Brigham 1993).

Hoary Bat (*Lasiurus cinereus*) has the broadest range of any North American bat, ranging from Northern Canada to South America. This bat has even managed to colonize remote islands such as the Hawaiian Islands (Nagorsen and Brigham 1993) and is the only endemic mammal to Hawaii. The hoary bat roosts in the branches of deciduous and coniferous trees. In Oregon, the hoary bat prefers old-growth Douglas fir forests (Nagorsen and Brigham 1993). Males are solitary and females roost with their young, but do not form maternity colonies. The hoary bat is a migratory species and the Pacific Northwest population appears to winter in California and Mexico. Over a portion of its range, males and females occupy separate summer areas. Mating occurs in fall or winter and sperm is stored over winter. Fertilization occurs in early spring and gestation is 80 to 90 days. One to four young are born in late May to late June (Nowak 1994). Young are capable of sustained flight at six weeks and family groups stay together for several weeks after young are flying (Nagorsen and Brigham 1993). With its swift flight and low frequency echolocation calls, this bat is well adapted for capturing large prey. The primary prey of the hoary bat is moths, beetles, and dragonflies (Nagorsen and Brigham 1993). The hoary bat hunts above canopy level, in clearings, and over water. This species has been known to set up foraging territories at bright lights where insects congregate (Fenton 1997).

Western Red Bat (*Lasiurus blossevillii*) is a Forest Service Sensitive species. Very little research has been done on the western red bat and little is known about this species. Much of the natural history is inferred from what is known about the Eastern red bat although the degree of similarity of the biology of these two species is unknown at present. The western red bat is a solitary foliage roosting bat. The western red bat is in the genus *Lasiurus*, the hairy-tailed bats. These bats are adapted for exposed roosting behavior with their hairy tail membrane and small ears. In California this species is known to roost in cottonwood trees and willows, but is commonly detected in a variety of habitats, including chaparral. Roost heights range from 3-15 meters (Pierson and Heady 1997). The range of the western red bat is from British Columbia to Central and South America. Migration occurs throughout its range and bats of Canada move into the coastal low lands of California, and the California population is thought to winter in Central America (Nagorsen and Brigham 1993). Mating takes place in late summer and fall, sperm is stored over winter and fertilization occurs in early spring. Gestation period is 80 to 90 days and one to four young are born in late May to early July. The young are born small, naked and underdeveloped (Nowak 1994). Females leave the young at the roosting site while foraging but will carry them when moving to a new roosting site. Young are capable of sustained flight at 6 weeks. Large moths are the primary prey of the western red bat. This bat is a fast flyer, foraging in straight flights or large circles (Nagorsen and Brigham 1993). The echolocation calls are highly variable depending on the terrain. Though variable, these calls are very distinct.

Townsend's big-eared bat (*Corynorhinus townsendii*) is a Federal Special Concern and California Special Concern species as well as a Forest Service Sensitive species. It is a year-round resident in California, occurring from low desert to mid-elevation montane habitats. It is found primarily in rural settings, from inland deserts to coastal redwoods, oak woodland of the inner Coast Ranges and Sierra Nevada foothills, and low to mid-elevation mixed coniferous-deciduous forests. It typically roosts during the day in caves

and mines, but can roost in buildings that offer suitable conditions (Kunz and Martin 1982). Night roosts are in more open settings and include bridges. It hibernates in mixed sex aggregations of a few to several hundred individuals. Hibernation occurs for prolonged periods in colder areas and intermittently in non-freezing areas. Townsend's big-eared bat arouses periodically and moves to alternative roosts, and actively forages and drinks throughout the winter. A single young is born per year between May and July. Females form maternity colonies of 35 to 200 individuals, while males roost individually (Kunz and Martin 1982). Townsend's big-eared bat feeds primarily on small moths that are gleaned from vegetation

Pallid Bat (*Antrozous pallidus*) is a California Special Concern species and Forest Service Sensitive species. A year-round resident in California, the pallid bat is found in arid desert areas, grasslands and oak savanna, coastal forested areas, and coniferous forests of the mountain regions of California. Roost sites are typically rock outcroppings, caves, hollow trees, mines, buildings and bridges (Hermanson and O'Shea 1983). Pallid bats make use of similar structures for night roosting and will use more open sites such as eaves, awnings, and open areas under bridges for feeding roosts. Pallid bats are largely inactive in the winter months and there is evidence for both hibernation and migration. Hibernation aggregations tend to be much smaller than summer aggregations. Pallid bats have been observed foraging during the winter when prey is available (Hermanson and O'Shea 1983). Copulation occurs in the fall, usually October through December, although in coastal California copulations have been observed as late as February. Females store the sperm and ovulation occurs the following spring. Parturition timing is determined by local climate and embryonic development usually takes about nine weeks with birth occurring in May or June. Twins are the norm in northern California but in other areas the pallid bat is known to have triplets. Maternity colonies range from 20 to 200 individual adult bats. Males roost in much smaller groupings (Hermanson and O'Shea 1983). The pallid bat feeds on large insects (20 to 70 mm in length). Prey is most often caught on the ground. Jerusalem crickets, scorpions and beetles make up most of the diet of pallid bats central California.

Mexican Free-Tailed Bat (*Tadarida brasiliensis*) is one of the most widely distributed mammalian species in the Western Hemisphere and is the famous bat of the Carlsbad Caverns in the southwest. Maternity roosts occur in bridges, buildings, culverts, hollow trees and caves. Maternity colonies vary in size from 20 individuals to millions. In general, maternity colonies in California do not reach the remarkable size of the southwestern cave roosts. The largest known colony in California consists of around 200,000 individuals in a cave. Although the Mexican free-tailed bat is a year round resident of Northern California, evidence indicates localized migrations and in other parts of its range migrations can be longer than 1,800 kilometers (Wilkins 1989). The Mexican free-tailed bat is found in many different habitats from sea level to over 3,600 meters. Mating takes place in late February and March and ovulation occurs in March. Gestation is 77 to 82 days and young are typically born in late June or July (Nowak 1994).

Western mastiff bat (*Eumops perotis*) is a federal Species of Concern and a California Species of Special Concern. *E. perotis* has an unusual distribution consisting of two widely separated populations. The northern population occurs from Southern Western United States to Southern Mexico, and the southern population occurring from Northern South America to North central Argentina. In California this species is found as far north as Butte County and recent acoustic data has placed it in Shasta County. The mastiff bat has been documented in the Sierra Nevada Mountain range at elevations of 2200 meters and above in Sequoia National Park and Yosemite National Park. This species is known from Fresno County, Tulare and Mariposa Counties (Constantine 1998). Maternity colonies of *E. perotis* are usually small <100. Males are often found roosting with the maternity colonies. Roosting sites are typically in crevices high in rock faces in dry arid places. The mastiff bat in California is found in cultivated areas, in mixed chaparral and live oak, and arid rocky regions where vegetation is sparse. The Mastiff bat is not capable of achieving flight from the ground and requires an unobstructed drop to obtain flight speed. In southern California *E. perotis* is known to roost in buildings and man made structures (Best et al. 1996). As with most molossid bats mating occurs in the spring. One young is born from June through August. Dates of reproduction for this species vary more than any North American species even within one colony. Little is known of the rate of development of the young or the longevity of adults (Best et al. 1996). Prey selection varies with geographic location. In Arizona diet primarily consist of moths and other soft-bodied insects. A high level of weak flying insects found in guano and the stomachs of individuals suggest that *E. perotis* may forage low to the ground. The presence of diurnal insects suggest that foraging may have taken place at altitudes >1000 m where diurnal insects are trapped aloft.

LITERATURE CITED

- Best, T. L., Kiser, W. M., Freeman, P.W. 1996. *Eumops perotis*. Mammalian Species 534:1-8.
- Constantine, Denny G. 1998. Range extensions of ten species of bats in California. Bulletin Southern California Academy of Sciences, v.97, n.2: 49-75.
- Fenton, M. B. 1997. Science and the Conservation of Bats. Journal of Mammalogy. 78(1): 1-14
- Fenton M B, and R.M. Barclay. 1980. *Myotis lucifugus* Mammalian Species, n.142:1-8.
- Harvey, M.J., Altenbach, J.S. and T. L. Best. 1999. Bats of the United States. Bat Conservation International, Austin, Texas.
- Heady, P.A. and W.F. Frick. 2001. Bats in redwood riparian. Proceedings of the Riparian Conference, Sacramento, California, March 2001. In press.
- Hermanson, J. W and O'Shea, T J. 1983. *Antrozous pallidus*. Mammalian Species 213:1-8.
- Kalko, E. K. V., J. Handley, C.O. and D. Handley. 1996. Organization, diversity, and long-term dynamics of the Neotropical bat community. pp. 503-553, in M. L. Cody and J. A. Smallwood, ed. Long-term studies of vertebrate communities, Academic Press, San Diego.
- Kunz, T. H, and Martin, R. A. 1982. *Plecotus townsendii*. Mammalian Species 175:1-6.
- Kurta, A, and R.H. Baker. 1990. *Eptesicus-Fuscus* Mammalian Species, n.356:1-10.
- Nagorsen, D. W., and Brigham, R. M. 1993. Bats Of British Columbia. UBC Press, University of British Columbia, Vancouver, pp 106-117.
- Nowak, R.M. 1994. Walker's Bats Of The World. John Hopkins University Press, pp 215-216, 237-239.
- Pierson, E.D., W. P. Collins, W.E. Rainey, P. A. Heady, and C.J. Corben. 2002. Distribution, Status and Habitat Associations of Bat Species on Vandenberg Air Force Base, Santa Barbara County, California. Santa Barbara Museum of Natural History Technical Reports – No. 1
- Pierson, E.D., W.E. Rainey, and C.J. Corben. 2001. Seasonal patterns of bat distribution along an altitudinal gradient in the Sierra Nevada. Contract Report. California

Department of Transportation, Yosemite Fund, Yosemite Association, and California State University at Sacramento Foundation. 67pp.

- Pierson, E.D., M.C. Wackenhut, J.S. Altenbach, P. Bradley, P. Call, D.L. Genter, C.E. Harris, B.L. Keller, B. Lengus, L. Lewis, B. Luce, K.W. Navo, J.M. Perkins, S. Smith, and L. Welch. 1999. Species conservation assessment and strategy for Townsend's big-eared bat (*Corynorhinus townsendii townsendii* and *Corynorhinus townsendii pallescens*). Idaho Conservation Effort, Idaho Department of Fish and Game, Boise, Idaho.
- Pierson, E.D., and Heady, P. A. 1997. Unpublished telemetry study of the Western red bat on Vandenberg Air Force Base California.
- Pierson, E.D., and W.E. Rainey. 1996 [ABS]. Techniques for sampling bat diversity: the bat community in the Sacramento River drainage of northern California. *Bat Research News* 37:32-33.
- Pierson, E.D., W.E. Rainey, and R.M. Miller. 1996. Night roost sampling: a window on the forest bat community in northern California. Pp. 151-163 *in* (R.M.R. Barclay and R.M. Brigham, eds.). *Bats and Forests Symposium*, October 19-21, 1995, Victoria, British Columbia.
- Heady, P.A. and W.F. Frick. 2001. Bats in redwood riparian. *Proceedings of the Riparian Conference*, Sacramento, California, March 2001. In press.
- Simmons, N. B. and R. S. Voss. 1998. The mammals of Paracou, French Guiana: A neotropical lowland rainforest fauna. Part 1. Bats. *Bulletin of the American Museum of Natural History* 237:1-219.
- Simpson, Mark R. 1993 *Myotis californicus*. *Mammalian Species*, v.0, n.428:1-4.
- Warner, R.M., and Czaplewski, N. J. 1984. *Myotis volans*. *Mammalian Species* 224:1-4.
- Wilkins, K.T. 1989. *Tadarida brasiliensis*. *Mammalian Species* 331:1-10.