BAT DISTRIBUTION IN THE FORESTED REGION OF NORTHWESTERN CALIFORNIA

Prepared by:

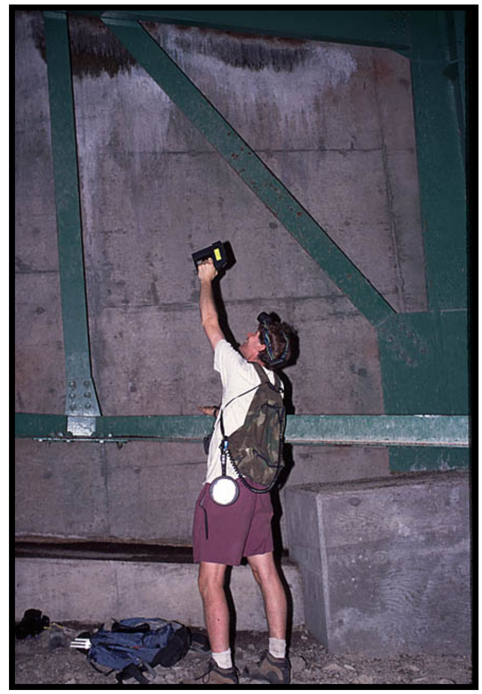
Elizabeth D. Pierson, Ph.D.
William E. Rainey, Ph.D.
2556 Hilgard Avenue
Berkeley, CA 9470
(510) 845-5313
(510) 548-8528 FAX
Edpierson@aol.com

Prepared for:

California Department of Fish and Game
Wildlife Management Division
Non Game Bird and Mammal Section
1416 Ninth Street
Sacramento, CA 95814

Contract #FG-5123-WM

November 2007



EXECUTIVE SUMMARY

Bat surveys were conducted in 1997 in the forested regions of northwestern California. Based on museum and literature records, seventeen species were known to occur in this region. All seventeen were identified during this study: fourteen by capture and release, and three by acoustic detection only (*Euderma maculatum*, *Eumops perotis*, and *Lasiurus blossevillii*).

Mist-netting was conducted at nineteen sites in a six county area. There were marked differences among sites both in the number of individuals captured per unit effort and the number of species encountered. The five most frequently encountered species in net captures were: *Myotis yumanensis*, *Lasionycteris noctivagans*, *Myotis lucifugus*, *Eptesicus fuscus*, and *Myotis californicus*; the five least common were *Pipistrellus hesperus*, *Myotis volans*, *Lasiurus cinereus*, *Myotis ciliolabrum*, and *Tadarida brasiliensis*. Twelve species were confirmed as having reproductive populations in the study area.

Sampling sites were assigned to a habitat class: young growth (YG), multi-age stand (MA), old growth (OG), and rock dominated (RK). There was a significant response to habitat class for the number of bats captured, and a trend towards differences for number of species detected. The largest numbers of bats were detected at multi-age or rock dominated sites. The fewest numbers of bats and number of species were detected in old growth stands. These data also strongly suggest that it is not possible to use netting sites in foraging areas to make inferences about roosting habitat. Various parameters regarding a netting site and the adjacent habitat may well provide information on selection of foraging areas, but say little, if anything, regarding selection of roosting sites.

We surveyed 36 bridges in Humboldt, Siskiyou and Trinity counties. Twenty-eight were used in some way by bats. All 28 were used as a night roost, and eight as a day roost. The species positively identified as using bridge day roosts were *C. townsendii*, *E. fuscus*, and *M. yumanensis*. The few bridges in this study that were checked at night were occupied either by *M. yumanensis*, or *A. pallidus.*

Comparisons of these results with those from surveys conducted in the White Mountains and the Sierra Nevada suggest there are significant differences in both the species composition and relative abundance among these mountain ranges. Particularly striking is the relative abundance of *L. noctivagans* and rarity of *T. brasiliensis* in the Trinity Mountains.

1.0 INTRODUCTION

Seventeen species of bats are known to occur in the ten county area of northwestern California (Grinnell 1916, Grinnell 1918, Hall 1981, Marcot 1984, Pierson and Rainey 1996a,b and 1998, Rainey and Pierson 1996a and 1997, Seidman and Zabel 2001, Weller and Zabel 2001, Zeiner et al. 1990, Zielinski and Gellman 1999). Four are currently considered Mammal Species of Special Concern (MSSC) by California Department of Fish and Game; three others were proposed in 1998 for Special Concern status (Brylski et al. 1998); eight are on the U.S. Fish and Wildlife Service Special Concern list. Yet prior to this study no attempt had been made to compile existing records for all species.

Distributional information is lacking for many of the forested areas of California, particularly the mountain ranges. Szewczak et al. (1998) provided a recent review of bat distribution in relation to elevation and habitat for the White and Inyo Mountains; Pierson et al. (2001) have examined distribution along an altitudinal transect in the central Sierra Nevada. Studies in North Coast ranges have focused on particular watersheds: Wilson Creek in Del Norte County (Gellman and Zielinski 1996, Zielinski and Gellman 1999), Pilot Creek in Six Rivers National Forest, Humboldt County (Seidman and Zabel 2001, Weller and Zabel 2001), and the upper Sacramento River drainage, Shasta and Siskiyou counties (in the context of damage assessment resulting from the 1991 Cantara spill -- Pierson et al. 1996, Rainey and Pierson 1996a,b and 1997). The only attempts at regional surveys for both the Sierra Nevada and the Trinity Mountains were sponsored by the Museum of Vertebrate Zoology at Berkeley early in the 1900s (Grinnell and Storer 1924, Kellogg 1916), before currently used survey equipment (e.g., mist nets, bat detectors) was available. Only three bat species were collected on the Trinity Mountains expedition, and the author notes, “There is nothing quite so wasteful of ammunition as shooting at bats” (Kellogg 1916).

A growing body of research on forest dwelling bats in western North America documents the importance of intact old growth areas or ‘legacy trees’ as roosting habitat for many species (Betts 1996, Christy and West 1993, Chung-MacCoubrey 1996, Crampton 1994, Crampton and Barclay 1996, Gellman and Zielinski 1996, Grindal 1994, Kalcounis 1994, Kalcounis and Hecker 1996, Morrell et al. 1994, Pierson and Heady 1996, Rainey and Pierson 1995, 1996b, 1997, Saugey 1991, Thomas 1988, 1991, Vonhof 1996, Vonhof and Barclay 1996). At a conference on bat/forest issues held in Victoria, British Columbia in October 1995 (Barclay and Brigham 1996), there was a consensus that most bat species use defective trees (with hollows, cavities, or loose bark), generally in the largest diameter classes available in the habitat, as day roosts. Preferred roost trees are most likely to be found in late successional, old growth, or multi-age stands, particularly those with an abundance of snags. Common timber harvest practices, including the emphasis on diameter cuts and selective removal of defective trees and hardwoods, favor low diversity stands with truncated age and size distributions which almost certainly reduce available roosting habitat for bats.

Northwestern California has been subjected to locally heavy timber harvest for almost 100 years. There is little old growth forest left in the coastal areas, which are primarily in private ownership. Forests of varying age structure, including late successional/old growth reserves remain on Forest Service land, particularly at mid to higher elevations throughout the region. Under Option 9, the Forest Service is mandated to manage for forest dwelling bat populations in the range of the northern spotted owl, yet the agency lacks data to respond to this mandate. At the time this study was conducted in 1997, virtually no research had been conducted in major timber harvest areas in California, and no recent overviews of regional distribution were available.

This project had two primary objectives. One was to evaluate the bat assemblage (species diversity, relative abundance, reproductive status) in forest stands of varying ages, with the hope this information would allow us to make inferences about habitat associations for various species. A second objective was to collate existing distributional information for all bat species in the region, and obtain new distributional records in a number of areas where data were sparse or lacking. Although the focus was on those tree-dwelling species either proposed or recognized as Species of Special Concern (*Antrozous pallidus*, *Lasiurus blossevillii*, *Myotis thysanodes* and *Myotis volans*), records were to be gathered simultaneously for all other species encountered.

The field work for this project was conducted in 1997.

2.0 METHODS

2.1 Study Area

Nineteen study sites were selected in a six county, forested region of northwestern California (Table 1, Figure 1). One site was located close to the coast in Mendocino County. Seven sites were in the Inner Coast Range (Colusa, Glenn, Tehama, and southern Trinity counties); eleven sites were in the Klamath Mountains/Trinity Alps in northern Trinity and western Siskiyou counties. All sites were located on watercourses -- the southern sites on secondary streams (the largest available in the area), and the northern sites on major river drainages or their tributaries. All these sites were mist-netting localities, and a number of site parameters (coordinates, elevation, channel type, channel width, forest age of surrounding habitat) are detailed in Table 1. A more complete description of each site, with the rationale for site selection, is given below.

The single site in Mendocino County (University of California Angelo Reserve) is a small patch of old growth Douglas fir (*Pseudotsuga menziesii*) and redwood (*Sequoia sempervirens*) forest on the South Fork of the Eel River. While this was the only site near the coast, it was an area where, in the context of another study, repeated sampling at the same sites was planned.

The seven sites in the Inner Coast Range were all located on the Mendocino National Forest. Two, both in Colusa County, were low elevation sites (Stony Creek and Little Stony Creek) where the habitat was mostly chaparral, with sparse riparian, a scattering of gray pine (*Pinus sabiniana*) and cottonwoods (*Populus fremontii*), and a limited number of rock outcrops along the creek drainages. The assumption was that these sites, essentially barren of trees, would offer virtually no roosting habitat for tree dwelling bats. There was, however, mature forest only 1.6 (Stony Creek) to ca. 10 km (Little Stony Creek) upstream from both sites. Two other sites (southern Trinity County), within 4 km of each other in the Yolla Bolly Wilderness, were located in an old growth forest. One on the Middle Fork of the Middle Fork of the Eel River was a mix of Douglas fir, black oak (*Quercus kelloggii*), ponderosa pine (*Pinus ponderosa*), and sugar pine (*Pinus lambertiana*), with a sparse alder (*Alnus* spp.)/willow (*Salix* spp.) riparian. The other, on the Balm of Gilead (a tributary to the Eel), was dominated by Douglas fir (ca. 90%) and sparse white fir (*Abies concolor*) with intact willow/alder riparian. The other three sites, Thomes Pocket on Thomes Creek, Upper Grindstone Creek, and Dutch Oven Creek, were each immediately surrounded by a mature, multi-age stand that had some old growth trees, but in an area that had also experienced some timber harvest. All these were mixed conifer/hardwood sites, with some large pines, Douglas fir and oaks.

The other eleven sites were located in the Klamath and Shasta-Trinity National Forests in association with major river drainages. Accessible sites were located primarily at relatively low elevation (146-884 m). All but one were in areas that had experienced some timber harvest, but were within commuting distance for the bats of more mature forest (generally located within wilderness areas). It became evident in a reconnaissance survey conducted in May 1997 that our original goal of conducting paired comparisons (logged versus unlogged areas) would be more challenging than we initially realized. The logging history has created a patchwork landscape in which the known nightly foraging range for most of the tree-dwelling bats exceeds the patch size for any treatment regime. Thus we opted for sites dominated by multi-age forest with relatively high snag density, and watercourse locations that permitted a substantial netting effort (focusing more on our second objective of documenting distribution of Special Concern species in a poorly known area). These sites did, however, differ substantially in the quality of surrounding habitat.

Starting in the north, there was one site on the Scott River, near Indian Scotty Campground. Here, the north side of the river was young ponderosa pine, incense cedar, and some black oak; the south side was a steep-sloped, mature mixed conifer forest, with a visible rock pinnacle on the ridge. While this site was located within the Klamath National Forest, it was only a few km downstream from an intensely cultivated valley, where agricultural discharge leads to contaminated water at low flow (S. Cuenca personal communication).

One site was selected on Dillon Creek, near its confluence with the Klamath River (the river was too deep to be mist netted with the set up we had available). This site was a deep rock canyon with a willow/alder riparian, and mixed conifer forest on the slopes. The drainage was relatively undisturbed, with the creek originating in the Siskiyou Wilderness about 10 km upstream.

Three sites, about 20 km. apart, were selected on the North Fork and Main Fork of the Salmon River. All were within 3-7 km of the Marble Mountain Wilderness. The site at Idlewild Campground was dominated by oak, ponderosa pine and sugar pine; the site at Sawpit Flat was mixed conifer with a high density of conifer snags on the north side of the river resulting from an old burn; the site at Somes Bar was dominated by Douglas fir and tanoak (*Lithocarpus densiflorus*).

Six sites were associated with the Trinity River drainage. The two most northern sites, Eagle Creek Campground and Trinity River Campground, were about 5 km apart. The Eagle Creek site was in view of a large burn area (dating from a 1959 fire) with a relatively high density of snags still standing. The habitat near the river was a young (< 40 years old), open stand of ponderosa pine, with a few incense cedar (*Calocedrus decurrens*). The Trinity River Campground site was characterized by more mature forest upstream, and younger forest downstream. The dominant tree species were ponderosa pine, Douglas fir, and incense cedar. Both these sites were within one km of the boundary of the Trinity Alps Wilderness. A cluster of three more sites were located on Canyon Creek (a tributary of the Trinity River), and the North Fork (Hobo Gulch) and the East Fork of the North Fork (Helena) of the Trinity River. The Canyon Creek and Helena sites were located about 4 km from each other, but differed in their immediate surroundings. The Helena site had an alder riparian and was near an old field, with one bank dominated by gray pine, black oak, and regenerating young ponderosa pine.The Canyon Creek site had an alder/willow riparian, but was dominated on its east bank by a meadow covering old mine tailings with a slope of oak and gray pine. Its west bank was dominated by an intact multi-age forest (sugar pine, ponderosa pine, Douglas fir, incense cedar, madrone and black oak). The North Fork site, at Hobo Gulch Campground, was located within the Trinity Alps Wilderness surrounded by an intact forest with many large ponderosa pine, sugar pine, and Douglas fir. The sixth Trinity River site was located in Hyampom, on Hayfork Creek near its confluence with the South Fork of the Trinity River. This site was located close to the small rural town of Hyampom, in a valley surrounded by forested slopes (mixed conifer) that have been subjected to various degrees of timber harvest.

Acoustic surveys were also conducted at one site on the Scott River near Callahan and at Deer Creek, a headwaters creek of the Trinity River.

Table 1. Localities sampled, with county, coordinates, and habitat parameters. Channel types taken from Montgomery and Buffington (1997). Forest age categories: OG = old growth; MA = multi-age; YG = young (< 40 yrs.); NA = not applicable.

Locality	County	Latitude	Longitude	Elevation (m)	Channel Width (m)	Channel Type	Forest Age
Netting							
Little Stony Ck	COL	39.27930	122.58424	465	4.3	Plane bed	NA
Stony Ck	COL	39.37777	122.65123	463	11.02	Plane bed	NA
Dutch Oven Ck	LAK	39.54003	122.74413	1036	4.4	Plane bed	MA
Angelo Reserve	MEN	39.72127	123.64902	422	18	Plane bed	OG
Dillon Creek	SIS	41.57387	123.54303	244	21	Plane bed	MA
Idlewild Cmpgrnd	SIS	41.32909	123.05852	790	12	Plane bed	MA
Indian Scotty Cmpgrnd	SIS	41.63535	123.07342	762	32	Pool riffle	MA
Sawpit Flat	SIS	41.27845	123.26668	423	24	Plane bed	MA
Somes Bar	SIS	41.37352	123.45143	163	30	Plane bed	MA
Thomes Pocket	TEH	40.00327	122.90658	1,372	6	Plane bed	MA
Upper Grindstone Ck	TEH	39.84139	122.90869	1,239	5.14	Step pool	MA
Balm of Gilead	TRI	40.02155	123.05977	1282	9	Plane bed	OG
Canyon Ck	TRI	40.78084	123.05574	535	18	Plane bed	MA
Eagle Ck Cmpgrnd	TRI	41.15244	122.66755	844	21	Plane bed	YG
Helena	TRI	40.77787	123.12960	440	21	Plane bed	YG/MA
Hobo Gulch Cmpgrnd	TRI	40.92842	123.15343	888	21	Plane bed	OG
Hyampom	TRI	40.61574	123.44827	393	15	Pool riffle	MA
Middle Fork Eel	TRI	40.02991	123.09440	1,160	9	Step pool	OG
Trinity River Cmpgrnd	TRI	41.11109	122.70542	782	21	Plane bed	YG/MA
Acoustic Only							
Callahan	SIS	41.30991	122.76844	993			NA
Deer Creek	TRI	40.95271	122.89710	2,023			NA

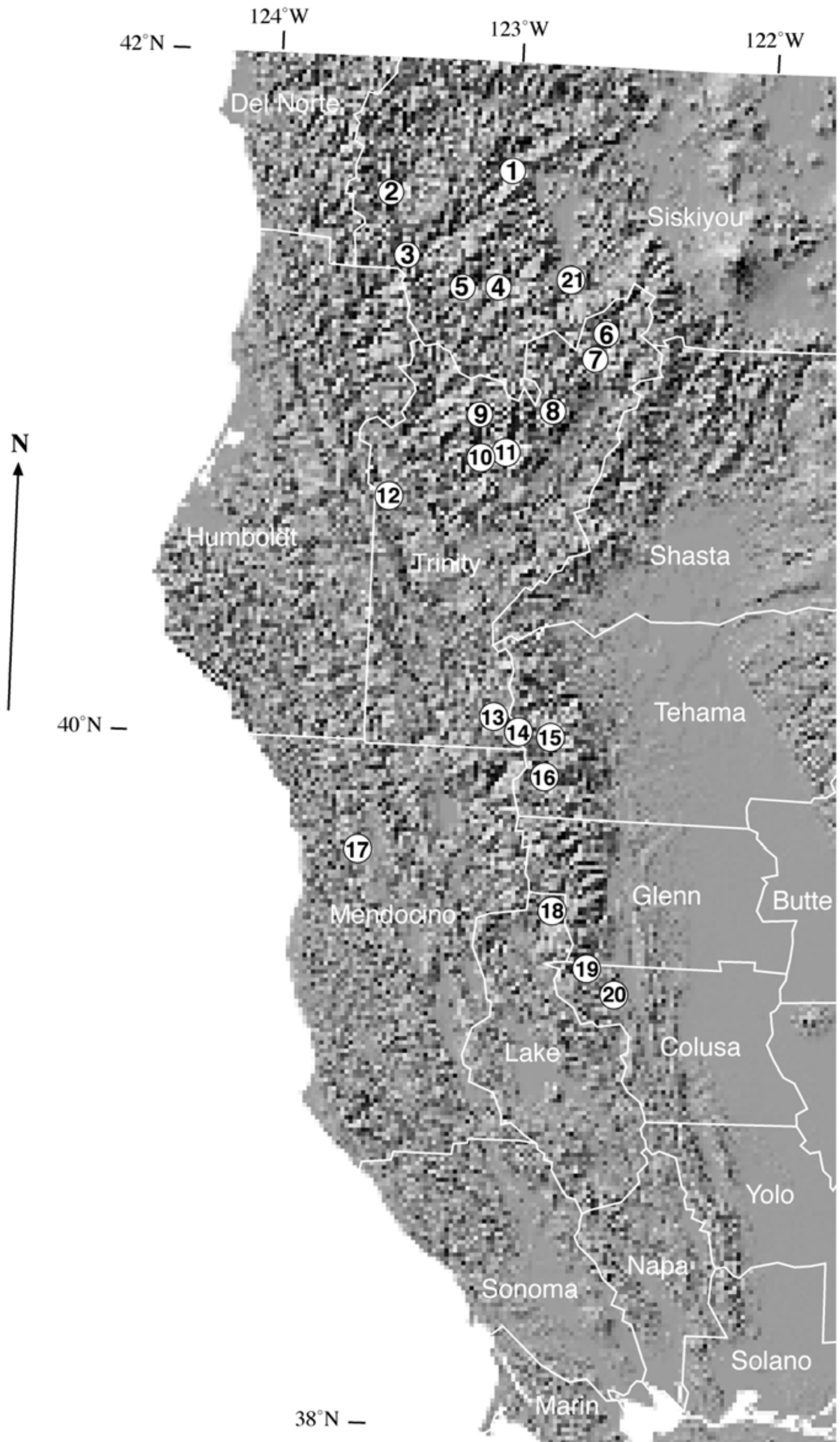


Figure 1. A map showing the location of netting and acoustic monitoring sites listed in Table 1. The numbers on the map refer to the following localities: 1 = Indian Scotty, 2 = Dillon Creek, 3 = Somes Bar, 4 = Idlewild, 5 = Sawpit Flat, 6 = Eagle Creek, 7 = Trinity River Campground, 8 = J.W. Cow Camp (acoustic only), 9 = Hobo Gulch Campground, 10 = Helena, 11 = Canyon Creek, 12 = Hyampom, 13 = Middle Fork of the Eel River, 14 = Balm of Gilead, 15 = Thomes Pocket, 16 = Upper Grindstone Creek, 17 = Angelo Reserve, 18 = Dutch Oven, 19 = Stony Creek, 20 = Little Stony Creek, 21 = Callahan.

2.2. Review of Existing Records

To examine background information on the recent and historic distribution of bat species in the project area and surrounding regions, records were reviewed in reports and published literature (Constantine 1959 and 1982, Constantine et al. 1979, Grinnell 1916, Grinnell 1918, Hall 1981, Marcot 1984, Pierson and Rainey 1996a,b and 1998, Rainey and Pierson 1996a and 1997, Seidman and Zabel 2001, Weller and Zabel 2001, Zeiner et al. 1990, Zielinski and Gellman 1999) and from 35 museum collections across the United States and Canada. Museum records were obtained from the following institutions: the American Museum of Natural History (AMNH), California Academy of Sciences (CAS), California State University at Humboldt (CSUH), Carnegie Museum of Natural History (CM), Los Angeles County Museum (LACM), Louisiana State University Museum of Zoology (LSUMZ), Michigan State University (MSU), Museum of Comparative Zoology at Harvard (MCZ), Museum of Vertebrate Zoology, University of California at Berkeley (MVZ), the Royal Ontario Museum (ROM), University of California at Los Angeles (UCLA), University of Kansas (KU), University of Montana Bird and Mammal Museum (UMZ), the United States National Museum (USNM). We reviewed specimens to verify identification at CAS and MVZ. None of the other records have been verified by us, and may contain errors, particularly for those species that are difficult to separate (e.g., *Myotis californicus* and *Myotis ciliolabrum*, *Myotis lucifugus* and *Myotis yumanensis*).

2.3. Sampling Methods

2.3.1. <u>Mist Netting</u>

Although each sampling method has advantages and limitations, mist netting remains the most effective technique overall for sampling bat species diversity. It allows positive species identification of most individuals, and assessment of reproductive condition and age. Following the procedures outlined by Kunz and Kurta (1988), 1.5 inch mesh black, 50 denier nylon or polyester nets of a size appropriate to the location (7’ or 10’ height; lengths of 18’, 30’, 42’ and 60’) were set on sectional poles from shoreline vegetation out into a river or creek. Where possible, nets were extended completely across the watercourse. Sizes of individual nets and total net area varied with the site, although 10’ x 42’ or 10’ x 60’ nets were preferred. Standardization for among site comparisons was based on number of bats captured per m^2 net area per hour.

To minimize captures of late flying birds, nets were opened 0.5 hrs after local sunset, monitored continually, and typically left open for 3.5-4.0 hours. Bats were removed as rapidly as possible to numbered cloth holding bags, logging the time and net for each individual or aggregate capture. Bats were held suspended in these bags for several hours prior to processing to facilitate collection of guano samples for diet analysis and to prevent repeated netting.

On-site processing of netted bats included identification (see van Zyll de Jong 1985 for keys; Constantine 1998); weighing (to 0.01 g) in temporary confinement on a portable electronic balance; measurement of one or both forearms with digital calipers (length read to 0.01 mm); assessment of age class (adult, juvenile) from ossification of the metacarpal phalangeal joints (Anthony 1988) combined with body size, pelage color and wing tissue texture; assignment to a five step tooth wear class by canine inspection with a hand lens or low power binocular microscope; and reproductive characterization, also using a binocular microscope or hand lens as needed. For males, characterization involved examination of the testes and checking epididymal tissue for pigmentation or distention; in females abdominal palpation served to detect advanced pregnancies (Racey 1988) and place the stage of pregnancy (by extent of distention) in a rank classification. Mammae were evaluated for nipple development, pigmentation, presence of milk (by expression), and loss of hair.

Selected individuals were light-tagged upon release so that they could be followed to record echolocation calls or to identify directions to roost sites. Small chemiluminescent (cyalume) tags (Ultraglow Mini Light Sticks, Chemical Light Inc.) were applied between the scapulae with a small round of masking tape; all fell off within 3-5 minutes.

Fourteen sites were sampled once. Four sites, all in the Inner Coast Range on the Mendocino National Forest were sampled twice -- six early season and mid-summer, and one at a seven day interval mid-summer. Early season surveys were conducted by one of us (E.D. Pierson) in cooperation with L. Angerer of the Mendocino National Forest; mid-summer surveys were conducted by L. Angerer and her trained crew. Repeated sampling occurred at the Angelo Reserve under the direction of W. Rainey.

2.3.2. <u>Acoustic Surveys</u>

Since mist nets capture only a small percentage of the bats present in an area, and sample only those animals that are flying close to the water, they are not the best indicator of overall activity levels. Thus acoustic surveys (sound-activated Anabat or Pettersen D980 detectors linked to tape recorders or computers) were run in parallel with the netting efforts at most locations. Detectors were sometimes set in the area of the netting site and run (in voice activation mode) until the sampling effort was completed. For the work on the Salmon and Klamath rivers we had the participation of an acoustic specialist (C. Corben), and were able to have him monitor acoustic activity in conjunction with spotlighting, allowing a greater level of certainty regarding species identification. We also obtained calls from most animals upon release to build a library of known calls.

Acoustic identification based on echolocation calls alone remains problematic for many species -- e.g., the three *Myotis* species that have a base frequency of ca. 40 kHz (*M. ciliolabrum*, *M. lucifugus*, and *M. volans*), two 50 kHz *Myotis* species (*M. californicus* and *M. yumanensis*). Also, because bats can alter call slope, shape and duration depending on the habitat in which they are operating, distinguishing *A. pallidus* from *Eptesicus fuscus*, *E. fuscus* from *Lasionycteris noctivagans*, *L. noctivagans* from *T. brasiliensis*, and *Tadarida brasiliensis* from *Lasiurus cinereus* can present significant challenges unless the animal in question is also visually observed. We have only indicated an acoustic record for a locality when the animal was either spotlighted or the call had some distinctive feature. Recorded calls were analyzed using the ANABAT ZCAIM module and software.

2.3.3. <u>Bridge Surveys</u>

Bridge surveys were conducted in consultation with California Department of Transportation (Caltrans). State highways follow large portions of these river corridors, and Caltrans has a data base for all bridges in their highway system. This data base allowed prior identification of which bridges would be structurally likely to serve as bat roosts. The majority of bridges surveyed were visited in the daytime, and inspected for roosting bats, guano accumulations, and urine staining. If guano and/or staining were present in open areas of a bridge and bats were absent, the site was presumed to be a night roost. Night roosting bats were sampled with hand nets on telescoping poles. Subsequent data collection on captures was the same as for mist-netted bats.

3.0 RESULTS AND DISCUSSION

3.1. Species Diversity and Reproductive Status

Seventeen bat species were identified during this study, fourteen by capture and release (*i.e.*, mist-netting over water and/or hand capture at roosts), and three by acoustic detection (Table 2). Thus all species expected to occur in the area were detected.

Twelve species were confirmed as having reproductive populations in the area (Table 3), as evidenced by capture of reproductive females and/or newly volant juveniles (eleven species) or the visual observation of females with dependent young (i.e., *Corynorhinus townsendii* at a bridge day roost). For two species, *Lasiurus cinereus* and *Tadarida brasiliensis*, the only animals captured were adult males (see Section 3.5 below). Since neither *Euderma maculatum* nor *Eumops perotis* were captured, we have no information regarding their reproductive status. For most species we captured many more adult females than adult males, with the male/female ratios ranging from 0.36:1 to 0.66:1. For two species, *Eptesicus fuscus* and *Lasionysteris noctivagans* the number of adult males greatly exceeded the number of adult females, yielding adult male to adult female ratios of 1.9:1 and 3.1:1 respectively. The implications of this are discussed in the species accounts below.

3.2. Relative Abundance

Table 4 details the number of individuals of each species detected at each site for all the dates sampled. The five most abundant species in mist net captures across sites were *Myotis yumanensis*, *Lasionycteris noctivagans*, *Myotis lucifugus*, *Eptesicus fuscus*, and *Myotis californicus*; the five least common were *Pipistrellus hesperus*, *Myotis volans*, *Lasiurus cinereus*, *Myotis ciliolabrum*, and *Tadarida brasiliensis* (Figure 2A). Since all our mist nets were set over stream or river corridors, our data provide a sample of the bat assemblage flying low over water, and do not necessarily provide a reliable assessment of relative abundance. Those animals that are adept at avoiding nets, fly at elevations above 4 m. (the maximum height of our nets), or do not use the open water corridor may not be well represented in the net captures. Those species that fly low over water and are reliant on aquatic emergent insects (e.g., *Myotis lucifugus* and *Myotis yumanensis*) are likely over-represented, while several species like *Eptesicus fuscus* and *Myotis volans*, known often to forage at canopy height, may be under-represented. *Corynorhinus townsendii* is known to be adept at avoiding mist nets and did not appear in our net captures, yet it is known (based on available roost information) to occur in the vicinity of at least three netting sites (Indian Scotty, Somes Bar, and Hyampom).

Table 2. Bat species known to occur in northwestern California, with type of record obtained in this study. N = mist net capture; H = hand net capture or direct observation of roosting animals; A = acoustic record.

SPECIES			**TYPE OF RECORD**
Family Vespertilionidae (mouse-eared bats)			
Antrozous pallidus [1,4]	Pallid bat	ANPA	N, H, A
Corynorhinus townsendii [1,3,4]	Townsend's big-eared bat	COTO	H
Eptesicus fuscus	Big brown bat	EPFU	A
Euderma maculatum	Spotted bat	EUMA	A
Lasionycteris noctivagans	Silver haired bat	LANO	N, A
Lasiurus blossevillii [2,4]	Red bat	LABL	A
Lasiurus cinereus	Hoary bat	LACI	N, A
Myotis californicus	California myotis	MYCA	N, A
Myotis ciliolabrum [3]	Small-footed myotis	MYCI	N, A?
Myotis evotis [3]	Long-eared myotis	MYEV	N, A
Myotis lucifugus	Little brown myotis	MYLU	N, A
Myotis thysanodes [2,3]	Fringed myotis	MYTH	N, A
Myotis volans [2,3]	Long-legged myotis	MYVO	N, A ?
Myotis yumanensis [3]	Yuma myotis	MYYU	N, H, A
Pipistrellus hesperus	Western pipistrelle	PIHE	N, A
Family Molossidae (free-tailed bats)			
Eumops perotis [1,3]	Western mastiff bat	EUPE	A
Tadarida brasiliensis	Mexican free-tailed bat	TABR	N, A

[1] California Department of Fish and Game, Mammal Species of Special Concern
[2] California Department of Fish and Game, 1998 Proposed Mammal Species of Special Concern
[3] U.S. Fish and Wildlife Service, Special Concern
[4] U.S. Forest Service, Sensitive

Table 3. All capture and distinctive acoustic records by species by date for all localities, including information on age, sex, and reproductive condition when known. Pr = pregnant; Lc = lactating; Pl = post-lactating; Nl = nulliparous; M = male; F = female; Unk = unknown. Totals include only netting and visual records, not acoustic only. Acoustic records are indicated by an "A", with the number of call sequences in parentheses.

Species	**Date**	**Locality**	**Adult**	**Adult Females**				**Juveniles**		**Unk**	**Total**
			Males	**Pr**	**Lc**	**Pl**	**Nl**	**M**	**F**		
Antrozous pallidus											
	10-Jul-97	Hyampom			2						2
	12-Jul-97	Helena	1								1
	13-Jul-97	Canyon Ck	2		9						11
	17-Jul-97	Indian Scotty	1								1
	30-Jul-97	Little Stony Ck						1			1
		Subtotal	**4**	**0**	**11**	**0**	**0**	**1**	**0**	**0**	**16**
Corynorhinus townsendii											
	18-Jul-97	Scott River Br.								1	1
	8-Aug-97	Somes Bar Br.								9	9
		Subtotal	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**10**	**10**
Eptesicus fuscus											
	6-Jun-97	Stony Ck	6		1		1				8
	8-Jul-97	Balm of Gilead	2								2
	9-Jul-97	Angelo Reserve	2								2
	10-Jul-97	Hyampom	1								1
	13-Jul-97	Canyon Ck	8								8
	15-Jul-97	Eagle Ck	1		1						2
	17-Jul-97	Indian Scotty	2								2
	24-Jul-97	Thomes Pocket	3		1		1	2	1		8
	25-Jul-97	Angelo Reserve			1						1
	28-Jul-97	Grindstone Ck	1								1
	29-Jul-97	Stony Ck						1	1		2
	30-Jul-97	Little Stony Ck			1	2					3
	31-Jul-97	Thomes Pocket	1				1				2
	4-Aug-97	Idlewild			2				1		3
	5-Aug-97	Sawpit Flat	1		3				1		5
	6-Aug-97	Somes Bar	1								1
		Subtotal	**29**	**0**	**10**	**2**	**3**	**3**	**4**	**0**	**51**
Euderma maculatum											
	17-Jul-97	Indian Scotty								A (1)	
Eumops perotis											
	3-Aug-97	Callahan								A (1)	
Lasionycteris noctivagans											
	6-Jun-97	Stony Ck	1	1							2
	5-Jul-97	Angelo Reserve	1								1
	6-Jul-97	Angelo Reserve	1								1
	8-Jul-97	Balm of Gilead	12	2			1				15
	10-Jul-97	Hyampom	1								1
	12-Jul-97	Helena	1								1
	13-Jul-97	Canyon Ck	4								4
	14-Jul-97	Hobo Gulch	8								8
	15-Jul-97	Eagle Ck	5				1				6

Table 3. Cont'd.

Species	Date	Locality	Adult Males	Adult Females Pr	Lc	Pl	Nl	Juveniles M	F	Unk	Total
Lasionycteris noctivagans											
	16-Jul-97	Trinity Cmpgrnd	2								2
	17-Jul-97	Indian Scotty	1		2		1				4
	24-Jul-97	Thomes Pocket			3			2	3		8
	31-Jul-97	Thomes Pocket	1		1			2	4		8
	28-Jul-97	Grindstone Ck						1			1
	29-Jul-97	Stony Ck			1			3	1		5
	4-Aug-97	Idlewild	6			1	1		1		9
	5-Aug-97	Sawpit Flat						1			1
	6-Aug-97	Somes Bar	2								2
		Subtotal	**46**	**3**	**7**	**1**	**4**	**9**	**9**	**0**	**79**
Lasiurus blossevillii											
	24-Sep-97	Angelo Reserve								A	
	25-Sep-97	Angelo Reserve								A	
Lasiurus cinereus											
	2-Jun-97	Dutch Oven	1								1
	6-Jun-97	Stony Ck	1								1
	4-Aug-97	Idlewild								A (?)	
	5-Aug-97	Sawpit Flat								A (1)	
	6-Aug-97	Somes Bar								A (8)	
	7-Aug-97	Dillon Ck								1	1
	15-Aug-97	Angelo Reserve								A	
		Subtotal	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**3**
Myotis californicus											
	4-Jun-97	Little Stony Ck		1							1
	29-Jul-97	Stony Ck					1				1
	7-Jul-97	M Fork Eel			3						3
	8-Jul-97	Balm of Gilead			1						1
	10-Jul-97	Hyampom			1		1				2
	12-Jul-97	Helena	1								1
	13-Jul-97	Canyon Ck	3		1						4
	17-Jul-97	Indian Scotty	1								1
	24-Jul-97	Thomes Pocket					1				1
	31-Jul-97	Thomes Pocket					1				1
	28-Jul-97	Grindstone Ck			1			1	1		3
	5-Aug-97	Sawpit Flat	1		1			3	4		9
	6-Aug-97	Somes Bar			1						1
	7-Aug-97	Dillon Ck				1					1
		Subtotal	**6**	**1**	**9**	**1**	**4**	**4**	**5**	**0**	**30**
Myotis ciliolabrum											
	28-Jul-97	Grindstone Ck							1		1
	5-Aug-97	Sawpit Flat							1		1
	6-Aug-97	Somes Bar							1		1
		Subtotal	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**0**	**3**

Table 3. Cont'd.

Species	Date	Locality	Adult Males	Adult Females Pr	Lc	Pl	Nl	Juveniles M	F	Unk	Total
Myotis cal/cil											
	8-Jul-97	Balm of Gilead			1						1
	30-Jul-97	Little Stony Ck							2		2
		Subtotal	**0**	**0**	**1**	**0**	**0**	**0**	**2**	**0**	**3**
Myotis evotis											
	6-Jun-97	Stony Ck					1				1
	7-Jul-97	M Fork Eel	1								1
	8-Jul-97	Balm of Gilead			1						1
	13-Jul-97	Canyon Ck			1				1		2
	15-Jul-97	Eagle Ck			1		1				2
	28-Jul-97	Grindstone Ck	1								1
	4-Aug-97	Idlewild	1		1						2
	5-Aug-97	Sawpit Flat						1			1
	7-Aug-97	Dillon Ck								1	1
		Subtotal	**3**	**0**	**4**	**0**	**2**	**1**	**1**	**1**	**12**
Myotis lucifugus											
	4-Jun-97	Little Stony Ck		1							1
	10-Jul-97	Hyampom	3		1	1	2				7
	12-Jul-97	Helena	1								1
	15-Jul-97	Eagle Ck	1			1					2
	16-Jul-97	Trinity Cmpgrnd	1		3	1			1		6
	17-Jul-97	Indian Scotty	14	1	8	1	5		1	2	32
	24-Jul-97	Thomes Pocket	1								1
	28-Jul-97	Grindstone Ck						1			1
	4-Aug-97	Idlewild			2			1	1		4
	6-Aug-97	Somes Bar	1		3	3	1	3	3		14
	7-Aug-97	Dillon Ck	1		1		1	3	3		9
		Subtotal	**23**	**2**	**18**	**7**	**9**	**8**	**9**	**2**	**78**
Myotis thysanodes											
	10-Jul-97	Hyampom					1				1
	13-Jul-97	Canyon Ck	1			1		1	1		4
	14-Jul-97	Hobo Gulch	1								1
	15-Jul-97	Eagle Ck					1	1			2
	17-Jul-97	Indian Scotty						1			1
	28-Jul-97	Grindstone Ck			1						1
	7-Aug-97	Dillon Ck						1			1
		Subtotal	**2**	**0**	**1**	**1**	**1**	**4**	**1**	**0**	**11**
Myotis volans											
	4-Jun-97	Little Stony Ck		1							1
	30-Jul-97	Little Stony Ck							1		1
	13-Jul-97	Canyon Ck	1			1					2
	15-Jul-97	Eagle Ck			1						1
	16-Jul-97	Trinity Campgrnd	1								1
	28-Jul-97	Grindstone Ck			1						1
		Subtotal	**2**	**1**	**2**	**1**	**0**	**0**	**1**	**0**	**7**

Table 3. Cont'd.

Species	Date	Locality	Adult	Adult Females				Juveniles		Unk	Total
			Males	Pr	Lc	Pl	Nl	M	F		
Myotis yumanensis											
	4-Jun-97	Little Stony Ck	1	2							3
	30-Jul-97	Little Stony Ck	1								1
	6-Jun-97	Stony Ck	5	10							15
	3-Jul-97	Angelo Reserve	1		3						4
	5-Jul-97	Angelo Reserve			2						2
	7-Jul-97	Angelo Reserve			1						1
	7-Jul-97	M Fork Eel	1								1
	8-Jul-97	Angelo Reserve			1						1
	9-Jul-97	Angelo Reserve					2				2
	10-Jul-97	Hyampom	8		15	5	1				29
	12-Jul-97	Helena	1						2	1	4
	13-Jul-97	Canyon Ck.	4								4
	14-Jul-97	Hobo Gulch	6				1			1	8
	15-Jul-97	Eagle Ck	3		1						4
	17-Jul-97	Indian Scotty	5		4	1	1			1	12
	24-Jul-97	Thomes Pocket	2								2
	25-Jul-97	Angelo Reserve	1		1			1	2		5
	28-Jul-97	Grindstone Ck	1								1
	4-Aug-97	Idlewild	3			1		1			5
	5-Aug-97	Sawpit Flat	1		7	4	5	12	24	1	54
	6-Aug-97	Somes Bar	3		2		1	11	9		26
	7-Aug-97	Dillon Ck	2		4	1	4	12	10		33
		Subtotal	**49**	**12**	**41**	**12**	**15**	**37**	**47**	**4**	**217**
Myotis luc/yum											
	30-Jul-97	Little Stony Ck						1	1		2
	10-Jul-97	Hyampom	1		1						2
	17-Jul-97	Indian Scotty	1					2	4		7
	29-Jul-97	Stony Ck					3	9		13	25
		Subtotal	**2**	**0**	**1**	**0**	**3**	**12**	**5**	**13**	**36**
Pipistrellus hesperus											
	4-Jun-97	Little Stony Ck		1							1
	30-Jul-97	Little Stony Ck				1					1
	6-Jun-97	Stony Ck	1	3							4
	29-Jul-97	Stony Ck	1					1			2
	12-Jul-97	Helena	1								1
	5-Aug-97	Sawpit Flat								A(3)	
	6-Aug-97	Somes Bar								A(5)	
		Subtotal	**3**	**4**	**0**	**1**	**0**	**1**	**0**	**0**	**9**
Tadarida brasiliensis											
	12-Jul-97	Helena	1								1
	13-Jul-97	Canyon Ck	1								1
		Subtotal	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**
TOTALS			**173**	**23**	**105**	**26**	**41**	**80**	**87**	**31**	**567**

Table 4. Numbers of individuals by species by locality. Totals include net captures and visual identifications only.

Date	Locality	*Anpa*	*Coto*	*Epfu*	*Euma*	*Eupe*	*Lano*	*Labl*	*Laci*	*Myca*	*Mc/c*	*Myci*	*Myev*	*Mylu*	*Myth*	*Myvo*	*Myu*	*Ml/y*	*Pihe*	*Tabr*	TOTAL
2-Jun-97	Dutch Oven Ck								1												1
4-Jun-97	Little Stony Ck									1				1		1	3		1		7
30-Jul-97	Little Stony Ck	1		3							2					1	1	2	1		11
6-Jun-97	Stony Ck			8			2		1				1				15		4		31
29-Jul-97	Stony Ck			2			5			1								25	2		35
3-Jul-97	Angelo Reserve																4				4
5-Jul-97	Angelo Reserve						1										2				3
6-Jul-97	Angelo Reserve						1														1
7-Jul-97	Angelo Reserve																1				1
8-Jul-97	Angelo Reserve																1				1
9-Jul-97	Angelo Reserve			2													2				4
25-Jul-97	Angelo Reserve			1													5				6
7-Jul-97	Middle Fork Eel									3			1				1				5
8-Jul-97	Balm of Gilead			2			15			1	1		1								20
10-Jul-97	Hyampom	2		1			1			2				7	1		29	2			45
12-Jul-97	Helena	1					1			1				1			4		1	1	10
13-Jul-97	Canyon Ck	11		8			4			4			2		4	2	4		A	1	40
14-Jul-97	Hobo Gulch	A					8								1		8				17
15-Jul-97	Eagle Ck			2			6						2	2	2	1	4				19
16-Jul-97	Trinity River						2							6		1					9
17-Jul-97	Indian Scotty	1		2	A		4			1				32	1		12	7			60
18-Jul-97	Scott River		1																		1
24-Jul-97	Thomes Pocket			8			8			1				1			2				20
31-Jul-97	Thomes Pocket			2			8			1											11
5-Jun-97	U. Grindstone Ck																				0
28-Jul-97	U. Grindstone Ck			1			1			3		1	1	1	1	1	1				11
3-Aug-97	Callahan					A															
4-Aug-97	Idlewild Cmpgrnd			3			9		A				2	4			5				23
5-Aug-97	Sawpit Flat			5			1		A	9		1	1				54		A		71
6-Aug-97	Somes Bar		9	1			2		A	1		1		14			26		A		54
7-Aug-97	Dillon Creek								1	1			1	9	1		33		A		46
24-Sep-97	Deer Creek						A						A								
25-Sep-97	Deer Creek						A		A				A							A	
	TOTALS	**16**	**10**	**51**	**A**	**A**	**79**	**A**	**3**	**30**	**3**	**3**	**12**	**78**	**11**	**7**	**217**	**36**	**9**	**2**	**567**

For certain species, acoustic data can provide important corollary data. For example, mist-netting data do not provide a reliable indication of the relative of abundance of *Tadarida brasiliensis*. While this species is readily captured in nets set in its flight path, it generally forages at heights greater than 7 m. It typically is caught in nets only when it comes down to the water surface, generally late in the evening, presumably to drink. Yet, its echolocation call is generally distinctive and detectable at considerable distances. If this species is present in the area, it will be most reliably detected acoustically. In our study on the Sacramento River, *T. brasiliensis* was relatively uncommon in mist net captures, but quite common acoustically (Rainey and Pierson 1996a). In this study, however, it was extremely rare in both mist net captures and acoustic records. The implications of this finding are discussed in the species account below.

Acoustic sampling was conducted in parallel with mist-net sampling at most of the study sites (all except those in the Mendocino National Forest). While there remains a fairly high degree of uncertainty in making species identifications based on acoustic data alone, this exercise proved to be extremely useful, and did yield some information not obtained by mist-netting. In general, the acoustic data appeared to parallel the mist-netting data, with *L. noctivagans*, 40 kHz *Myotis* (*M. lucifugus*, *M. ciliolabrum*, or *M. volans*) and 50 KHz *Myotis* (*M. californicus* and *M. yumanensis*) constituting the majority of call sequences. A number of calls tentatively assigned to *Lasionycteris noctivagans* could, however, have been *Tadarida brasiliensis* or *Eptesicus fuscus*. A number of species -- *Antrozous pallidus*, *Lasiurus blossevillii*, *Lasiurus cinereus*, *Myotis evotis*, *Myotis thysanodes*, and *Pipistrellus hesperus* -- do have fairly distinctive calls if an adequate sequence is obtained. Relying on comparisons between our samples and sequences from known individuals, we were able to determine with a fairly high level of certainty that certain species occurred at sites where they were not present in mist net captures -- e.g., *A. pallidus* at Hobo Gulch, *L. cinereus* at Idlewild Campground, Sawpit Flat and Somes Bar, and *P. hesperus* at Canyon Creek, Somes Bar, and Sawpit Flat (Table 4). *M. evotis* and *M. thysanodes*, relatively uncommon in net captures, were also relatively uncommon in acoustic detections, being sometimes detected acoustically at sites where they were netted, and not detected at any site where they were not also captured.

Figure 2A plots the number of individuals for each species against the number of sites at which that species reliably occurred, pooling those sites that were sampled more than once. The five most commonly encountered species were also the most widespread, with *M. yumanensis* being both the most abundant and the most ubiquitous. *A. pallidus* ranked sixth in relative abundance, but occurred with certainty at only five sites. This is explained by the fact that eleven of the sixteen individuals were captured at one site (Canyon Creek) where the netting site was likely close to a nursery roost (see species account below).

There were marked differences among sites both in the number of individuals captured per unit of effort (Table 5) and the number of species encountered (Figure 2B). The greatest number of bats per unit effort were encountered at Thomes Pocket, Dillon Creek, Sawpit Flat, Stony Creek, and Indian Scotty. These results are largely explained by the large numbers of *M. lucifugus* and/or *M. yumanensis* obtained at these sites. The only exception is Thomes Pocket, where a relatively small net area captured a relatively large number of *L. noctivagans*. The greatest number of species were encountered at Canyon Creek, Indian Scotty, Somes Bar, Upper Grindstone Creek, and Sawpit Flat.

Table 5. Capture rate (# bats/sq. m*h), from lowest to highest, by date and by site.

Date	Locality	Net Area (Sq.m)	Nets Open (h)	Total # Bats	#Bats/ sq.m*h
5-Jun-97	Upper Grindstone Ck	79	4	0	0.000
7-Jul-97	Angelo Reserve	206	3	1	0.002
6-Jul-97	Angelo Reserve	150	4	1	0.002
2-Jun-97	Dutch Oven Ck	88	4	1	0.003
5-Jul-97	Angelo Reserve	150	3	3	0.007
3-Jul-97	Angelo Reserve	190	3	4	0.007
16-Jul-97	N Trinity River Cmpgrnd	245	3	9	0.012
4-Jun-97	Little Stony Ck	245	4	7	0.007
12-Jul-97	Helena	150	3	9	0.020
30-Jul-97	Little Stony Ck	224	4	11	0.012
7-Jul-97	Middle Fork Eel	98	4	5	0.013
14-Jul-97	Hobo Gulch Cmpgrnd	206	3	17	0.028
15-Jul-97	Eagle Ck Cmpgrnd	162	3	19	0.039
8-Jul-97	Balm of Gilead	153	3	20	0.044
28-Jul-97	Upper Grindstone Ck	108	4	11	0.025
10-Jul-97	Hyampom	245	3	45	0.061
6-Aug-97	Somes Bar	262	3.25	45	0.053
31-Jul-97	Thomes Pocket	78	4	11	0.035
4-Aug-97	Idlewild Cmpgrnd	150	3.75	23	0.041
13-Jul-97	Canyon Ck	201	3	40	0.066
17-Jul-97	Indian Scotty Cmpgrnd	223	3	61	0.091
6-Jun-97	Stony Ck	147	4	31	0.053
29-Jul-97	Stony Ck	147	4	36	0.061
5-Aug-97	Sawpit Flat	223	3.5	71	0.091
7-Aug-97	Dillon Creek	134	3.25	46	0.106
24-Jul-97	Thomes Pocket	70	4	20	0.071

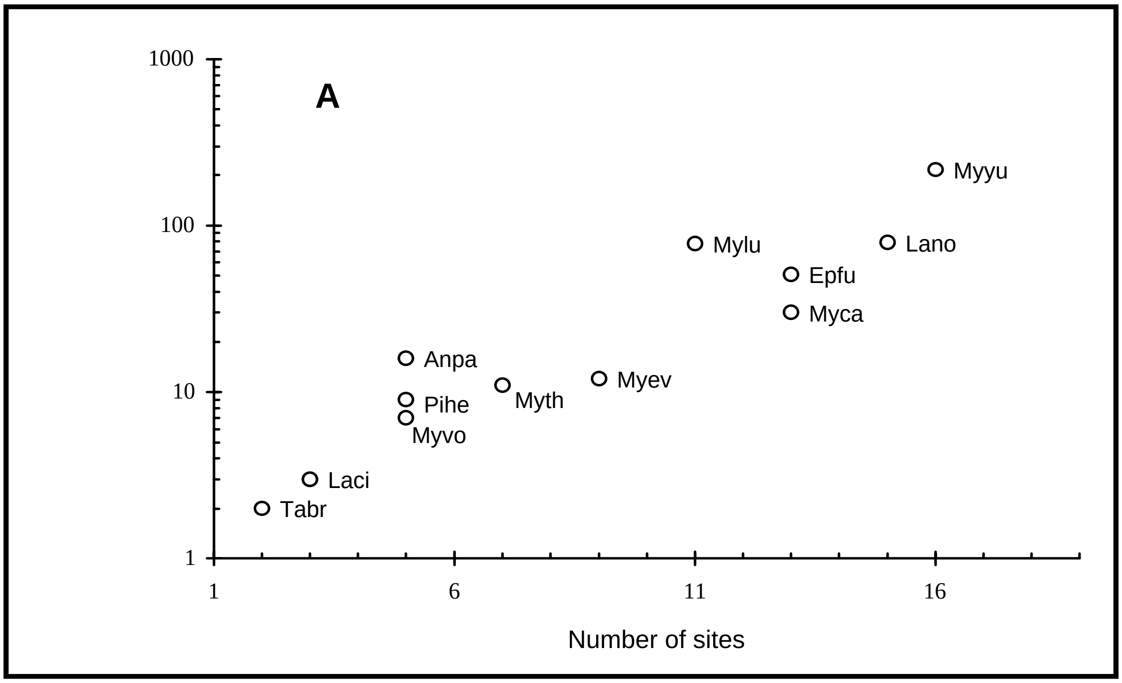


Figure 2A. A scatter plot showing number of individuals of each species plotted against number of sites at which that species was encountered. Since it is often not possible with acoustic data to identify the number of individuals being detected, only net capture data for which positive species identification was possible, are included.

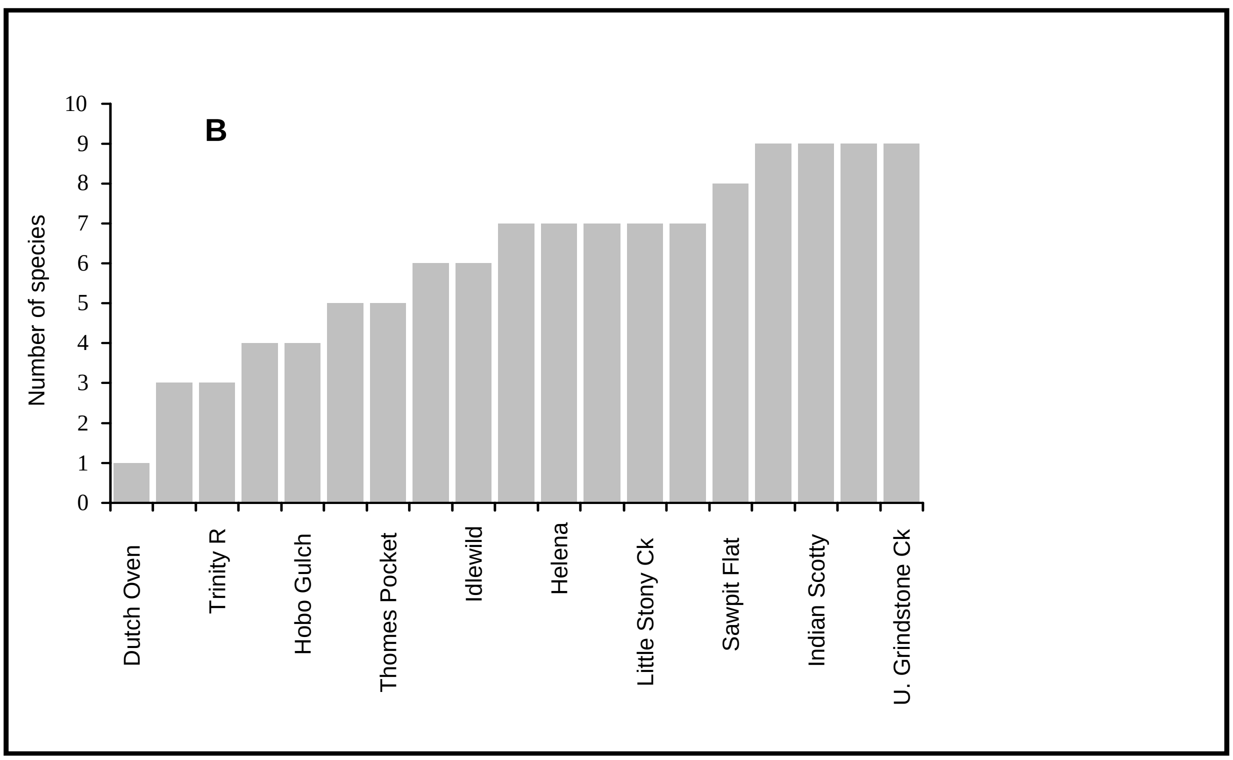


Figure 2B. A bar graph showing number of species encountered at each site. The totals include records for which species identification was possible based on acoustic records.

3.3. Numbers of Individuals and Species in Relation to Habitat Class

We allocated each netting/sampling site to a forest age class: young growth (YG), multi-age stand (MA), old growth (OG), with an additional category dominated by rock (RK). We calculated both the number of bats captured per unit effort and the number of species detected in one night of sampling at all the sites. Using a one-way ANOVA there was a significant response to habitat class for the number of bats captured (Figure 3, Table 6), with the most bats being captured in multi-aged stands. There is also a trend toward differences for number of species in response to habitat class, especially when comparing mixed-age to old-growth (Figure 4, Table 7).

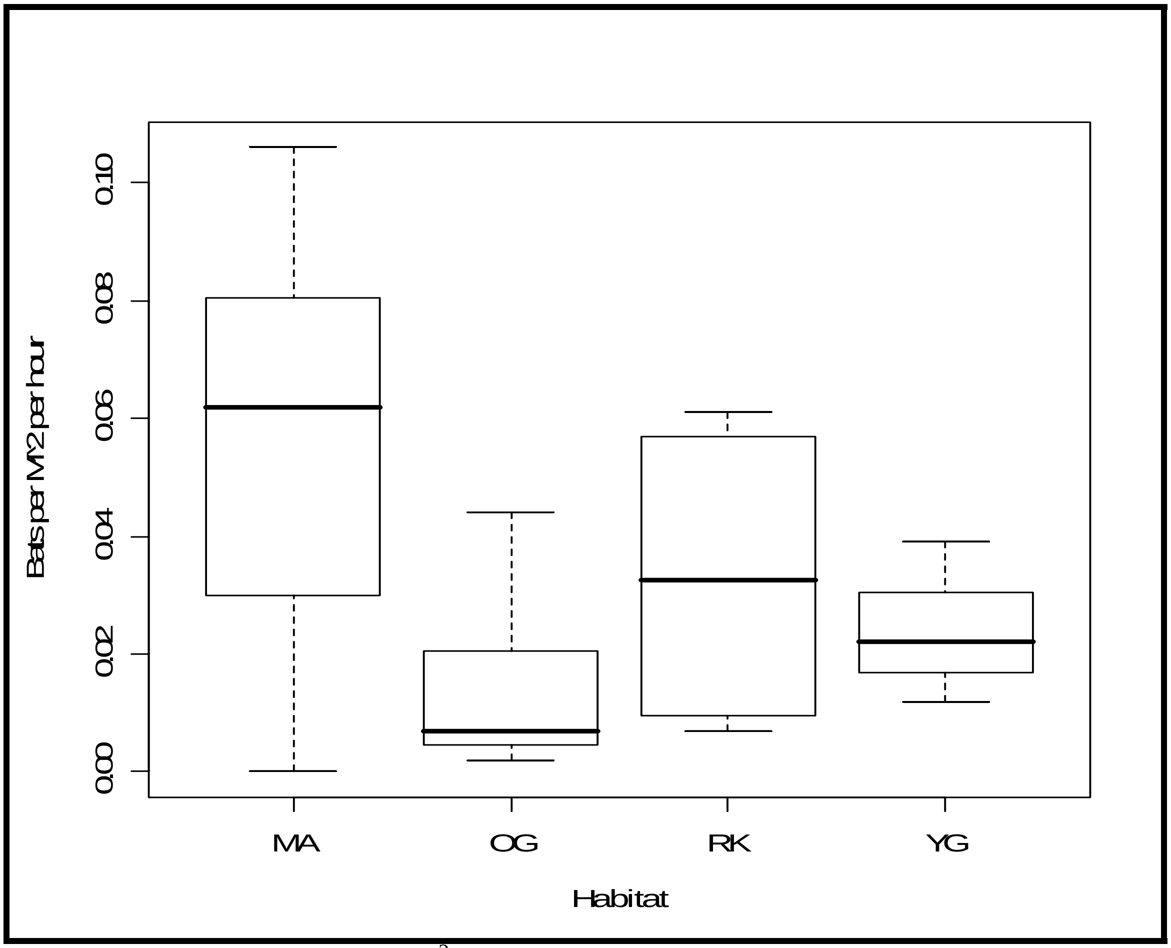


Figure 3. Bats per unit effort (=m^2 of net area per hour of sampling time) by Habitat.Type. The dark bar in the middle of each box shows the median value, boxes show the interquartile range and whiskers show the extremes

Table 6. A comparison of mean values: Bats per unit effort by Habitat Type:

MA	OG	RK	YG	Overall	P_value
0.0543	0.0147	0.0332	0.0243	0.0317	0.0396 *

* Significant at 0.05.

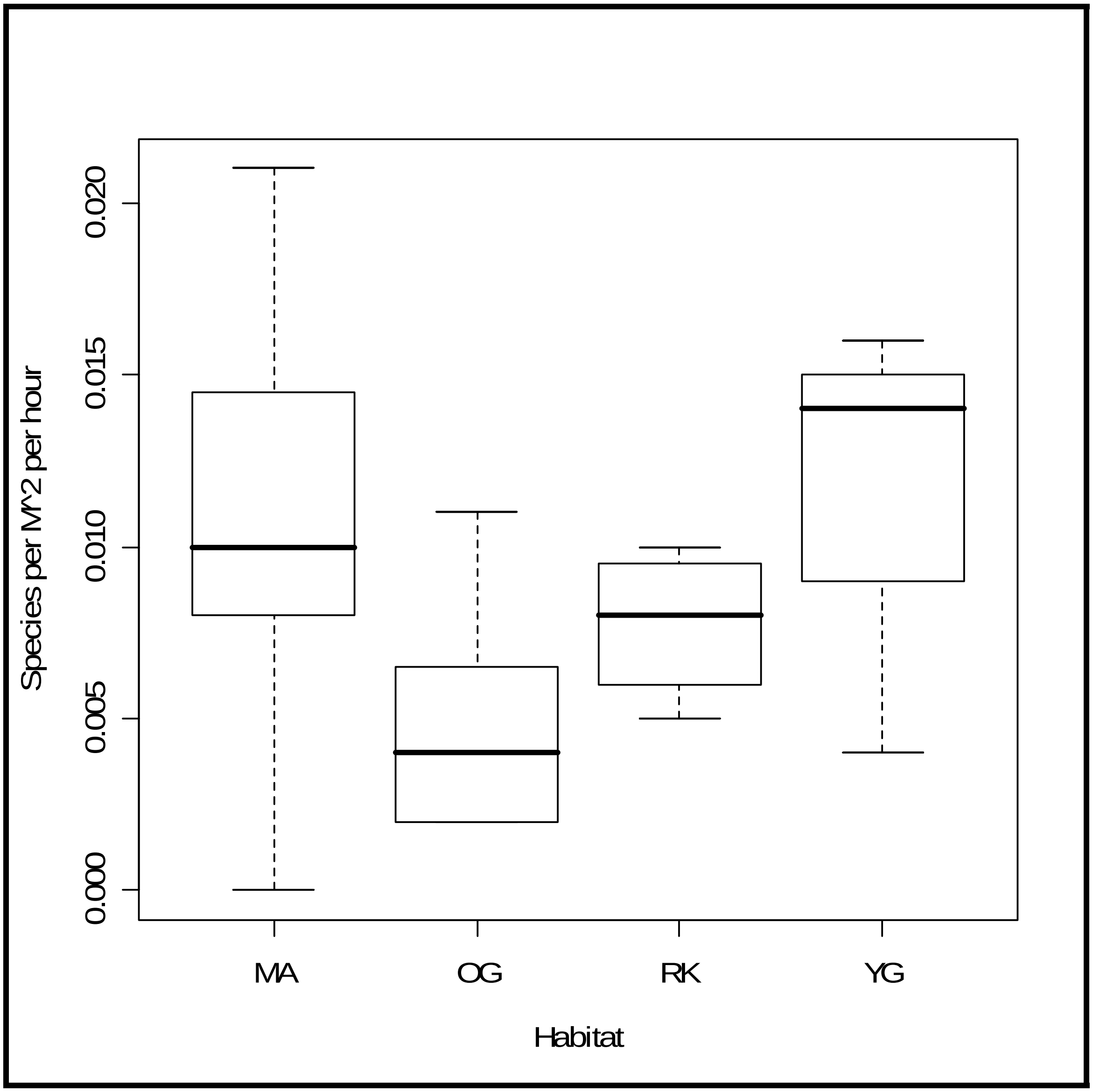


Figure 4. Species per unit effort (=m^2 of net area per hour of sampling time) by Habitat Type. The dark bar in the middle of each box shows the median value, boxes show the interquartile range and whiskers show the extremes.

Table 7. A comparison of mean values: Species per unit effort by Habitat Type:

MA	OG	RK	YG	Overall	P_value
0.0105	0.00486	0.00775	0.0113	0.00861	0.1147

In a post-hoc Tukey multiple comparison of means, the only significant difference for number of bats per habitat class is between old growth and mixed age stands (Table 8).

Table 8. Tukey multiple comparison of means at 95% family-wise confidence level for number of bats captured per unit effort by habitat class.

	diff	lwr	upr	p adj
OG-MA	-0.039619048	-0.07629963	-0.002938461	0.0311063
RK-MA	-0.021083333	-0.06561188	0.023445209	0.5636347
YG-MA	-0.030000000	-0.07978442	0.019784424	0.3608604
RK-OG	0.018535714	-0.02980538	0.066876804	0.7139284
YG-OG	0.009619048	-0.04360274	0.062840836	0.9577710
YG-RK	-0.008916667	-0.06782239	0.049989059	0.9744056

This analysis does not account for the tendency for species to accumulate with more sampling. More replicates, especially in classes other than mixed-age, would possibly affect these results.

These data do suggest that it is not possible to use netting sites in foraging areas to make inferences about roosting habitat. Various parameters regarding a netting site and the adjacent habitat may well provide information on selection of foraging areas, but say little, if anything, regarding selection of roosting sites. It would appear that the animals generally seek relatively warm sites for foraging, leading to the reasonable inference that temperature is directly correlated with insect productivity. We know from radio-tracking data obtained on the Sacramento River project that a number of the forest dwelling bats, particularly *Lasionycteris noctivagans* and *Myotis volans*, travel considerable distances (up to 17 km one way) to reach foraging areas (Rainey and Pierson 1996a). In this context, the appearance of *L. noctivagans* and *M. volans*, both nearly obligate tree roosting species (Betts 1996 and 1998, Campbell et al. 1996, Mattson et al. 1996, Ormsbee 1996, Ormsbee and McComb 1998, Rainey and Pierson 1996a, Vonhof 1996), in net captures at virtually treeless sites (Stony Creek and Little Stony Creek respectively) suggests that both species were roosting at higher elevation forested sites, and traveled down the stream drainages to forage. This scenario is also consistent with radio-tracking data from a number of studies suggesting that bats frequently roost at ridge tops and forage along watercourses, which are generally at lower elevation (see Barclay and Brigham 1996). The mountain ranges associated with our study sites (the Inner Coast Range and the Trinity Alps) are relatively small compared to the Sierra Nevada or Rocky Mountains. As a consequence, distances are relatively short from the lowest to the highest elevation, making it entirely feasible that a single individual of some species (most particularly the tree roosting species) could travel the entire elevational gradient in one night.

Figure 5d shows that there is a positive correlation between capture rate and air temperature one hour after sunset. Thus it is not surprising that more foraging bats were encountered in the warmer, more open reaches found in multi-age stands than in the cooler, more shaded reaches of old growth stands. Ongoing work at one old growth site, the Angelo Reserve, provides evidence (via acoustic, building and bridge surveys) that there are at least seven species in this habitat even though no more than three have been encountered in repeated mist-net sampling.

There was also a weak negative correlation between elevation and air temperature one hour after sunset (Figure 5a). There was no apparent correlation between capture rates and elevation in this study (Figure 5c). This is likely because our study sites covered a fairly limited elevational range (146-1,280 m).

It should be noted that our sampling method (generally one night per site) was not expected to provide a complete species list for that site. Repeat sampling on the Sacramento River suggested that the cumulative number of species caught did not begin to asymptote until a site had been sampled three times (Rainey and Pierson 1996a & b). It is nevertheless possible to discern some trends, and make some inferences from these data. Most notably, *M. yumanensis* and/or *M. lucifugus* tended to be present in relatively large numbers where the netting site had the combined characteristics of being wide (>15 m) and having a slow flow rate that allowed the water to form relatively still, riffle-free pools. Also, there was some indication that both temperature and season affected both number of individuals and species diversity. The most compelling example of seasonal differences is offered by the Grindstone Creek site, where no bats were captured early in the season (June 5) and nine species, the maximum number detected at any one site, were encountered mid-summer (July 28).

An indication that multiple samples per site are necessary to determine the species assemblage for an area comes from examining the results of what were effectively paired sites. Eagle Creek and the Trinity River Campground were only a few kms apart, and yet the yield both in number of animals and number of species was markedly different at the two sites. Comparable differences were observed at other pairs of sites that were within a few kilometers of each other: the two sites in the Yolla Bolly Wilderness (Balm of Gilead and the Middle Fork of the Eel), and the Helena and Canyon Creek sites (Table 4, Figure 2B).

3.4 Bridge Surveys

We surveyed 36 bridges in Humboldt, Siskiyou and Trinity counties. Twenty-eight (77.8%) were used in some way by bats. All 28 were used as a night roost, and eight (22.2%) as a day roost. The species positively identified as using bridge day roosts were *C. townsendii*, *E. fuscus*, and *M. yumanensis*. Most of our surveys were conducted during the day. Plans to conduct extensive roost surveys at night as had been done on the Sacramento project (Pierson et al. 1996a) were never realized, since they were dependent on volunteer help that backed out of the project too late to find a replacement. Work on the Sacramento River indicated that night roost surveys of bridges were the most effective, time efficient method for detecting certain species, particularly *A. pallidus*, *E. fuscus*, *M. evotis*, *M. thysanodes*, *M. volans*, and *M. yumanensis* (Pierson et al. 1996a). The few bridges in this study that were checked at night were occupied either by *M. yumanensis*, or *A. pallidus* (one bridge near Helena). Based on the size and shape of guano found under bridges, 23 were being used by *Myotis* spp. and seven were being used by *A. pallidus* and/or *E. fuscus*.

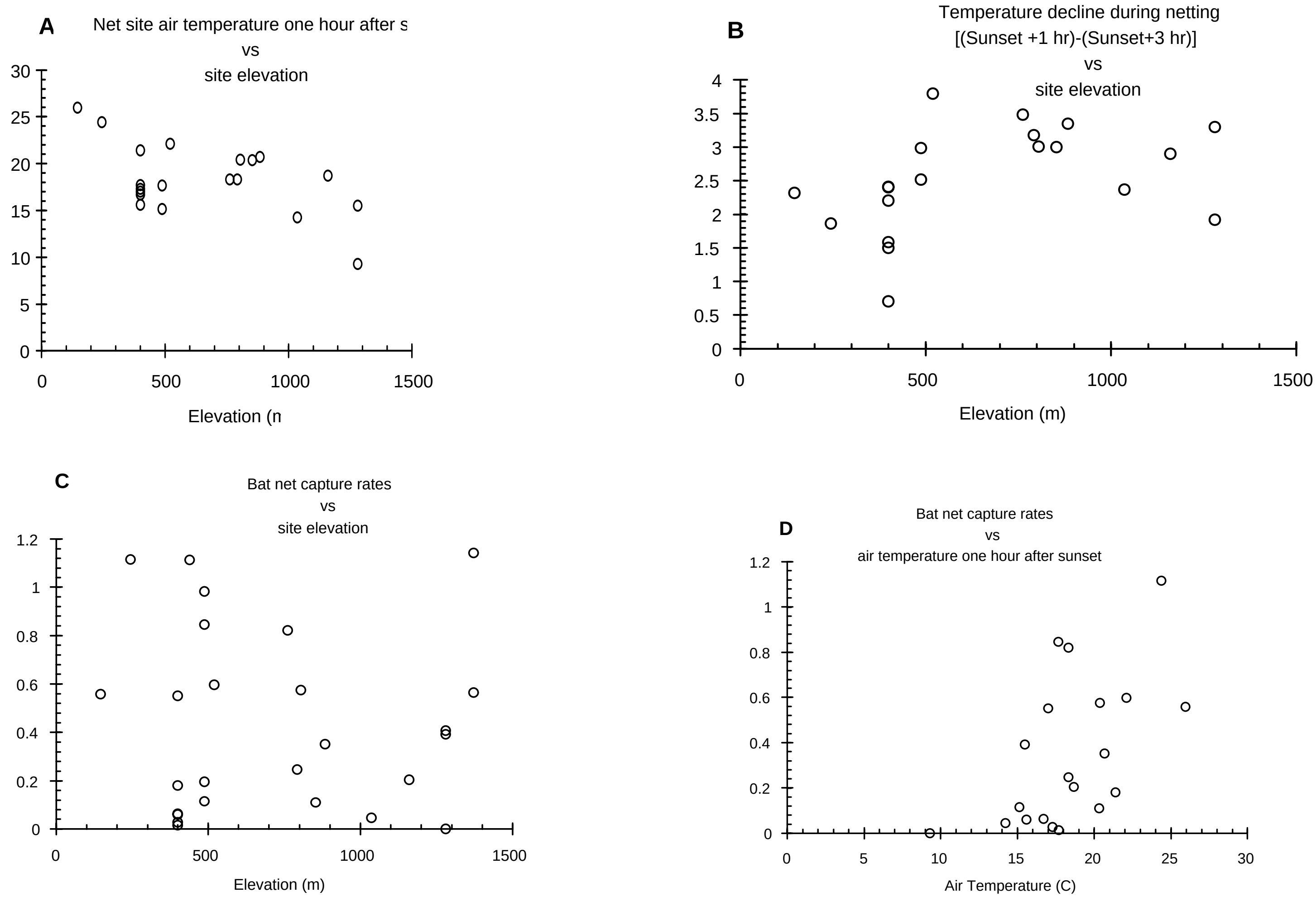


Figure 5. Scatter plots showing the relationship between (5a) temperature and elevation, (5b) temperature differential during netting and elevation, (5c) capture rates and elevation, and (5d) capture rates and air temperature one hour after sunset.

3.5. Species Distribution

A review of museum records (AMNH, CAS, CM, CSUH, KU, LACM, LSUMZ, MCZ, MSU, MVZ, ROM, UCLA, UM, UMZ, USNM) revealed 852 specimen records representing 148 localities for the six county area included in this study. The majority of these records are from localities at the rim of the Central Valley or along major highway corridors. Relatively few come from the forested mountain region, the Klamath Mountains/Trinity Alps that run north to south through western Siskiyou, eastern Humboldt, and Trinity counties. For example, prior to this study, in Trinity County there were only 13 localities, representing nine species, at which bats had been seen or taken. We encountered 14 species in Trinity County, thus providing significant new records for *Myotis ciliolabrum*, *Myotis lucifugus*, *Myotis volans*, *Pipistrellus hesperus*, and *Tadarida brasiliensis*. *Myotis yumanensis*, the most abundant and widespread species in our records, was known from only one locality in Trinity County -- Burnt Ranch on Highway 299 (CSUH). The data collected during this project provide range extensions, as evaluated using Hall (1981), Zeiner *et al*. (1990), and available museum/literature records for 3-4 species: *Myotis ciliolabrum, Pipistrellus hesperus, Euderma maculatum,* and possibly, *Eumops perotis*.

Grinnell (1916) notes that the Trinity Region has “but very slight endemic individuality,” and claims that its fauna is closely allied with that of the Sierra Nevada. While the bat species list for this region taken as a whole might be identical to that for the Sierra Nevada, there are some striking differences between the two regions in relative abundance and distribution of certain species. Most notably, *T. brasiliensis*, which is one of the most common species throughout most of the Sierra Nevada, appears to be rare in the Trinities, and *L. noctivagans*, which is rare in the central and southern Sierra Nevada, is one of the most common species in the Trinities (Pierson et al. 2001). A species by species review of known distribution (museum and literature records plus records obtained in this study) is provided below.

3.5.1 CDFG Species of Special Concern (Current and Proposed in 1998 MSSC Revision)

3.5.1.1. *Antrozous pallidus* (MSSC; FSS)

There are museum records (43 specimens from 18 localities) for *A. pallidus* from all six counties included in the study area (CAS, CSUH, FMNH, LACM, MSU, MVZ, UCLA, UIMNH, USNM). The only Siskiyou County record is from the central part of the county (MVZ), and the only Trinity County records are from along the Route 299, Trinity River corridor (CSUH, MVZ). This species was also captured at multiple sites on both the Sacramento River and Squaw Creek drainages (Rainey and Pierson 1996a), and monitored at a significant bridge night roost on the Sacramento River (Pierson et al. 1996).

During this study, sixteen *A. pallidus* were captured (15 in mist nets, and one in a hand net at a night roost close to the Helena netting site) at five (26 %) of the mist-netting sites, and possibly detected acoustically at one other. It ranked sixth in abundance among our mist net captures. The fact that the only Trinity County museum records are from an area close to where we captured the majority of our animals suggests that the distribution of *A. pallidus* in the Trinity Mountains could be somewhat patchy, and perhaps linked to areas with substantial concentrations of oak. Data from the Sacramento River (Rainey and Pierson 1996a) and from elsewhere in California (unpublished data) suggest an association with oak woodlands (both foothills oak savannah and black oak), a habitat in which it both roosts and forages. At the Canyon Creek site where we netted eleven lactating females, light-tagged individuals all flew directly upon release to a heavily forested area dominated by large oaks. Studies elsewhere have also documented this species roosting in large ponderosa snags, redwoods and giant sequoias (Cross and Clayton 1995, Pierson and Heady 1996, Rainey et al. 1992). The Indian Scotty record from western Siskiyou County provides the most northern locality for the state. Since this species is caught readily in nets when present, and quite distinctive acoustically, we conclude that it may be relatively rare in the Trinity region.

3.5.1.2. *Corynorhinus townsendii* (MSSC; FSS; USFWS-SC)

There are museum and/or literature records (Marcot 1984, Pearson et al. 1952, Pierson and Fellers 1998, Pierson and Rainey 1996b) for all the counties included in the study. These include 159 specimen records, representing 37 localities (CAS, CM, KU, LACM, MVZ, USNM). The majority of these records were investigated in the course of a recent CDFG survey of this species in California (Pierson and Rainey 1996b), and were further investigated in a 1997 study (Pierson and Fellers 1998). The status of most of these sites, particularly those known to be nursery roosts, has been were assessed in these two studies. There are a number of significant maternity and hibernating sites in both lava tubes and limestone caves in the region, particularly in Shasta, Siskiyou and Trinity counties.

Since *C. townsendii* is adept at avoiding nets and not readily detected with a bat detector, the methods used in this study were biased against its detection. No *C. townsendii* were captured in mist nets. This species was, however, located twice roosting in bridges during the day -- a single individual under a bridge near the confluence of the Scott and Klamath rivers (a new locality), and a cluster of nine under a bridge near Somes Bar. The Somes Bar site contained at least two adult (presumably female)/juvenile pairs, and was within a few hundred meters of a known maternity roost (Pierson and Rainey 1996b). Parallel surveys being conducted concurrently (Pierson and Fellers 1998) identified three nursery sites in limestone caves in the Hayfork/ Hyampom area. Also, although not detected in1997, *C. townsendii* has been found recently at the Angelo Reserve in Mendocino County (Pierson and Rainey 1996b).

3.5.1.3. *Euderma maculatum* (MSSC; USFWS-SC)

Prior to recent studies on the Sacramento River, the only record for *E. maculatum* in northern California was from Palo Cedro in Shasta County (Bleich and Pauli 1988), although there are also records for eastern Oregon (McMahon et al. 1981; M. Perkins pers. comm.) and southern British Columbia (e.g., Woodsworth et al. 1981). Although the type specimen for this species comes from the Coast Range in southern California (Ventura County)(Allen 1891), all other California records are from the desert region or the Sierra Nevada. During the Sacramento River project, a population was identified at Castle Crags State Park in Shasta County, and the species was detected at several sites in that general area, plus one site on Squaw Creek (Pierson and Rainey 1998). These observations led us to speculate that the species may be more widely distributed in the Trinity Mountains. A primary goal for a back country trip in September 1997 was to look for this species at higher elevation sites comparable to those at which we have found them in the Sierra Nevada (generally wet meadows in association with cliffs).

In this study, we had one acoustic detection of *E. maculatum* near the Indian Scotty Campground on the Scott River. Although not recorded, its audible call was heard by an experienced observer (P. Heady), and we are confident of the identification. The presence of the species at this site is not surprising. Roost sites for *E. maculatum* are often in rock features that are also suitable for raptors, and a rock pinnacle containing a raptor aerie was visible from the netting site.

The focus in this study on creek and river sites did not favor detection of *E. maculatum.* The one back country trip survey trip was limited in scope, and thus failure to detect the species is not conclusive. We expect, based on habitat characteristics (e.g., availability of cliffs and wet meadows) that this species, while likely rare, is more widely distributed in this region than is currently recognized.

3.5.1.4. *Lasiurus blossevillii* (MSSC Proposed; FSS)

There are only three museum records from three localities for *L. blossevillii* in the six county study area (MVZ, USNM), with four additional records from four localities in other areas of northwestern California (CSUH, MVZ). Two of these records are from the north coastal area (Laytonville in Mendocino County [MVZ]) and Arcata in Humboldt County [CSUH]]), which are consistent with both historical and recent observations of this species occurring in the coastal belt farther south, e.g., in Golden Gate Park in San Francisco (Orr 1950), in the Delta (Constantine 1959), and at Point Reyes National Seashore (C. Corben pers. comm., pers. obs.). Other northern California records are all from the Central Valley or its eastern rim (Redding in Shasta County, and Tehama and Dale's Station in Tehama County). We obtained additional records for this species at two localities on the Sacramento River (Siskiyou County) and three localities on Squaw Creek (Shasta County) (Rainey and Pierson 1996a). Thus there are records both to the East and to the West of our Trinity Mountain study sites. There are also museum records for Yolo County, just south of our Colusa and Lake County sites.

No *L. blossevillii* were captured in nets during this study. Its fairly distinctive echolocation call was detected only at the site nearest the coast (the Angelo Reserve), which is ca. 16 km from one of the museum localities (Laytonville [MVZ]). It was detected repeatedly at the Angelo Reserve in the summer and fall (Figure 6). If it occurs along the central axis of the Trinity Mountains, its presence there may be intermittent or seasonal. Capture patterns for this species on the Sacramento River (observed in 1993 and 1994; not observed in 1991, 1992, 1995 or 1996) suggest a year to year shift in movement patterns. Thus our limited surveys in the summer of1997 should not be considered definitive.

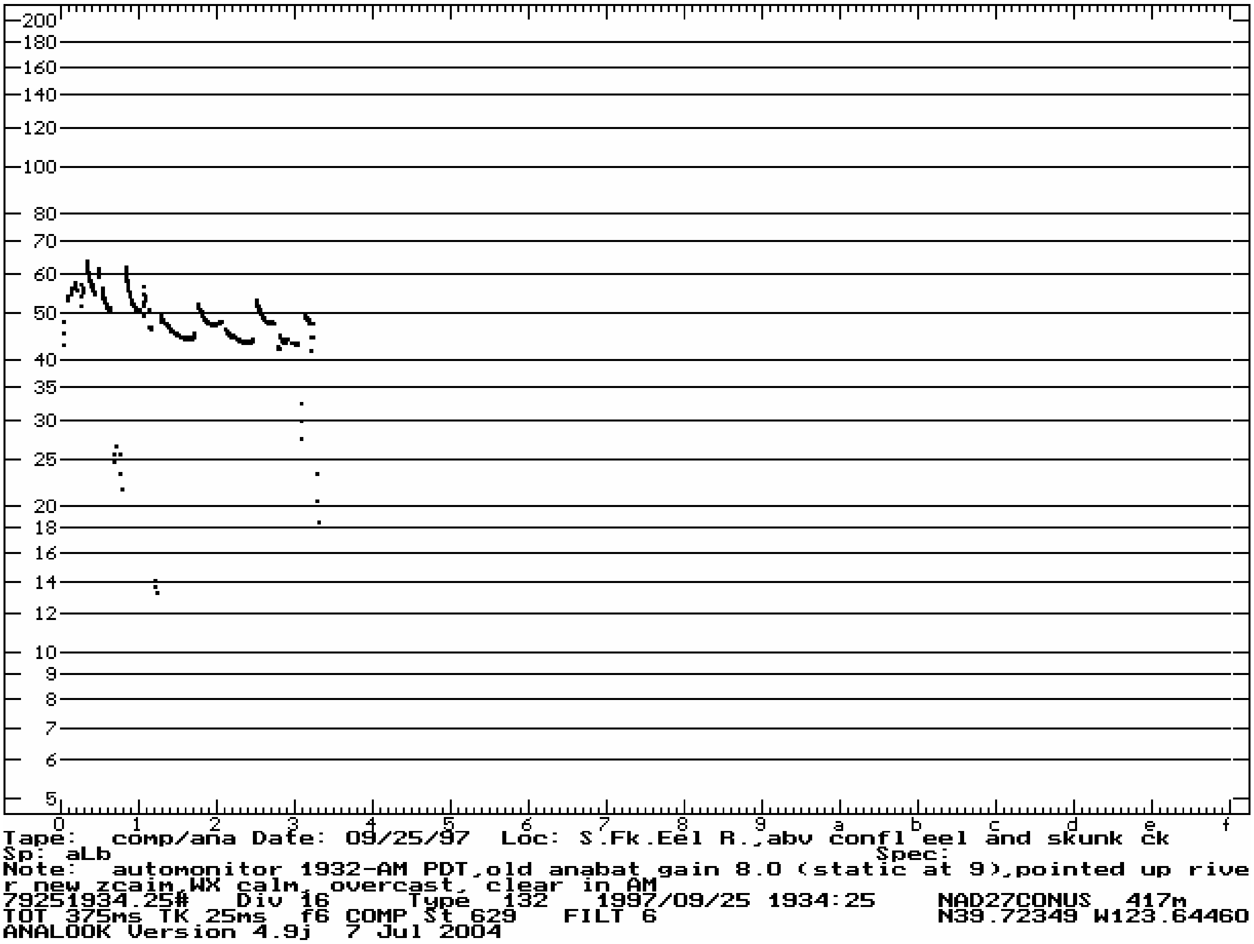


Figure 6. Sonogram for *L. blossevillii* recorded with Anabat on 27 September 1997 at the Angelo Reserve on the Eel River, Mendocino County.

3.5.1.5. *Myotis thysanodes* (MSSC Proposed; USFWS-SC)

Museum records for *M. thysanodes* in the six county study area are very limited, with only fourteen specimens taken from two localities : one in Trinity County (CAS), and thirteen from a mine tunnel (which no longer exists) near Lucerne in Lake County [MVZ]). There are four additional specimens from four localities in Humboldt County (CAS, CSUH). This species was not identified in one study in Del Norte County (Zielinski and Gellman 1999), but was the third most abundant species captured in a study conducted in the Pilot Creek watershed in Humboldt County (Seidman and Zabel 2001). This species was very rare, comprising <1.0% of the animals encountered, in our Sacramento River project (Rainey and Pierson 1996a). Individuals were netted at only four localities in the six years of the study, three on the Sacramento River and one on Squaw Creek. It was found additionally at four night roosts (two under bridges and two in buildings). Two small nursery colonies, both in buildings and somewhat associated with much larger *M. lucifugus*/*M. yumanensis* nursery roosts, were also located. This species appears to be uncommon in the Sierra Nevada (Pierson et al. 2001).

Eleven *M. thysanodes* were captured at seven sites (37%) in this study. Although the species was not one of the more common species, ranking eighth in abundance and constituting only 1.9 % of net captures, it was nevertheless more common and widespread than might have been expected based both on museum records and our work on the Sacramento River. Although in various parts of its range it is found primarily at higher elevations (e.g., Jones 1965, Jones and Suttkus 1972), and most frequently encountered at mid-elevations (1,000-2,000 m) in the Sierra Nevada (Pierson et al. 2001), it was netted in this study at both low (Dillon Creek at 244 m) and higher (Upper Grindstone Creek at 1,280 m) elevation sites. While it was captured at primarily heavily forested areas, it was also caught at Eagle Creek, one of the most open sites (which was, however, was within 1 km of the Trinity Alps Wilderness). Although not located in 1997, it has also been found recently at the Angelo Reserve (unpubl. obs.).

How dependent this species is on tree roosts in forested areas remains somewhat uncertain. Studies in California (Weller and Zabel 2001; Pierson et al. 2002), New Mexico (Chung-MacCoubrey 1996), and Oregon (Cross and Clayton 1995) have documented *M. thysanodes* roosting in large conifer snags, but a study in southern California documented three radiotagged *M. thysanodes* foraging in the forest but roosting in rock crevices in chaparral/scrub habitat (Miner and Brown 1996). Several nursery roosts in northern California are in abandoned mines or in buildings (E. Pierson and W. Rainey, unpublished data). We have found this species in or netted at fire-scarred basal hollows of both coast redwoods (*Sequoia sempervirens*) (Rainey et al. 1992) and giant sequoia (*Sequoia giganteus*) (Pierson and Heady 1996; Pierson et al. 2002). Since roosts inside conifer snags are only likely to be found through radiotracking, no conclusions can be drawn from our netting data about roosting preferences for this species in this region of California. This species is also known to travel considerable distances (up to 12.8 km) from its roost to its foraging area (Miner and Brown 1996).

3.5.1.6. *Myotis volans* (MSSC Proposed; USFWS-SC)

There are only ten museum specimens from eight localities in the six county area (CAS, MVZ, USNM) for *M. volans*, with no records Colusa, Tehama, Trinity, or western Siskiyou counties. The species was also rare in our Sacramento River study (Rainey and Pierson 1996a). Over the six year period it was only captured in mist nets 5 times at three localities (one on the Sacramento River and two on Squaw Creek). It was, however, encountered 19 times at six bridge night roosts (Pierson et al. 1996). Although the majority of the records were from the late summer and early fall, reproductive females were captured mid-summer. Our experience with this species in northwestern California differs dramatically from that of investigators in the White and Inyo Mountains where *M. volans* is one of the most commonly encountered bat species (Szewczak et al. 1998). Also, in summer surveys in subalpine forests of Colorado, *M. volans* accounted for >90 % of the bats captured (Storz and Williams 1996).

M. volans was one of the rarest bats in our capture records for this study, ranking eleventh in abundance of the fourteen species captured. Seven individuals were captured at five sites, representing only 1.2% of all captures. Three sites were in the Trinity River drainage (Canyon Creek, Eagle Creek, and the Trinity River itself; the other two were in the Inner Coast Range). Although this species is generally associated with high elevation conifer forest (Jones and Suttkus 1972, Storz and Williams 1996, Szewczak et al. 1998), it was found in this study in the foothills of the Inner Coast Range, in chaparral/gray pine habitat. Radiotracking data from the

Sacramento River documented that this species flies considerable distances (>10 km) from its roosting to its foraging areas, and all foraging sites at which it was encountered were within flying range of conifer forest. Although this species has been found roosting in abandoned buildings, mines, and rock crevices (Barbour and Davis 1969, Warner and Czaplewski 1984), recent research, including that from the Sacramento River, suggests *M. volans* roosts primarily in trees, particularly large diameter conifer snags, or live trees with lightning scars (Chung-MacCoubrey 1996, Cryan 1996, Ormsbee 1996, Rainey and Pierson 1996a).

3.5.1.7. *Eumops perotis* (MSSC; USFWS-SC)

Prior to recent CDFG surveys (Pierson and Rainey 1996a) and the Sacramento River studies (Rainey and Pierson 1996a), there were no known records of *E. perotis* north of Oroville (Butte Co.; Eger 1977). During the six years of the Sacramento River project, we obtained acoustic recordings (attributable, based on present knowledge, only to *E. perotis*) at several localities in the region: one on the upper Sacramento River near Dunsmuir, one in the Medicine Lake Caldera, and a third at Gumboot Lake.

In this study, one of us (E. D. Pierson) had a brief acoustic detection (ca. three pulses) on the South Fork of the Scott River near Callahan that most likely was *E. perotis*. Although not recorded, this audible call had the tone and interpulse interval characteristic of *E. perotis*. Also, this site is only ca. 25 km from Gumboot Lake (well within the possible foraging range of up 40-80 km/night for this species), and only 9 km from a likely roosting site (which we identified from the highway, but were unable to visit at the time due to the necessity of obtaining permission to cross private land).

3.5.2. Other Species

3.5.2.1. *Eptesicus fuscus*

There are 96 museum records from 39 localities for *E. fuscus* in the six county area (CAS, CM, KU, MVZ, UCLA, USNM), including one from Canyon Creek in Trinity County (USNM). This species was relatively uncommon but widely distributed in our net captures on the Sacramento River and Squaw Creek, and individual animals, particularly males, were encountered frequently in bridge night roosts (Pierson et al. 1996a).

In this study, *E. fuscus* was the fourth most abundant species, with 51 captures at 13 (68%) of the sites. The striking feature of our results here and in the Sacramento River study was that adult males outnumbered adult females almost 2:1 (Rainey and Pierson 1996a). Whereas we have found aggregations of reproductive females using bridge night roosts at a number of sites in the Sierra Nevada (Pierson et al. 2001), we never found such an aggregation along the Sacramento River. It is thus unfortunate we were unable, due to personnel limitations, to conduct the planned night roost surveys in this study. At this point it remains somewhat uncertain whether the skewed sex ratio we observed represents a sampling bias, or indicates that reproductive females are actually less common than males in the Trinity Mountains.

3.5.2.2. *Lasionycteris noctivagans*

L. noctivagans is distributed throughout northwestern California, with 28 musuem records from 15 localities in the five county study area (CAS, CSUH, MVZ, USNM). While records are missing for Mendocino County, they include four localities in Trinity County (one from Canyon Creek)(CSUH, MVZ, USNM). *L. noctivagans* was the second most commonly encountered species in our studies on both the Sacramento River and Squaw Creek (Rainey and Pierson 1996a).

In this study *L. noctivagans* was also the second most commonly encountered species, with 79 individuals being captured at 15 (79 %) of the sites. The single male captured at the Angelo Reserve provides the first record of this species from Mendocino County. As with *E. fuscus*, the adult sex ratio was skewed in favor of males (3.1:1). This contrasts markedly with our results on the Sacramento and Squaw drainages, where adult males were encountered far less frequently than adult females (0.4:1). Reproductive females or volant young were observed at most of the sites in the Inner Coast Range, particularly Thomes Pocket, which is within a few km of an historically documented breeding population in Plaskett Meadows, and on the Scott River (Indian Scotty). Idlewild Campground and Sawpit Flat were the only sites in the Trinity, Salmon or Klamath drainages where reproductive females and/or volant young were encountered. At all the sites in these drainages males were more common than females. In a one night netting effort on the McCloud River on 6 August 1997, *L. noctivagans* was the most abundant species, with adult males outnumbering adult females 2:1 (W. Philpott pers. comm.). In a study on the Plumas National Forest (Lengas and Bumpus 1992 and 1993), *L. noctivagans* was by far the most abundant species in net captures, but the authors do not indicate the reproductive status of the population nor the ratio of males to females. These data, taken together with information that can be gleaned from museum records and the literature (e.g., Grinnell 1918, Rainey and Pierson 1995) strongly suggest that in California breeding females of this species are found primarily in the northern part of the state, likely along ridge tops in the Coast Range (with records extending down to Lake County, and an isolated record from a mountain top in Ventura County [S. Sweet pers. comm.]). Distribution in the Sierra Nevada remains somewhat unclear. Breeding females are known from Lake Amador (Grinnell 1918, B. Hogan pers. comm.) and several other sites in the northern Sierras. The species appears to be generally rare in the central Sierra Nevada. For example, rather extensive netting efforts in Yosemite Valley have yielded only a few males (Pierson et al. 2001). The available data taken together suggest that while the species may be fairly widespread in northern California, breeding females are somewhat patchily distributed, and the populations occurring in the upper Sacramento River basin and along the ridge of the Inner Coast Range are unusual and significant.

3.5.2.3. *Lasiurus cinereus*

There are only 20 museum records from seven localities for *L. cinereus* from the study area, with none from either Colusa or Siskiyou counties (CAS, MVZ, USNM). The only Trinity County record is from the Mad River, near Ruth (MVZ). There are four Mendocino County records, two from the general area of the Angelo Reserve (CAS, MVZ) The majority of records, including the only females, are from either the spring or the fall. Spring and fall migration is known to occur through California, particularly along the coast (Dalquest 1943; Tenaza 1966), and reproductive females have not been found in California during the summer months when the young are born and raised. We obtained 33 records for *L. cinereus* in the Sacramento River study, from both Siskiyou and Shasta counties, and both the Sacramento River and Squaw Creek drainages. Although most of our sampling was done in the summer, approximately half the records (and the only females) were taken during two limited netting efforts in September.

Only two *L. cinereus*, both adult males, were captured in this study, one at Dutch Oven Creek (where, in early June, it was the only animal caught) and the other at Stony Creek, providing the first record for this species for Colusa County. Another individual, positively identified by a combination of acoustic recording and spotlighting, was observed at Dillon Creek (Figure 7). This species, which has an often distinctive echolocation call, was detected acoustically at five additional sites -- the Angelo Reserve, Deer Creek, and all three sites along the Salmon River (Idlewild Campground, Sawpit Flat, and Somes Bar). Since this species frequently forages at canopy height (Kalcounis et al. 1996), it is not surprising that it was detected acoustically more frequently than it was captured. Thus, although it ranked twelve in our net captures, it is likely more widespread in this region than the limited net captures would suggest.

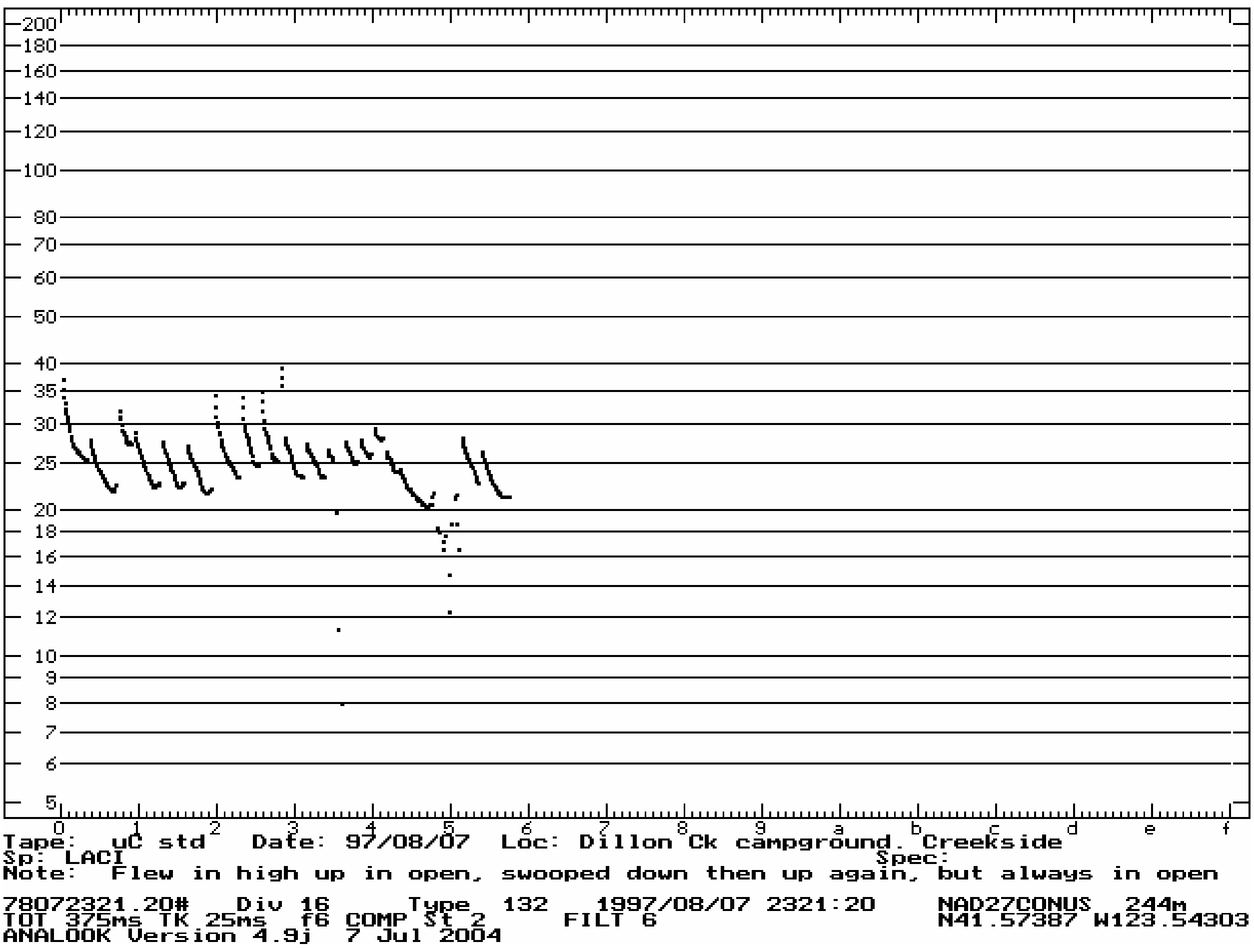


Figure 7. Sonogram for *L. cinereus* recorded with Anabat on 7 August 1997 at Dillon Creek, near confluence with Klamath River, Siskiyou County.

3.5.2.4. *Myotis californicus*

There are 95 museum records for *M. californicus* from 38 localities across the study area, including a few records from localities along the Trinity and Klamath rivers (CAS, CSUH, MVZ, UIMNH). In our Sacramento River study, this species, while nowhere abundant, was widespread and observed in low numbers in our net captures at multiple sites on both the Sacramento River and Squaw Creek.

In this study *M. californicus* was the fifth most commonly observed species in net captures, and occurred at 13 (68 %) of the netting sites. This species was also frequently detected acoustically, foraging above net height in canopy vegetation.

3.5.2.5. *Myotis ciliolabrum* (USFWS-SC)

The only museum records for *M. ciliolabrum* from the northwestern region of California are spring, fall and winter records for two caves in Shasta County (MVZ; Pearson et al. 1952). There are none for the northern coast ranges or the Trinity/Klamath Mountains. The distribution of this species is still poorly understood for California. The majority of the museum records are for the southern part of the state, with only a few reaching north in the Sierra Nevada and White Mountains. Szewczak et al. (1998) found this species, both summer and winter (hibernating) in both Great Basin scrub and Pinyon-Juniper habitat in the White Mountains. During the course of the Sacramento River study we identified 13 animals as most likely being *M. ciliolabrum*, using the characters outlined by van Zyll de Jong (1985) and, more recently, Constantine (1998): flat skull, exposed rostrum, and a tail extending 2 mm or more beyond the interfemoral membrane.

We captured three animals in this study (at Grindstone Creek, Sawpit Flat and Somes Bar) that we tentatively identified as *M. ciliolabrum*, and three others we could not distinguish from *M. californicus* (meaning they had features characteristic of both species). The majority were juveniles, making identification more difficult. We also used acoustic characteristics, which based on large samples collected by C. Corben (personal communication) and M.J. O'Farrell (personal communication) appear to reliably distinguish the species, with *M. californicus* having a characteristic base frequency of 50 kHz, and *M. ciliolabrum* of 40 kHz. The Grindstone Creek animal had a protruding tail; the animal at Sawpit Flat could not be distinguished morphologically (it had an exposed rostrum and an enclosed tail), but echolocated at 40 KHz. The Somes Bar animal had been identified as a *M. californicus*, but upon release gave a search phase call with a base frequency of 39 kHz. Thus our identification of this species remains somewhat uncertain. Documenting its presence in the Trinity Mountains would, however, constitute a significant range extension.

3.5.2.6. *Myotis evotis* (USFWS-SC)

There are 20 museum locality records for *M. evotis* from 14 localities in the six county study area (MVZ, UCLA, UMZ, USNM), including one from Branscomb (UCLA), near the Angelo Reserve in Mendocino County and five from Trinity County (MVZ, UMZ). We encountered this species 67 times in the Sacramento River study, at multiple bridge night roosts, at multiple netting stations on both the Sacramento River and Squaw Creek, and in a building roost near the Oregon border (Rainey and Pierson 1996a).

In this study we captured 12 animals at 9 (47 %) of the sites, ranking it seventh in abundance among the 14 species captured. Thus, while it did not appear to be common anywhere, it was fairly widespread. These results are consistent with our experience of this species in the Sierra Nevada and with the data presented by Szewczak et al. (1998) for the White Mountains. While *M. evotis* is known to use a variety of roosts including caves, mines, buildings, and rock crevices at ground level, it also in forested regions appears to make extensive use of tree roosts (Vonhof and Barclay 1996, Waldien et al. 1999). In this region of northern California, black oaks may provide significant roost sites (Rainey and Pierson 1997).

3.5.2.7. *Myotis lucifugus*

There are 49 musuem records from 12 localities for *M. lucifugus* in the six county area (with no records from Colusa or Trinity counties)(CAS, CM, MVZ, USNM). In considering the entire northwestern region, the majority of records are from the most northern areas: Humboldt, Shasta and Siskiyou counties (AMNH, CAS, CSUH, MVZ, USNM). In our Sacramento River study, this species was rare in the Squaw Creek drainage, and increasing abundant with increasing latitude on the Sacramento drainage. We also identified a large nursery colony near the Oregon border (Rainey and Pierson 1996a).

In this study, we captured 78 animals identifiable as *M. lucifugus* and another 36 which could not be adequately distinguished from *M. yumanensis*, making this species the second or third most abundant species in net captures. It occurred at eleven (58 %) of the sites. It co-occurred with *M. yumanensis* at 10 sites, but was significantly more abundant only on the Scott River (Indian Scotty). These results suggest that, while northwestern California is a zone of overlap for these two species, *M. lucifugus* becomes relatively more abundant with increasing latitude.

3.5.2.8. *Myotis yumanensis* (USFWS-SC)

Although there are museum records for *M. yumanensis* from all the counties of northwestern California, with 237 specimens from 30 localities in the six county study area, there are only three from the drainages involved in this study -- two from the vicinity of Happy Camp on the Klamath River, and one from Burnt Ranch on the Trinity (CAS, CM, CSUH, KU, MVZ, USNM). Yet, in both this study and our work on the Sacramento River and Squaw Creek, *M. yumanensis* was the overall the most widespread and most abundant species in net captures (Rainey and Pierson 1996a).

In this study *M. yumanensis* was by far the most abundant species in net captures, and was encountered at 16 (84 %) of the sites. The only localities at which it was not found were Dutch Oven (where we netted in early June and only caught one bat, a *L. cinereus*), Balm of Gilead, and the North Trinity River Campground. Of all the species, *M. yumanensis* forages most intensively on emergent aquatic insects, typically flying in a broad ellipse less than one meter from the water surface. Capture rates indicate that they favor wide channels and still, slow moving, preferably pooled water. The sites that yielded relatively large numbers of *M. yumanensis* all had these characteristics.

3.5.2.9. *Pipistrellus hesperus*

Museum records for *P. hesperus* are extremely limited for northwestern California, with the most northern records being from the vicinity of Red Bluff (Tehama County) and Lake Shasta (Constantine 1982) -- although the species is known from eastern Oregon and southern Washington, (Hall 1981). There are nineteen specimens from six localities in Lake and Tehama counties (MCZ, MVZ, UIMNH, USNM). There are no museum records from Colusa, Mendocino, Siskiyou, or Trinity counties. In the course of the Cantara project, we repeatedly and predictably captured multiple individuals at one site on Squaw Creek, and single animals at three sites on the Sacramento River, significantly extending this species known range within California (Rainey and Pierson 1996a).

Nine *P. hesperus* were caught in this study (making it tenth in abundance in net captures). Eight, including reproductive females and young, were taken at the two Colusa County sites. One individual, an adult male, was mist-netted on the North Fork of the Trinity River near Helena, 65 km from the nearest known record. This species has quite a distinctive echolocation call, and was also detected acoustically at Canyon Creek, a site only ca. 5 km from the Helena site, at two sites along the Salmon River (Sawpit Flat and Somes Bar), and at Dillon Creek (Figure 8). These observations provide a notable range extension for this species. Although *P. hesperus* is generally considered a low elevation, desert bat, it has been found up to 2,740 m in the Inyo Mountains (Szewczak et al. 1998), and occurs in Yosemite Valley (Pierson et al. 2001). Its presence seems to depend on the availability of cliffs, where it roosts in crevices. In this context, its occurrence in the Trinity and Salmon river drainages, both of which have abundant exposed rock and very warm summer temperatures, is not surprising.

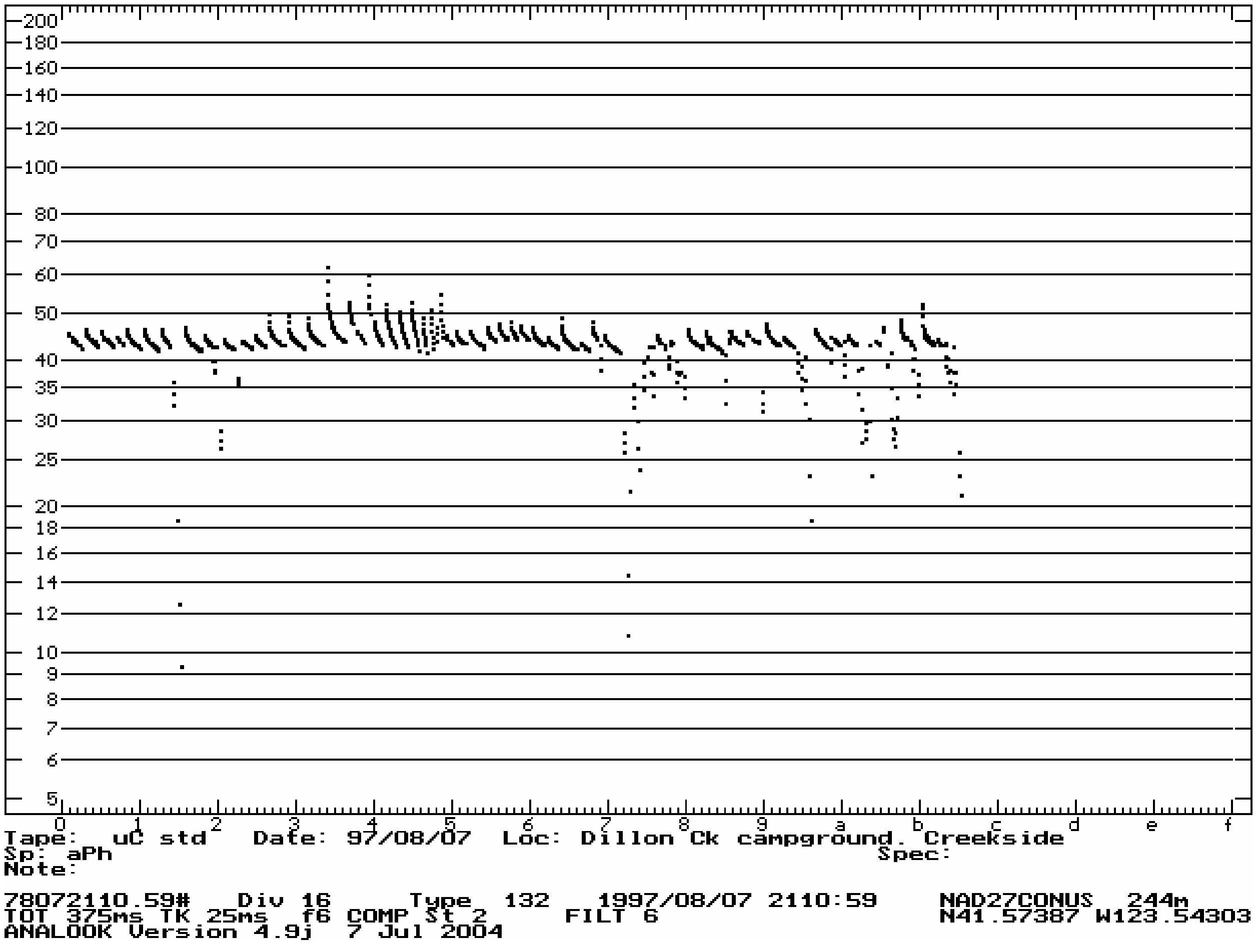


Figure 8. Sonogram for *P. hesperus* recorded with Anabat on 7 August 1997 at Dillon Creek, near confluence with Klamath River, Siskiyou County.

3.5.2.10. *Tadarida brasiliensis*

There are remarkably few museum locality records for *T. brasiliensis* in northwestern California, occurring only in Colusa, Humboldt, Lake and Tehama counties. The Humboldt records are all from the spring, fall or winter; the Tehama County records all from the Central Valley or the eastern foothills. There are 59 records from 16 localities in the six county study area (CAS, MVZ, UCLA). Nevertheless, the largest colony known in the state (>200,000) is in Lava Beds National Monument in Siskiyou County. From 1991-1996, we captured this species infrequently at multiple sites on both the Sacramento River and Squaw Creek (Rainey and Pierson 1996a), where there was a notable increase in the relative abundance of this species in the fall. We interpreted this to be fall migration, possibly from the Lava Beds colony. Spring migration has also been observed, when large numbers of animals are resident for a short period of time at caves near Mt. Shasta.

In this study, *T. brasiliensis* was the rarest species in our net-captures. We captured only two individuals, both adult males, at adjacent sites in the Trinity drainage (Canyon Creek and

Helena). Characteristic echolocation calls were also detected in late September at Deer Creek in the Trinity Mountains. The near absence of *T. brasiliensis* from our netting and acoustic records is very striking, especially since this species is very readily detected acoustically. We conclude from this that this species is very rare, at least during the summer months, in the Trinity Mountains. The appearance of acoustic records in late September at Deer Creek is suggestive of fall migration through the area. These results offer a striking contrast to the Sierra Nevada where this species is ubiquitous and common throughout the range, from the foothills to over 3,600 m in elevation, including areas such as S. Lake Tahoe, the Stanislaus and Sierra National Forests, Yosemite National Park, and Sequoia/Kings Canyon National Park.

4.0 CONCLUSIONS AND RECOMMENDATIONS

Comparisons of these results with those from surveys conducted in the White Mountains (Szewczak et al. 1998), the Sierra Nevada (Lengas and Bumpus 1992 and 1993, Pierson and Heady 1996; Pierson et al. 2001) suggest there are significant differences in both the species composition and relative abundance among these mountain ranges. While the species list for this region is the same as that established by our six year study on the Sacramento River (Rainey and Pierson 1996a), there are also intriguing differences in relative abundance of some species (e.g., *A. pallidus*, *E. fuscus*, *M. thysanodes*, *T. brasiliensis*).

Because there was such a paucity of locality records for this region, particularly in the less populated mountain areas, we opted to sample a number of sites, rather than repeatedly sample fewer sites. With this choice, we gained information on distribution over a broad area, and established new county and regional records for a number of species. We lost the ability to say anything very conclusive about species composition at a particular locality. What we do know is that most of bats, because of their ability to fly, have fairly broad distributions relative to other small mammals, and what is interesting and important for most of them is not so much whether they occur at a particular locality, but rather their relative abundance in a region, and how they are using the habitat. Repeated sampling at a number of sites, as was done in the Sacramento River study, allows us to make reasonable inferences regarding relative abundance, which in turn may help shape inquiries regarding habitat needs. For example, it did appear, even from this limited sample, that *M. thysanodes* is more common in the Trinities than it was on the Sacramento River. A radiotracking study involving animals from both areas could address focused questions on habitat use.

There is a tendency in a management context to treat all presence/absence data equally when, in fact, its meaning is very much related to behavioral characteristics of the particular species. For example, in interpreting mist-netting data it is important to consider the foraging range of the species. Many of the tree-dwelling taxa (e.g., *L. noctivagans*, *L. cinereus*, *M. thysanodes*, and *M. volans*) travel considerable distances to forage, whereas others appear to forage relatively close to their roost sites (e.g., *A. pallidus*, *M. evotis*, *P. hesperus*) (Pierson 1998). For the latter group it might well be appropriate to look closely at the habitat in the vicinity of the netting site for clues regarding roosting habitat, but for the others it might be more appropriate to investigate the habitat 10-15 km upstream or on nearby ridge tops.

This study also illustrates the importance of using multiple techniques in a distributional survey. The only records we obtained for *C. townsendii* were from roost surveys; the only records for *L. blossevillii*, *E. maculatum*, and *E. perotis* were acoustic. Acoustic monitoring in conjunction with netting also provided locality records for several species (e.g., *A. pallidus, L. blossevillii, L. cinereus*, *P. hesperus*) that would not have been obtained by mist-netting alone. Because, at this point we do not know how to distinguish *M. volans* acoustically from other 40 KHz *Myotis*, mist-netting and bridge night roost surveys remain the survey method of choice for this species.

What is most needed from a distributional perspective, both in the Trinity/Klamath region and the Sierra Nevada, is a better understanding of the elevational distribution of various species. Information on high elevation distribution has been investigated in the White Mountains (Szewczak et al. 1998), but is lacking for the other ranges. Information of specific habitat needs -- roost site selection, foraging range, and degree of flexibility in foraging behavior -- is also needed for many species, and can best be obtained by focal radiotracking studies of particular species.

5.0 ACKNOWLEDGEMENTS

We gratefully acknowledge the extensive participation of Chris Corben, Paul Heady, Wendy Philpott, and Cynthia Poett in various aspects of this project. We especially appreciate the contribution made by the Mendocino National Forest, particularly Linda Angerer, Coleen Pelles, Desiree Haigt, Fran Peters and other volunteers. L. Angerer was responsible for arranging a pack trip into the Yolla Bolly Wilderness, and for the resampling of the Mendocino National Forest sites. Wendy Philpott donated a week of time to assist with netting, and offered data she collected in Trinity and Siskiyou counties for inclusion in this report. We thank Tom Ingersoll of U.C. Berkeley for providing the statistical analysis. Work at the Angelo Reserve was conducted primarily with the assistance of Paola Bernazza, and was partially funded by a National Science Foundation Grant to Mary Power of U.C. Berkeley. Gregg Erickson, Caltrans Environmental Division, provided data on bridges. Ray Miller participated in some of the netting and bridge surveys, and conducted some of the original site reconnaissance. Liz Wolff assisted with netting and cave locations.

6.0 LITERATURE CITED

Allen, J. A. 1891. Description of a new species of big-eared bat, of the genus *Histiotus*, from southern California. Bulletin of the American Museum of Natural History 3:195-198.

Anthony, E. L. P. 1988. Age determination in bats. pp. 47-58, *in* T. H. Kunz, ed. Ecological and behavioral methods for the study of bats, Smithsonian Institution Press, Washington, D.C.

Barbour, R. W. and W. H. Davis. 1969. Bats of America. Vol. University of Kentucky Press, Lexington, Ky. 286 pp.

Barclay, R.M.R. and R.M. Brigham (eds.) 1996. Bats and Forests Symposium, October 19-21, 1995, Victoria, British Columbia, Canada. Research Branch, BC Ministry of Forests, Victoria, BC, Working Paper 23/1996.

Betts, B. J. 1996. Roosting behaviour of silver-haired bats (*Lasionycteris noctivagans*) and big brown bats (*Eptesicus fuscus*) in northeast Oregon. pp. 55-61, *in* (R.M.R. Barclay and R.M. Brigham, eds.). Bats and Forests Symposium, October 19-21, 1995, Victoria, British Columbia, Canada. Research Branch, BC Ministry of Forests, Victoria, BC, Working Paper 23/1996.

Betts, B. J. 1998. Roosts used by maternity colonies of silver-haired bats in northeastern Oregon. Journal of Mammalogy 79:643-650.

Bleich, V. C. and A. M. Pauli. 1988. Additional records of the spotted bat (*Euderma maculatum*) from California. Great Basin Naturalist 48:**563.**

Brylski, P.V., P.W. Collins, E.D. Pierson, W.E. Rainey, and T.E. Kucera. 1998. Mammal Species of Special Concern in California, DRAFT Final Report to California Department of Fish and Game, Sacramento, CA.
.

Campbell, L. A., J. G. Hallett, and M. A. O'Connell. 1996. Conservation of bats in managed forests: use of roosts by *Lasionycteris noctivagans*. Journal of Mammalogy 77:976-984.

Christy, R. E. and S. D. West. 1993. Biology of bats in Douglas fir forest. U.S. Dept. of Agriculture, Forest Service, Pacific Northwest Research Station. General technical report PNW-GTR-308. 1-28.

Chung-MacCoubrey, A. L. 1996. Bat species composition and roost use in pinyon-juniper woodlands of New Mexico. pp. 118-123, *in* (R.M.R. Barclay and R.M. Brigham, eds.). Bats and Forests Symposium, October 19-21, 1995, Victoria, British Columbia, Canada. Research Branch, BC Ministry of Forests, Victoria, BC, Working Paper 23/1996.

Constantine, D. G. 1959. Ecological observations on lasiurine bats in the north Bay area of California. Journal of Mammalogy 40:13-15.

Constantine, D. G. 1982. Batproofing of buildings by installation of valvelike devices in entryways. Journal Of Wildlife Management 46:507-513.

Constantine, D.G. 1998. An overlooked external character to differentiate *Myotis californicus* and *Myotis ciliolabrum* (Vespertilionidae). Journal of Mammalogy 79:624-630.

Constantine, D. G., G. L. Humphrey, and T. B. Herbenick. 1979. Rabies in *Myotis thysanodes, Lasiurus ega, Euderma maculatum* and *Eumops perotis* in California. Journal of Wildlife Diseases 15:343-345.

Crampton, L.H. 1994 [Abs.]. Bat abundance and distribution in northern Alberta mixed wood stands of different seral stages. Bat Research News 35:95.

Crampton, L. H. and R. M. R. Barclay. 1996. Habitat selection by bats in fragmented and unfragmented aspen mixedwood stands of different ages. Pp. 238-259, *in* (R.M.R. Barclay and R.M. Brigham, eds.). Bats and Forests Symposium, October 19-21, 1995, Victoria, British Columbia, Canada. Research Branch, BC Ministry of Forests, Victoria, BC, Working Paper 23/1996.

Cross, S. P. and D. Clayton. 1995. [ABS]. Roosting habits of bats in southern Oregon. Abstracts. Wildlife Society Meetings, Portland, OR.

Cryan, P. M. 1996. [ABS]. Habitat use and roosting ecology of bats inhabiting the southern Black Hills of South Dakota: a progress report. Bat Research News 37:24-25.

Dalquest, W. W. 1943. Seasonal distribution of the hoary bat along the Pacific coast. Murrelet, 24:21-24.

Eger, J. L. 1977. Systematics of the genus *Eumops* (Chiroptera, Molossidae). Life Sciences Contributions of Royal Ontario Museum, Contribution No. 110:1-69.

Gellman, S. T. and W. J. Zielinski. 1996. Use by bats of old-growth redwood hollows on the north coast of California. Journal of Mammalogy 77:255-265.

Grindal, S.D. 1994 [Abs.]. Impacts of forest harvesting on the foraging ecology of bats in southern British Columbia. Bat Research News 35:100.

Grindal, S. D., J. L. Morissette, and R. M. Brigham. 1999. Concentration of bat activity in riparian habitats over an elevational gradient. Canadian Journal of Zoology 77:972-977.

Grinnell, H. W. 1918. A synopsis of the bats of California. University of California Publications in Zoology 17:223-404.

Grinnell, J. 1916. An analysis of the vertebrate fauna of the Trinity region of northern California. University of California Publications in Zoology 12:399-410.

Grinnell, J. and T. I. Storer. 1924. Animal life in the Yosemite. University of California Press, Berkeley.

Hall, E. R. 1981. The mammals of North America. J. Wiley and Sons, New York.

Jones, C. J. 1965. Ecological distribution and activity periods of bats of the Mogollon Mountains area of New Mexico and adjacent Arizona. Tulane Studies in Zoology, 12:93-100.

Jones, C. and R. D. Suttkus. 1972. Notes on netting bats for eleven years in western New Mexico. Southwestern Naturalist 16:261-266.

Kalcounis, M. 1994 [ABS]. Selection of tree roost sites by big brown (*Eptesicus fuscus*), little brown (*Myotis lucifugus*) and hoary (*Lasiurus cinereus*) bat in Cypress Hills, Saskatchewan. Bat Research News 35:103.

Kalcounis, M. C. and K. R. Hecker. 1996. Intraspecific variation in roost-site selection by little brown bats *(Myotis lucifugus*). Pp. 81-90, *in* (R.M.R. Barclay and R.M. Brigham, eds.). Bats and Forests Symposium, October 19-21, 1995, Victoria, British Columbia, Canada. Research Branch, BC Ministry of Forests, Victoria, BC, Working Paper 23/1996.

Kalcounis, M. C., K. A. Hobson, and R. M. Brigham 1996. [ABS]. Spatial and temporal habitat use by bats along a vertical gradient in temperate forest. Bat Research News 37:137.

Kellogg, L. 1916. Report upon mammals and birds found in portions of Trinity, Siskiyou and Shasta Counties, California, with description of a new *Dipodomys*. University of California Publications in Zoology 12:335-398.

Kunz, T. H. and A. Kurta. 1988. Capture methods and holding devices. Pp. 1-29, *in* T. H. Kunz, ed. Ecological and behavioral methods for the study of bats, Smithsonian Institution Press, Washington, D.C.

Lengas, B. J. and D. Bumpus. 1992. An initial sampling of the bat fauna of the Plumas National Forest. Unpublished Report, Beckworth Ranger District, Plumas National Forest, Blairsden, CA, 15 pp.

Lengas, B. J. and D. Bumpus. 1993. An additional sampling of the bat fauna of the Plumas National Forest. Unpublished Report, Beckworth Ranger District, Plumas National Forest, Blairsden, CA, 32 pp.

Marcot, B. G. 1984. Winter use of some northwestern California caves by western big-eared bats and long-eared myotis. Murrelet 65:46.

Mattson, T. A., S. W. Buskirk, and N. L. Stanton. 1996. Roost sites of the silver-haired bat (*Lasionycteris noctivagans*) in the Black Hills, South Dakota. Great Basin Naturalist 56:247-253.

McMahon, E. E., C. C. Oakley, and S. F. Cross. 1981. First record of the spotted bat (*Euderma maculatum*) from Oregon. Great Basin Naturalist 41:270 or 185.

Miner, K.L. and P.E. Brown. 1996. A report on the southern California forest bat survey and radio-telemetry study of 1996. Report to USFS, San Diego, CA, 13 pp.

Montgomery, D.R. and J.M. Buffington. 1997. Channel-reach morphology in mountain drainage basins. Geological Society of America Bulletin 109:596-611.

Morrell, T. E., H. M. Green, K. Yasuda, R. Miller, J. deVos and J. B. Grantges. 1994. Roost-site characteristics of forest dwelling bats in north-central Arizona. Bat Research News 35(4):108.

Ormsbee, P. C. 1996. Characteristics, use, and distribution of day roosts selected by female *Myotis volans* (long-legged myotis) in forested habitat of the central Oregon Cascades. Pp. 124-131 *in* (R.M.R. Barclay and R.M. Brigham, eds.). Bats and Forests Symposium, October 19-21, 1995, Victoria, British Columbia, Canada. Research Branch, BC Ministry of Forests, Victoria, BC, Working Paper 23/1996.

Ormsbee, P. C. and W. C. McComb. 1998. Selection of day roosts by female long-legged myotis in the central Oregon Cascade Range. Journal of Wildlife Management 62:596-603.

Orr, R. T. 1950. Notes on the seasonal occurrence of red bats in San Francisco. Journal of Mammalogy 31:457-558.

Pearson, O. P., M. R. Koford, and A. K. Pearson. 1952. Reproduction of the lump-nosed bat (*Corynorhinus rafinesquei*) in California. Journal of Mammalogy 33:273-320.

Pierson, E.D. 1998. Tall trees, deep holes, and scarred landscapes: conservation biology of North American bats. In (T.H. Kunz, and P.A. Racey, eds.) Bats: phylogeny, morphology, echolocation, and conservation biology. Smithsonian Institution Press, Washington, DC.

Pierson, E.D. and G. M. Fellers. 1998. Status, Distribution and Habitat Associations of *C. townsendii* in California. Report to U.S. Fish and Wildlife Service, Species at Risk Program.

Pierson, E.D. and P.A. Heady. 1996. Bat Surveys Giant Forest Village and Vicinity, Sequoia National Park. Report to National Park Service, Denver, CO, 27 pp.

Pierson, E.D. and W.E. Rainey. 1996a. Distribution, habitat associations, status, and survey methodologies for three molossid bat species (*Eumops perotis*, *Nyctinomops femorosaccus*, *Nyctinomops macrotis*) and the vespertilionid (*Euderma maculatum*). Calif. Dept. of Fish and Game, Bird and Mammal Conservation Program Rep.96-8. 46 pp.

Pierson, E.D. and W.E. Rainey. 1996b. The distribution, status and management of Townsend's big-eared bat (*Corynorhinus townsendii*) in California. Calif. Dept. of Fish and Game, Bird and Mammal Conservation Program Rep. 96-7. 49 pp.

Pierson, E.D. and W.E. Rainey. 1998. Distribution of the spotted bat, *Euderma maculatum*, in California, with notes on habitat associations and status. Journal of Mammalogy 79:1296-1305.

Pierson, E.D., W.E. Rainey, and C. J. Corben. 2001. Seasonal patterns of bat distribution along an altitudinal gradient in the Sierra Nevada. Report to California State University at Sacramento Foundation, Yosemite Association, and Yosemite Fund, 70 pp.

Pierson, E .D., W. E. Rainey, C. J. Corben, M. E. Colberg, and W. F. Frick. 2002. Bat use of the giant sequoias (*Sequoia giganteus*) in Yosemite National Park. Report to Yosemite National Park and the Yosemite Fund. (In preperation).

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, Canada. Research Branch, BC Ministry of Forests, Victoria, BC, Working Paper 23/1996.

Racey, P. A. 1988. Reproductive assessment in bats. Pp. 31-45, *in* T. H. Kunz, ed. Ecological and behavioral methods for the study of bats, Smithsonian Institution Press, Washington, D.C.

Racey, P. A. 1998. The importance of the riparian environment as a habitat for British bats. pp. 69-91, *in* N. Dunstone and M. L. Gorman, ed. Behaviour and ecology of riparian mammals, Cambridge University Press, Cambridge.

Rainey, W. E. and E. D. Pierson. 1995 [ABS]. Maternity roosts and geographic scale of foraging activity of *Lasionycteris noctivagans* in northern Californian forests. Bat Research News 35:111.

Rainey, W. E. and E. D. Pierson. 1996a. Cantara spill effects on bat populations of the upper Sacramento River, 1991-1995. Report to California Department of Fish and Game, Redding, CA, (Contract # FG2099R1), 98 pp.

Rainey, W.E. and E.D. Pierson. 1996b. [Abs.]. Species composition and variation in the bat community over a northern California forested river. Bat Research News 36: 31.

Rainey, W. E. and E. D. Pierson. 1997. Monitoring of bat populations on the Upper Sacramento River, 1996. Report to California Department of Fish and Game, Redding, CA, (Contract # FG 5730 CA), 35 pp.

Rainey, W.E., E.D. Pierson, M. Colberg, and J. H. Barclay. 1992. [ABS.]. Bats in hollow redwoods: seasonal use and role in nutrient transfer into old growth communities. Bat Research News 33:71.

Saugey, D. A. 1991. U.S. National Forests: unsung home to America's bats. Bats 9(3):3-6.

Seidman, V. M. and C. J. Zabel. 2001. Bat activity along intermittent streams in northwestern California. Journal of Mammalogy 82:738-747.

Storz, J. F. and C. F. Williams. 1996. Summer population structure of subalpine bats in Colorado. Southwestern Naturalist 41:322-324.

Szewczak, J. M., S. M. Szewczak, M. L. Morrison and L. S. Hall. 1998. Bats of the White and Inyo Mountains of California-Nevada. Great Basin Naturalist 58:66-75.

Tenaza, R. R. 1966. Migration of hoary bats on South Farallon Island, California. Journal of Mammalogy 47:533-535.

Thomas, D. W. 1988. The distribution of bats in different ages of Douglas-fir forests. Journal of Wildlife Management 52:619-626.

Thomas, D. 1991 [Abs.]. Forest age associations of bats in the southern Washington Cascades and Oregon Coast Range. Bat Research News 32:88.

van Zyll de Jong, C.G. 1985. Handbook of Canadian mammals. Vol. 2. National Museum of Natural Sciences, Ottawa, 212 pp.

Vonhof, M. J. 1996. Roost-site preference of big brown bats (*Eptesicus fuscus*) and silver-haired bats (*Lasionycteris noctivagans*) in the Pend d'Oreille Valley in southern British Columbia. pp. 62-80, *in* (R.M.R. Barclay and R.M. Brigham, eds.). Bats and Forests Symposium, October 19-21, 1995, Victoria, British Columbia, Canada. Research Branch, BC Ministry of Forests, Victoria, BC, Working Paper 23/1996.

Vonhof, M. J. and R. M. R. Barclay 1996. Roost-site selection and roosting ecology of forest-dwelling bats in southern British Columbia. Canadian Journal of Zoology 74:1797-1805.

Waldien, D. L., J. P. Hayes and B. E. Wright. 1999. Use of conifer stumps as day-roosts by bats in western Oregon. Northwestern Naturalist 80:134.

Warner, R. M. and N. J. Czaplewski. 1984. *Myotis volans*. Mammalian Species 224:1-4.

Weller, T. J. and C. J. Zabel. 2001. Characteristics of fringed myotis day roosts in northern California. Journal of Wildlife Management 65:489-497.

Woodsworth, G. C. , G. P. Bell, and M. B. Fenton. 1981. Observations of the echolocation, feeding behaviour, and habitat use of *Euderma maculatum* (Chiroptera: Vespertilionidae) in southcentral British Columbia. Canadian Journal of Zoology 59:1099-1102.

Zeiner, D. C., W. F. Laudenslayer, Jr., K. E. Mayer, and M. White. 1990. California's wildlife. Vol. III. Mammals. California Department of Fish and Game, Sacramento.

Zielinski, W. J. and S. T. Gellman. 1999. Bat use of remnant old-growth redwood stands. Conservation Biology 13:160-167.