Bat and Bridges Technical Bulletin

Hitch Hikers Guide to Bat Roosts

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Preface

When species are cryptic and difficult to detect, their ecological significance may not be appreciated. They may be overlooked in the environmental assessment process and effects of our activities may not be adequately evaluated. This is especially true for species that are small, nocturnal, or do not announce themselves with bright colors or distinctive vocalizations--such is the case for the Microchiroptera.

Similarly, the results of actions we take are not always apparent or well understood. Often, Microchiropteran response is subtle or occurs in a timeframe that makes detection difficult. This is especially true when multiple aspects of a system are simultaneously undergoing change. In some cases, what is perceived by us to be a negative impact could be a positive offset to another change--such is the case of building and maintaining bridge structures.

Bridge structures have historically been considered an intrusion into biologically valuable riparian areas. They are not generally considered an asset to the local ecosystem. Yet, depending on the type of structure and other habitat features, they can and do provide important habitat for diurnal and nocturnal predators of insects, such as bats. Thus, the presence of a bridge in an area may dramatically affect local insect populations and alter the ecosystem considerably. Deposited bat guano redistributes nitrogen throughout the area and is focused under roosts in riparian habitats.

In California alone, 25 million people regularly pass within feet of roosts as they pass over bridges without even realizing that bats are present below them. The structures that support them provide little outward evidence that they are functioning as an important habitat feature of our modified landscape. The bridges act as an analog to aspects of the large oak, cottonwood and sycamore trees felled long ago, and to the rock outcroppings and caves now submerged by reservoirs.

It is quite remarkable that these adaptive little animals have learned to use a prominent symbol of our intrusion into their world as a base from which to attack the insect pests that affect our food supply, and in effect, have forged a symbiotic relationship with us. Yet, the presence of these secretive species has not been widely known, nor have they been considered during the process of constructing and maintaining bridge structures.

Purpose and Intended Readership

The purpose of this volume is to provide information and approaches to solve issues related to bats and structures. The approaches presented here are intended as options that are flexible and evolving with increasing knowledge.

The intended readership includes people and organizations that control or provide input on how the California Department of Transportation designs, builds, and maintains bridge structures. This information may also be of use to researchers and biologists striving to learn more about these remarkable animals and how to ensure their survival long into the future.

Safety and the Law

It is very important to recognize that working with wildlife in proximity to active transportation facilities requires special considerations to assure safety and legality of one's actions.

Safety and the Law (Gregg Erickson)

Safety should always be first and foremost. Moving traffic, flying debris, and rough terrain can easily injure or kill anyone who does not respect the dangers, pay attention to detail and the surroundings, and conduct their activities in a safe manner. The men and women who design, build, and maintain America's roads and bridges are specially trained in awareness and safety, and are required to always use safety devices, including but not limited to: hard hats, reflective vests, long pants, boots with ankle support, and eye protection. Even with safety measures in place, the rate of injury and death is higher among these dedicated workers than any other civil service duty. Anyone who expects to be within proximity to traffic or structures should *always* pursue safety training and use it, regardless of where they are or how light traffic may appear.

Safety should also be considered when working with soils, plants, wildlife, or other natural resources. Injury and illness can be prevented with, for example, attention to detail, adherence to proper procedures, appropriate hygiene, vaccinations, and

protective equipment. Anyone who expects to come in proximity to natural resources such as wildlife should educate themselves on proper precautions and procedures necessary in the field, and they should implement them. County veterinarians, county agricultural extensions and universities are good sources of information. Good practices will keep both wildlife and people safe and healthy.

Permits and legal access must always be considered and obtained when required. The capture and release of wildlife is regulated and requires some form of license, permit, or MOU from the Department of Fish and Game, and, in the case of federally listed species, the U.S. Fish and Wildlife Service. Likewise, access to public and private lands often requires permits or letters of permission. Structures, as mentioned in this document, are often in locations where private property runs underneath the bridge or where access is restricted for safety's sake.

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1.0 Introduction

1.1 Context

The California Department of Transportation is one of the largest property managers in the State of California. This property includes tens of thousands of miles of state and interstate highways, as well as associated structures, buildings, right-of-way easements, and connected parcels. The highway system crosses and interacts with nearly every bioregion and habitat type in California, a state containing some of the richest diversity of species and ecosystems in the nation.

Maintenance, rehabilitation, and improvements to California's transportation infrastructure are a constant process. Caltrans and other transportation agencies plan, design, and supervise changes to hundreds of miles of roads, railroads, and other transportation subsystems. They also team with other federal, state, and local agencies involved in infrastructure planning and repair, such as those involving bridges.

Many of the habitats, structures, buildings, mines, and bridges associated with these projects are likely to be inhabited by bats. Night roosting by pallid bats in the warm air pockets of certain bridges and crevice use by Mexican free-tailed bats are examples of transportation facilities inhabited by bats. Large colonies of other species, such as the Yuma myotis and big brown bat, are also likely to occur in buildings and other structures in the Department of Transportation's right of way.

The full extent of interactions between bats and transportation facilities is not yet completely understood. Understanding of the transportation facility features that provide habitat value for bats are only now reaching a level sufficient to provide a basis for evaluations and incorporation into project design. Gaps in understanding stem from information needs on current facility use and the Department's ongoing efforts to develop and incorporate consistent and effective methods of habitat use assessment into the natural environment study process.

The purpose of this bulletin is to present a better understanding of transportation facility interaction with bats, develop improved assessment methods, and provide an

approach for accommodating bat species within the context of environmental planning. This effort is necessary for ensuring the persistence of bat populations using bridges. Positive contributions from studies such as this may reduce the need for formal protection in the future.

Figure 1.1-1: Multiple Species Roosting (Carolyn Brown)

2.0 Species

California provides habitat for 24 bat species in the families Phyllostomidae, Vespertillionidae, and Mollossidae. All but the nectivorous *Choeronycteris mexicana* of southern California, are insectivorous. Fifteen are rare and/or considered Mammal Species of Special Concern by California Department of Fish and Game, Species of Concern by the U.S. Fish and Wildlife Service or the U.S. Forest Service. All of these species are known to have behavioral and ecological interactions with the transportation system, directly or indirectly. These interactions can be positive, such as roosting opportunities, or negative, such as physical injury from moving vehicles.

The most common, and perhaps the most significant feature of their life history that has a direct relationship with transportation, is their need for roosting locations. The bridges of California are as diverse as the many species of bats and for many species provide analogs for natural roosts.

This section provides a list California species and their relative probability for using bridge structures. It also provides data on their legal status, roost type, and common colony sizes.

2.1 Species Found on Bridges

Ninety three percent of the rare bats in California either use or are likely to use bridges. A total of eighteen species use bridges in one way or another. A listing of the species and their probable use of bridges are found in the following tables.

2.1.1 Species Commonly Found on Bridges

Species	Common Name	Legal Status	Roost Type	Colony Size	Roost Style
Family Vespertillionidae (mouse eared bats)					
Antrozous pallidus	Pallid bat	SSC	D,M,N	30-300	V
Eptisicus fuscus	Big Brown Bat	WL	D,M,N	30-300	V
Myotis yumanensis	Yuma myotis	C21	D,M,N	100-3,000	V
Family Molossidae					
Tadarida brasiliensis	Mexican free-tailed bat	WL	D,M,N	30-250,000	V

1 Species added to animal candidate list by U.S. Fish and Wildlife Service in 1994.
2 This species could use bridges, but is not well documented due to their rare nature.
C2 = Federal Species of Concern, Formerly Candidate 2 for federal Endangered Species Act listing, from Federal Register Vol. 59, No 219, November 15, 1994:58981-59028
SSC = Species of Special Concern, listed by the California Department of Fish and Game as a species with a non-cyclical population that is showing a significant downward population trend. WL = Species covered by Wildlife Related Fish and Game Code. Destruction of Colonies without permission can be a felony due to economic value.
D = Day Roost
M = Maternity Roost
N = Night Roost
H = Hibernation Roost
V = Crevice
C = Cavity

2.1.2 Species Sometimes Found on Bridges

Species	Common Name	Legal Status	Roost Type	Colony Size
Family Vespertillionidae (mouse eared bats)				
Myotis californicus	California myotis	WL	D,N	1
Myotis ciliolabrum (=leibii)	Small-footed myotis	C2[1]	D,N	1
Myotis evotis	Long-eared myotis	C2[1]	N	30-50
Myotis lucifigus	Little brown bat	WL[3]	D,M,N	100-3000 V
Myotis thysanodes	Fringed myotis	C2[1]	D,M,N	30-50
Myotis velifer	Cave myotis	C2,SSC	D,M,N?	30-1,000
Myotis volans	Long-legged myotis	C2[1]	N	30-300
Coryrhynus townsendii townsendii	Pacific Townsend's big-eared bat	C2,SSC	D,M,N	30-500

[1] Species added to animal candidate list by U.S. Fish and Wildlife Service in 1994.
2 This species could use bridges, but is not well documented due to their rare nature.
[3] Yosemite race/sub-species may be rare.
C2 = Federal Species of Concern, Formerly Candidate 2 for federal Endangered Species Act listing, from Federal Register Vol. 59, No 219, November 15, 1994:58981-59028
SSC = Species of Special Concern, listed by the California Department of Fish and Game as a species with a non-cyclical population that is showing a significant downward population trend. WL = Species covered by Wildlife Related Fish and Game Code. Destruction of Colonies without permission can be a felony due to economic value.
D = Day Roost
M = Maternity Roost
N = Night Roost
H = Hibernation Roost

2.1.3 Species Rarely Found on Bridges

Species	Common Name	Legal Status	Roost Type	Colony Size
Family Phyllostomidae (leaf nosed bats)				
Macrotus californicus	California leaf-nosed bat	C2,SSC	D?	25-500
Family Vespertillionidae (mouse eared bats)				
Myotis occultus	Arizonia myotis	C2,SSC	D,M,N	< 800
Pipistrellus hesperus	Western pipistrelle	WL	D	1

[1] Species added to animal candidate list by U.S. Fish and Wildlife Service in 1994.
2 This species could use bridges, but is not well documented due to their rare nature.
C2 = Federal Species of Concern, Formerly Candidate 2 for federal Endangered Species Act listing, from Federal Register Vol. 59, No 219, November 15, 1994:58981-59028
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D = Day Roost
M = Maternity Roost
N = Night Roost
H = Hibernation Roost

2.1.4 Species Possibly Using Bridges (but not recorded in California).

Species	Common Name	Legal Status	Roost Type	Colony Size
Family Phyllostomidae (leaf-nosed bats)				
Choeronycteris mexicana[2]	Mexican long-tongued bat	C2,SSC	?	40-50
Leptonycteris curasoae	Southern Long-nosed Bat	FE	N	100+
Family Molossidae (free-tailed bats)				
Nyctinmops macrotis[2]	Big free-tailed bat	SSC	?	ca50
Eumops perotis californicus	Greater western mastiff bat	C2,SSC	?	10-300
Nyctinomops femorosaccus[3]	Pocketed free-tailed bat	SSC	?	30-50

[1] Species added to animal candidate list by U.S. Fish and Wildlife Service in 1994.
[2] This species could use bridges, but is not well documented due to their rare nature.
[3] This species is known to use bridges in Nevada.
FE = Listed as endangered under the Federal Endangered Species Act
C2 = Federal Species of Concern, Formerly Candidate 2 for federal Endangered Species Act listing, from Federal Register Vol. 59, No 219, November 15, 1994:58981-59028
SSC = Species of Special Concern, listed by the California Department of Fish and Game as a species with a non-cyclical population that is showing a significant downward population trend. WL = Species covered by Wildlife Related Fish and Game Code. Destruction of Colonies without permission can be a felony due to economic value.
D = Day Roost
M = Maternity Roost
N = Night Roost
H = Hibernation Roost

2.1.5 Species Not Known to Use Bridges

Species	Common Name	Legal Status	Roost Type	Colony Size
Family Vespertillionidae (mouse-eared bats)				
Euderma maculatum	Spotted bat	C2,SSC		
Lasionyteris nocitvagans	Silver-haired bat	WL		
Lasiurus blossevilli (=borealis)	Red Bat	WL		
Lasiurus cinereus	Hoary Bat	WL		
Lasiurus xanthinus (=ega)	Southern Yellow Bat	WL		

[1] Species added to animal candidate list by U.S. Fish and Wildlife Service in 1994.
2 This species could use bridges, but is not well documented due to their rare nature.
C2 = Federal Species of Concern, Formerly Candidate 2 for federal Endangered Species Act listing, from Federal Register Vol. 59, No 219, November 15, 1994:58981-59028
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D = Day Roost
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2.2 Species Distribution

Species distribution is a strong factor is determining the potential species using a bridge structure. This is especially true in the southern part of the state where more tropical species extend up from Mexico. This section provides a brief overview of the distribution of species within California by Department of Transportation District.

2.2.1 Distribution by District

Species	1	2	3	4	5	6	7	8	9	10	11	12	CA
Macrotus californicus							K	K			K	P	K
Choeronycteris mexicana							K	K			K	K	K
Leptonycteris curasoae								K			K		K
Antrozous pallidus	K	K	K	K	K	K	K	K	K	K	K	K	K
Eptesicus fuscus	K	K	K	K	K	K	K	K	K	K	K	K	K
Lasionycteris noctivagans	K	K	K	K	K	K	K	K	K	K	K	P	K
Myotis californicus	K	K	K	K	K	K	K	K	K	K	K	K	K
M. ciliolabrum	K	K	K	K	K	K	K	K	K	K	K	K	K
M. evotis	K	K	K	K	K	K	K	K	K	K	K	K	K
M. lucifugus	K	K	K	K	K	K	K	K	K	K			K
M.. occultus								K			K		K
M. thysanodes	K	K	K	K	K	K	K	K	K	K	K	K	K
M. velifer								K			K		K
M. volans	K	K	K	K	K	K	K	K	K	K	K	K	K
M. yumanensis	K	K	K	K	K	K	K	K	K	K	K	K	K
Pipistrellus hesperus	K	K	K	K	K	K	K	K	K	K	K	K	K
Corynorhinus townsendii	K	K	K	K	K	K	K	K	K	K	K	K	K
Euderma maculatum	P	K	P			K	K	K	K	K	K	P	K
Lasiurus blossevillii	K	K	K	K	K	K	K	K	K	K	K	K	K
L. cinereus (=borealis)	K	K	K	K	K	K	K	K	K	K	K	K	K
L. xanthinus (=ega)					K		K	K			K	K	K
Tadarida brasiliensis	K	K	K	K	K	K	K	K	K	K	K	K	K
Eumops perotis	P	K	K	K	K	K	K	K	K	K	K	K	K
Nyctinomops femorosaccus							K	K			K	K	K
Nyctinomops macrotis				K	K		K	K			K	K	K
Potential in District	2	0	1	0	0	0	0	0	0	0	0	3	0
Known in District	15	17	16	17	18	17	22	24	17	17	24	18	25
District Total	17	17	17	17	18	17	22	24	17	17	24	21	25

p=potential

k=known

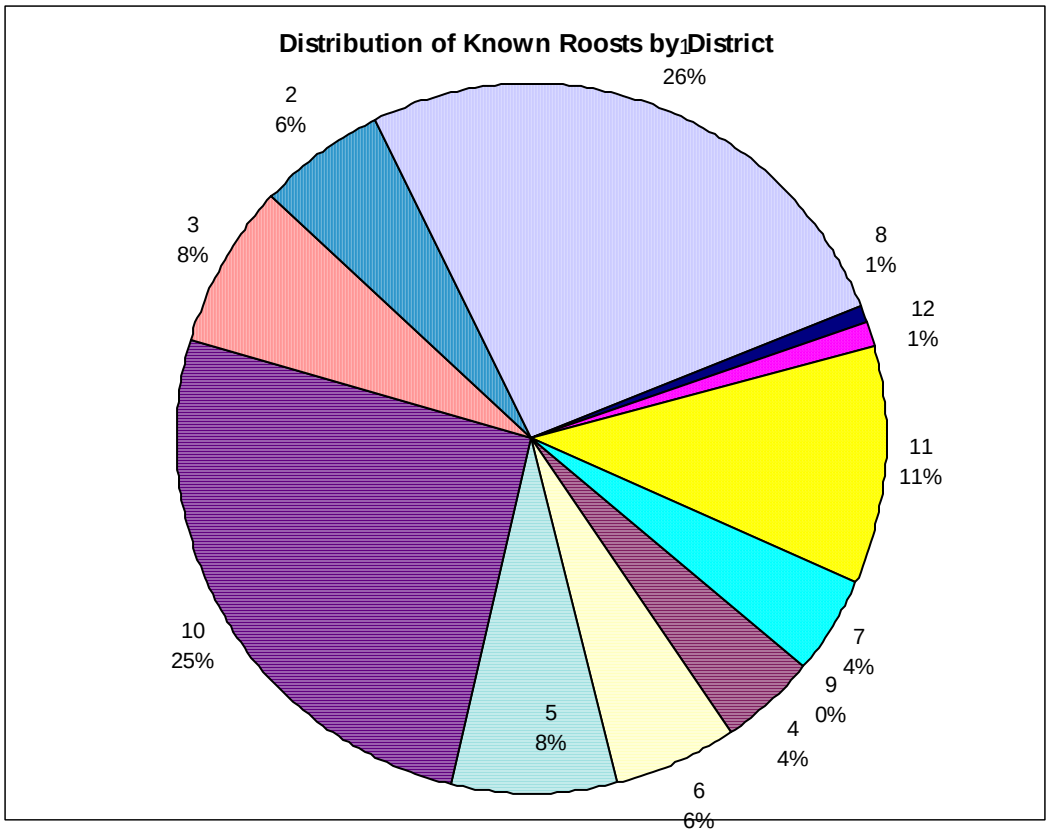


Figure 2.2.1-1 Roost Distribution by District

2.2.2 Distribution Within California

Bats may be found on bridges located through out California. The species found on a particular bridge is subject to the geographical location and habitat features available. Lack of species records in a particular habitat or geographic area is more likely a reflection of inefficient survey methods rather than species absence. Bridge records, for example, are very sparse for the Modoc Plain, Eastern Sierra, Great Basin, and southeast desert regions. However, these are areas of considerable bat habitat. Figure 2.2.2-1 shows bat roost locations with 5, 15, and 30 mile radii to indicate the 6.7 to 26.5 million hectares areas of California that are likely to be habitat for bats that use known Caltrans bridge roosts. For further information on distribution see Fish and Game species accounts. Also see *Hall 1981. And Barbour & Davis 1969*

For additional life history information s*ee Appendix 11.9 by Wendy Philpot as edited by E.D. Pierson*

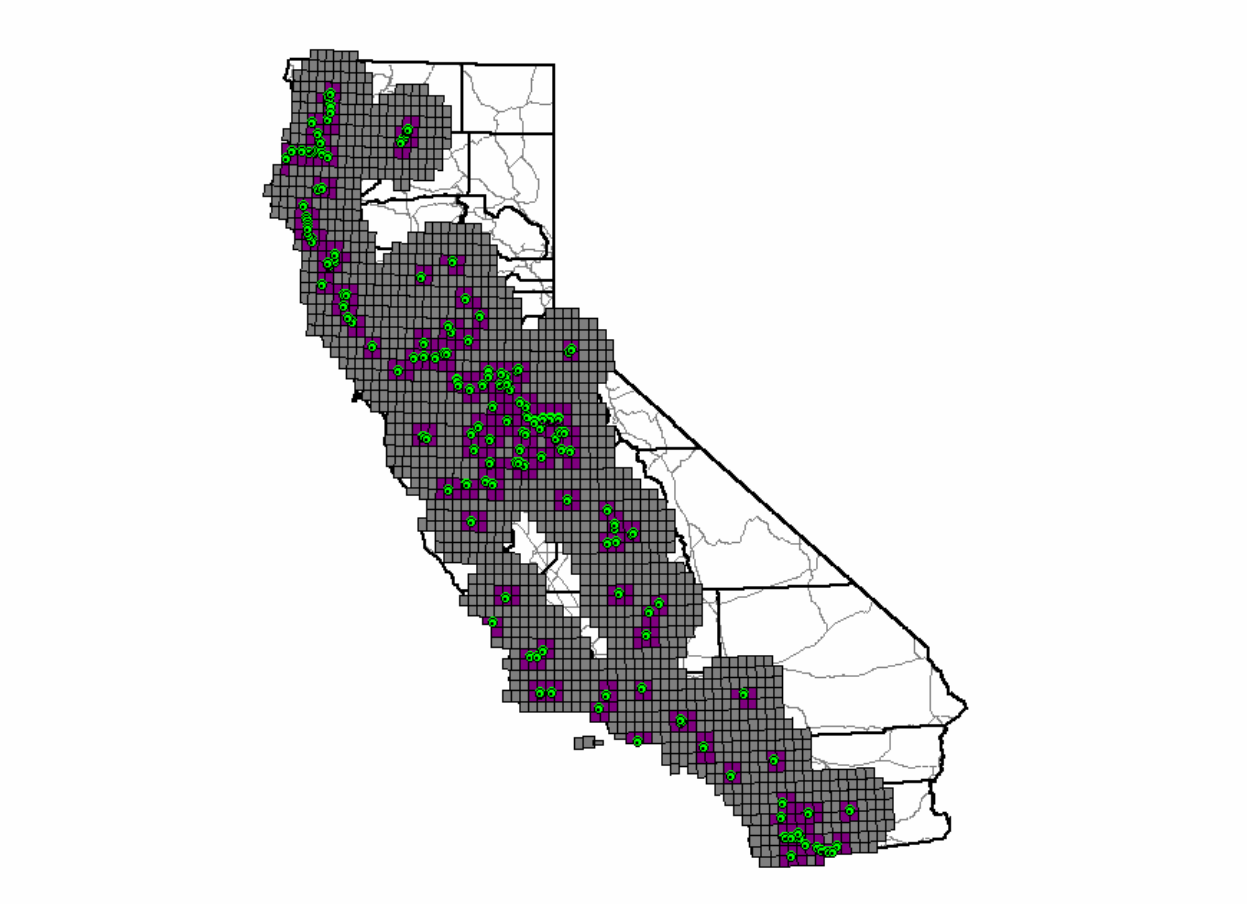


Figure 2.2.2-1 Area of California Served by Caltrans Bat Roosts

2.3 Identification

(SFSU BIO 315 – Dixie Pierson)

QUESTIONS TO ASK YOURSELF FOR IDENTIFYING CALIFORNIA BATS

1. Does it have a leaf nose (Fig. 1)?

Yes = *Choeronycteris mexicana* (very long, narrow rostrum)
Macrotus californicus (relatively blunt rostrum)

No = All others

1. Does it have a free-tail (Fig. 2) ?

Yes = *Eumops perotis* (Forearm 72-82; ears joined at mid-line; Fig. 3)
Nyctinomops femorosaccus (Forearm 44-50; ears joined at mid-line; Fig. 3)
Nyctinomops macrotis (Forearm 58-64; ears joined at mid-line; Fig. 3)
Tadarida brasiliensis (Forearm 36-46; ears not joined at mid-line; Fig. 3)

No = All others

2. Is it red, yellow, black, or frosty?

Yes = *Lasionycteris noctivagans* (black with silver tipped fur)
Lasiurus blossevillii (red)
Lasiurus cinereus (frosty grey with yellow on face)
Lasiurus xanthinus (yellow)
Euderma maculatum (black with white spots; huge pink ears)
No = All others

2. Does it have a keel on its calcar (Fig. 4)?

Yes = *Eptesicus fuscus* (blunt tragus; large size)
Myotis californicus (pointed tragus; FA 29-36; sloped forehead)
Myotis ciliolabrum (pointed tragus; FA 29-36; flat forehead)
Myotis volans (pointed tragus; FA 36-44; hairy armpits; melted ears)
Pipistrellus hesperus (blunt tragus; tiny; black mask)
No = All others

3. Does it have a fringe of hair along the back edge of the tail membrane (Fig. 5)?

Yes = *Myotis thysanodes*
No = All others

4. Does it have a pointed tragus (Fig. 6)?

Yes = *Antrozous pallidus* (blonde; big ears; pig snout)
Plecotus townsendii (huge ears facing forward; horseshoe on nose)
All *Myotis* species (must be distinguished from each other by other features)
No = All others

From: Schmidly, D.J. 1991. The Bats of Texas. Texas A & M Univ. Press, College Station, TX.

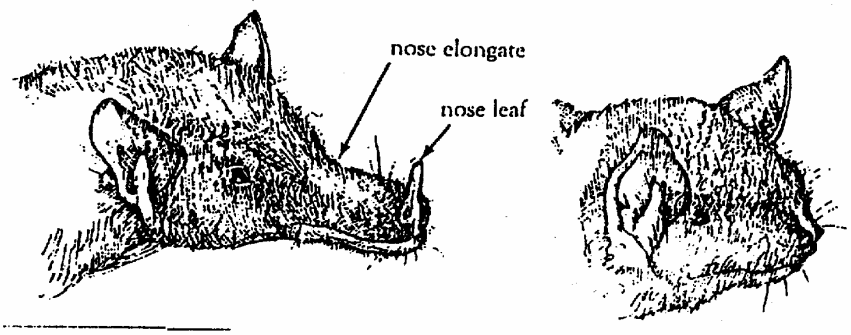


Fig. 1

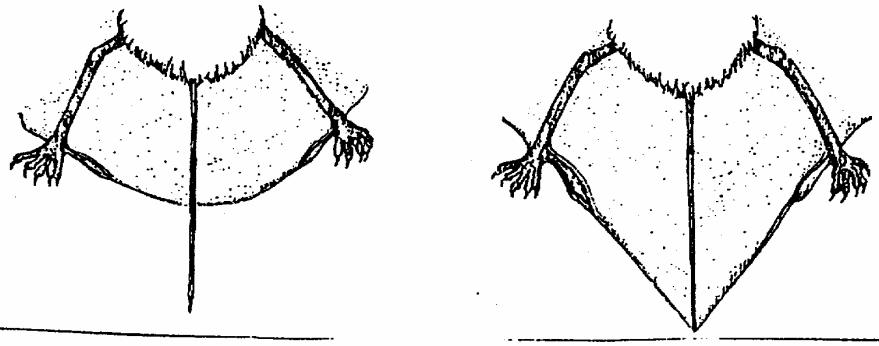


Fig. 2.

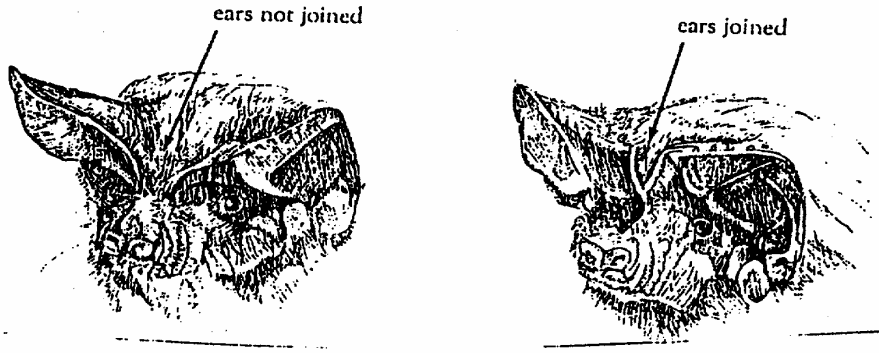


Fig. 3.

DIAGNOSTIC FEATURES FOR CALIFORNIA BATS

1. **Nose configuration.** The presence of a nose-leaf is diagnostic for the Family Phyllostomidae (leaf-nosed bats). This is basically a Central and South American family of bats, but several species make it into the southern U.S. -- two into southern California. Although a few other species have some fleshy modifications of the nostril (e.g., Plecotus townsendii has horse-shoe shaped protuberances on the nostrils; Antrozous pallidus has a tiny rim of flesh around the nostril, making a pig-like snout), only members of the Family Phyllostomidae have a true leaf-nose.

2. **Relationship between the tail and tail membrane.** Among North American bats, only the Family Molossidae (free-tailed bats) have a tail extending beyond the back edge of the interfemoral (= tail) membrane. In all other species the tail is completely enclosed within the interfemoral membrane.

3. **Forearm length.** The forearm, which is the dominant bone along the leading edge of the wing membrane, is one of the most important features to examine when trying to identify species. In some cases it can be diagnostic; in others it will help narrow the field. The range of forearm lengths reported in the literature should not be taken too literally, however, because: 1) if you are handling an immature animal, its forearm may be smaller than expected; 2) it is not uncommon to find individuals with forearms a bit (1-2 mm) smaller or larger than expected.

4. **Size and shape of the tragus.** The tragus (a thin, erect, fleshy projection arising from the inner base of the ear) varies in size and shape among species. All *Myotis* species have a very long, pointed tragus, which helps to separate them from look-alike species like *Eptesicus fuscus* or *Pipistrellus hesperus*, both of which have a blunt tragus.

5. **Calcar (keeled or unkeeled).** The calcar (i.e., heel bone) in bats is frequently elongated, and forms structural support for the connection between the interfemoral membrane and the leg. In some species, the calcar has a keep-shaped fleshy projection. This is a key feature for distinguishing among potentially confusing *Myotis* species (see keys).

6. **Size and shape of ear.** The size and shape of the ear helps separate groups of bats (e.g., all molossids have rounded forward projecting ears, that are very different from the erect ears of all phyllostomids and vespertilionids), and can be diagnostic for species (e.g., ear length can separate *M. evotis* from all other *Myotis*).

7. **Coloration.** Some species can be identified immediately based on color patterns of the fur (e.g., no other species has the red fur of *Lasiurus blossevillii*, or the white spots on a black background of *Euderma maculatum*)

RECENT NAME CHANGES FOR CALIFORNIA BAT SPECIES

Lasiurus blossevillii (= *Lasiurus borealis*)
Lasiurus xanthinus (= *Lasiurus ega*)
Myotis ciliolabrum (= *Myotis leibii*)
Nyctinomops femorosaccus (= *Tadarida femorosacca*)
Nyctinomops macrotis (= *Tadarida macrotis*)

CHECKLIST FOR IDENTIFICATION OF CALIFORNIA BATS							
SPECIES	Leaf nose	Free tail	Keeled calcar	Tragus	Ear length	FA length	Distinctive Features
Macrotus californicus	**Yes**	No	No		>25	47-55	Prominent nose leaf; two chin pads
Choeronycteris mexicana	**Yes**	No	No		15-18	43-45	Very long pointed rostrum, with nose leaf at tip
Eumops perotis	No	**Yes**	No	Blunt		72-82	Largest free-tail bat; ears joined at mid-line
Nyctinomops femorosaccus	No	**Yes**		Blunt		44-50	Ears joined at mid-line; smaller than N. macrotis
Nyctinomops macrotis	No	**Yes**		Blunt		58-64	Ears joined at mid-line; larger than N. femorosaccus
Tadarida brasiliensis	No	**Yes**	No	Blunt		36-46	Ears not joined at mid-line; smaller than all other free-tails
Antrozous pallidus	No	No	No	**Pointed**	21-37	45-60	Only bat this blonde; big ears; pig snout
Eptesicus fuscus	No	No	**Yes**	Blunt	12-19	41-52	Large; shiny fur; looks like Myotis except for blunt tragus
Euderma maculatum	No	No	No	Blunt	37-47	48-51	Huge ears; only bat with distinctive white spots
Lasionycteris noctivagans	No	No	No	Blunt	15-16	37-44	Black w/ silver-tip fur;no yellow on face as in L. cinereus
Lasiurus blossevillii	No	No	No	Blunt	10-12	36-42	Red fur
Lasiurus cinereus	No	No	No	Blunt	13-16	54-58	Frosty grey w/ yellow on face and ears
Lasiurus xanthinus	No	No	No	Blunt		45-48	Very yellow (as opposed to blonde or beige) fur
Myotis californicus	No	No	**Yes**	**Pointed**	15-11	29-36	Keel separates it from lucifugus/yumanensis;
							forehead more sloped than in ciliolbrum
Myotis ciliolabrum	No	No	**Yes**	**Pointed**	13-15	30-36	Keel separates it from lucifugus/yumanensis;
							forehead less sloped than in californiucus
Myotis evotis	No	No	No	**Pointed**	22-25	36-41	Distinguish from other Myotis by ear length
Myotis lucifugus	No	No	No	**Pointed**	14-16	34-41	Lack of keel separates it from californicus/ciliolabrum;
							flat forehead; shiny fur
Myotis thysanodes	No	No	No	**Pointed**	16-20	40-47	Fringed interfemoral membrane
Myotis vellifer	No	No	No	**Pointed**	15-12	37-47	Large Myotis; no keel on calcar; no fringe on tail membrane
Myotis volans	No	No	**Yes**	**Pointed**	8-16	36-44	short ears w/ "melted plastic" rim; very long tibia; wing
							underside furred to elbow; only large Myotis with keeled calcar
Myotis yumanensis	No	No	No	**Pointed**	14-15	32-38	Lack of keel separates it from californicus/ciliolabrum;
							sloped forehead; dull fur
Pipistrellus hesperus	No	No	**Yes**	Blunt		25-30	tiny; black mask; blunt tragus
Plecotus townsendii	No	No	No	**Pointed**	30-39	39-48	Huge, forward facing ears; horseshoe on nose

3.0 Roost Types

Roosts are places that provide security and protection where bats can rest, sleep, hibernate, mate, socialize, or feed. Roosts are diverse in function and structure. They can also vary tremendously in spatial and temporal aspects. In general, roosts are categorized into two distinct types, focused around the time of day when the roost is used: day roosts and night roosts. A particular roost may serve one or many functions and be both a day and a night roost.

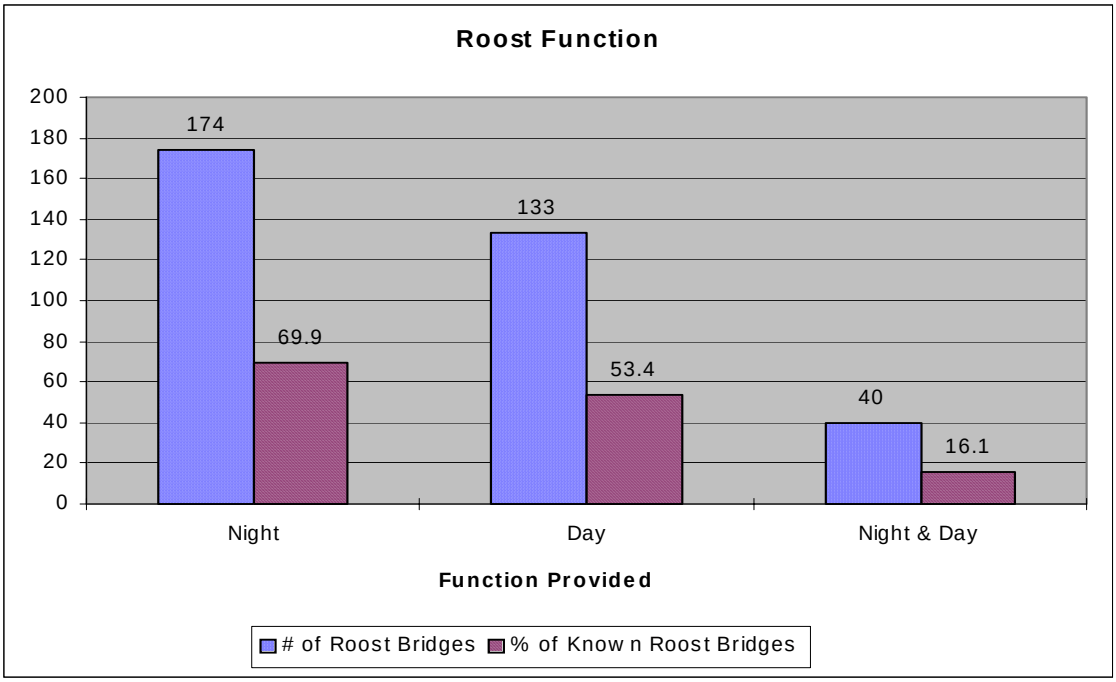


Figure 3.0-1: Roost Function

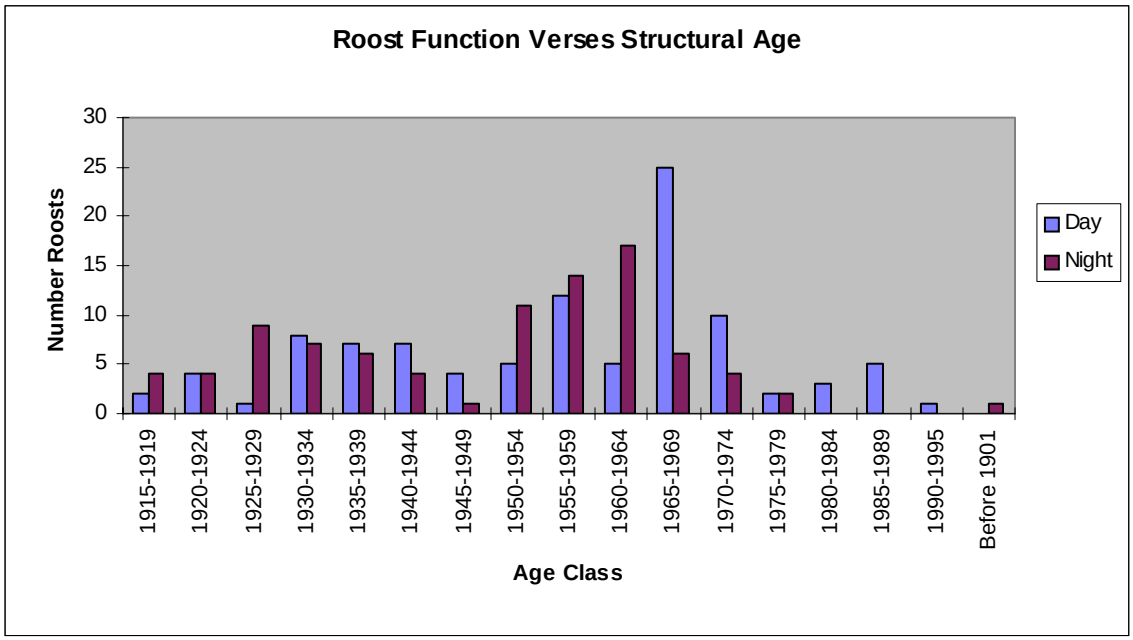


Figure 3.0-2: Roost Function by Year

3.1 Day Roosts

Day roosts, which are used from sunrise to sunset, are the places where bats sleep and raise their young. They can also be used in winter as hibernacula. They are an important habitat feature that tends to be limiting for bat populations, and can heavily influence their geographic distribution. Bridges have an important role in providing day roosts for many species by providing analogs to natural structures. Although not as extensive or as spacious as natural roosts, these bridges provide most of the features (e.g., either crevices or cavities) necessary for their life history.

Figure 3.1-1 Natural Day Roost (Karen Miner)

Figure 3.1-2 Artificial Day Roost (David Wyatt)

3.1.1 Resting

Day roosts provide a protected and sheltered location for bats to rest and sleep within a short flight to foraging areas. Although lactating females remain active and alert, most species have the capacity to lower their body temperature and enter a state of torpor to save energy. Thus, an appropriate temperature regime and safety from predation are critical factors in roost selection. Animals frequently seek a site that offers thermal choice, allowing them to thermoregulate by moving between warmer and cooler sites within the roost.

Bridges often occur close to or over prime foraging areas, such as riparian corridors, and provide a variety of temperature options and spaces for resting bats.

3.1.2 Maternity

A very important function of day roosts is to provide a safe, cryptic, thermally stable site for the raising of young. The young are often tucked up in the crevices or on ledges while the mother forages. The configuration of the roost is generally such that that the risks of falling and predation are reduced. The location of the site must be such that the mother can return to nurse the young on a regular basis without expending a large amount of energy. Later in the season, the roost becomes a staging site for first flights of young bats as they try to follow their mothers on the evening feeding flight.

3.1.3 Hibernation

Hibernation and winter roosts provide environmental conditions that allow extended periods of torpor or hibernation when food supplies are limited and temperatures are low. In California, this generally occurs from late fall (October-November) through early spring (March-April). Bats occasionally emerge from hibernation roosts to replenish water supplies or conduct minimal hunting. In areas with extended periods of non-freezing temperatures, bats will emerge from winter roosts to forage and drink.

Hibernation roosts are not well known in bridge structures. Winter roosts that provide habitat for non-hibernating bats are more common. This may be due to airflow dynamics and the limited thermal mass of bridges as compared to caves or mines. Warmer temperatures during warm spells could unnecessarily wake hibernating bats.

3.2 Night Roosts

Night roosts, which are used from approximately sunset to sunrise, are primarily sites where animals congregate to rest and digest their food between foraging bouts. They also appear to have a social function, since adult males that do not roost with females during the day are often found mixed with females at night roosts. Night roosts are important habitat features that tend to be relatively abundant and are less likely to be limiting. Bridges often serve as significant night roosts. Those most commonly used are open cavity sites.

Figure 3.2-1 Night Roost (Margaret Lawrence)

3.2.1 Resting

Night roosts reduce energy consumption in at least four ways:

1) Roosts generally occur at or near the evening's foraging ground. Proximity to foraging habitat allows the bats to remain in the area between hunting forays without expending energy to fly back to the day roost or to a distant night roost.
2) Night roosts tend to be warm and protected from the wind, allowing the bats to remain in an environment that is closer to their thermal neutral range.
3) The relative safety of the roosts allows the bats to enter a state of torpor and further reduce energy consumption.
4) Night roosts provide a gathering place where multiple individuals may share heat.

3.2.2 Social

Multiple species and multiple colonies often are present at the same night roost due to the proximity to water and foraging areas. This provides an opportunity for intra- and inter-specific interactions and socialization. Although individual bats may have different foraging areas, their night roost may be the same due to availability and the benefits of colonial behavior. The social benefits of night roosting behavior are not yet well understood.

3.2.3 Mating

Some species, such as big brown bats, may use night roosts seasonally for courtship behavior and/or mating. Examples of Yuma Myotis courtship have been observed on bridge structures and some species have shown a high fidelity to such sites.

3.2.4 Food Processing / Digestion

Night roosts provide a site where food can be processed, and from which animals can make periodic forays to nearby foraging areas. Night roosts also allow bats the opportunity to consume large prey where disassembly may be required to reduce the bulk of the evening meal and facilitate eating.

The high-energy requirements of bats can lead to consumption of up to 100 percent of their body weight in a night. To reduce the weight they must carry in flight and allow additional foraging, they

frequently eliminate the portions of the exoskeletons that do not provide energy. They also convert as much as possible to fat which weighs only 1/4 of the weight of carbohydrates

3.2.5 Migration

Some night roosts are important stopping points as species move in response to seasonal factors or move toward hibernation/wintering sites. These locations may also be used during the rest of the warm season by local individuals, but tend to receive very heavy use when migrating animals are on the move.

Figure 3.2.5-1 Migration Roost (Gregg Erickson)

4.0 Structures

Note: The data figures used in this section are based upon state highway bridges but are reflective of many local public bridges.

4.1 Bridge Construction Materials

Bridge structures are generally constructed of one of three main materials: timber, concrete, or steel. There is a strong correlation between utilization rates by bats and the construction materials and design of a bridge. Figure 4.1-1 shows the relative utilization rate of bridges based on type.

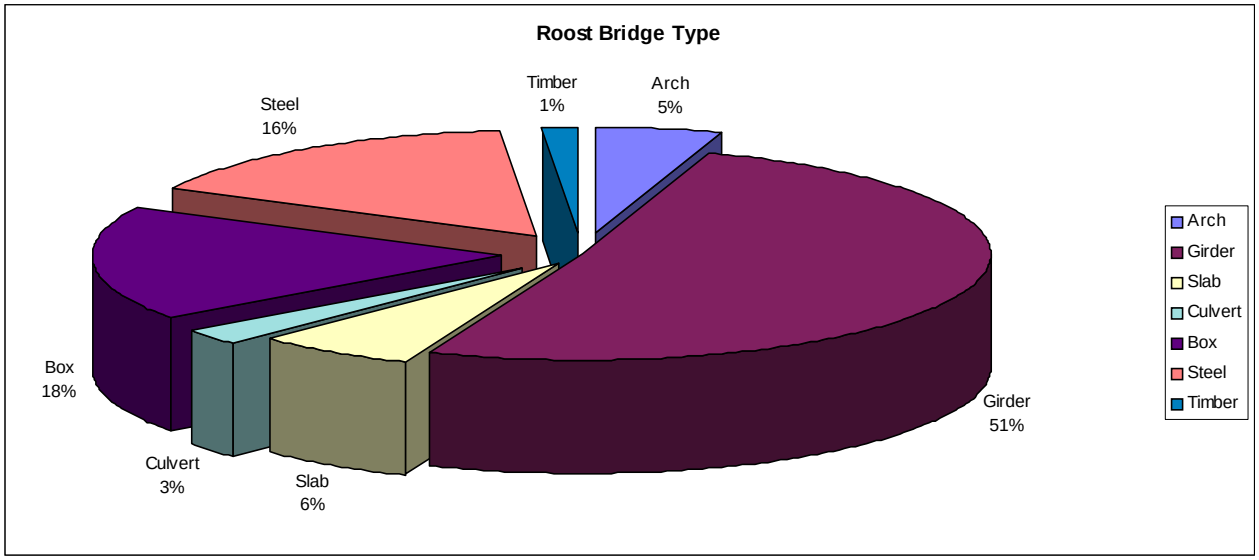


Figure 4.1-1: Roost Structural Type

4.1.1 Timber

Timber, also referred to as wood construction, is rare in highway structures, but is more common on private and secondary public roads. A concrete or asphalt surface coat is usually applied on the highway and on secondary roads. Private roads often do not have a surface coat. The crevices of timber structures are commonly used as day roosts for large colonies of crevice roosters. Approximately two percent of the known bridge roosts are made of timber. This is a high number relative to the number of bridges available. The probability of finding bats on a wooden bridge is high.

The standard timber structure types are:

LS	=	Log Stringer
TS	=	Timber Stringer
TT	=	Timber Truss
TA	=	Timber Arch
TB	=	Timber Slab (laminated)
CT	=	Combinations Truss (Steel and Timber)

Figure 4.1.1-1 Timber Structure (Michael Marquez)

4.1.2 Concrete

Concrete is the most common construction material found on highways and public secondary roads. It is occasionally found on private roads. The surface usually remains concrete on highways and may have an asphalt surface on secondary or private roads. Concrete structures commonly provide night roost habitat and occasionally provide day roost values.

4.1.2.1 Slab

Slab structures rarely provide habitat value unless the structure has deterioration hollows, expansion joints, or other similar feature that provides a day roost crevices or hollows. Approximately seven percent of the known roosts are of a slab design. This type of bridge is not particularly bat friendly.

The standard concrete slab structure types are:

CS	=	Concrete Slab
PS	=	Pre-cast Concrete Slab
QS	=	Cast In Place Pre-stressed Slab
QA	=	Pre-cast Pre-stressed Slab

Figure 4.1.2.1-1 Slab Construction (Gregg Erickson)

4.1.2.2 Culverts

Culvert structures rarely provide habitat value unless the structure has deterioration hollows, expansion joints, or other similar features, that provide day roost crevices or hollows. Approximately one percent of the known roosts are a culvert design. Roosts in culverts are not common.

The standard concrete culvert structure types are:

CC = Concrete Box Culvert
CP = Concrete Pipe
CU = Concrete Arch Culvert

Figure 4.1.2.2-1 Concrete Culvert (Paul Helwer)

4.1.2.3 Arch

Arch structures commonly provide night and day roost potential. Approximately five percent of the known roosts are an arch design. This is a high number relative to the number available. The probability of finding bats on an arch bridge is high. This design is bat friendly. The standard concrete arch structure types are:

CA = Concrete Arch
MA = Masonry Arch
(CG Concrete Girder Bridges may have an arch shape)

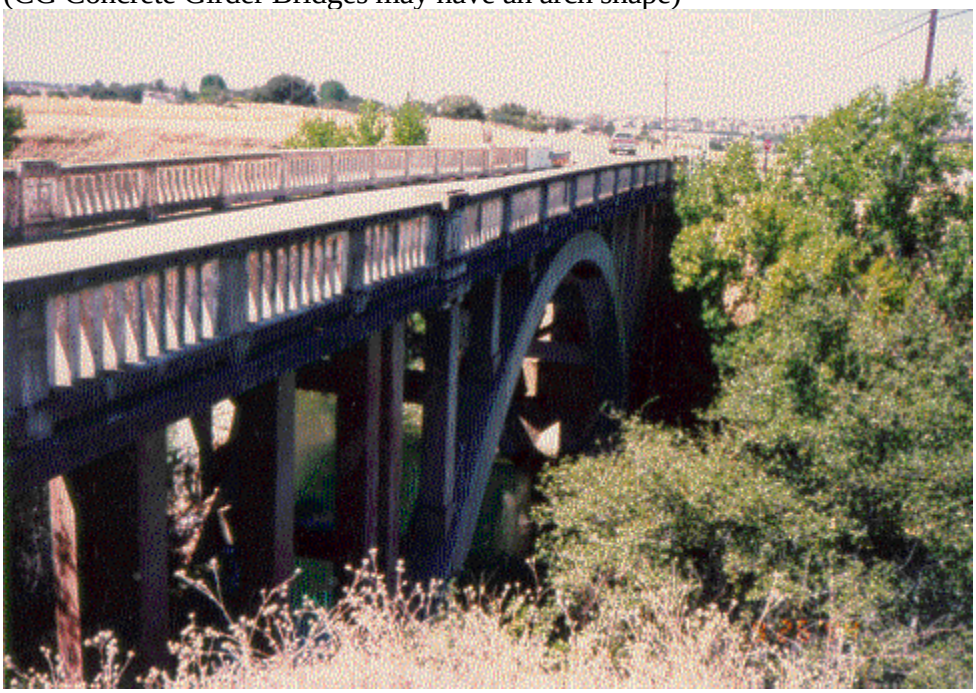


Figure 4.1.2.3 Arch Construction (Gregg Erickson)

4.1.2.4 Girder

Girder structures commonly provide night potential and occasional day roost value in expansion joints. Approximately sixty percent of the known roosts are a girder design. This design is considered very bat friendly, provided that the girders are at least a meter tall.

The standard concrete girder structure types are:

CG = Concrete Girder
PG = Precast Concrete Girder
QG = Cast In Place Prestressed Girder (Not Box)
QI = Precast Prestressed "I" Beam Girder
QJ = Precast Prestressed Double "T" Girder

QK = Precast Prestressed "T" Girder
QT = Precast Prestressed Inverted "T" Girder
QU = Precast Prestressed Inverted "U" Girder
QW = Precast Prestressed Inverted "W" Girder

Figure 4.1.2.4-1 Girder Construction (Gregg Erickson)

Figure 4.1.2.4-2 Precast Twin Beam Construction (Gregg Erickson)

4.1.2.5 Box

Box structures provide cryptic roosting sites inside the hollow interior. Less cryptic roosts may also occur in deterioration cavities, expansion joints, or other similar features. Approximately thirteen percent of the known roosts are of a box design. The most common type of use of these structures is for day roosting.

The standard concrete box structure types are:

QB	=	Cast In Place Pre-stressed Box Girder
QX	=	Pre-cast Pre-stressed Box Girder
PB	=	Pre-cast Concrete Box Girder
CB	=	Concrete Box Girder

Figure 4.1.2.5-1: Box Construction (Dale Steele)

4.1.3 Steel

Steel is common on large structures and those built during the 1950's on highways and public secondary roads. It is very common on private roads. Steel structures usually have a steel or concrete surface. Some may have a secondary coat of asphalt.

Steel structures can provide valuable habitat. Day roosts are sometimes found between trusses and concrete abutments or within the structure. Night roosting sometimes occurs on the concrete bent or beam caps to which the steel beams are attached. Approximately twelve percent of the known roosts are of a steel design.

The standard steel structure types are:

SP	=	Steel Box Pipe (Girder)
SS	=	Steel Stringer Rolled Sections
SG	=	Steel Plate Girder
SB	=	Steel Box Girder
ST	=	Steel Truss
SA	=	Steel Arch
SU	=	Suspension Bridge
MP	=	Multi-plate

Figure 4.1.3-1 Steel Girder Construction (Gregg Erickson)

Figure 4.1.3-2 Multi Plate Steel Culvert

4.1.4 Hybrid and Non Bridge

Hybrid structures may be made of any combination of timber, concrete, or steel. These multi-material structures are most likely encountered on long bridges or where widening or extensions have occurred.

Hybrid structures often have habitat values of the types that are combined. A few types, particularly tunnels and concrete dams, can provide roosting habitat. Some standard "non-bridge" structure types are:

TU	=	Tunnel
EW	=	Reinforced Earth Retaining Wall
TW	=	Timber Retaining Wall
CW	=	Concrete Retaining Wall
SW	=	Steel Retaining Wall
CD	=	Concrete Dam
ED	=	Earth Dam
SLS	=	Seal Slab

Modifiers that may be found on the various bridge types are:

A	=	Welded
J	=	Welded Continuous
T	=	Through
L	=	Through Continuous
D	=	Deck
H	=	Deck Continuous
P	=	Pony
O	=	Open Spandrel
F	=	Earth Fill
B	=	Box (Box Girder)
C	=	Continuous
E	=	Continuous with Standard Cantilevered Ends (No Abuts)
W	=	Sidewalks
K	=	Pier or Tower Span
I	=	Continuous over Inclined Bents
Q	=	Pre-stressed
S	=	Stayed
R	=	Orthotropic
X	=	Vertical Lift
Z	=	Rotary or Swing

4.2 Roost Types

4.2.1 Intrastructural (IAR)

Intrastructural roosts are crevices, cavities, or both within the structure or its supports. Expansion joints, hinge joints, parallel beams, stress cracks, and abutment gaps provide useful crevices. Hollow columns, box bridges, hinges joints, concrete flaws, and covered edge-drain pipes provide cavities. Other features with similar configurations may also provide roosting habitat. Roosts have also been found associated with non-structural features like the space behind a posted sign.

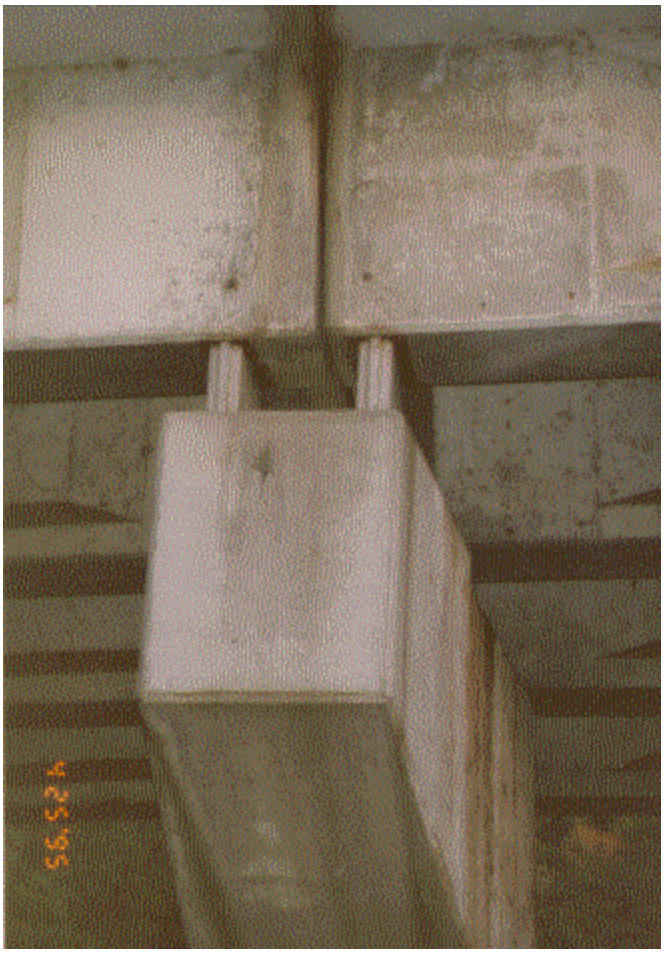


Figure 4.2.1-1: Expansion Joint (Gregg Erickson)

Figure 4.2.1-2: Hinge Joint (Gregg Erickson)

4.2.2 Interstructural (IER)

Interstructural roosts are crevices, cavities, or both between the structures and an adjacent structure or the surrounding topography. Abutted bridges, widening extensions, and abutted walls provide crevices. The configuration of girders and arch with the topography provide cavities. Other features with similar configurations may also provide roosting habitat.

Figure 4.2.2-1 External Cavity (Gregg Erickson)

4.2.3 Ectostructural (EOR)

Ectostructural roosts are generally semi-enclosed cavities on the surface of the structure. The undersides of girders and arch configurations, as well as abutment sheaths, provide open cavities. Other features with similar configurations may also provide roosting habitat. Minor surface defects during forming provide toeholds near the top of the vertical surfaces and occasionally on the underside of horizontal surfaces.

Figure 4.2.3-1 External Multispecies Grouping (Carolyn Brown)

4.2.4 Extrastructural (EAR)

Extrastructural roosts are crevices, cavities, and foliage occurs in proximity to a structure. Rock faces, mines, caves, buildings, signs, rock slopes, and trees provide adjacent crevices, cavities, or foliage. Other features with similar configurations may also provide roosting habitat.

Figure 4.2.4-1 Talus Slope and Rock Crevices

Figure 4.2.4-2 Rock Slope Protection (Gregg Erickson)

Figure 4.2.4-3 Tree (Gregg Erickson)

4.2.5 Examples

The variety of roosts is great. For every example where no roosts are thought to exist, an example seems waiting to be found. However, some features are used consistently and predictably by bats. These are correlated to the structural type and age of the structure.

The most common examples shown in figures 4.2.5-1 through 4.2.5-6 include: form gap free-hangs(1), beam corners(2), beam walls(3), paved drains(4), expansion joints(5), abutment crevice (6), concrete defects & deterioration(7), hollow columns(8), abutment hollows(9), column sheaths, external cavities, internal cavities(10), abutment sheaths(11), beam crevices, beam fascias(13), interstructural crevices (14), interstructural free-hangings(15)

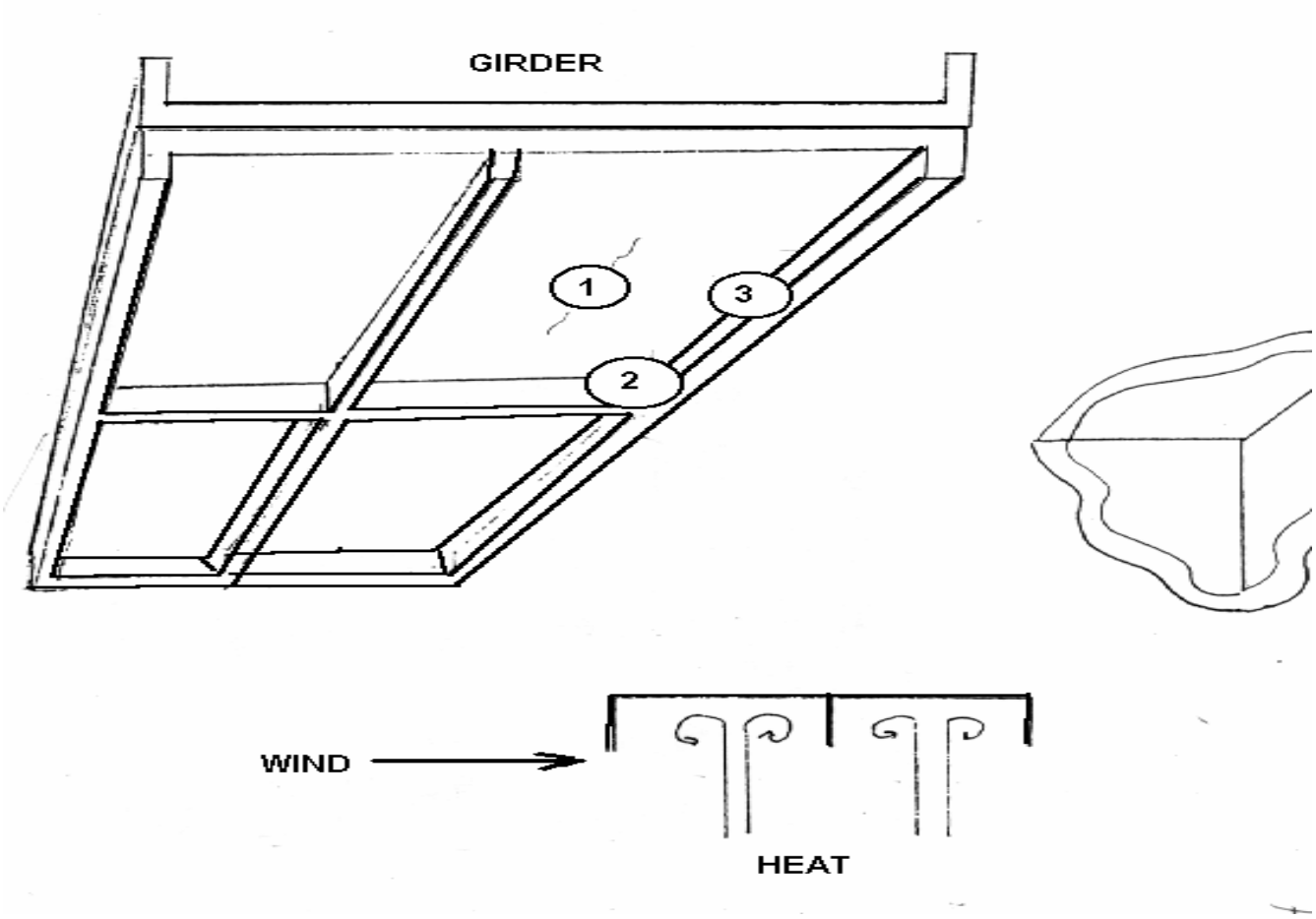


Figure 4.2.5-1 Example Roost Locations

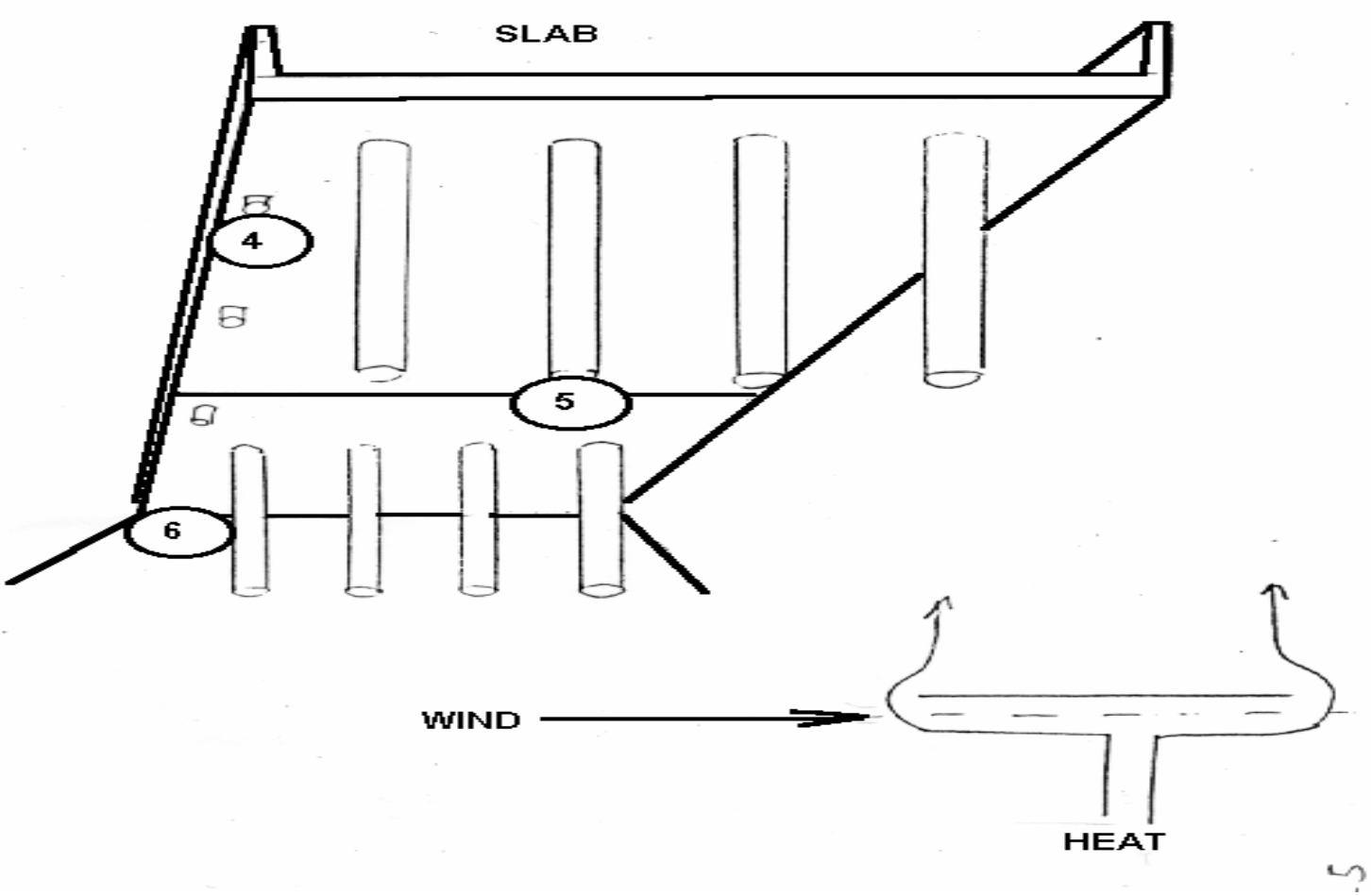


Figure 4.2.5-2 Example Roost Locations

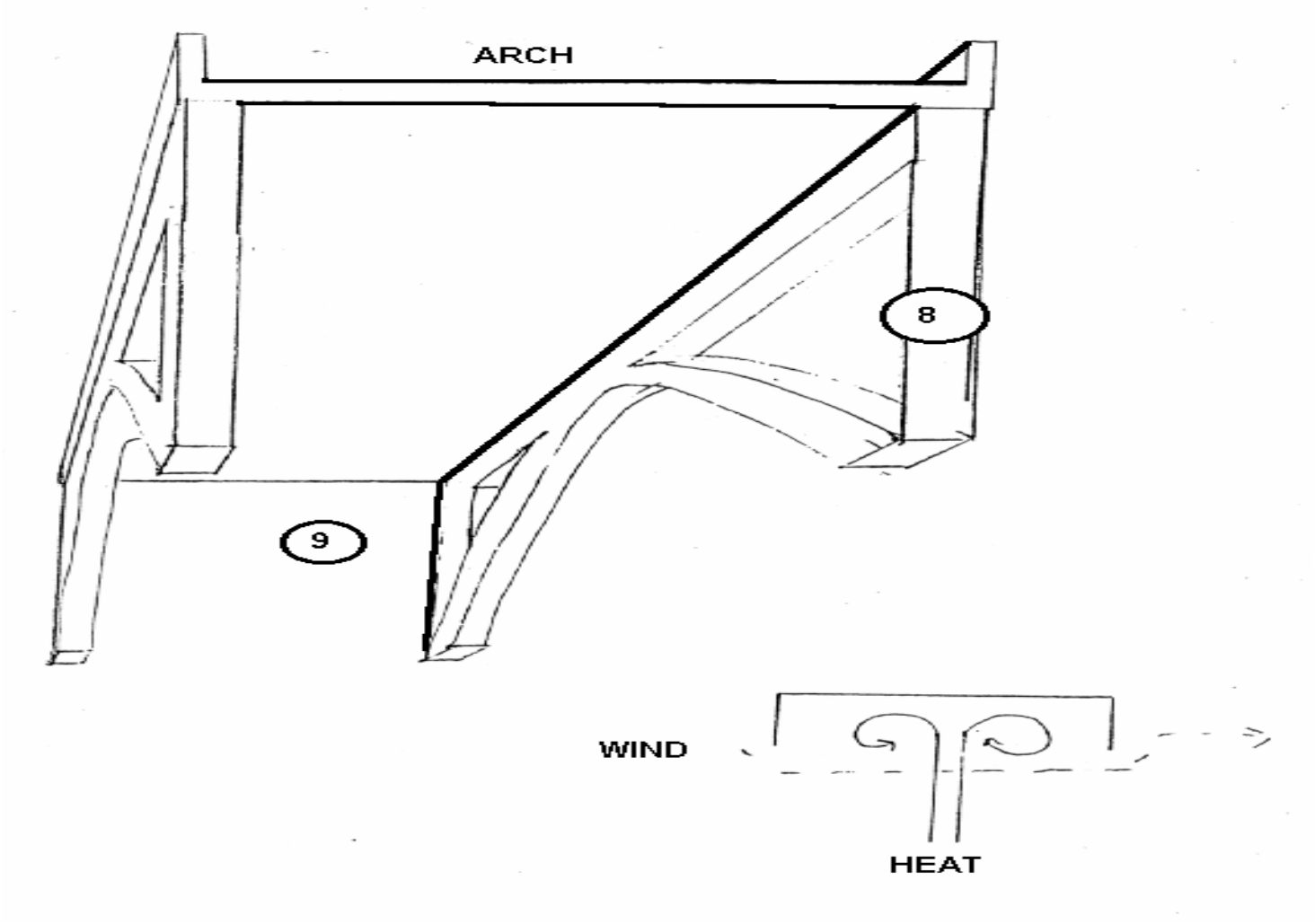


Figure 4.2.5-3 Example Roost Locations

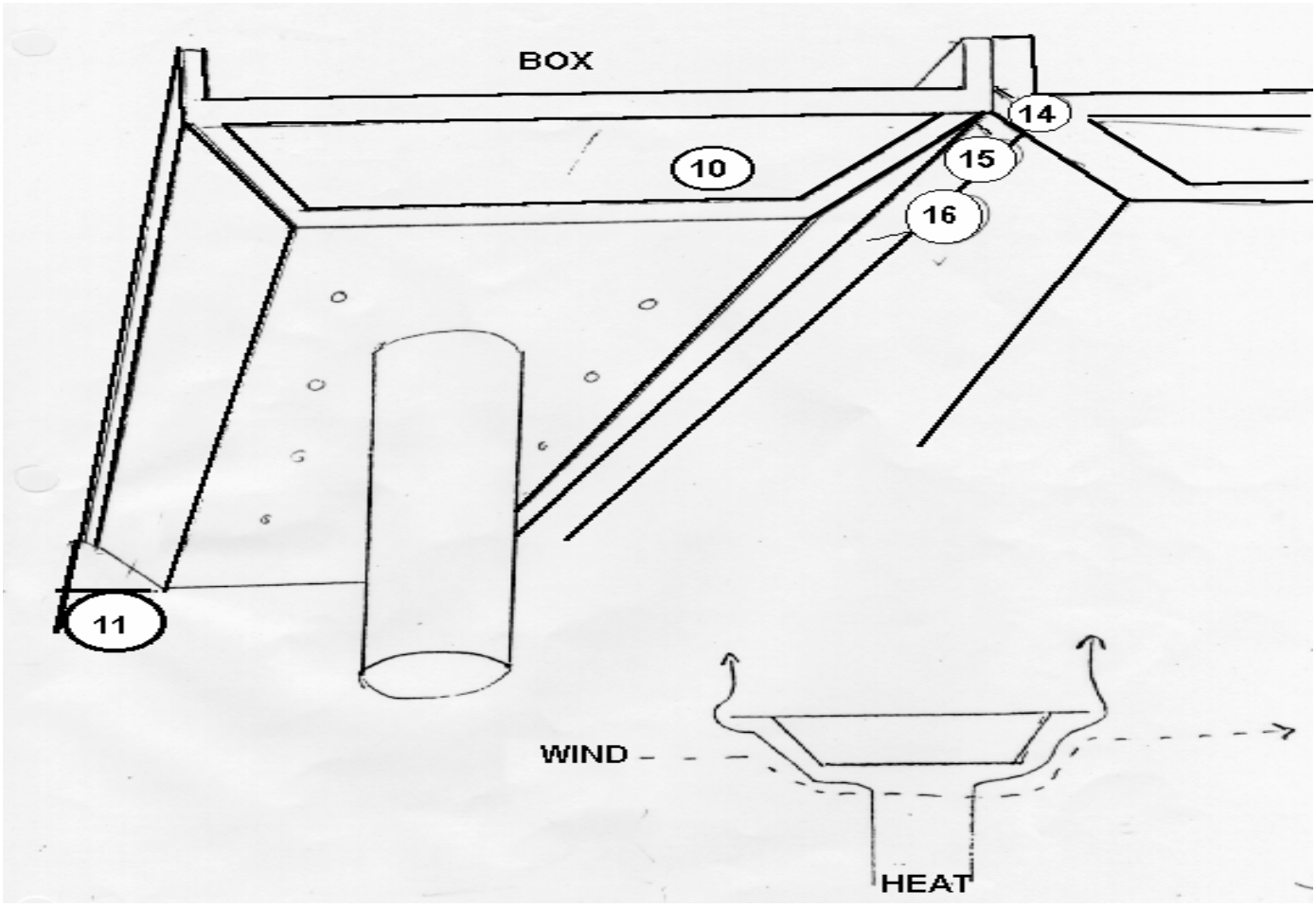
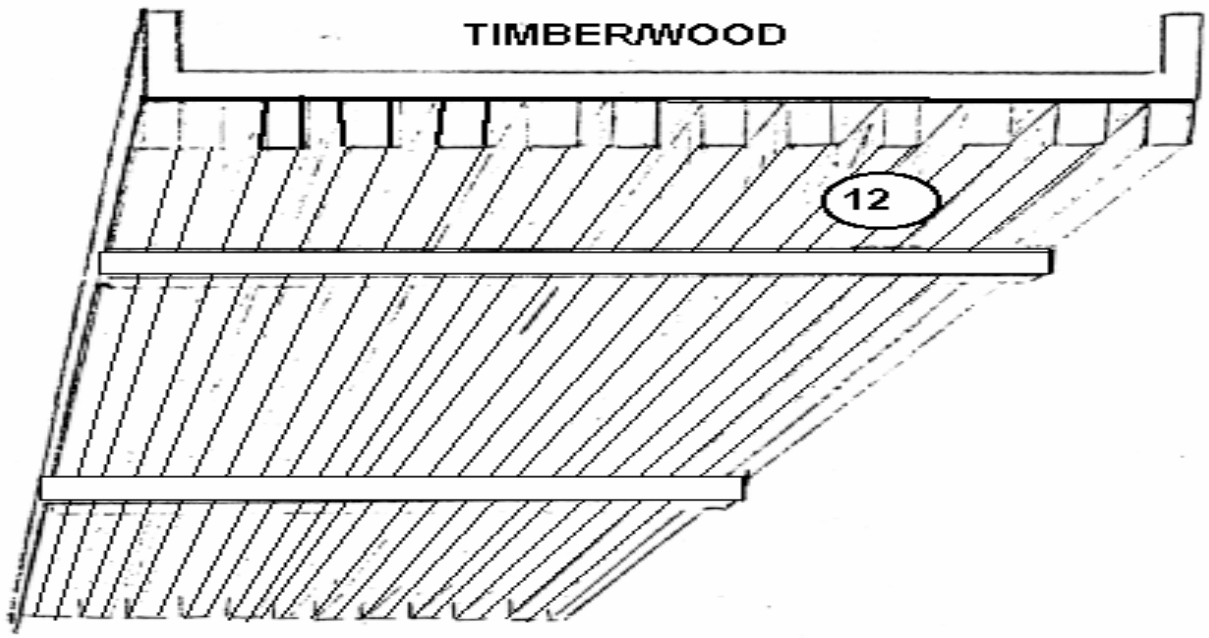


Figure 4.2.5-4 Example Roost Locations



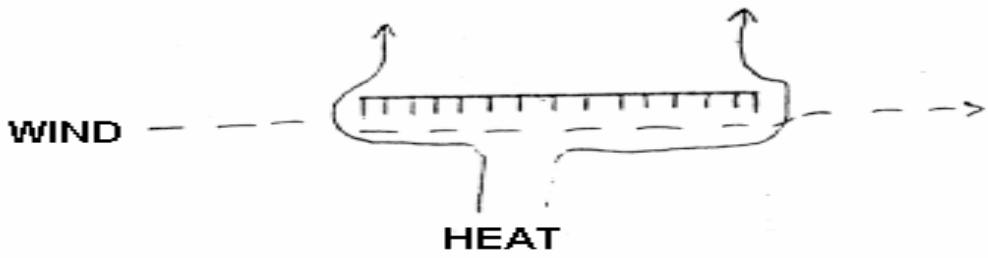


Figure 4.2.5-5 Example Roost Locations

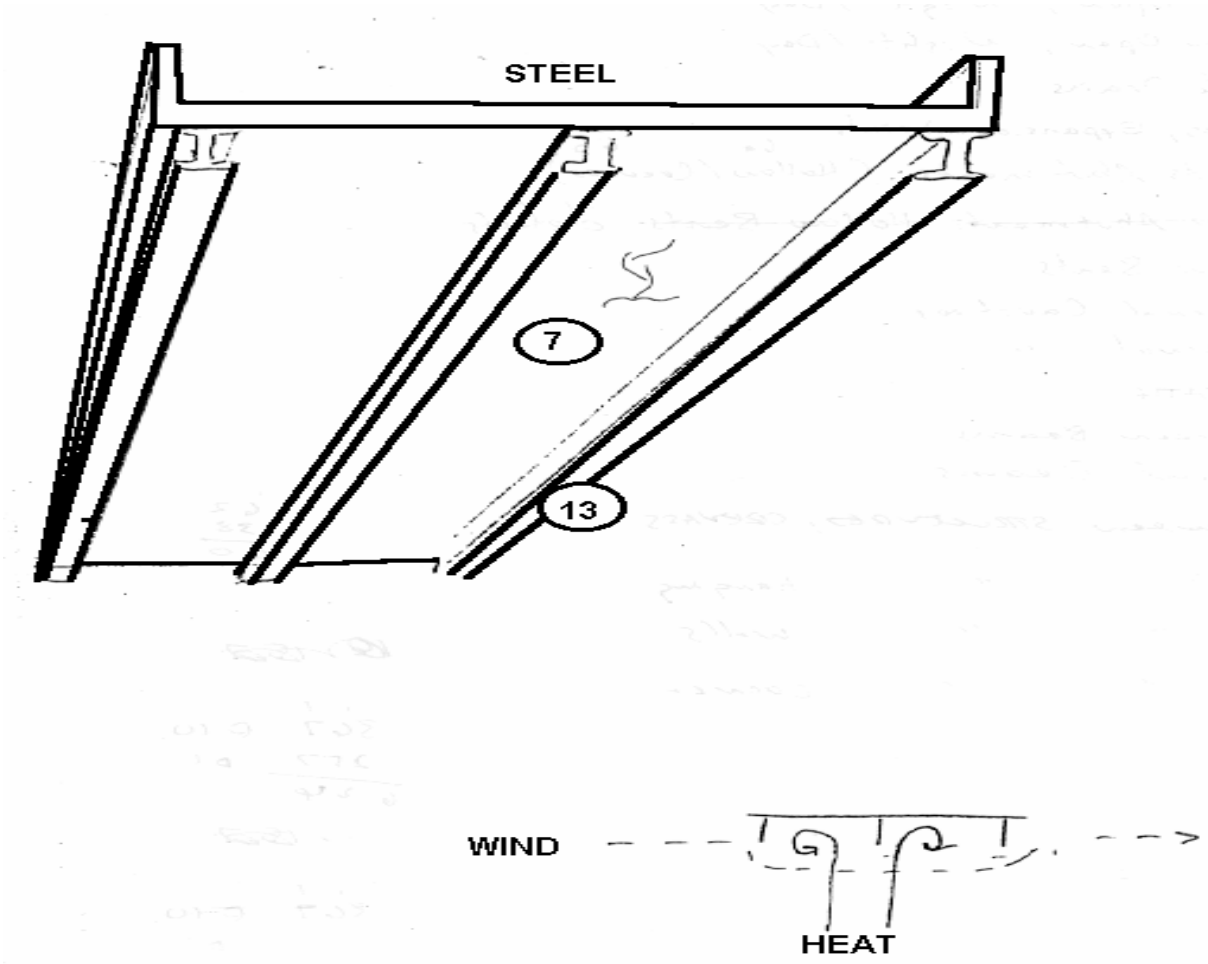


Figure 4.2.5-6 Example Roost Locations

4.3 Roost Environmental Parameters

Certain characteristics such as temperature, moisture, and degree of protection are known to be very important in roost selection.

4.3.1 Temperature

The thermal mass and configuration of bridge structures provides microclimates with relatively stable temperatures that do not change as dramatically as outside air temperatures. The average temperature in a night roost may be 3 to 17 degrees Fahrenheit above ambient.

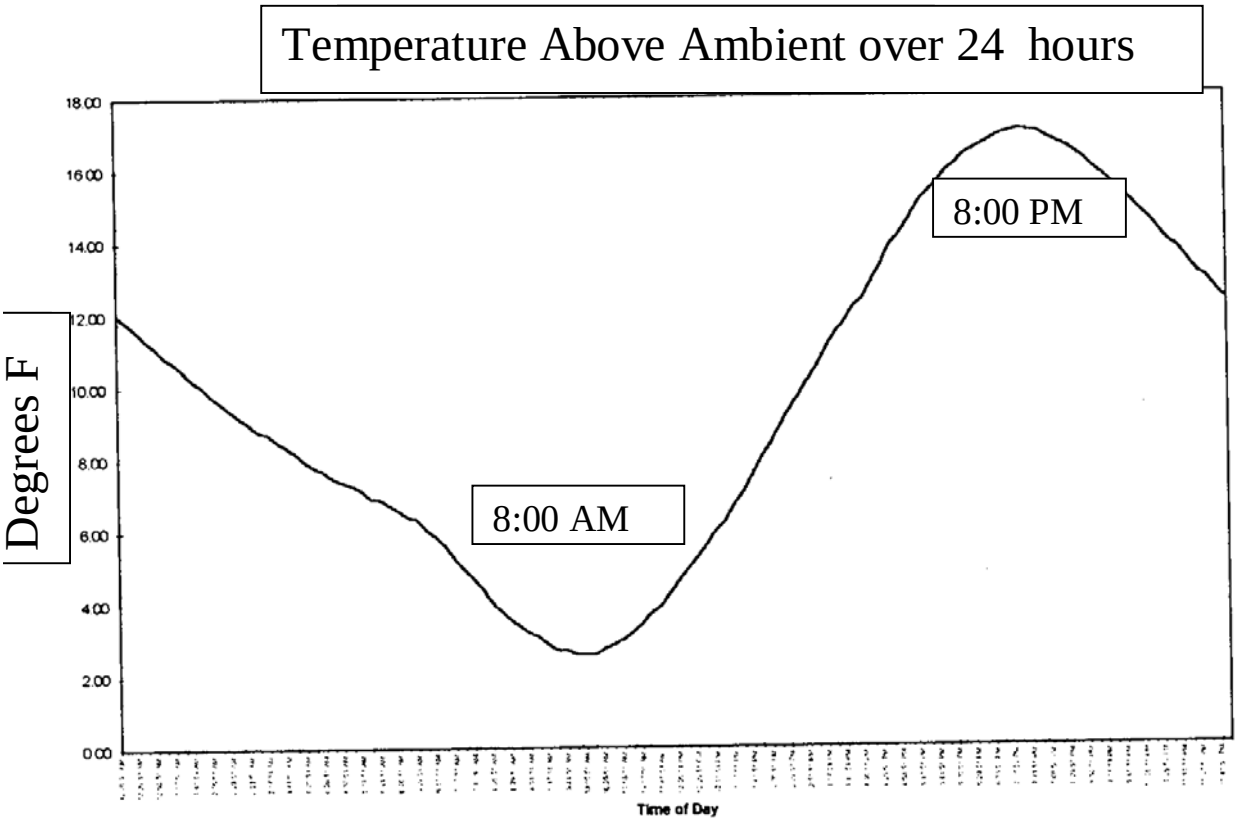


Figure 4.3.1-1 Temperature Moderation

4.3.2 Precipitation and Humidity

4.3.2.1 Precipitation

The precipitation rate at known roosts is highest in the 12.6 to 25 inches per year range, with a secondary abundance in the 75 to 62.3 inches per year range. The former, lower peak rainfall is indicative of a large number of roosts in foothill areas. The latter, higher peak rainfall is indicative of a large number of roosts in the forests of the northwest. (Note: this may reflect the sampling bias inherent in bridge distribution, density, and design evolution.)

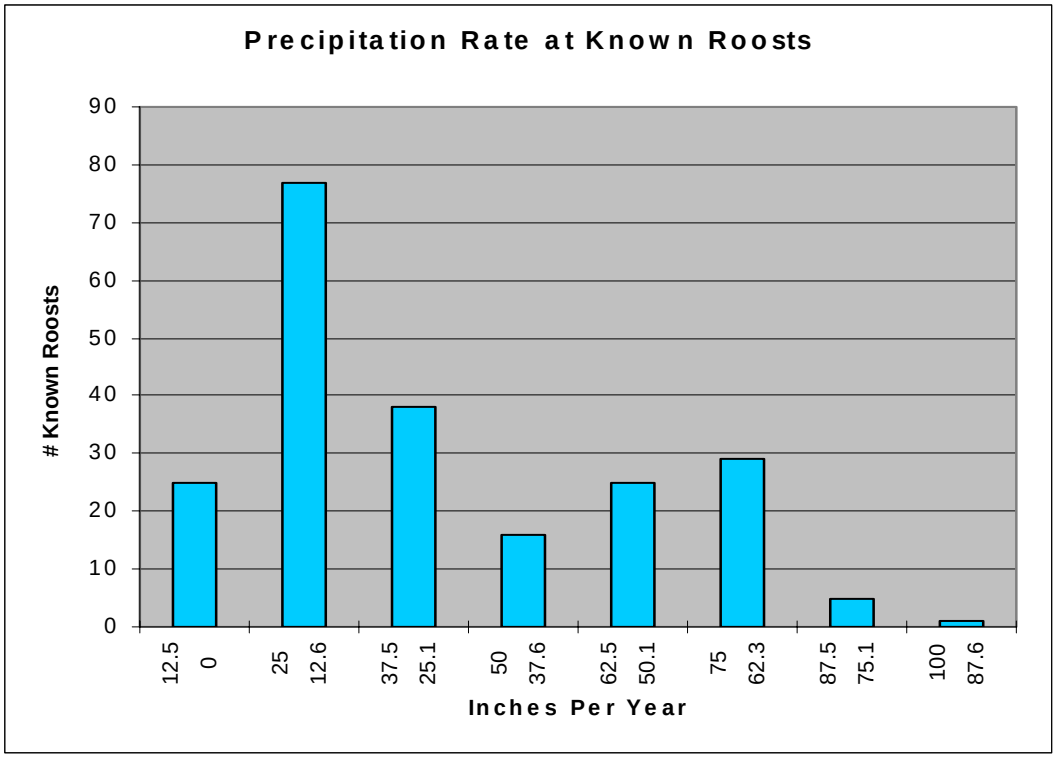


Figure 4.3.2.1 Precipitation Rate by Roost

4.3.2.2 Humidity

Generally, the interior of a structure is moist all year. The areas under a structure traps warm moist air and the humidity is generally higher near a roost than in the surrounding area.

4.3.3 Light

The area below and within a bridge is shaded from light sources, such as streetlights or a full moon. Bats have not been found on bridges where lights have been installed.

4.3.4 Wind

The bridge attenuates the wind and reduces wind chill and dehydration potential.

4.3.5 Disturbance

Although bats roosting in bridges are subjected to traffic noise, they are generally protected from harassment or disturbance by people. Ironically, they are very tolerant of noise and vibration from above, but not from below.

Figure 4.3.5-1 Snow Cannon (Dennis Smith)

4.3.6 Predation

The configuration of bridges inhabited by bats generally lacks features that facilitate predators such as owls or hawks. Night roosts often are under structures in corners that would be difficult for owls to attack, and are too high for terrestrials predators, such as ringtails. The configuration also usually allows a good view of anything approaching the roost.

4.3.7 Substrate under the Roost

4.3.7.1 Substrate Prevalence

We examined the number of known bridge roosts in relationship to the type of feature crossed. Over 90 percent are found over water or related floodplain. About 10 percent are found over side roads or non-riparian areas. The most common substrates under roosts are creeks (57 percent), followed by rivers (27 percent). No roosts have been found over busy highways; many have been found under busy highways. Structures that provide both day and night roosts were found only over rivers and creeks. Structures over roads were found primarily to be night roosts.

Figure 4.3.7.1-1 Substrate Prevalence

4.3.7.2 Substrate Preference

Examination of the usage rate (number of bridges used per 1000 available) for different substrates revealed a preference for structures located over floodplains (155/1000), followed by rivers (115/1000), and then creeks (30/1000). Bridges over rivers or floodplains appeared to always have usage where structural features were available. Viaducts over floodplains were primarily used as day roosts and rarely as night roosts.

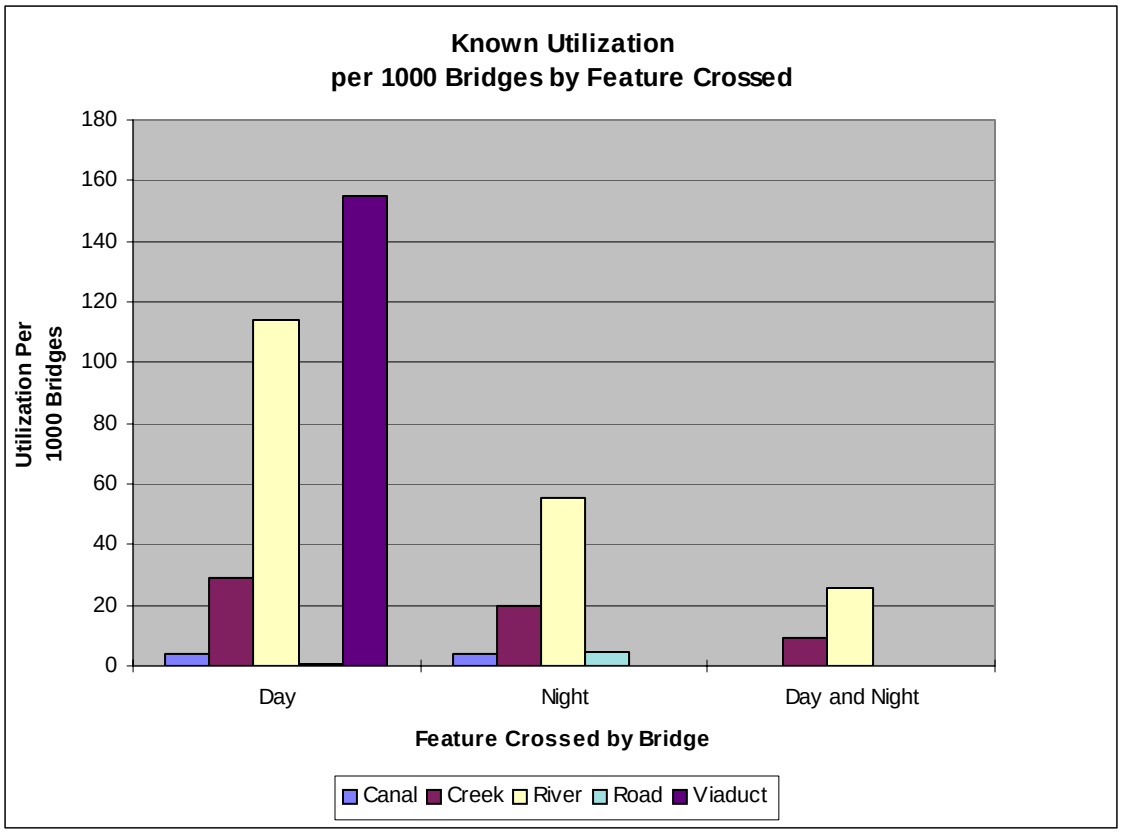


Figure 4.3.7.2 Substrate Preference

4.3.8 Elevation

The range in elevations of known roosts is correlated with the elevations where the majority of human populations occur. The higher population densities, and therefore, the largest network of roads, highways and bridges, occur at lower elevations.

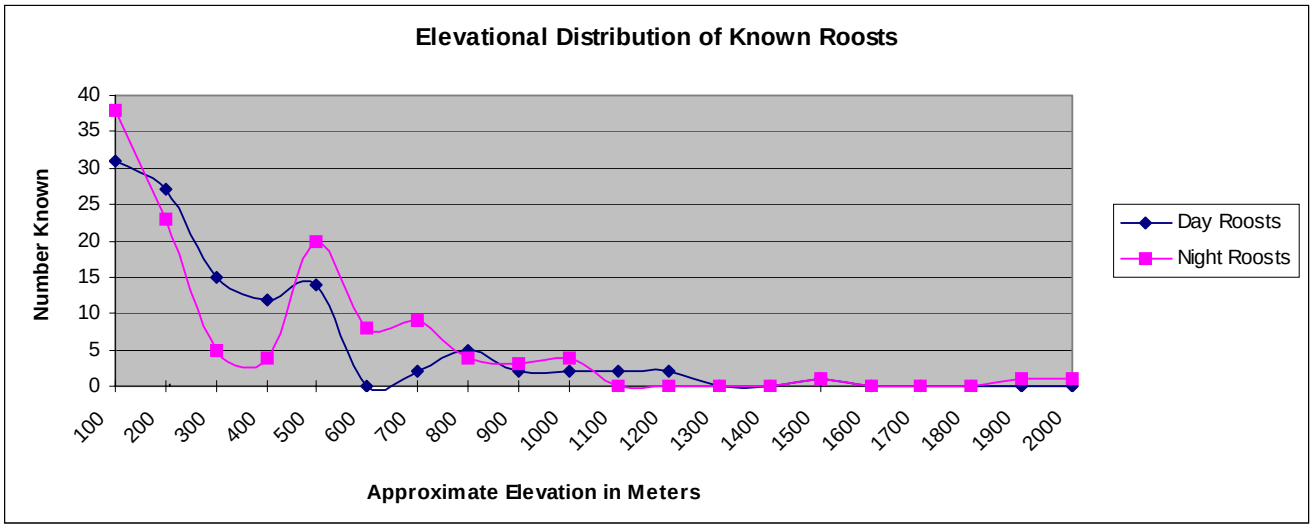


Figure 4.3.8-1 Roost Elevations

4.3.9 Latitude

The greatest numbers of known roosts are from near the Mexican border and in the northern half of the state. These results may be biased by the fact that survey efforts have been greater in some areas than in others.

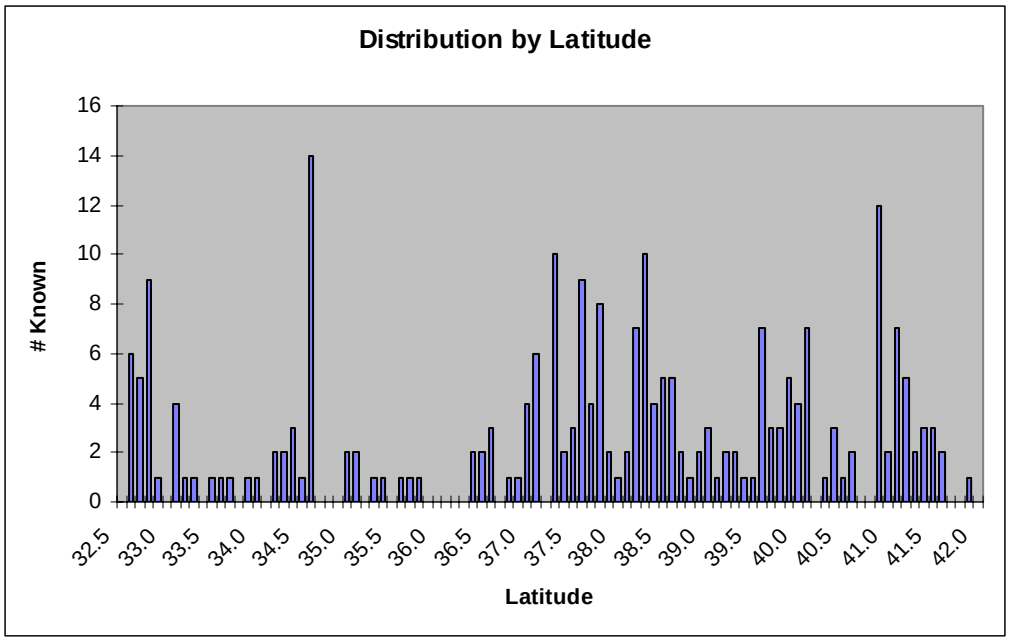


Figure 4.3.9-1: Roost Latitude

4.4 Roost Details

Bridge roosts are known to provide crevice or cavity roost analogs. Foliage roost-analogs are not expected on modern bridge structures. The one main difference between bridge roosts and natural roosts is the proximity of noise and disturbance from traffic.

4.4.1 Crevice Roosts

Crevice roosts tend to be approximately 3/4 to 1 1/2 inches across and at least 18 inches deep. In most cases, they run from one side of the bridge to the other. This provides a variety of temperature conditions within the same roost. The purpose of most of these crevices is to provide thermal expansion for the bridge. The resident engineer usually sets the exact dimensions in the field based on site conditions.

Asphalt, a rubber gasket, or a steel plate generally covers the roosts. These covers are designed to prevent debris from falling into the crack and to prevent the bridge from expanding. The cover provides shelter for the colony from rain, direct sun, and most predators.

The drop below these crevices is usually at least two meters. In some cases, they are hundreds of meters above the ground. This provides protection from predation. In many cases, the bats prefer launching and landing on the lateral vertical exposure of the joint. Some crevices may be used even though the bent is <1 meter below the roosts, provided that a lateral entrance is available.

4.4.2 Cavity Roosts

Cavity roosts, although less common, can be found on bridges. The cavities provide an analog to cave or mine roosts. Temperature and humidity parameters tend to be similar to those found in more natural sites.

The inside of modern bridges is very much like a cave or a mine and tends to be dark, moist, and cool, with wood and rock-like substrates.

The access to these roosts requires a vertical climb, in contrast to a vertical dive or horizontal flight for caves and mines. Often, the only access is a 6-inch hole, though occasionally, a large opening is available. This type of roost can be very cryptic and difficult to access.

4.5 Bridge Names and Numbers

All bridges have a bridge name and number. The name and number can usually be found at the end of the bridge on the rail or on a paddle in front of the bridge. A date is often imprinted on older bridges in the same area. The name generally refers to the features crossed, except for honorary titles.

The bridge number is a two-part number separated by a dash ("-"). The first two-digit number identifies the county where the bridge is located. The second number is the bridge number, which often has a suffix that distinguishes among multiple structures in close proximity.

Figure 4.5-1 Bridge Sign

4.5.1 Bridge Number Prefix - County Information

1	*Del Norte*	*30*	*Calaveras*
2	*Siskyou*	*31*	*Alpine*
3	*Modoc*	*32*	*Toulumne*
4	*Humbodlt*	*33*	*Alameda*
5	*Trinity*	*34*	*San Francisco*
6	*Shasta*	*35*	*San Mateo*
7	*Lassen*	*36*	*Santa Cruz*
8	*Tehama*	*37*	*Santa Clara*
9	*Plumas*	*38*	*Stanislaus*
10	*Mendocino*	*39*	*Merced*
11	*Glen*	*40*	*Mariposa*
12	*Butte*	*41*	*Madera*
13	*Sierra*	*42*	*Fresno*
14	*Lake*	*43*	*San Benito*
15	*Colusa*	*44*	*Monterey*
16	*Yuba*	*45*	*King*
17	*Nevada*	*46*	*Tulare*
18	*Sutter*	*47*	*Mono*
19	*Placer*	*48*	*Inyo*
20	*Sonoma*	*49*	*San Luis Obispo*
21	*Napa*	*50*	*Kern*
22	*Yolo*	*51*	*Santa Barbara*
23	*Solano*	*52*	*Ventura*
24	*Sacramento*	*53*	*Los Angeles*
25	*Ed Dorado*	*54*	*San Bernardino*
26	*Amador*	*55*	*Orange*
27	*Marin*	*56*	*Riverside*
28	*Contra Costa*	*57*	*San Diego*
29	*San Joaquin*	*58*	*Imperial*

4.5.2 Bridge Number Suffixes - Placement

J	Outer Outer Left
K	Left Outer Highway Structure
L	Left Structure or Left Inner Structure
C	Center Structure
R	Right Structure or Right Inner Structure
S	Right Outer Structure
T	Outer Outer Right
Y	Structure on State Owned and Maintained Connections not on Main Highway (May be Closed)
W	Drainage Pumping Plant
M	Buried Hazard or Miscellaneous Structure

Z	Access to Private Property or Closed with No Access
E	Connector Structure
F	Connector Structure
G	Connector Structure
H	Connector Structure

4.6 Bridge Locations

Bridge locations are referred by a system known as the District-County-Route-Post Mile. A typical location, such as the Mokelumne River Bridge on Route 49 in southern Amador County, would look like "10-Ama-49 PM 0.0," where--

10	=	Caltrans District 10
Ama	=	Amador County Abbreviated
49	=	Route 49
PM	=	Post Mile
0.0	=	The site is 0.0 miles from the southern or eastern limit of the route within the county.

(The latitude and longitude is also recorded for each structure in the structures maintenance database.)

4.7 Bridge Age

4.7.1 Age Distribution of Structures

Structures may last in excess of 100 years depending upon factors such as construction materials, environmental conditions, and level of maintenance. A few structures that were built before 1901 remain in the state highway system.

The greatest numbers of structures in the state inventory were built during the construction of the great interstate system in the years between 1950 and 1980. During this time, the rate of bridge construction was as high as 10 times the normal rate.

Wood structures are the oldest style of construction; unfortunately, very few of these old structures still exist due to deterioration and the cost of maintenance. With the exception of new experimental laminate designs, wood structures are rarely seen today.

Most steel structures around today were constructed in the 1950s and 1960s with a few older examples.

Concrete bridges, which were common back to the 1920s, became the cost-efficient bridge of choice for the interstate system. Older structures tend to be of concrete girder designs. Concrete slabs were common during the early portion of the interstate system formation. Recent advances have resulted in the prevalence of concrete box bridges that can span longer reaches with fewer supports and expansion joints.

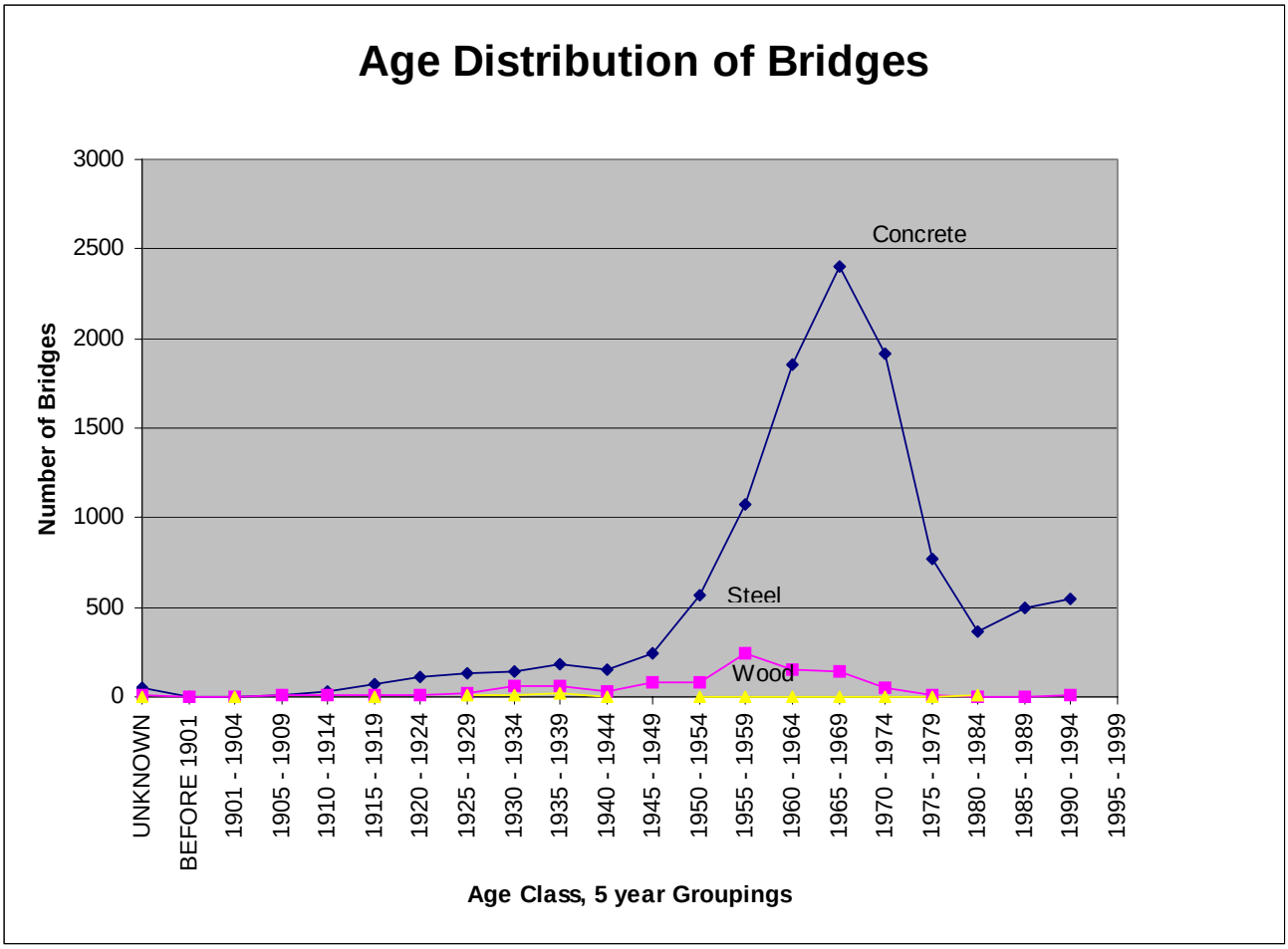


Figure 4.7.1-1: Bridge Age Distribution

4.7.1.1 Number Bridges Built

Approximately 12,000 bridges are currently in the state inventory, with an additional 12,000 in the inventory of local and federal agencies.

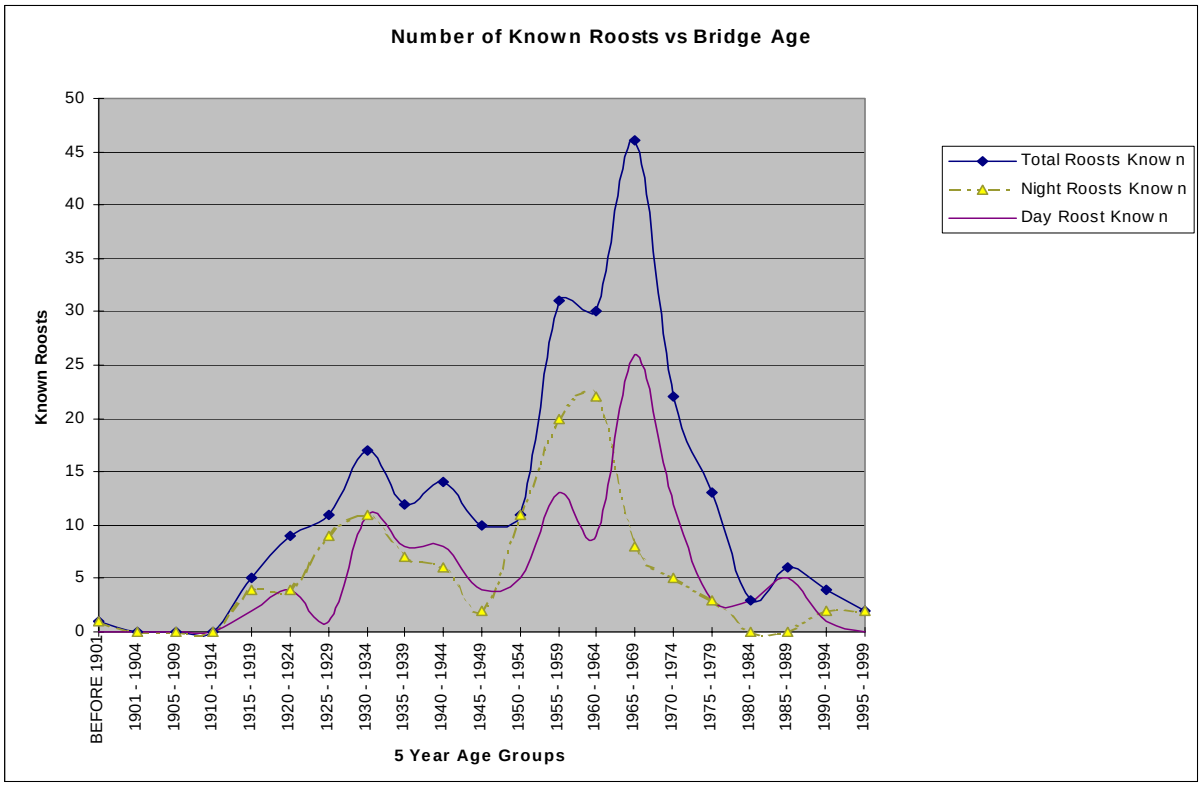


Figure 4.7.1.2-1 Numbers of Roosts by Age Class

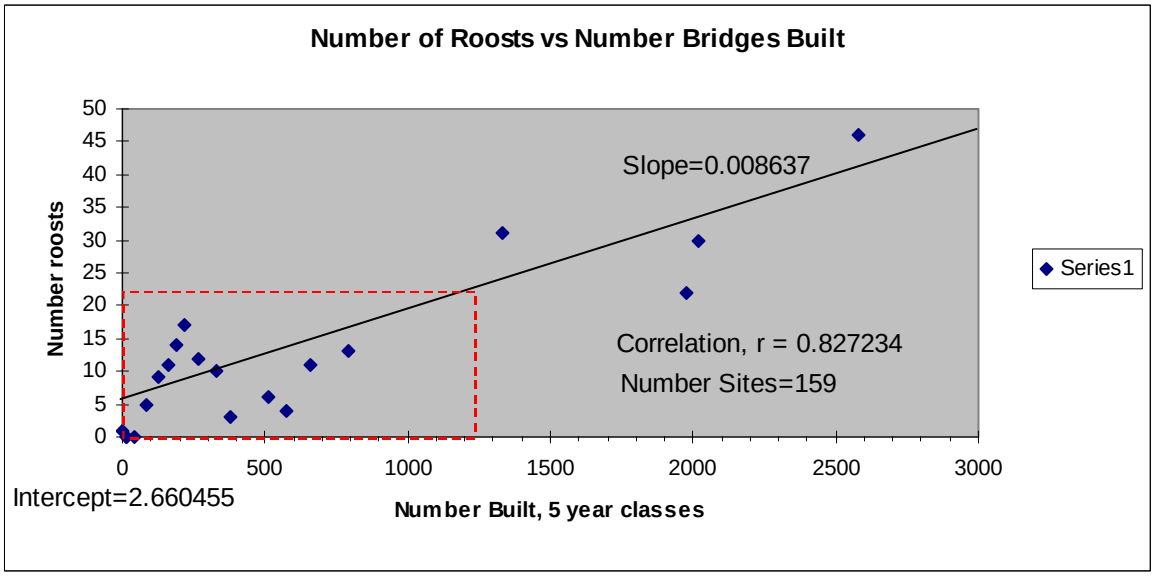


Figure 4.7.1.2-2 Correlation of Bridges Built per Year and Number of Roosts

4.7.2 Relationship of Structural Age to Habitat Value

4.7.2.1 Bridge Evolution

The numberd of roosts found on a bridge of a particular age class is related to the number built and the design of the structure; this in turn is profoundly influenced by advancements in bridge engineering over time.

4.7.2.2 Preferences of Structural Age Classes

The rate of use or preference for a bridge roost is independent of the number of bridges built.

The greatest rate of use, as measured in known roosts per 1000 available structures, is seen in structures built between 1910 and 1945. The overall rate of use during this period is double the rate of use for bridges built after 1945. The rates of night roosting and day roosting are proportional during this period.

The rate of use rapidly declines for structures built after 1945, and by the 1970's is less than 1/6 the pre-1945 rate. Night roosting rates drop precipitously to almost none for structures built in the 1980's, while the rate of day roosting remains constant.

This loss of night roosts is related to the prevalence of concrete slab designs for small structures and concrete box designs for larger structures. (Complicating the data is the relatively cryptic nature of roosts in newer designs)

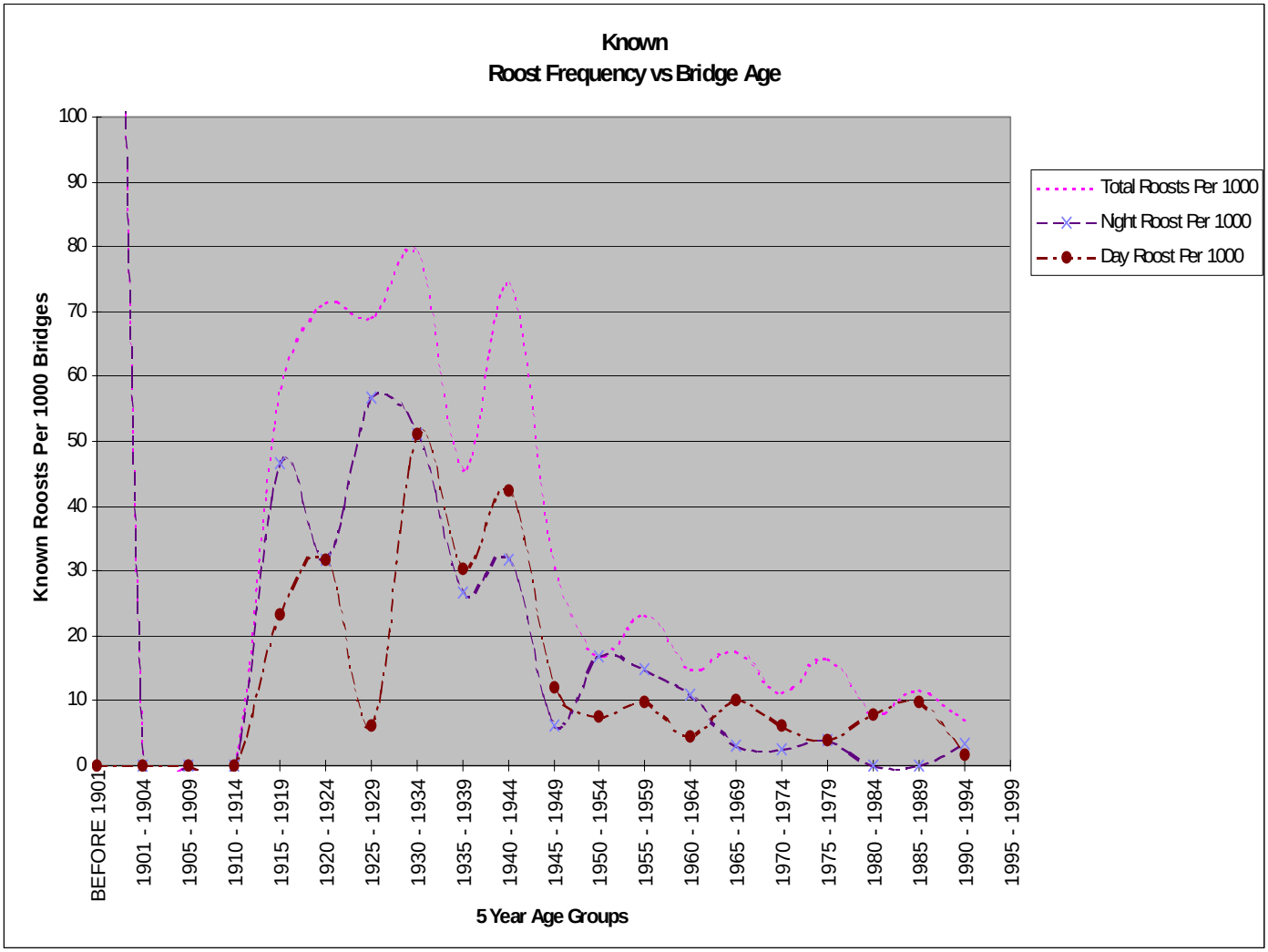


Figure 4.7.2.2-1 Frequency of Use by Bridge Age Class

4.8 Length and Width

4.8.1 Length

The highest numbers of bridge roosts are found on the most common, smaller bridge sizes of 100 to 200 feet long. This size bridge is commonly used for creeks, canyons, and smaller drainages. Smaller bridges provide sheltered locations for both day and night roosts. Day roosts are more common where the bridge is long enough to require expansion joints or hinges.

Longer bridges tend to have more opportunities for roosts and so are more likely to be used. Longer bridges tend primarily to be day roosts.

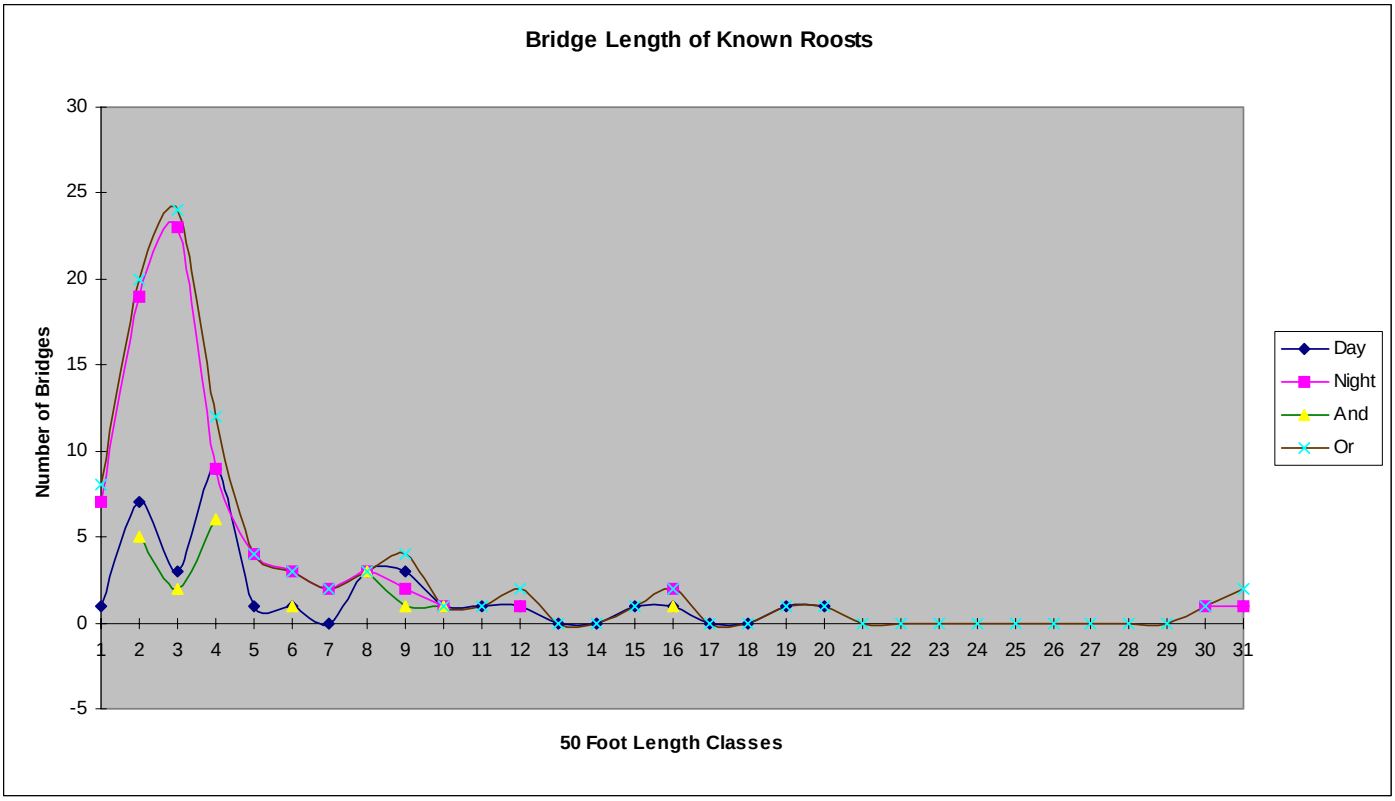


Figure 4.8.1-1 Bridge Use by Length

4.8.2 Width

Bridge width has not been shown to be a statistically dominant aspect in the suitability of bridges as bat colony hosts; however, wider bridges may offer greater thermal buffering. There is a tendency for bats to night roost in those cells that are farthest from the edge of the bridge where the roost is most protected from temperature fluctuations and wind. The wider bridges also tend to be darker underneath, with more cells or other suitable features.

5.0 Survey and Evaluation Protocols

5.1 Survey Protocol

Specific studies for bridges and transportation facilities can become complex when the scale of the project is considered along with a potentially high number of species and individuals. While this document provides a starting point, it is important to consult a bat biologist experienced with bridges or a qualified biologist who has attended the Caltrans Bats and Bridges Training Course.

5.1.1 Seismic

5.1.1.1 LEVEL 1: Habitat Potential Screening

(District biologist, specialist for advice)

The first level of screening assesses whether potential habitat exists for a specific structure. The bridge log, as-builts, topographic maps, bridge inspection reports, and location maps, can provide the initial data. Assessment of potential should consider the following features: bridge type, geographic region, special (red flag) features, and potential deterrents. If habitat potential is thought to exist, assessment proceeds to the next level. No bridge should be excluded at this level unless you are certain there are no habitat features for bats. ***Remember***, these animals can live in *1" wide cracks*, and the bridge may have non-standard features in the abutments, or have small modifications that might not show up in any of the paper records.
There is no substitute for getting your boots muddy and using your eyes.

Bridge Types:

Higher Potential	Lower Potential
Timber	All steel
Concrete Girder	Slab Concrete
Box Girder with access	Box Girder with no access
Arch style	Continuous slab
Multi-section	Any design with < 1.5 m clearance*
Any design with expansion joints	
Any design that combines materials (e.g., junction between wood and concrete, or steel and concrete)	

*Survey data from low clearance features is limited. Those that are effectively concrete tunnels and have structural refuges within (inspection wells, lateral extensions, or even significant surface voids in concrete) may be occupied by bats.

Geographic Areas (High bat densities and/or presence of rare species):

Colorado River Basin
San Diego County
Central Valley, extending into foothills
Sierra Nevada
Coast Range
Forested areas of northern California, particularly Trinity Alps

Red Flag Features:

Expansion joints
Open abutments
Open cavities
Two bridges abutting
Wood construction
Railroad bridges/tunnels
Large cracks
Rollers at joints
Old bridge
Rare bridge design
Inspection report of bats

Significant Habitat Features in the Area:

Water (river, stream, pond, lake, etc.) within 1 km.
Significant rock features, particularly exfoliating rocks
Mines
Forest (with snags)
Riparian areas with pools

Potential Deterrents:

Lights under bridge
Urban setting
Heavy traffic underneath the bridge

5.1.1.2 LEVEL 2: Site Investigation

The second level of screening involves a site investigation to determine bat presence at the structure. The assessment will be based on site features and at least one sign of bat use. Identify whether use is day roosting or night roosting. Remember that use could be seasonal. The most substantial use will be in warmer months (spring through fall), although hibernation by some species (in bridges with substantial refuges) is possible. Always survey the entire bridge. Frequently, bats will prefer one end of a bridge more than the other, or they will use only one portion of the bridge. Collect guano samples and/or dead bats (see below). Take photographs or a video of the site. Bats that night roost singly or in small groups may leave no visible sign. Therefore, if the bridge appears to have high potential with no bat sign, it should be surveyed at night (3-5 hours after dark).

Bat sign

Urine stains (usually predominantly white on concrete)
Guano, Insect parts
Odor (must be distinguished from that of other mammals, including human)
Vocalizations (may not occur during the day; may not be audible without a bat detector; most likely to be audible near dusk in the summer)
Dead bats

Figure 5.1.1.2-1 Urine (Gregg Erickson)

Figure 5.1.1.2-3 Guano (Gregg Erickson)

Techniques for Sample Collection

Guano: Identification from guano is based on pellet shape and size, odor, and the presence of culled insect parts (moth wings, Jerusalem cricket legs, beetle elytra, etc.). Unlike mouse and rat droppings, bat guano pellets are easily disaggregated (i.e., they crumble easily when crushed, and shiny exoskeleton parts are generally visible). Remember that several bat species may be present under a single bridge. These may be represented by discrete guano deposits of different pellet sizes in different locations. In some locations, bat guano may co-occur with grossly similar- looking feces from other small vertebrates.

Collections should preferably be several milliliters in volume and be carried in rigid containers (e.g., snap cap vials the size of 35 mm film vials or larger). The void space above the guano should be filled loosely with dry facial tissue or toilet paper, although larger volumes of guano in Whirlpaks or other small sample bags may remain identifiable if they are handled gently. Do not ship guano for identification without filling void volumes of containers with tissue or other material to prevent movement. To avoid crushing pellets when collecting, it is often easiest to press a sheet of heavy paper against the surface and gently brush pellets onto it. Older guano deposits at sites seasonally exposed to rain or runoff may have fresh pellets deposited on a

consolidated layer of disaggregated material. If only consolidated material is available, select pieces in which the original pellet structure is still visible. If guano is wet when collected, it will degrade in a sealed container, unless it is subsequently left open for several days in a protected, dry location. Also, collect a sample of culled insect parts, if present, and note their abundance.

There are no records of clinical histoplasmosis (a pathogenic fungus found elsewhere in bird and bat guano) from California. Biologists can make their own judgments (see Constantine 1988 for a discussion of health hazards to bat researchers which predates hantavirus outbreaks) regarding risks, but a reasonable precaution to avoid inducing or triggering existing respiratory allergies and unknown pathogen exposure would be to wear a dust mask if moving guano into collection vials or engaging in other activities that might suspend significant volumes of organic particulates.

Dead bats: Occasionally dead bats are encountered beneath bridge roosts.
Mortality may result from natural causes or vandalism incidents, but either provides material for identification of bridge populations. One natural cause of mortality for bats is rabies and, while the incidence in bats is low, clinical rabies is typically fatal to un-immunized humans. While dead bats beneath bridges might contain rabies virus, in the absence of human contact it is unlikely that financially strapped county health authorities with competing priorities, will find it cost effective to screen them.

Biologists should treat reasonably intact dead bats (i.e., not isolated skeletal elements) as rabies suspect, and place them, using gloves or forceps, in sealed plastic bags or large vials. Bats that are not completely mummified can be preserved with rubbing alcohol (95% isopropanol is widely available in drugstores) or standard laboratory 4% formaldehyde solution.
Note that the latter, which assuredly kills all microbes, is also a potent irritant and a suspected carcinogen. Storage in 95% isopropanol will severely dehydrate a bat carcass over a week or more. For subsequent storage or transfer, the alcohol can later be discarded. Note that most solvent-based ink labels (e.g., permanent marking pens) will be dissolved by alcohols.

M rochiroptera Bridge Survey Form[2]

Surveyors:
Bridge Name:
Bridge Number:
County/Route/PM:
Location (T/R/S):

Date/Time:
Function/Feature Crossed[1]:
Year Built[1]: Last Mod[1]:
Elevation (meters):
Lat[1]: Long[1]:
UTM: Z- N- E-

Span[1] (meters) :
Width[1](meters) :
Type[1](meters) :

Centerline Orientation(deg):
Feature Orientation(deg) :
Vertical Clearance(meters):

Bents/Rows :
Girders :

Air Pockets:
Exp. Joints :

Air Temp.(°C) :
Roost Temp.(°C):
Sub. Temp.(°C) :
Air Windspeed(Km/H):

Area Hab. Type :
Site Hab. Type :
Disturbance Factors:
Roost Windspeed(Km/H):

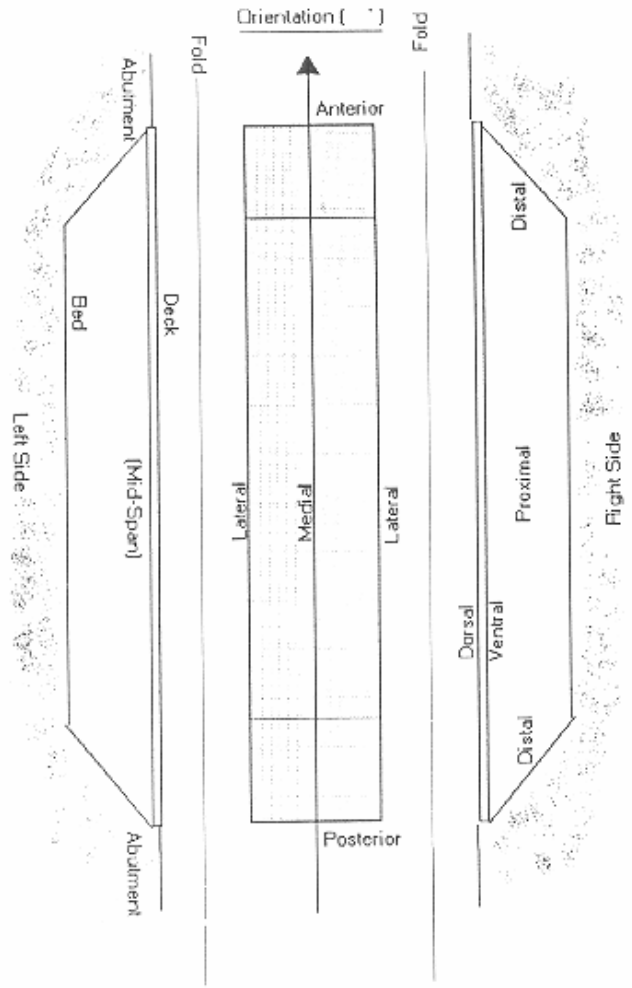
Stain Length:
Stain Type:
Stain Location:
Air Pockets Used:

Guano Amount :
Guano Location:
Guano Description :
Guano Sample#:

Species Known:

Species Likely:

Day Roost?: Night Roost?: Other Roost?:
Features Used:
Site Significance:
Recommendations and Notes:



Bridge Typical, note locations, features, and sketch of bridge, including exp. joints, bents, piles and arches.

[1] Data in Caltrans Bridge Log for Highways, [2] Send Copy of Form to: 1976 E. Charter Way, Stockton, CA 95201, or FAX (209) 948 3631, Attn: Gregg Erickson

5.1.1.3 LEVEL 3: Potential Impact Assessment
(District biologist, specialist for advice)

The third level of screening assesses the potential for impacts to bats, regardless of species. The data from the site visit and the work items for the proposed project will provide information for the assessment. The location of the bats relative to the work area, and other parameters of the proposed work, (e.g., noise levels, duration, timing) will be considered. If impact is likely to occur, then the assessment will proceed to the next level. No assumptions about size of day roosting colonies should be made based on daytime investigation. To assess colony size, the sight should be monitored from just before sunset until total darkness (end of astronomical twilight), generally one hour after sunset. Ideally, the investigator will have a broadband bat detector available for these surveys, since some species emerge primarily after dark, and might be missed by visual monitoring.

Information Needed

Colony size
Features used
Day roost or night roost
Alternative roost availability
Timing of work
Type of work

5.1.1.4 LEVEL 4: Species Prediction/Identification; Species Specific Impacts

(District biologist, specialist as needed)

Figure 5.1.1.4-1 Species Identification (Victoria Alvarez)

Assessment of bat use may require capture of animals for positive species identification and determination of reproductive status. Some assessment of species present can be made from collection of guano and carcasses, as well as direct observations of live animals in the roosts. Species identification should never be based on guano collection alone, since several species may use the same site. It is important to keep in mind that multi-species assemblages can be present in a single structure, with rare, difficult to detect species co-existing with more common species.

Assessing the significance of a roost may require input from someone knowledgeable regarding the ecology of the species. Different species may require different mitigation strategies. Although, in general, large colonies are of greater concern than small, and day roosts (particularly maternity roosts) are of greater concern than night roosts, other factors (e.g., rarity of the species, sensitivity of the species to disturbance) need to be considered.

A complete assessment of bat use may require capture of animals for positive identification and determination of reproductive status. Additionally, because different species may use a site at different times of the year, and even within one season, sites should be surveyed at least four times: late spring to early summer (May-June), mid-summer (mid-July to mid-August), and late summer to early fall (late August through the end of September). A fourth visit should be made in the winter to determine if the site is being used as a wintering site by non-hibernating bats, (in areas that have prolonged periods of non-freezing temperatures), or as a hibernation site in colder areas. If guano deposits are evident but animals are not found during any of the summer visits, then the site is likely serving as a migratory stopover and needs to be looked at more frequently during the spring and fall The appropriate time window may vary somewhat with altitude and latitude and will have to be adjusted accordingly.

The goal is not to impede operations, nor to require unreasonable mitigation measures, but to provide a realistic assessment of impacts and design mitigation measures responsive to the needs of particular species.

Note: California Department of Fish and Game requires that any person capturing and handling bats have an MOU with CDFG, and recommends that they be immunized against rabies.

5.1.2 General Survey

General survey methods should follow the general basis of the seismic protocol (Section 5.1.1) except that every bridge should be more closely examined.

5.1.3 Other Structures

For a number of projects, structures or landscape features other than bridges may be located within the project zone or themselves be subject to impacts, e.g., buildings to be demolished for a road realignment or a mine, cave or lava tube that runs under a highway. These structures should be examined to determine bat use and conducted as thoroughly as safety allows. Special caution is to be taken regarding abandoned mines, since these are often too dangerous to enter ansurveys should emphasize observation of portals at emergence time.

The steps taken are similar to those for bridge surveys:

1. A review of available records to identify potential structures;

2. A site investigation to assess whether the structures have potential for bats, to look for bats, or bat sign;

3. An assessment of potential impacts to bats from project activities, including an initial assessment of the numbers of bats utilizing the structure, using both acoustic and visual observation techniques at the time of emergence;

4. An identification of any species using the site, along with an assessment of species-specific impacts.

5.1.4 Evaluating Ecological Context and Site Significance

5.1.4.1 Assessing Roost Availability

In order to evaluate the significance of a roost, it may be necessary to assess the availability of alternative roosting sites in the vicinity of the project. Since many bat species travel 5-7 miles on a nightly basis to reach foraging areas, and some travel up to 15 miles or more, a fifteen-mile radius should be surveyed for alternative roosts sites within right of way access. If the structure in question occurs on a major drainage, then animals could travel even greater distances up and down that drainage, and large bridges over the drainage should be surveyed for a 25-mile radius around the structure.

5.1.4.2 Assessing Foraging Habitat

All except one bat species in California feed on insects or other arthropods. The exception is *Choeronycteris mexicana*, a nectar feeding species most common in southern San Diego County. Different species have different foraging requirements. Some feed almost exclusively over water on aquatic emergent insects; others feed high over water and/or in association with riparian vegetation; others forage predominantly away from water in meadows or oak savannah; and others feed in the open air over meadows or above the forest canopy. Nevertheless, surface water supplies and healthy riparian plant communities benefit the majority of species.

Should the proposed project substantially reduce or adversely impact foraging habitat, the availability of alternative foraging habitat within a fifteen-mile radius of the site should be evaluated.

5.1.4.3 Assessing Bat Diversity

Conduct a database search to determine what species would be expected in the project area. In some cases, it is possible to determine simply by visual observation what species are using a structure, but it is important to remember that not all species are visible and that the species assemblage may vary seasonally.

An experienced observer may also be able to identify the presence of a nursery roost by identification of non-volant young. In many cases, it will be necessary to use other methods to determine the full species assemblage using a structure, or more typically, to determine what other species are using the project area.

5.1.4.3.1 Acoustic Monitoring

Acoustic monitoring of bats is conducted with ultrasonic devices linked to lap-top computers or tape recorders. This system detects and records for later analysis the ultrasonic echolocation calls of bats.

Acoustic monitoring can effectively be used in two ways:

1. When used in combination with visual observation, it can be very helpful in identification of animals as they exit a roost and can often supply information on how many different species are present.

2. Acoustic monitoring can also be valuable for assessing and/or comparing levels of foraging activity in differing habitats, and for evaluating general bat diversity and abundance in an area.

In some circumstances, using acoustical methods for species identification can be very effective and quite problematic in others. Although all species will vary their call structure to a certain degree based on the surrounding habitat, (i.e., degree of clutter), some species can be identified a large percentage of the time based on their echolocation calls. This means that the basal frequency and/or the structure of their calls are somehow distinctive and do not overlap with other species found in the same geographic area. Unfortunately, there are also a number of species that do have overlapping call characteristics, making positive identification based solely on recorded calls difficult or impossible. In short, identifying bat species by their calls is rarely straightforward, and requires considerable experience.

It is not possible at this point to suggest a formula for how much acoustic monitoring is required to answer questions regarding a species assemblage in an area. What is clear is that detectors placed even a short distance apart (e.g., 50 m), especially in different microhabitats, often detect different species. Due to difficulties posed by night-to-night variation in bat activity at any one site, it was highly preferable to sample multiple sites simultaneously. To detect seasonal patterns (e.g., migration along river corridors) and to increase the likelihood of detecting rare species, an acoustic monitoring regime should be repeated at least three times (spring-early summer, mid-summer, and late summer-early fall).

While it is possible to set up an acoustic system to record passively, it is important that for each sampling session, at least one detector be actively monitored. The person actively monitoring a detector can, by using a bright spotlight, frequently obtain visual observations that can facilitate species identification. For example, both *Myotis californicus* and *Myotis yumanensis* echolocate at 50 kHz and usually cannot be distinguished based on their calls alone, yet they forage in different places --- *M. yumanensis* typically skims water surfaces, while *M. californicus* typically feeds at canopy level. Thus, a visual observation accompanying the recorded call can often serve to make a distinction between these two species.

5.1.4.3.2. Capture Techniques

Any person proposing to capture and handle bats must have undergone training and have obtained an MOU from California Department of Fish and Game. There are three capture methods in common use: hand nets, mist nets, and harp traps. Which method employed would depend on both the physical situation and the question being addressed. Hand nets are most effective for capture at night roosts. Day roosts should only be observed from a distance, and animals should never be physically removed from a day roost due to the risk of disturbing and/or injuring nursing females and their young. Should it be necessary to capture animals from a day roost, this can be done by setting either a harp trap or mist nets at some distance from the exit point (in the case of a bridge) or close to the entrance (in the case of a mine or building).

5.2 CEQA / NEPA Evaluation

Using an appropriate combination of structure inspection, sampling, exit counts, and acoustic surveys, a biologist with specific Bats and Bridges training is to survey each structure and surrounding area that may be affected by the project.

If bats are found, the bat biologist will identify them to species and evaluate the colony to determine the CEQA Significance and NEPA effects by analyzing the following issues:

a) Substantial adverse effects, either directly or through habitat modifications, on any species identified as a candidate, sensitive or special status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service.

b) Substantial adverse effects on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the California Department of Fish and Game or U.S. Fish and Wildlife Service where such effects may be caused by alteration of a colony.

c) Substantial interference with the movement of any native, resident, or migratory bat species, with any corridor used by resident or migratory bat species, or with the ability of any bat species to use nursery sites.

d) Degradation to the quality of the environment, substantially reduce bat habitat, reduce a bat population to below self-sustaining levels, threaten to eliminate a bat community, or to reduce the number or restrict the range of a rare or endangered bat.

e) Potential to substantially degrade a county integrated pest management program in agriculture or silviculture.

f) Alteration to a scientific study or potential for substantial loss of scientific data identified in a resource agency recovery plan as a necessary component for recovery, management, and research.

g) Availability of appropriate and feasible species-specific mitigation and monitoring measures to offset impacts, including seasonal and daily timing.

h) Availability of effective and humane exclusion techniques that reflect seasonal and structural constraints.

6.0 Survey Data

6.1 Statewide

The data collected to date is dominated by information from north and central California. However, southern California data appears to be congruent to the extent known. The northern region represents 44%, the central region represents 41%, and the southern region represents 15% of the data collected. Very little data is available for northeastern and southeastern California. The data from statewide surveys consists primarily of positive survey results only.

The data collected from the seismic surveys was collected throughout the state. However, the bridges of focus were bridges where seismic safety was the primary factor. This, combined with the use of the seismic protocol, skewed the data collected.

6.4 Type Use Rate Estimates

Estimated # of California
State Owned Bridges by Type
based on District 10 rates and
statewide types used

9/23/96

Rated Type	Number Possible	Known Rate	# Likely
PG	20	100	20
QJ	7	100	7
SB	3	100	3
CAO	41	67	27
CG	1262	26	328
CB	1066	12	128
SG	288	7	20
QI	203	5	10
SS	173	4	7
CS	1774	3	53
QB	992	1	10
Subtotal	5829	11	**614**

Unknown Type	Number Possible	Expected Rate	# Likely
LS	0	*100*	0
TT	32	*100*	32
TA	0	*100*	0
SP	0	*0*	0
TB	0	*100*	0
SB	3	*0*	0
SA	5	*0*	0
PS	32	*0*	0
PB	1	*0*	0
CAF	34	*0*	0
CC	886	*0*	0
CP	7	*0*	0
QG	4	*26*	1
QS	30	*0*	0
QA	41	*0*	0
QX	12	*0*	0

QK	15	*26*	4
QT	3	*26*	1
QU	18	*26*	5
QW	2	*26*	1
SU	4	*0*	0
TU	15	*25*	4
MA	15	*0*	0
CT	0	*50*	0
EW	0	*0*	0
TW	0	*0*	0
CW	0	*0*	0
SW	0	*0*	0
CD	0	*0*	0
ED	0	*0*	0
SLS	1	*0*	0
Subtotal	1160	4	**47**

Unrated Type	**Number Possible**	**Expected Rate**	**# Likely**
TS	37	*100*	37
ST	64	*7*	4
MP	60	*5*	3
CU	24	*5*	1
Subtotal	185	25	**46**

Total	**706**
Percent of 12000 Structures	**5.9**
Percent of 6515 sub-facility Structures	**10.8**

6.4.4 Theoretical by Structural Age Estimate

Year Class	Estimated Day Roosts	Estimated Night Roost	Estimated Total Roosts
BEFORE 1901	0.0	12.2	12.2
1901 - 1904	0.0	0.0	0.0
1905 - 1909	0.0	0.0	0.0
1910 - 1914	0.0	0.0	0.0
1915 - 1919	24.5	49.0	73.5
1920 - 1924	49.0	49.0	98.0
1925 - 1929	12.2	110.2	122.5
1930 - 1934	134.7	134.7	269.5
1935 - 1939	98.0	85.7	183.7
1940 - 1944	98.0	73.5	171.5
1945 - 1949	49.0	24.5	73.5
1950 - 1954	61.2	134.7	196.0
1955 - 1959	159.2	245.0	404.2
1960 - 1964	110.2	269.5	379.7
1965 - 1969	318.4	98.0	416.4
1970 - 1974	147.0	61.2	208.2
1975 - 1979	36.7	36.7	73.5
1980 - 1984	36.7	0.0	36.7
1985 - 1989	61.2	0.0	61.2
1990 - 1994	12.2	24.5	36.7
1995 - 1999	0.0	24.5	24.5
Total	**1409**	**1433**	**2842**

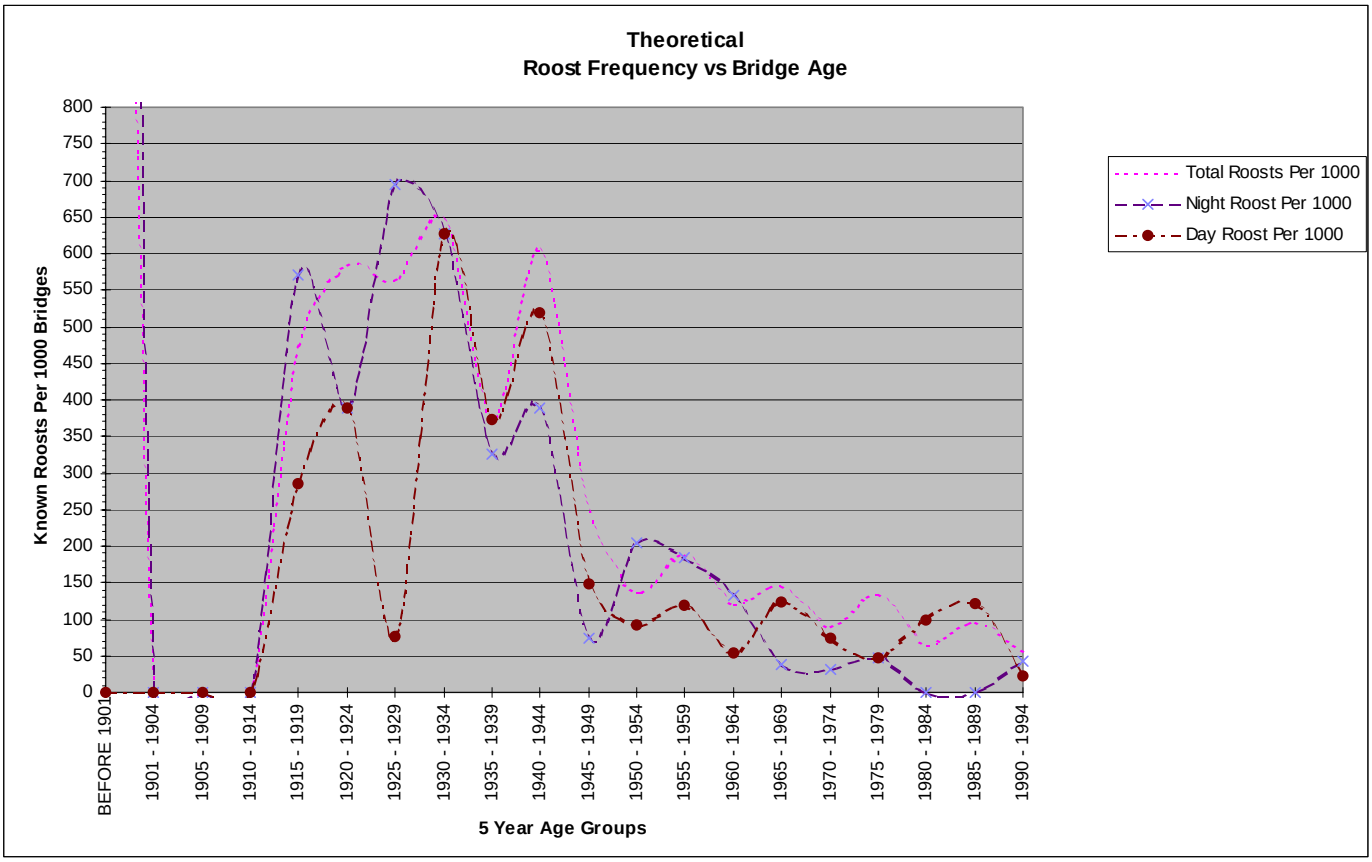


Figure 6.4.4-1 Theoretical Use by Age

7.0 Mitigation Strategies

Mitigation should always focus *first* on avoidance; if avoidance is not possible, then impacts should then be minimized. Replacement should only be used as a last resort and must be species-specific, lest increased harm to the bat assemblage occur. The best solutions are simple and fit within the parameters of normal operations.

Accommodation and mitigation should use the following approach:

1) Existing roosts are to be accommodated to the extent feasible while, maintaining the safety, operation, maintenance, and inspection aspects of the structure.
    a. Impacts and interactions with the species are to be avoided whenever possible through timing of work, method selection, and retention of features that provide naturalized habitat.
    b. If avoidance is not possible, impacts are to be minimized by careful planning of activities to complement the life history of the animal. Measures might include items such as temporary humane exclusions at appropriate times of year to avoid take, and the retention of portions of the features that provide naturalized habitat.
    c. Where appropriate, measures to minimize accumulation of guano from existing roosts and to allow inspection without disturbance to the bats are to be incorporated into projects.

2) Cost effective and ecologically sound mitigation should be considered where impacts to the roost could:
(a) Affect substantial values for migration, breeding, rearing of young, hibernation, or scientific study;
(b) Result in substantial adverse effects on any species or habitat identified as candidate, sensitive, or special status in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or the U.S. Fish & Wildlife Service; or
(c) Cause a wildlife population to drop below self-sustaining levels that are based on careful analysis of the best scientific and commercially available data for the local population.

3) Options for mitigation are to be considered at the watershed scale and should include such measures as:

    a. Ecologically sound compensation and/or enhancement, integrated with regional habitat planning to offset affected functions and natural systems.

        i. Off-Structure measures that provide suitable replacement roosting opportunities, such as mine gate closures or enhancements of structures in wildlife areas, should be considered as the highest priority option where feasible and cost effective.

ii. Off-Structure, out-of-kind habitat improvements should be considered as a preferred comprehensive solution, in coordination with appropriate resource agencies, where roosting is not necessarily the limiting factor for the species present, and where sufficient information is available to indicate that habitat enhancement would benefit the population to an equal or greater extent than in-kind enhancements. The implementation of resource management measures can cumulatively offset impacts and rectify chronic issues through the application of proven resource management principles, such as riparian restoration to proportionally improve ecological system function and species production.

iii. On-structure measures may be considered where:

1. Offsite measures are not available, economically feasible or ecologically effective.
2. Structural integrity and safety are not compromised.
3. They are compatible with social, economic and environmental goals of the local area, such that
    a. density and distribution of species is not increased in areas of human occupation, e.g., urban, residential, farms, and recreational areas;
    b. presence of the colony complements the surrounding natural communities;
    c. design is aesthetic and discourages vandalism or tampering;
    d. the site is not in close proximity to homes, businesses, schools, or public areas.
4. A design detail or structural design selection is available from the designer that
    a. does not compromise structural integrity or safety;
    b. allows routine maintenance and inspection of the bridge structure with features to prevent
        i. accumulation of guano and or/urine,
        ii. deterioration of materials;
        iii. wildlife contact by
            1. temporary containment of animals if bats and people are present at the same time,
            2. easy temporary removal of features during maintenance and inspection, or
            3. placement of features, such as panels away from catwalks (<20') and other areas routinely used for inspection.

5. Related resource agencies accept the following disclaimer in any agreements in order to allow required operations:

> *Disclaimer:*
>
> The structural elements and features that facilitate the life history of bat species on a bridge or other transportation facility are subject to regular inspection, repair, rehabilitation, alteration, and/or replacement as part of normal operations and maintenance, and may on occasion reduce or eliminate the habitat values provided.
>
> The Department will take reasonable measures to avoid and minimize unnecessary disruptions to the animal's normal behavior patterns, which include, but are not limited to, breeding, feeding and sheltering. However, this accommodation does not preclude the Department from future engineering actions that are found to be necessary to meet the transportation needs of California, or from measures to ensure the safety of the public or Department personnel. Habitat values may be removed with little or no advanced notice in those situations where it is necessary to immediately prevent or inspect damage or where the stability of the structure is in question.

iv. The recovery of information through focused research would result in more effective resource management techniques and contribute to the improvement of ecological function and production. In some cases, such research would be acceptable to offset impacts; however, participation and reimbursement by the Federal Highway Administration may be limited.

4) Enhancement of a structure where habitat does not currently exist should be considered where the following conditions are met:
   a. The need for a specific habitat, such as night roosting, is outlined in a species recovery plan or land use plan provided by the Department of Fish and Game or U.S. Fish and Wildlife Service.
   b. The appropriate environmental and engineering managers concur that the proposal is consistent with operations and stewardship goals.
   c. The approach meets the criteria of these guidelines.

7.1 On-Site Night Roost Avoidance, Minimization, Mitigation Measures

Night roosts are typically utilized from the approach of sunset until sunrise. In most parts of the state use will only occur from spring through fall. These example measures (each site is unique) apply when bats are present, the evaluation criteria are met, and where work cannot occur during the off-season, before the bats arrive or after the bats leave.

Each generic approach is designed to control disturbance to a specific level for the most sensitive species. Specific project measures may be less stringent once site conditions, species sensitivity, and relative significance of the impact are considered.

7.1.1 Avoidance (No Impact)

Work activities are not to occur within 100 feet of the bridge between sunset and sunrise. Airspace access to and from the bridge is to remain approximately the same. Bird exclusion netting must not be used. No clearing and grubbing is to occur adjacent to the structure. Lighting is not to be used near the structure where it would shine on the structure. Combustion equipment, such as generators, pumps, and vehicles are not to be parked, nor operated, under or adjacent to the structure. Personnel are not to be present under the bridge during the evening or at night.

7.1.2 Minimization (Minor Impact)

Work activities are not to occur under the structure between 10:00 p.m. and sunrise. Airspace access is not to be severely restricted. Bird exclusion netting must not be used. Clearing and grubbing near the bridge is to be minimized. Lights are not to be used under the structure. Combustion equipment, such as generators, pumps, and vehicles, are not to be parked or operated under the structure. Personnel are not to be present under the bridge during the evening and at night.

7.1.3 Minimization (Moderate Impact)

Between 10:00 p.m. and sunrise, work activities are to be limited to one portion of the structure at a time. Airspace access is not to be eliminated. Constant (daily) exclusion is to be in place at the work areas. If netting is used, it is to be made of thick plastic and with no exposed overlap joints. Lighting is to focus very specifically on the portion of the bridge actively under construction. Combustion equipment, such as generators or pumps, are not to be parked nor operated under the structure unless they are required to be in contact with the structure. Use ESA flagging to delineate work active work areas from non-active work areas. Personnel are not to be present under the bridge during the evening and night in non-active areas.

7.1.4 Mitigation (Major Impact)

The configuration that supports night roosting should be retained where feasible. Bridge replacements should consider use of a similar bridge design when the roost is large, unique or supports a rare species.

Should an alternate design be used, consideration is to be given to minor modifications that will provide semi-open cavities. The cavities should have sidewalls that are at least 0.6 meters tall and hang from the underside of the structure. The longitudinal walls should be spaced approximately 2 meters apart. Transverse walls, which can double as shear walls, should be 4+ meters apart.

Other options could include surveying the surrounding area and improving other potential sites with minor modifications or careful brush removal.

7.2 On-Site Day Roost Avoidance, Minimization, Mitigation

Day roost use usually only occurs during the spring, summer, and fall in California, except in coastal areas, the Central Valley, and some other areas. (Some species do not hibernate.) These measures apply to those circumstances where the bats are present. The most critical time, known as the non-volant period, is when young are present, but are not yet ready to fly. The non-volant period is generally May through July. Due to seasonal variation between sites, April and August are to be avoided.

The best avoidance measure is to work when the colony is not present and to retain or restore the roost characteristics after work is complete. If this measure is not feasible, measures taken should be consistent with the general approach guidelines. As noted in the general guidelines, on-site day roost replacement is to be considered as a last resort for avoiding further impacts to the species when structures are regularly inspected, maintained, and replaced.

Each generic approach is designed to control disturbance to a specific level for the most sensitive species. Specific project measures may be less stringent after site conditions, species sensitivity, and the relative significance of the impacts are considered.

7.2.1 Avoidance (No Impact)

Work is not to occur within 100 feet of an active roost. The area around the bridge is to be designated as an ESA. Airspace access to and from the bridge should remain approximately the same. No clearing and grubbing is to occur adjacent to the structure. Combustion equipment, such as generators, pumps, and vehicles, are not to be parked nor operated under or adjacent to the structure. Personnel are not to be present under the colony, especially during the evening exodus.

7.2.2 Minimization (Minor Impact)

Work is not to occur directly under or adjacent to the roost. The area under the roost within visual sight of the bats is to be designated as an ESA. Airspace access to and from the bridge is not to be severely restricted. Clearing and grubbing is to be minimized wherever possible. Combustion equipment such, as generators, pumps, and vehicles, should not be parked nor operated under or adjacent to the structure. Personnel should are not to be present directly under the colony, especially during the evening exodus.

7.2.3 Minimization (Moderate Impact)

Where work must occur in the area of a seasonal colony:

Bats are to be excluded from directly effected work areas prior to April 15 of the construction year. Exclusion is to be done selectively, and only to the extent necessary, to prevent morbidity or mortality to the colony. Expandable foam, steel wool, or other method is to be used. Exclusionary devices are to be removed between August 31 and April 15, once construction is complete.

Airspace access to and from the bridge is not to be eliminated. Colony ventilation and protection is to remain the same. Clearing and grubbing is to be minimal, whenever possible. Combustion equipment, such as generators, pumps, and vehicles, are not be parked nor operated under or adjacent to the structure unless they are required to be in contact with the structure. The presence of personnel directly under the colony is to be minimized.

Provision of alternative roost sites may be considered when a substantial portion of the colony is to be excluded for a season or more. However, this is very experimental and close monitoring and reporting of observations is needed to document performance strengths and weaknesses of this measure.

7.2.4 Mitigation (Major Impact)

The ideal situation is to replace the current roost habitat with an identical roost containing the same species-specific physical parameters. If this is not possible due to engineering requirements, e.g., safety, replacement habitat may be considered. Supplemental habitat may also be considered when exclusion will occur for more than one season.

If an alternate design is used, consideration of minor modifications to provide similar roost characteristics is important where feasible.

Critical issues include access, ventilation, and protection. Crevice roosts should be replaced with crevices of similar area and cavities should be replaced with cavities of similar parameters.

Note: All potential on-site measures must be coordinated in advance with the structural engineer and incorporated into the project planning process.

7.2.4.1 Replacement Cavity Roosts

Replacement cavities that make the roost compatible with the bridge design and operation must be closely coordinated with structural engineers in order to incorporate the physical parameters that are of key importance to the specific species affected.

7.2.4.2 Replacement Crevice Roosts

7.2.4.2.1 Crevice Modification

Within engineering limitations, minor modifications of existing or proposed expansion joints or similar crevices may provide adequate replacement habitat without compromising the structure.

The gap of the joint should be between 1.9 and 3.8 centimeters unless engineeringly unfeasible. Ideally, the replacement gap should match the original gap. The larger end of the range is better for larger crevice dwellers, such as mastiffs, pallids, and big browns. Smaller crevices tend to favor smaller species, such as Mexican free-tails and pocketed free-tails. The inside surface area of the replacement crevice should be located near the original roost. The replacement roost should have an equivalent inside surface area as close as possible to the same compass orientation.

The crevice should have good aerial access, such as a clear 2-meter drop below or a lateral launching pad, where bats can drop down out of the crevice. The top of the crevice should be protected from sunshine, precipitation, and debris, but should have a small shelf for the bats to tuck their babies. The cover may be made of metal, concrete, gasket material, or other nontoxic substances. Gasket material should be omitted from the bottom thirty or more centimeters of the joint. The surface should remain rough; it should not be smoothed.

The replacement crevice should be swabbed with bat guano and urine collected from the original roost and additional guano should be placed in a row under the new roost.

7.2.4.2.2 Add on Panels

Supplemental panels made of lightweight concrete or wood may provide some habitat value. These panels have been successful in California, but are of limited size. The panels must be very carefully placed vertically to avoid compromising the structural integrity or the ability to inspect the structure. The design and placement is extremely critical to allow proper temperature control and variety, as well as to allow for routine bridge inspections and maintenance. Airspace access to an entrance at the bottom of the panel should also be considered. A small ledge must be provided at the top for the bats to place their young.

The 1-meter tall panels are bolted on to the structure and must be sealed at the top to prevent rain from entering. The opportunity for limited ventilation should be provided at the top to allow temperature control. The surface should remain rough; it should not be smoothed.

Figure 7.2.4.2.2 Add On Panels (Brian Keeley)

7.2.4.2.3 Add-On Collars

Collars around large piers are similar to flat panels, with a broader internal temperature range. Since their design may hamper column inspections, use of this method must be coordinated with the structural engineer to ensure accessibility. Collars are to be at least one meter high and subdivided internally by vertical staves that extend a quarter of the way down the inside.

These collars may be made of lightweight concrete or as simple as sheet metal. The opportunity for limited ventilation should be provided at the top to allow temperature control. The surface should remain rough; it should not be smoothed.

7.2.4.2.4 Capped Edge Drains

Standard edge drains can provide small day roosts. The 6-8 inch steel cylindrical drain is capped with the bottom of coffee can tin paved over with asphalt. This creates a tube about 18 inches deep with a ledge at the top. The bats can use the edge to grip and the ledge to rest upon or hold their young.

7.2.4.2.5 Wooden Signs

Metal or wood signs with wooden backing that are bolted to chain-link fence and suspended more than two meters off the ground can provide small to medium crevice day roosts. These signs provide tight spaces, the signboards being kept apart approximately one inch, and they can also provide places for maternal bats to tuck their young.
Note: This has only been recorded being used by Yuma myotis from one record in Tuolumne County. Future observations might yield additional species use. This observation importantly illustrates that suitable crevices can be very deceiving and cryptic.

7.2.4.2.6 Bat Houses

Bat houses may provide limited habitat in some cases. They have not been used successfully in California, but they have seen successful in Texas. There are a variety of designs and ready-made houses available. Bat Conservation International evaluates and approves bat houses for effectiveness and is a good source for information and approved designs. Important considerations include opportunities for behavioral thermal regulation, thermal mass, interior size, ventilation, maintenance, permanency, protection from vandalism, correlation with the original structure, and effectiveness.

7.3 Wintering and Hibernation Roosts

Wintering-or hibernation-roosting usually occurs from late fall through early spring in California. In many cases, the sites are also used as day roosts during the balance of the year. These measures apply when the bats are present for wintering or hibernation purposes.

The critical time is when the temperatures are low and the bats are in hibernation or deep torpor. The metabolic cost of waking a bat from hibernation can be very high and could be enough to reduce their energy supply to the point where survival of the individual is not possible. It is especially costly to disturb them during cold spells where the cost of maintaining the body's temperature is high.

The best avoidance measure is to schedule work when the colony is *not* present and to retain the roost characteristics when work is complete. If this cannot be done, the following measures are to be considered:

7.3.1 Avoidance (No Impact)

To avoid stimulating energy-draining arousal, several measures are essential. Designate the area around the bridge as an ESA site. No work will take place or occur within 100 feet of an active roost. Airspace access to and from the bridge should remain consistent. No clearing and grubbing should occur adjacent to the structure. Combustion equipment, such as generators, pumps, and vehicles are not to be parked or operated under or adjacent to the structure. Personnel are not to be present under the colony, especially during the evening exodus from day roosts.

7.3.2 Minimization (Minor Impact)

Work must not occur directly under or adjacent to the roost. Designate the area around the bridge as an ESA site. Airspace access to and from the bridge would not be severely restricted. Clearing and grubbing will be minimized wherever possible. Combustion equipment, such as generators, pumps, and vehicles will not be parked or operated under or adjacent to the structure. Personnel shall not be present directly under the colony, especially during the evening exodus. Vibration and noise will be avoided.

7.3.3 Minimization (Moderate Impact),

Exclusions, when needed, will be installed at directly effected sites in late August, after completion of the maternity season. Exclusion is to be done selectively and only to the extent necessary to prevent morbidity or mortality in the colony. An expandable foam or steel wool should be used. Remove exclusionary devices after November 1 when the temperatures have gotten cold and the animals have relocated. After construction is complete, be sure to remove the exclusionary device.

Airspace access to and from the bridge must not be eliminated. Colony ventilation and protection should remain the same. Clearing and grubbing will be minimized, where feasible. Combustion equipment, such as generators, pumps, and vehicles should not be parked or operated under or adjacent to the structure unless they are required to be in contact with the structure. Minimize presence of personnel directly under the colony. Minimize vibration, noise and light to the maximum extent possible.

Provision of alternative roost sites is to be considered when a substantial portion of the colony will be excluded for a season or more.

7.3.4 Mitigation (Major Impact)

The magnitude of impacts to hibernation and wintering roosts can be substantial from a species and wildlife perspective. Therefore, major impacts, such as removal, must only be considered when there are no other alternatives. In such a case, a bat expert familiar with the particular species must be consulted.

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11.0 Appendices

11.1 Appendix A. Bibliography

REFERENCE BOOKS

Altringham, J. D. 1996. Bats: biology and behaviour. Oxford University Press, Oxford, 300 pp.

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

Barclay, R.M.R., and R. M. Brigham, ed. Bats and Forests Symposium, October 19-21, 1995, Victoria, British Columbia, Canada., Research Branch, BC Ministry of Forests, Victoria, British Columbia.

Fenton, M. B. 1992. Bats. Vol. Facts on File, Inc., New York, New York, 238 pp.

Fenton, M.B. The bat: wings in the night, 144 pp.

Hall, E. R. 1981. The Mammals of North America. John Wiley and Sons, Inc., New York, 600 pp.

Hill, J. E. and J. D. Smith. 1984. Bats: A natural history. British Museum (Natural History), London, 243 pp.

Kunz, T. H., ed. 1982. Ecology of bats. Plenum Press, London, 425 pp.

Kunz, T. H. and P. A. Racey 1998. Bat biology and conservation. Smithsonian Institution Press, Washington,365 pp.

Nowak, R. M. 1994. Walker's bats of the world. Johns Hopkins University Press, Baltimore, 287 pp.

PAPERS ON DISTRIBUTION OF BATS IN CALFORNIA

American Society of Mammalogists. Mammalian Species Accounts (available for most species).

Constantine, D. G. 1998. Range extensions of ten species of bats in California. Bulletin Southern California Academy of Sciences 97(2):49-75.

Pierson, E. D. and W. E. Rainey 1998. Distribution of the spotted bat, *Euderma maculatum,* in California. Journal of Mammalogy 79(4):1296-1305.

Pierson, E. D. and W. E. Rainey. 1998. Distribution, habitat associations, status and survey methodologies for three molossid bat species (*Eumops perotis,Nyctinomops femorosaccus,Nyctinomops macrotis*) and the vespertilionid (*Euderma maculatum*), final

report. California Dept. of Fish and Game. Bird and Mammal Conservation Program, Sacramento, CA , 61pp.

Pierson, E.D. and W.E. Rainey. 1998. Bat distribution in the forested region of northwestern California. Report to California Department of Fish and Game, Wildlife Management Division, Sacramento, CA.36 pp.

Pierson, E.D., W.E. Rainey, and C. Corben. 2000. Distribution and status of red bats in California. Contract Report. Species Conservation and Recovery Program, Habiat Conservation Planning Branch, California Department of Fish and Game, Sacramento, CA, 30 pp.

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(1):66-75.

PAPERS ON BATS AND BRIDGES

Adam, M. D. and J. P. Hayes. 2000. Use of bridges as night roosts by bats in the Oregon coast range. Journal of Mammalogy 81:402-407.

Constantine, D. G. 1961. Locality records and notes on Western bats. Journal of Mammalogy 42(3):404-405.

Davis, R. and E. L. Cockrum. 1963. Bridges utilized as day-roosts by bats. Journal of Mammalogy 44(3):428-430.

Perlmeter, S. I. 1996. Bats and bridges: patterns of night roost activity in the Willamette National Forest. pp. 132-150, in R. M. R. Barclay and M. R. Brigham, ed. Bats and Forest Symposium, October 19-21,1995, Victoria, British Columbia, Canada, Research Branch, B.C. Ministry of Forests, Victoria, British Columbia.

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, ed. Bats and Forests Symposium, October 19-21, 1995, Victoria, British Columbia, Canada, Research Branch, BC Ministry of Forests, Victoria, BC, Working Paper 23/1996.

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11.3 Appendix C. Field Equipment - Basic

Tools

Data sheet (Preprinted)
Clip Board
Pencil
Compass
Thermometer / Temperature Probe, Degrees C
Marked Vehicle
Camera and film
Cellular Phone / Radio
Calipers, 150 $\pm$0.1 millimeters
Plastic Zip Lock Bags
Binoculars
Map
Bridge List

Clothing

Boots with Ankle Support
Hard Hat
Vest
Safety Glasses
Gloves

11.4 Appendix D Blank

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11.5 Appendix E. - Additional References

ADDITIONAL REFERENCES

Books/References on Bats:

American Society of Mammalogists. Mammalian Species. Dept. Zoology, Brigham Young University, Provo, UT. (Available for many California species).

Barbour, R. W. and W. H. Davis. 1969. Bats of America. University of Kentucky Press, Lexington, Ky, 285 pp. (Out of Print).

Fenton, M. B. 1983. Just Bats. University of Toronto Press, Toronto. $14.00

Fenton, M. B. 1992. Bats. Facts on File, New York, 207 pp. $45.00

Kunz, T. H., ed. 1982. Ecology of bats. Plenum Press, New York, 425 pp. $75.00

Kunz, T. H. 1988. Ecological and behavioral methods for the study of bats. Smithsonian Press, Washington, DC. 533 pp. $35.00.

Nagorsen, D. W. and R. M. Brigham. 1993. Bats of British Columbia. UBC Press, Vancouver, 164 pp. $16.00.

Nowak, R. M. 1994. Walker's bats of the world. Johns Hopkins Univ. Press, 287 pp. $19.95

Schmidly, D. J. 1991. The bats of Texas. University of Texas Press, Austin, TX, 189 pp. $19.00.

Tuttle, M. D. 1988. America's neighborhood bats: understanding and learning to live in harmony with them. University of Texas Press, Austin, TX, 96 pp. $10.00.

Distribution Maps:

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

Zeiner, D.C., W.F. Laudenslayer, Jr., K.E. Mayer, M. White. 1990. California's wildlife. Vol III: Mammals. Calif. Dept. Fish and Game, Sacramento. **Note:** The distribution maps provided in this book contain a number of errors, but are the best available for California.

Educational Materials:

Bat Conservation International
P.O. Box 162603
Austin, TEXAS 78716
(512) 327-9721
(512) 327-9724 FAX

Bat Talks, Information on California Bats:

California Bat Conservation Fund
P.O. Box 1502
Ross, CA 94957
Tel./FAX (415) 456-6598 (Christine Scott)
Tel./FAX (415) 893-9532 (Patricia Winters)

11.6 Appendix F. Caltrans Data

I. District Bridge Log

The District Bridge Log has traditionally been kept in the Permits Section. This log is organized by district and provides basic information on bridge types, specifications, location, features crossed, and location of other nearby Caltrans bridges.

II. Post Mile Log

The Post Mile log is commonly found in the engineering section. The Post Mile log will feature the location and features crossed, as well as proximity to other features. This is very useful is coordinating locations on a Quad map.

III. Bridge Design and Maintenance Log

The bridge design and maintenance logs are kept in Sacramento Design. A minimized copy is available in District 10 in Excel format. This is a relatively comprehensive database on bridge design and maintenance. It has many details on the structure and history.

IV. Bridge Inspectors and Maintenance Supervisors

These people are located in the Districts. They have a wealth of first-hand knowledge and know the structures well.

V. Standard Plans and Specification

Most engineers in the district will have a copy of the Standard Plans. This may be very useful in understanding how things are designed and built.

VI. Specific Bridge Plans

The engineer should have a good set of plans prior to any project. As-builts of structures are also available for older projects.

VII. Quad Map

Always review the quad maps. They have elevation, terrain, water features, and proximity to other features.

VIII. Aerial Photographs and Roadway Postmile Film

These images are available in the district and provide a good rough idea of the terrain and habitat type near the bridges. They also give an idea of what the bridge looks like. Oblique aerial photographs and photos by the engineer are also good sources.

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11.9 Appendix I. General Life History

(Prepared by Wendy Philpot, as edited by E.D. Pierson)

This appendix provides general background on the life histories of bats in California. However, regional variations in habitat usage and behavior should be considered when evaluating specific situations and regional local experts should be consulted with questions and concerns. Specific references for each species account are included. The following references apply to all species accounts:

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

Hall, E. R. 1981. The Mammals of North America. John Wiley and Sons, Inc., New York, 600 pp.

Nowak, R. M. 1994. Walker's Bats of the World. Johns Hopkins University Press, Baltimore, 287 pp.

***Antrozous pallidus* (Pallid Bat)**

Distribution: Most often found in low and middle elevation areas (< 6,000 ft) throughout California.

Habitat Characteristics: Found in a variety of habitats, from scattered desert scrub, grassland, shrub land, woodland, and forests, from sea level through mixed conifer. Associated with oak woodland, ponderosa pine, mixed conifer, redwood, and giant sequoia habitats in central and northern California.

Ontogeny and Reproduction: Mating takes place between late October and February. After a period of delayed fertilization, gestation occurs between April and June. Up to twelve young are born per year, with two being most common. Nursery colonies may contain up to several hundred females, but generally fewer than 100. Maternity colonies are formed around April and usually consist of 20-100 individuals; males may roost in the nursery or separately. Young can fly well at 6 weeks of age, and are weaned by 7 weeks.

Roost Sites: Selects a variety of day roosts including rock outcrops, mines, caves, tree hollows, buildings, and bridges. Night roosts may vary, but commonly under bridges; but also in caves and mines. Intolerant of roosts in excess of 40"C.

Food Habit: Maneuvers well on the ground. Commonly feeds on large ground-dwelling arthropods such as Jerusalem crickets, beetles, and scorpions, but also include large moths, and grasshoppers. It forages at a height of 0.5 to 2.5 meters above the ground. This species typically has two nightly foraging periods with an intervening roosting period.

Behavior : **Winter Status** Hibernates, but periodically arouses and actively forages and drinks throughout the winter. **Resident Status** Year-round resident. **Other** Highly social.
Status: **Listed as a Mammal of Special Concern with the California Department of Fish and Game.** The Pallid bat is very sensitive to roost site disturbance, and has suffered substantially due to pesticide use (primarily by the loss of edible insects) and from human development and removal of oak woodland habitats. California populations have declined in desert areas and in areas where oak woodland has been lost.

Conservation/Management Issues: Timber harvest; oak woodland conversion; pest control exclusions; mine reclamation; renewed mining; bridge replacement. Behaviorally sensitive to roost disturbance.

Relevant References:

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

Hall, E. R. 1981. The Mammals of North America. John Wiley and Sons, Inc., New York, 600 pp.

Hermanson, J. W. and T. J. O'Shea 1983. *Antrozous pallidus*. Mammalian Species 213:1-8.

Lewis, S. E. 1994. Night roosting ecology of pallid bats (*Antrozous pallidus*) in Oregon. American Midland Naturalist 132(2):219-226.

Licht, P. and P. Leitner 1967. Behavioral responses to high temperatures in three species of California bats. Journal of Mammalogy 48(1):52-61.

Orr, R. T. 1954. Natural history of the pallid bat, *Antrozous pallidus* (LeConte). Proc. Cal. Acad. Sci. 28(4):165-246.

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, ed. Bats and Forests Symposium, October 19-21, 1995, Victoria, British Columbia, Canada, Research Branch, BC Ministry of Forests, Victoria, BC, Working Paper 23/1996.

***Choeronycteris mexicana* (Mexican Long-tongued Bat)**

Distribution: The majority of California records are from San Diego County, although there are occasional records from Los Angeles, Ventura and Orange Counties.

Habitat Characteristics: Found in a variety of arid habitats (lower and upper Sonoran life zones, from scrub to tropical deciduous forests), outside California at elevations of 600-2,400 meters. Tends to favor desert canyons with riparian vegetation.
Ontogeny and Reproduction: One young per year, with birth occurring in June to July. Females congregate in maternity colonies. Colony size can be up to 40-50, but more commonly is a dozen or fewer.
Roost Sites: Selects primarily mines, caves and rock fissures for diurnal roosting. May also use buildings. Prefer sites near the entrance in twilight rather than total darkness. Sexes may roost together, but females separate from the males when young are born.

Food Habits: Food items limited to pollen and nectar.

Behavior: **Winter Status** Does not hibernate. **Resident Status** Not known if resident year round. The majority of records are from the fall.

Status: Rare in California.

Conservation/Management Issues: Recreational caving; mine reclamation; renewed mining; water impoundments; loss of food source. Behaviorally sensitive to disturbance at roost sites.

Relevant References:

Arroyo Cabrales, J., R.R. Hollander, and J.K. Jones, Jr. 1987. *Choeronycteris mexicana*. Mammalian Species 291:15.

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

Constantine, D. G. 1998. Range extensions of ten species of bats in California. Bulletin Southern California Academy of Sciences 97(2):49-75.

Hall, E. R. 1981. The Mammals of North America. John Wiley and Sons, Inc., New York, 600 pp.

Huey, L. M. 1954. Choeronycteris mexicana from southern California and Baja California, Mexico. Journal of Mammalogy 35(3):436-7.

Nowak, R. M. 1994. Walker's bats of the world. Vol. Johns Hopkins University Press, Baltimore. vii+287 pp.

Olson, A. C., Jr. 1947. First record of *Choeronycteris mexicana* in California. Journal of Mammalogy 28(2):183-184.

***Corynorhinus townsendii* (Townsend's Big-eared Bat)**

Distribution: Found throughout California, from low desert to mid elevation montane habitats in the summer. Hibernates at high elevation in the White and Inyo mountains.

Habitat Characteristics: Highly associated with caves and mines. Desert scrub, mixed conifer, and pinyon juniper or pine forest.

Ontogeny and Reproduction: One young per year, with birth occurring in May to July, depending on latitude and local climate. Females form maternity colonies; mates roost individually. Historically, maternity colonies typically contained several hundred females. Mating occurs in the winter roost.

Roost Sites: A cavern dwelling species that roosts primarily in mines and caves, but also in bridges and buildings that have cave-like spaces. Will night roost in more open settings, including under bridges. In the summer males roost alone or in small groups (around six individuals), nursery colonies may contain 200 to 500 adult females, and winter hibernacula may have anywhere from a few to 500 individuals.

Food Habits: Food items are primarily moths. Foraging occurs near vegetation, often following stream corridors. In California, shown to forage preferentially in association with native vegetation.

Behavior : **Winter Status** Hibernates in mixed sex aggregations. Periodically arouses, moves to alternate roosts. Actively forages and drinks throughout the winter. Hibernation prolonged in colder areas, and intermittent where climate is predominantly non-freezing. **Resident Status** Year-round resident. **Other** Gregarious.

Status: Serious population declines in past forty years in parts of California.

Conservation/Management Issues: Highly sensitive to disturbance at roost sites. Mine reclamation; renewed mining; water impoundments; recreational caving; loss of building roosts; bridge replacement. Avoidance of human disturbance is essential.

Relevant References:

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

Brown, P.E., R.D. Berry, and C. Brown. 1994. Foraging behavior of Townsend's big-eared bats (*Plecotus townsendii*) on Santa Cruz Island. Pp 367-369 in W.L. Halvorson and G.J. Maender, editors. Fourth California Islands Symposium, Santa Barbara Museum of Natural History, Santa Barbara, CA.

Dobkin, D.S., R.G. Gettinger, and M.G. Gerdes. 1995. Springtime movements, roost use, and

foraging activity of Townsend's big-eared bat (*Plecotus townsendii*) in central Oregon. Great Basin Naturalist 55:315-321.

Hall, E. R. 1981. The Mammals of North America. John Wiley and Sons, Inc., New York, 600 pp.

Idaho Conservation Effort. 1999. Species conservation assessment and conservation strategy for the Townsend's big-eard bat (*Corynorhinus townsendii townsendii* and *Corynorhinus townsendii pallescens*). Idaho Department of Fish and Game, Boise, Idaho, 67 pp.

Pierson, E. D., and G.M. Fellers. 1998. Distribution and ecology of the big-eared bat, *Corynorhinus* (= *Plecotus*) *townsendii* in California. Report to USGS, BRD, Species at Risk Program 1998, 90 pp.

Pierson, E. D., and W. E. Rainey. 1996. 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. W.E. Rainey, and D.M. Koontz. 1991. Bats and mines: experimental mitigation for Townsend's big-eared bat at the McLaughlin mine in California. Pages 31-42 in Proceedings of the Thorne Ecological Institute: issues and technology in the management of impacted wildlife. Snowmass, Colorado, USA.

Sherwin, R.E., D. Stricklan, and D.S. Rogers. Habitat and roosting affinities of Townsend's big-eared bat (*Corynorhinus townsendii*) in northern Utah. Journal of Mammalogy (In press).

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(1):66-75.

***Eptesicus fuscus* (Big Brown Bat)**

Distribution: Found throughout California from sea level to high elevation.

Habitat Characteristics: Variety of habitats

Ontogeny and Reproduction: Most breeding occurs in the fall; fertilization is delayed until spring, and one young is born in late May to June. Females form relatively small maternity colonies of 20-300; at this time males roost alone or in small groups. Later in the summer both sexes will roost together.

Roost Sites: Day roosts include, but are not limited to mines, caves, buildings, bridges, and trees (e.g., ponderosa, aspen, oaks, and sycamores). Night roosts are in more open settings in buildings, mines, and bridges. Roosts in groups of up to several hundred. Roosts and hibernacula are found within cracks or crevices, or beneath rocks in mines and caves.

Food Habits: Feeds on a variety of insect taxa, but beetles and caddis flies are dominant in the diet. Feed over both water and land, in both forested and edge habitats. This bat forages repeatedly over the same route, emerging shortly after dusk and flying 810 meters above the ground and in open areas, near water sources, or among fairly open stands of trees. Feeding occurs throughout the night. Frequently shares its foraging area and roosts with other species, such as the Pallid, Mexican free-tailed, and Yuma bats.

Behavior: **Winter Status** Known to hibernate for months, frequently at ambient temperatures below freezing. May arouse from hibernation and actively forage.
Roosts and hibernacula are found within cracks or crevices, or beneath rocks in mines and caves. Winter and summer ranges are the same. **Resident Status** Year-round resident. **Other** Emerge about sunset.
Status: Widespread and regionally common.

Conservation/Management Issues: Timber harvest; bridge replacement; building demolition; recreational caving; mine reclamation; renewed mining; pest control exclusion.

Relevant References:

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

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

Brigham, R. M. 1991. Flexibility in foraging and roosting behaviour by the big brown bat (*Eptesicus fuscus*). Canadian Journal of Zoology 69(1):117-121.

Hall, E. R. 1981. The Mammals of North America. John Wiley and Sons, Inc., New York, 600 pp.

Kurta, A. and R. H. Baker 1990. *Eptesicus fuscus.* Mammalian Species 356):1-10.

Whitaker, J. O., Jr., C. Maser and L. E. Keller 1977. Food habits of bats of Western Oregon. Northwest Sci. 51(1):46-55.

***Euderma maculatum* (Spotted Bat)**

Distribution: Patchy distribution limited by availability of cliff roosting habitat. Found from low desert to high elevation. Majority of records are from the Sierra Nevada, with limited records from northern coast range.

Habitat Characteristics: Found in a wide variety of habitats, from low desert to high elevation coniferous forests. Closely associated with rocky cliffs.

Ontogeny and Reproduction: One young per year, with birth occurring in June to July.

Roost Sites: Day roosts are primarily in crevices in cliff faces, but some indication that mines and caves may occasionally be used, primarily in winter. Likely roosts singly.

Food Habits: Eats a variety of insects, but moths are primary food items. In desert settings, foraging occurs in canyons, in the open, or over riparian vegetation. In montane habitats, animals forage over meadows, along forest edges, or in open coniferous woodland, typically remaining at or above treetop height, 1030 meters above the ground.

Behavior: **Winter Status** Hibernates, but periodically arouses and actively forages and drinks throughout the winter. **Resident Status** Year-round resident. **Other** Usually solitary.

Status: Rare and patchy in occurrence.

Conservation/Management Issues: Recreational climbing; water impoundments; grazing/meadow management; mining and quarry operations; highway construction.

Relevant References:

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

Hall, E. R. 1981. The Mammals of North America. John Wiley and Sons, Inc., New York, 600 pp.

Navo, K. W., J. A. Gore, and G. T. Skiba 1992. Observations on the spotted bat, *Euderma maculatum*, in northwestern Colorado. Journal of Mammalogy 73(3):547-551.

Pierson, E. D. and W. E. Rainey 1998. Distribution of the spotted bat, *Euderma maculatum*, in California. Journal of Mammalogy 79(4):1296-1305.

Pierson, E. D. and W. E. Rainey. 1998. Distribution, habitat associations, status and survey methodologies for three molossid bat species (*Eumops perotisNyctinomops femorosaccus, Nyctinomops macrotis*) and the vespertilionid (*Euderma maculatum*), final report. California Dept. of Fish and Game. Bird and Mammal Conservation Program, Sacramento, CA , 61pp.

Wai Ping, V. and M.B. Fenton 1989. Ecology of spotted bat (*Euderma maculatum*): roosting and foraging behavior. Journal of Mammalogy 70(3):617-622.

Watkins, L. C. 1977. *Euderma maculatum*. Mammalian Species 77:1-4.

***Eumops perotis* (Western Mastiff Bat)**

Distribution: Known primarily from southern and central California, at low to mid elevations. Isolated records in northern California. Very few records east of Sierra Crest. Primarily southern California and west side of Sierra Nevada. Have records of occurrences in the coast range.

Habitat Characteristics: Found in a variety of habitats, from desert scrub to chaparral to mixed coniferous forest. Have been detected in montane meadows above 8.000 ft. and in giant sequoia habitat. Distribution is tied to availability of suitable roosting habitat and can sometimes be predicted based on presence of significant rock features (large granite or basalt formations).

Ontogeny and Reproduction: One young per year, with birth occurring from June to July. Females form maternity colonies, and males are sometimes present.
Roost Sites: Day roosts primarily crevices in cliff faces, and cracks in boulders, occasionally buildings. Generally, roost in groups fewer than 100. Roosts are typically 6 meters or more above the ground. Known to move to different roosts with the changing seasons. Males are sometimes found roosting with females at nursery sites.

Food Habits: Feeds on small insects, mainly member of the order Lepidoptera (moths). Foraging occurs in the open and ranges to high altitude (1,000 ft.). May travel more than 25 miles to reach feeding grounds. Detected most frequently over desert washes, grasslands, or meadows, but will also feed above forest canopy.

Behavior: **Winter Status** Active all winter at lower elevations. **Resident Status** Year- round resident.

Status: Serious declines in Los Angeles basin.

Conservation/Management Issues: Recreational climbing; pest control; loss of foraging habitat; water impediments; highway construction.

Relevant References:

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

Best, T. L., W. M. Kiser, and P. W. Freeman 1996. *Eumops perotis.* American Society of

Mammalogists, Mammalian Species 534:1-8.

Constantine, D. G. 1998. Range extensions of ten species of bats in California. Bulletin Southern California Academy of Sciences 97(2):49-75.

Hall, E. R. 1981. The Mammals of North America. John Wiley and Sons, Inc., New York, 600 pp.

Pierson, E. D. and W. E. Rainey. 1998. Distribution, habitat associations, status and survey methodologies for three molossid bat species (*Eumops perotis, Nyctinomops femorosaccus, Nyctinomops macrotis*) and the vespertilionid (*Euderma maculatum*), final report. California Dept. of Fish and Game. Bird and Mammal Conservation Program, Sacramento, CA , 61pp.

Vaughan, T. A. 1959. Functional morphology of three bats: *Eumops, Myotis,* and *Macrotus*. University Kansas Publ., Mus. Nat. Hist. 12(1):1-153.

Leptonycteris curasoae **(Southern Long-nosed Bat)**

Distribution: Until recently not known to occur in California. There are now two records, one from San Bernardino County in October 1993 and one from San Diego County in October 1996.

Habitat Characteristics: Inhabits Sonoran desert scrub, semi-desert grasslands and lower oak woodlands in the U.S. Found in thorn forest, pine-oak woodlands and ponderosa pine habitat in Mexico.

Ontogeny and Reproduction: One young per year, with birth occurring in late May or early June. Females congregate in large maternity colonies.

Roost Sites: Roosts in caves and mines. Only known nursery roosts in U.S. are in mines. The two California specimens that were turned in to public health facilities were found in association with buildings. One was flushed from a meter high bush adjacent to a residence, and the other was hanging under a canopy over the front door of a business concern. Both were males.

Food Habits: Feeds on pollen and nectar from flowers of paniculate agaves, saguaros, and organ pipe cactus. May feed on fruit at certain times during the season.

Behavior: **Winter Status** Does not hibernate. Thought to migrate to Mexico in winter. **Resident Status** Unknown. Only records are from the fall**. Status**: Only two records in California.

Conservation/Management Issues: Recreational caving; mine reclamation; renewed mining; water impoundments; loss of food source. Behaviorally sensitive to disturbance at roost sites.

Relevant References:

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

Cockrum, E. L. 1991. Seasonal distribution of northwestern populations of the long-nosed bats, *Leptonycteris sanborni*, family Phyllostomidae. Anales Inst. Biol. Univ. Nac. Auton. Mexico, Ser. Zool. 62(2):181-202.

Cockrum, E. L. and Y. Petryszyn 1991. The long-nosed bat, *Leptonycteris:* an endangered species in the Southwest? Occ. Pap. Mus. Texas Tech Univ. 142:1-32.

Constantine, D. G. 1998. Range extensions of ten species of bats in California. Bulletin Southern California Academy of Sciences 97(2):49-75.

Fleming, T. H. 1993. Plant-visiting bats. American Scientist 81(5):460-467.

Hall, E. R. 1981. The Mammals of North America. John Wiley and Sons, Inc., New York, 600 pp.

Wilkinson, G. S. and T. H. Fleming 1996. Migration and evolution of lesser long-nosed bats *Leptonycteris curasoae*, inferred from mitochondrial DNA. Molecular Ecology 5(3): 329-339.

Lasionycteris noctivagans **(Silver-haired bat)**

Distribution: In California, distributed primarily in the northern portion of the state, or at higher elevations in the southern and coastal mountain ranges, confined primarily to forested habitats.

Habitat Characteristics: A coniferous/mixed deciduous forest-associated species. Prefers mature and old growth forests. Found primarily at higher latitude or altitudes. In California, one area where species is relatively common, Douglas fir, ponderosa pine and black oak are the dominant tree species.

Ontogeny and Reproduction: One to two young per year, generally two, with birth occurring in June to July. Forms small maternity colonies of several to about 75 individuals.

Roost Sites: Roosts almost exclusively in trees in summer. Maternity roosts are generally in woodpecker hollows. Uses multiple roosts sites and switches roosts frequently. Small group and single animals will roost under flaking bark. Winter roosts include hollow trees, rock crevices, mines, caves, and buildings. Has been found hibernating under duff.

One study showed that the two tree species most frequently used for roosting was ponderosa pine (*Pinus ponderosa*) with a DBH range of 32"74", white pine (*Pinus monticula*) with a

diameter-at-breast-height (DBH) range of 37-55. Other species include grand fir (Abies grandis) with a mean DBH of 54"; western larch (*Larix occidentalis*) with a mean DBH of 48"; lodgepole pine (*Pinus contorta*) with a mean DBH of 26"; Douglas fir (*Pseudotsuga menziesii*) with a mean DBH of 36"; and western red cedar (*Thuja plicata*) with a mean DBH of 52". In the same study all roost trees were in decay class 4 or greater (loss of some or all bark, extensive vertical cracks; some may have broken tops and cavities). All roosts were located in gaps in closed canopy patches. Snag height ranged from 6.9 to 61.5 m. Slope aspect varied considerably. All roost sites were > 100 m upslope from a riparian area.

Food Habits: Food items include a variety of insects but moths are preferred. Foraging is generally in or near wooded areas, along edges of streams, or water bodies. Travels considerable distances (up to 15 km) from roost sites to foraging areas.

Behavior: **Winter Status** Migrates, but probably hibernates in winter range. **Resident Status** Year-round resident, although distribution shifts seasonally. Most commonly found in southern areas during the winter months.

Status: Locally common.

Conservation/Management Issues: Because it is an obligate tree roosting species, it is at risk from timber harvest.

Relevant References:

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

Barclay, R. M. R., P. A. Faure and D. R. Farr 1988. Roosting behavior and roost selection by migrating silver haired bats (*Lasionycteris noctivagans*). Journal of Mammalogy 69(4):821-825.

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

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(4): 976-984.

Constantine, D. G. 1998. Range extensions of ten species of bats in California. Bulletin Southern California Academy of Sciences 97(2):49-75.

Hall, E. R. 1981. The Mammals of North America. John Wiley and Sons, Inc., New York, 600 pp.

Izor, R. J. 1979. Winter range of the silver-haired bat. Journal of Mammalogy 60(3):641-643.

Kunz, T. H. 1982. *Lasionycteris noctivagans*. Mammal. Species 172:1-5.

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(3):247-253.

Perkins, J. M. and S. P. Cross 1988. Differential use of some coniferous forest habitats by hoary and silver haired bats in Oregon. Murrelet 69(1):21-24.

Perkins, J. M. and S. P. Cross 1991. Sexual differentiation in migratory patterns of L*asionycteris noctivagans* in Oregon and Washington. Bat Research News 32 (4):83

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 M. R. Brigham, ed. Bats and Forest Symposium, October 19-21,1995, Victoria, British Columbia, Canada, Research Branch, B.C. Ministry of Forests, Victoria, British Columbia.

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.

***Lasiurus blossevillii* (Western Red Bat)**

Distribution: The majority of records are from lower elevations in the Central Valley, Salinas Valley, San Diego County, and along the central and southern coast. There are scattered high elevation records up to 8,000 ft. in the Sierra Nevada.

Habitat Characteristics: Found in riparian and wooded habitats. Breeding females are highly associated with mature cottonwood and sycamore riparian, particularly in the Central Valley. Also found in orchards. The species winters primarily along the central and southern coast.

Ontogeny and Reproduction: One to five young per year, at an average of 2.3. Birth occurs in June. Individuals roost singly; colonies are not formed.

Roost Sites: Day roosts in trees, within the foliage. Found in fruit orchards and sycamore riparian in the Central Valley.

Food Habits: Food items consist of a variety of insects taken opportunistically, apparently based on size rather than type. Foraging is generally high altitude over the tree canopy.

Behavior: **Winter Status** Thought to be migratory. Has been shown to hibernate in duff. Known to winter in the San Francisco Bay Area and to the south. **Resident Status** Year-round resident in California.

Status: Rare throughout California.

Conservation and Management Issues: Agricultural conversion of riparian zones; agricultural spraying; water impoundments; fire; predation, particularly by jays.

Relevant References:

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

Constantine, D. G. 1959. Ecological observations on lasiurine bats in the north Bay area of California. Journal of Mammalogy 40(1):13-15.

Constantine, D. G. 1998. Range extensions of ten species of bats in California. Bulletin Southern California Academy of Sciences 97(2):49-75.

Corben, C.C., E.D. Pierson, W.E. Rainey. 1999. Acoustic activity for western red bats, *Lasiurus blossevillii*. Bat Research News, 40:167.

Hall, E. R. 1981. The Mammals of North America. John Wiley and Sons, Inc., New York, 600 pp.

Hickey, M. B. C., L. Acharya and S. Pennington 1996. Resource partitioning by two species of vespertilionid bats (*Lasiurus cinereus* and *Lasiurus borealis*) feeding around street lights. Journal of Mammalogy 77(2):325 334.

Hutchinson, J. T., and M. J. Lacki 2000. Selection of day roosts by red bats in mixed mesophytic forests. Journal of Wildlife Management, 64:87-94.

Menzel, M. A., T. C. Carter, B. R. Chapman and J. Laerm. 1998. Quantitative comparison of tree roosts used by red bats (*Lasiurus borealis*) and seminole bats (*L. seminolus*). Canadian Journal of Zoology, 76:630-634. Shump, K. A., Jr. and A. U. Shump 1982. *Lasiurus borealis*. Mammal. Species 183):1-6.

Pierson, E.D., W.E. Rainey, and C. Corben. 2000. Distribution and status of red bats in

California. Report to California Dept. of Fish and Game. Bird and Mammal Conservation Program, Sacramento, CA , 27 pp.

***Lasiurus cinereus* (Hoary Bat)**

Distribution: Found scattered throughout California. Found from sea level to 13,200 feet.

Habitat Characteristics: Tree associated species. Found primarily in forested habitats.

Ontogeny and Reproduction: One to four young per year, but generally two, with birth occurring in May to June. Individuals roost singly, colonies are not formed.

Roost Sites Day roosts in trees, within foliage, 312 m above the ground, in both coniferous and deciduous trees. May on rare occasions roost in caves, beneath ledges, in woodpecker holes, and in squirrel nests.

Food Habits: Diet is primarily moths, but may also include dragonflies and beetles. Foraging occurs over the tree canopy, may forage long distance, up to 40 km from its roost. . Will follow watercourses for foraging and drinking. One study indicated that moths from the family Noctuidae are preferred.

Behavior: **Winter Status** Migrates along California coast and east side of Sierra Nevada in spring and fall. Suspected to hibernate in the winter range. **Resident Status** Year-round in California. Summer residents in California are primarily males. Adult females occur in the winter, but only rarely in the summer.

Status: Status is unknown.

Conservation/Management Issues: Timber harvest; pesticide spraying; loss of riparian habitat.

Relevant References:

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

Constantine, D. G. 1959. Ecological observations on Lasiurine bats in the north Bay Area of California. Journal of Mammalogy 40(1):13-15.

Dalquest, W. W. 1943. Seasonal distribution of the hoary bat along the Pacific coast. Murrelet 24(2):21-24.

Hall, E. R. 1981. The Mammals of North America. John Wiley and Sons, Inc., New York,

600 pp.

Hickey, M. B. C., L. Acharya and S. Pennington 1996. Resource partitioning by two species of vespertilionid bats (*Lasiurus cinereus* and *Lasiurus borealis*) feeding around street lights. Journal of Mammalogy 77(2):325-334.

Perkins, J. M. and S. P. Cross 1988. Differential use of some coniferous forest habitats by hoary and silver haired bats in Oregon. Murrelet 69(1):21-24.

Shump, K. A., Jr. and A. U. Shump 1982. *Lasiurus cinereus*. Mammal. Species 185:1-5.

Tenaza, R. R. 1966. Migration of hoary bats on South Farallon Island, California. Journal of Mammalogy 47(3):533-535.

***Lasiurus xanthinus* (Southern Yellow Bat)**

Distribution: Found in fan palm oases and associated riparian habitats in the Colorado Desert of California. Appears to be expanding its range northward in association with ornamental palms. Range extends into Los Angeles and southern San Bernardino Counties.

Habitat Characteristics: Palm oases and Lower and upper Sonoran riparian habitats.

Ontogeny and Reproduction: One to two young per year (generally two), with birth occurring in June.

Roost Sites: Day roosts in trees, particularly in palms under shag.

Food Habits: Forages above the canopy on a variety of insect prey, predominantly moths.

Behavior: **Winter Status** May be active year around in southern California, except during coolest periods. **Resident Status** Records for southern California except December and January.

Status: Rare except in appropriate habitats.

Conservation/Management Issues: Fire management of palms (removing the shag that shelters the bats). Destruction of riparian habitats and palm oases for agriculture and development.

Relevant References:

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

Constantine, D. G. 1998. Range extensions of ten species of bats in California. Bulletin Southern California Academy of Sciences 97(2):49-75.

Hall, E. R. 1981. The Mammals of North America. John Wiley and Sons, Inc., New York, 600 pp.

Kurta, A. and G. C. Lehr 1995. *Lasiurus* ega. Mammalian Species 515):1-7.

Mirowsky, K. 1997. Bats in palms: precarious habitat. Bats, 15(2):1-6

***Macrotus californicus* (California Leaf-nosed Bat)**

Distribution: Historically in California this species was distributed in the desert region across the southern portion of the state. Now it is confined primarily to the Colorado River Basin, with some records from desert mountain ranges in the eastern part of the state south of Death Valley.

Habitat Characteristics: Lower elevation desert scrub habitats. Roosts are located below 3,000 ft. in proximity to desert wash areas.

Ontogeny and Reproduction: Ovulation, insemination, and fertilization occurs September-October. The embryo experiences delayed development until March.
One young per year, with birth occurring May to June. Females congregate in maternity roosts of 6 to >100. They frequently form clusters with each cluster associated with an adult male. In the fall, males congregate at courtship sites in mines.

Roost Sites: Dependent on mines and caves for diurnal roosting. Mines used as winter roosts have internal temperatures >290C, and are usually geothermally heated. More than one diurnal roost may be used during the year. Night roosting occurs in a variety of places, including buildings, cellars, porches, bridges, rock shelters, and mines. Summer colonies may range from six to several hundred individuals, with winter colonies containing 100 to over 1,000 individuals. Complete darkness is not required, and bats may roost within 10-30 meters of the entrance of a cave or other selected roost site.

Food Habits: Food items include grasshoppers', cicadas, moths, butterflies, dragonflies, beetles, and caterpillars. Foraging occurs close to vegetation or the ground and prey items are gleaned form these surfaces. Does not require drinking water, but gets moisture form prey items.

Behavior: **Winter Status** Does not hibernate. Both sexes congregate together in warm winter roosts. Year-round activity. **Resident Status** Year-round resident. **Other** Emergence is usually 90120 minutes after sunset. These bats are gregarious.

Status: Distribution is very limited in California. Range has contracted considerably in the past 50 years.

Conservation/Management Issues: Recreational caving; water impoundments; mine

reclamation; renewed mining; loss of foraging habitat. Behaviorally sensitive to roost disturbance.

Relevant References:

Anderson, S., 1969. *Macrotus watethousii*. Mammalian Species. No. 1:114.

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

Berry, R.D. and P.E. Brown. 1995 [ABS]. Natural history and reporductive behavior of the California leaf-nosed bat (*Macrotus californicu*s). Bat Resarch News 36(4):49-50

Brown, P. E., R. D. Berry, and C. Brown. 1995. The California leaf-nosed bat (Macrotus californicus) and American Girl Mining joint venture - impacts and solutions. Pp 54-56 in
Proceedings VI: Issues and techonology in the management of impacted wildlife, Thorne Ecological Institute, CO.

Constantine, D. G. 1998. Range extensions of ten species of bats in California. Bulletin Southern California Academy of Sciences 97(2):49-75.

Hall, E. R. 1981. The Mammals of North America. John Wiley and Sons, Inc., New York, 600 pp.

Vaughan, T. A. 1959. Functional morphology of three bats: *Eumops, Myotis*, and *Macrotus*. University Kansas Publ., Mus. Nat. Hist. 12(1):1-153.

***Myotis californicus* (California myotis)**

Distribution: Found throughout California typically at elevations < 6,000 feet, although occasionally found at higher altitude.

Habitat Characteristics: Variety of habitats from lower Sonoran desert scrub to forests.

Ontogeny and Reproduction:
Mates in the fall, and a single young is born between late May and June. Females often roost singly, but may form small maternity colonies, usually fewer than 100 individuals.

Roost Sites: Wide variety of day roosts including mines, caves, buildings, rock crevices, hollow trees, and under exfoliating bark. Crevice roosting. Night roosts in a wider variation of structures. Generally roost singly or in small groups.

Food Habits: Feed on a variety of insects, such as moths, flies, beetles, and spiders. Often fly at canopy height. Most active during early evening, with foraging beginning shortly after sunset. Hunts and feeds rapidly, returns to night roost for rest, then resumes hunting. Foraging usually occurs above 3 meters a short distance from the roost.

Behavior : **Winter Status** Known to hibernate, but may be active on warmer days for brief periods. **Resident Status** Year-round resident.

Status: Widespread and regionally common.

Conservation/Management Issues: Closure of mines for reclamation and renewed mining. Pesticide spraying.

Relevant References:

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

Brigham, R. M., M. J. Vonhof, R. M. R. Barclay and J. C. Gwilliam 1997. Roosting behavior and roost-site preferences of forest-dwelling California bats (*Myotis californicus*). Journal of Mammalogy 78(4):1231-1239.

Constantine, D. 1998. An overlooked external character to differentiate *Myotis californicus* and *Myotis ciliolabrum* (Vespertilionidae). Journal of Mammalogy 79:524 630.

Hall, E. R. 1981. The Mammals of North America. John Wiley and Sons, Inc., New York, 600 pp.

Krutzsch, P. H. 1954. Notes on the habits of the bat, *Myotis californicus*. Journal of Mammalogy 35(4):539-545.

Simpson, M. R. 1993. *Myotis californicus*. Mammalian Species 428:1-4.

***Myotis ciliolabrum* (Smallfooted myotis)**

Distribution: Distribution in California poorly understood, but most records are from low to mid-elevation.

Habitat Characteristics: Inhabits a variety of habitats including desert scrub, grasslands, oak and pinyon juniper woodlands into pine forests.

Ontogeny and Reproduction: One young per year with birth occurring in May to June. Females may form small maternity colonies, generally fewer than 30 individuals, although they have been known to have more than 50 individuals.

Roost Sites: Roosts have been found in cavities, such as mines and trees. Roosting preferences expected to be similar to those of *Myotis californicus*.

Food Habits: Food items include small moths, flies, ants, and beetles. Foraging occurs in the open.

Behavior: **Winter Status** Hibernates. **Resident Status** Year-round resident.

Status: Widespread and regionally common

Conservation/Management Issues: Mine reclamation; renewed mining; water impoundments; timber harvest.

Relevant References:

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

Constantine, D. 1998. An overlooked external character to differentiate *Myotis californicus* and *Myotis ciliolabrum* (Vespertilionidae). Journal of Mammalogy 79:524 630.

Hall, E. R. 1981. The Mammals of North America. John Wiley and Sons, Inc., New York, 600 pp.

***Myotis evotis* (Long-eared myotis)**

Distribution: Found throughout California, higher elevation forests, mixed coniferous/hardwood forests, in high desert, and near sea level with appropriate habitat. One of the most abundant species in giant sequoia habitat.

Habitat Characteristics: Primarily a forest associated species. Found in mixed hardwood/conifer forest and montane conifer forest in northern California, in pinyon juniper, mesquite scrub, and pine/oak woodland in southern California. Known to roost in highway rip-rap.

Ontogeny and Reproduction: One young per year with birth occurring in June to July. Females may form small maternity colonies, with generally fewer than 40 individuals.

Roost Sites: Caves, mines, trees, crevices, buildings, and bridges.

Food Habits: Diet includes moths, small beetles, and flies. Foraging occurs near vegetation and the ground. Appears to have a flexible foraging strategy, catching insects by both substrate gleaning and aerial pursuit. Forages along rivers and streams, over ponds, and within cluttered forest environment. Night roost use of caves and mines may involve feeding within the structure gleaning moths from the rock walls.

Behavior : **Winter Status** Presumed to be non-migratory and to hibernate locally. Hibernating individuals have been found in caves in northern California. **Resident Status** Year-round resident.

Status: Widely distributed in California, but uncommon almost everywhere. Status not well understood.

Conservation and Management Issues: Timber harvest; recreational caving; mine reclamation; renewed mining; highway projects; bridge replacement, building demolition and pest control.

Relevant References:

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

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 M. R. Brigham, ed. Research Branch, B.C. Ministry of Forests, Victoria, British Columbia.

Hall, E. R. 1981. The Mammals of North America. John Wiley and Sons, Inc., New York, 600 pp.

Manning, R. W. and J. K. Jones, Jr. 1989. *Myotis evotis*. Mamm. Species 329):1-5.

Miner et al. 1996 [ABS}. Habitat use by *Myotis evotis* and *Myotis thysanodes* in a southern California pine-oak woodland. Bat Research News 37: 141.

Pierson, E. D. and W. E. Rainey 1997 [ABS]. Roosting and foraging behavior of *Myotis yumanensis* and *Myotis evotis* along the upper Sacramento River in northern California. Bat Research News 37(4):124.

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.

Vonhof, M. J. and R. M. R. Barclay 1997. Use of tree stumps as roosts by the western long-eared bat. Journal of Wildlife Management 61(3):674-684.

***Myotis lucifugus* (Little Brown Myotis)**

Distribution: Found through the northern portions California, along the Sierra Nevada, with an isolated population as far south as Big Bear Lake in San Bernardino County. High Sierran form may be genetically distinct.

Habitat Characteristics: Found primarily at higher elevations and higher latitudes, often associated with coniferous forest. Needs water nearby.

Ontogeny and Reproduction: One young per year with birth occurring in May to June. Large maternity roosts (100 to several thousand) are formed comprised of adult females. Males roost singly or in small groups. Hibernating groups contain both sexes.

Roost Sites: Known primarily from buildings and only recently found in trees. They day roost in hollow trees, rock outcrops, buildings, and occasionally mines and caves. One of the species most commonly found in human structures. Night roosts may be same structures used for day roost, but in more open locations. Hibernacula elsewhere are generally mines or caves. Often found in same roost sites with *Myotis yumanensis* in northern California.

Food Habits: Feeds on small aquatic insects such as caddis flies, midges, and mayflies. Foraging occurs in primarily open areas among vegetation, along water margins, and sometimes about one meter above water surface. When young begin to fly, however, adults move to more cluttered environment, and leave open foraging areas to the juveniles.

Behavior: **Winter Status** hibernates, but no hibernating colonies have been found in California. **Resident Status** Probably year-round resident.

Status: Regionally common.

Conservation/Management Issues: Timber harvest; pesticide spraying; building demolition; pest control exclusion; mine reclamation; renewed mining.

Relevant References:

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

Fenton, M. B. and R. M. R. Barclay 1980. *Myotis lucifugus*. Mammal. Species 142):1-8.

Hall, E. R. 1981. The Mammals of North America. John Wiley and Sons, Inc., New York, 600 pp.

Herd, R. M. and M. B. Fenton 1983. An electrophoretic, morphological, and ecological

investigation of a putative hybrid zone between *Myotis lucifugus* and *Myotis yumanensis* (Chiroptera: Vespertilionidae). Canadian Journal of Zoology 61(9):2029 2050.

Nagorsen, D. W., R. M. Brigham and I. M. Cowan 1993. Bats of British Columbia. Vol. University of British Columbia Press, Vancouver. 164 pp.

Pierson, E.D., W.E. Rainey, and C. Corben. 2000. Seasonal bat distribution along an altitudinal gradient in the Sierra Nevada. Report to California Department of Transportation, Sacramento, CA and Yosemite Association and Yosemite Fund, Yosemite National Park, CA.

***Myotis occultus* (Arizona Myotis)**

Distribution: In California, confined to the Colorado River between the Nevada and Mexico borders.

Habitat Characteristics: Generally associated with high elevation coniferous forest elsewhere in its range, but in California was found in low desert. Vegetation association in California includes cottonwoods, sycamores, and willows.

Ontogeny and Reproduction: One young per year with birth occurring in May to June. Large maternity roosts (up to 800 adult females). Males roost singly or in small groups. Hibernating groups contain both sexes.

Roost Sites: Day roosts in buildings, mines, bridges, trees, and caves. Hibernacula elsewhere are generally mines or caves. Historic California records were in mines and a bridge.

Food Habits: Information on diet is limited, although known to forage close to water and riparian vegetation.

Behavior : **Winter Status** Hibernates but no winter individuals have been found in California. **Resident Status** Summer resident. There are no known wintering locations, nor current roosts known in California.

Status: Last seen in California in 1945. Original bridge roost demolished.
Conservation/Management Issues: Loss of riparian habitat; bridge replacement; renewed mining and closure for hazard abatement.

Relevant References:

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

Hall, E. R. 1981. The Mammals of North America. John Wiley and Sons, Inc., New York,

600 pp.

Hayward, B. J. 1963. A maternity colony of *Myotis occultus*. Journal of Mammalogy 44:279.

Hoffmeister, D. F. 1986. The mammals of Arizona. Vol. University of Arizona Press, Tucson. 602 pp.

Stager, K. E. 1943. Remarks on *Myotis occultus* in California. Journal of Mammalogy 24(1): 197-199.

***Myotis thysanodes* (Fringed Myotis)**

Distribution: Found from coastal region to at least 6,400 ft in Sierra Nevada in California. May be absent from lowest elevations in the Central Valley.

Habitat Characteristics: Varies from low desert scrub to high elevation coniferous forest. In California, has been found in mixed deciduous/coniferous forest, in both redwood and giant sequoia groves, and in Joshua tree woodland.

Ontogeny and Reproduction: One young per year, with birth occurring in May to June. Maternity roosts are comprised of adult females and may include several hundred individuals, although most known California roosts are small (fewer than 40 females). One roost in southern California has more than 400. Males roost individually. Hibernating groups contain both sexes.

Roost Sites Day and night roosts in mines, caves, trees, and buildings. The majority of roosts documented in California have been in buildings or mines. Has been known to roost in tree hollows, particularly large conifer snags in Oregon and Arizona, and in rock crevices in cliff faces in southern California. Hibernacula are generally in mines or caves.

Food Habits: A variety of small beetles is preferred, but includes a variety of other taxa including moths. Foraging occurs in and among vegetation, with some gleaning activity. Foraging also occurs along forest edges and over the forest canopy.

Behavior: Winter Status Hibernates, but capable of periodic winter activity. Resident Status Year round resident.

Status: Widely distributed but very rare. Few records for California. Very sensitive to roost disturbance.

Conservation/Management Issues: Recreational caving; mine reclamation; renewed mining; building demolition; pest control; timber harvest; bridge replacement.

Relevant References:

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

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 M. R. Brigham, ed. Research Branch, B.C. Ministry of Forests, Victoria, British Columbia.

Hall, E. R. 1981. The Mammals of North America. John Wiley and Sons, Inc., New York, 600 pp.

Miner et al. 1996 [ABS}. Habitat use by *Myotis evotis* and *Myotis thysanodes* in a southern California pine-oak woodland. Bat Research News 37: 141.

O'Farrell, M. J. and E. H. Studier 1980. *Myotis thysanodes*. Mammal. Species 137):1-5.

Rainey, W. E., E. D. Pierson, M. Colberg and J. H. Barclay 1992. Bats in hollow redwoods: seasonal use and role in nutrient transfer into old growth communities. Bat Research News 33(4):71.

***Myotis velifer* (Cave Myotis)**

Distribution: Restricted primarily to the lower Colorado River valley in California. Three recently reported fall or spring records from Los Angeles County suggest possible migratory patterns for this species.

Habitat Characteristics: Primarily lower elevations, in and habitat dominated by creosote bush, Palo Verde, cactus, and desert riparian,

Ontogeny and Reproduction: Mating takes place in fall (Oct.), ovulation in April, then one young is born per year with birth occurring in June to July. Forms large maternity colonies numbering in the tens of thousands. Males roost groups of usually fewer than 100 individuals. Hibernating groups contain both sexes.

Roost Sites: Day roosts in caves and mines (occasionally buildings and bridges). Tolerates summer roost temperatures as high as 370C. Night roosts may be same structure used for day roost, but locations nearest the entrance are preferred. Has been found in swallow nests. Hibernacula are generally in mines or caves.

Food Habits: Foraging occurs in open areas near the edge or over vegetation. In California, forages primarily over floodplain of Colorado River. Food items include moths and beetles.

Behavior : **Winter Status** Hibernates. **Resident Status** Summer resident in California.

Status: Declining numbers in California.

Conservation/Management Issues: Loss of riparian habitat and intense agricultural conversion along the Colorado River. Mine reclamation and renewed mining could pose threats.

Relevant References:

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

Constantine, D. G. 1998. Range extensions of ten species of bats in California. Bulletin Southern California Academy of Sciences 97(2):49-75.

Hall, E. R. 1981. The Mammals of North America. John Wiley and Sons, Inc., New York, 600 pp.

Jackson, J. A., B. J. Schardien, C. D. Cooley and B. E. Rowe 1982. Cave myotis roosting in barn swallow nests. Southwestern Naturalist 27(4):463-464.

Kunz, T. H. 1974. Feeding ecology of a temperate insectivorous bat (*Myotis velifer*). Ecology 55(4):693-711.

Pitts, R. M. and J. J. Scharninghausen 1986. Use of cliff swallow and barn swallow nests by the cave bat, Myotis velifer, and the free-tailed bat, *Tadarida brasiliensis*. Texas Journal of Science 38(3):265-266.

Stager, K. 1939. Status of *Myotis velifer* in California, with notes on its life history. Journal of Mammalogy 20:225-228.

Vaughan, T. A. 1959. Functional morphology of three bats: *Eumops*, *Myotis*, and *Macrotus*. University Kansas Publ., Mus. Nat. Hist. 12(1):1-153.

***Myotis volans* (Long-legged myotis)**

Distribution: Found throughout California. Has been found from coast to high elevation in Sierra Nevada and White Mountains in California. Absent from low desert.

Habitat Characteristics: Found throughout California, in pinyon juniper, Joshua tree woodland, montane coniferous forest habitats, and in forested habitats along the coast. Most abundant species at high elevation in White Mountains in Califomia. Found in pine/oak woodland in the Laguna Mountains of San Diego County. Also found in unforested desert settings. Relatively rare in Sierra Nevada.

Ontogeny and Reproduction: One young per year with birth occurring in June to July. Maternity colonies of up to 200-500 individuals,

Roost Sites: Day roosts primarily in hollow trees, particularly large diameter snags or live trees with lightning scars. Also uses rock crevices, mines, and buildings. Caves and mines may be used for night roosts. Hibernacula are generally in mines or caves.

Food Habits: Feeds primarily on moths, but also feeds on other insect taxa, including beetles, flies, and termites. Foraging occurs in open areas, often at canopy height.
Behavior : **Winter Status** Hibernates but has the capability of winter activity. It is suspected that there are elevational and latitudinal movements between summer and winter roosts. Transient colonies in the spring on the east side of the Sierra Nevada. **Resident Status** Probably year-round resident.

Status: Not well known.

Conservation/Management Issues: Timber harvest; aerial pesticide spraying; recreational caving; mine reclamation; renewed mining; building demolition and pest control.

Relevant References:

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

Hall, E. R. 1981. The Mammals of North America. John Wiley and Sons, Inc., New York, 600 pp.

Ormsbee, P. C., ed. 1996. Characteristics, use, and distribution of day roosts selected by female *Myotis volans* (long-legged myotis) in forested habitat of the central Oregon Cascades. Vol. Work. Pap. 23/1996. 124-131 pp.

Pierson, E.D., W.E. Rainey, and C. Corben. 2000. Seasonal bat distribution along an altitudinal gradient in the Sierra Nevada. Report to California Department of Transportation, Sacramento, CA and Yosemite Association and Yosemite Fund, Yosemite National Park, CA.

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(1):66-75.

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

***Myotis yumanensis* (Yuma myotis)**

Distribution: Found throughout California, from lower elevations up to 8,000 ft. Breeding females predominantly at lower elevations.

Habitat Characteristics: Variety of habitats from the coast to mid elevation. Associated with most low elevation reservoirs in California. May be referred to as the "building bat," but it is also found in heavily forested settings, and is known to roost in trees.

Ontogeny and Reproduction: One young per year, with birth occurring in June to July. Maternity colonies can be large, up to several thousand individuals), and contain only adult females and their young. Males roost singly or in small groups.

Roost Sites: Day roosts in buildings, trees, mines, caves, bridges, and rock crevices. Night roosts usually associated with buildings, bridges, or other man-made structures. Colonies found inside hollow redwoods in coastal California and in large snags (primarily sugar pine) in northern California.

Food Habits: Feeds primarily on emergent aquatic insects, such as caddis flies and midges. Foraging occurs directly over the surface of open water and above vegetation. Feed over relatively still water, such as ponds, reservoirs, or pools in streams and rivers.

Behavior: **Winter Status** Hibernates. **Resident Status** Year-round resident. **Other** Seems closely associated with water.

Status: Locally common.

Conservation/Management Issues: Timber harvest; renewed mining; building demolition; pest control exclusions; bridge replacement.

Relevant References:

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

Betts, B. J. 1997. Microclimate in Hell's Canyon mines used by maternity colonies of Myotis yumanensis. Journal of Mammalogy 78(4):1240-1250.

Brigham, R. M., H. D. J. N. Aldridge and R. L. Mackey 1992. Variation in habitat use and prey selection by yuma bats, *Myotis yumanensis*. Journal of Mammalogy 73(3):640 645.

Hall, E. R. 1981. The Mammals of North America. John Wiley and Sons, Inc., New York, 600 pp.

Pierson, E. D. and W. E. Rainey 1997 [ABS]. Roosting and foraging behavior of *Myotis yumanensis* and *Myotis evotis* along the upper Sacramento River in northern California. Bat Research News 37(4):124.

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, ed. Bats and Forests Symposium, October 19-21, 1995, Victoria, British Columbia, Canada, Research Branch, BC Ministry of Forests, Victoria, BC, Working Paper 23/1996.

Rainey, W. E., E. D. Pierson, M. Colberg and J. H. Barclay 1992. Bats in hollow redwoods: seasonal use and role in nutrient transfer into old growth communities. Bat Research News 33(4):71.

***Nyctinomops femorosaccus* (Pocketed Free-tailed Bat)**

Distribution: Found in the lower Colorado Desert and coastal areas of southern California. The majority of records are from San Diego County, but are known as far north as Los Angeles and southern San Bernardino Counties.

Habitat Characteristics: Arid lowland areas, particularly desert canyons. Found only in lower and upper Sonoran life zones in California, associated with creosote bush and chaparral habitat.

Ontogeny and Reproduction: One young per year, with birth occurring from June to July.

Roost Sites: Day roosts primarily in crevices in cliff faces and boulders, although has been found in caves and buildings. Generally roosts in groups fewer than 100, consisting of adult females and their young; males roost separately.

Food Habits: Variety of insects, but moths and beetles predominate.

Behavior: **Winter Status** Suspected not to hibernate. **Resident Status** Year-round resident in California.

Status: Relatively rare.

Conservation/Management Issues: Recreational rock climbing; water impoundments; pest control exclusion; loss of foraging habitat.

Relevant References:

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

Constantine, D. G. 1998. Range extensions of ten species of bats in California. Bulletin Southern California Academy of Sciences 97(2):49-75.

Hall, E. R. 1981. The Mammals of North America. John Wiley and Sons, Inc., New York, 600 pp.

Kumirai, A. and J. K. Jones, Jr. 1990. *Nyctinomops femorosaccus.* Mammalian Species 349:1-5.

Nowak, R. M. 1994. Walker's bats of the world. Vol. Johns Hopkins University Press, Baltimore. vii+287 pp.

Pierson, E. D. and W. E. Rainey. 1998. Distribution, habitat associations, status and survey methodologies for three molossid bat species (*Eumops perotis, Nyctinomops femorosaccus,Nyctinomops macrotis*) and the vespertilionid (*Euderma maculatum*), final report. California Dept. of Fish and Game. Bird and Mammal Conservation Program, Sacramento, CA , 61pp.

***Nyctinomops macrotis* (Big Free-tailed Bat)**

Distribution: Scattered distribution. The majority of records are from southern California (San Diego, Orange and Los Angeles Counties), with additional records from Riverside and Imperial Counties, and scattered records along the coast as far north as Contra Costa County.

Habitat Characteristics: Associated primarily with rock country (canyon lands). Found in arroyo scrub desert and woodland habitats. In Arizona, occurs in ponderosa pine, Douglas fir, and desert scrub, but requires rocky cliffs with crevices and fissures for roosting.

Ontogeny and Reproduction: One young per year, with birth occurring in June to July. Foraging occurs in the open and ranges to high altitude.

Roost Sites: Day roosts primarily in crevices in cliff faces, but occasionally in buildings. Generally roosts in groups fewer than 100 individuals, consisting of adult females and their young; males roost separately.

Food Habits: Variety of insects, but moths predominate. Foraging occurs in open habitats and ranges to high altitude.

Behavior : **Winter Status** Suspected not to hibernate. **Resident Status** May be a year-round resident in southern California.

Status: Few records in California.

Conservation/Management Issues: Recreational rock climbing; water impoundments; loss of foraging habitat.

Relevant References:

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

Constantine, D. G. 1998. Range extensions of ten species of bats in California. Bulletin Southern California Academy of Sciences 97(2):49-75.

Hall, E. R. 1981. The Mammals of North America. John Wiley and Sons, Inc., New York, 600 pp.

Milner, J., C. Jones, and J. K. Jones, Jr. 1990. *Nyctinomops macrotis.* Mammalian Species 355:1-4.

Pierson, E. D. and W. E. Rainey. 1998. Distribution, habitat associations, status and survey methodologies for three molossid bat species (*Eumops perotis, Nyctinomops femorosaccus,Nyctinomops macrotis*) and the vespertilionid (*Euderma maculatum*), final report. California Dept. of Fish and Game. Bird and Mammal Conservation Program, Sacramento, CA , 61pp.

***Pipistrellus hesperus* (Western Pipistrelle)**

Distribution: Concentrated in desert areas, but found as far north as Shasta County.

Habitat Characteristics: Lower and upper Sonoran desert and coastal sage scrub, usually in association with rock features such as granite boulders and canyons.

Ontogeny and Reproduction: One or two young per year, with birth occurring in June. females may form small maternity colonies, but usually contain fewer than 12 individuals, including both females and young.

Roost Sites: Day roosts primarily in rock crevices, but may include mines, caves, or rarely buildings. Generally roost singly or in small groups.

Food Habits: Primarily small moths, leafhoppers, mosquitoes, and flying ants. Foraging is characterized by slow, erratic flight patterns and usually occurs in the open.

Behavior: **Winter Status** Hibernates, but may have periodic activity throughout the winter. **Resident Status** Year-round resident. **Other** Not gregarious.

Status: Common in appropriate habitat.

Conservation/Management Issues: Destruction of roosting and foraging habitat with development and mine closure and reclamation. Water impoundments may flood roost sites.

Relevant References:

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

Hall, E. R. 1981. The Mammals of North America. John Wiley and Sons, Inc., New York, 600 pp.

Hayward, B. J. and S. P. Cross. 1979. The natural history of *Pipistrellus hesperus* (Chiroptera: Vespertilionidae). West. New Mex. Univ. Office of Research. 3. 1-36.

von Bloeker, J. C., Jr. 1932. The roosting-place of *Pipistrellus hesperus.* Journal of Mammalogy 13:273.

***Tadarida brasiliensis* (Brazilian Free-tailed Bat)**

Distribution: Found throughout California, ranging from low desert to high elevation. Maternity colonies likely concentrated at mid to low elevations.

Habitat Characteristics: Found mostly at lower elevations, this species has been known to occur from sea level to over 10,000 ft. in the Sierra Nevada. Is the most common species in the Central Valley of California.

Ontogeny and Reproduction: Mating takes place in February and March. Ovulation occurs around late March and gestation lasts about 77 to 84 days, with one young per year, birth occurring in June to July. Females form large maternity colonies. Males segregate and may form smaller bachelor colonies.

Roost Sites: Roosts may vary considerably, from cliff faces, bridges, building, mines, and caves. Although colonies number in the millions in some areas, colonies in California are generally several hundred to several thousand.

Food Habits: Food items include a variety of insect species, but moths predominate. Foraging occurs in the open and may range to high altitudes. A significant predator on agricultural pests.

Behavior: **Winter Status** Migrates away from colder portions of California and over-winters in areas with nonfreezing temperatures (particularly along the coast). Migratory individuals appear to be active in their winter range. **Resident Status** Year-round resident in northern California and all warmer portions of the State.

Status: Population declines in California.

Conservation/Management Issues: Pesticide spraying; bridge replacement; water impoundments; mine reclamation; renewed mining; loss of foraging habitat; bridge replacement; pest control exclusions are probably primary.

Relevant References:

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

Hall, E. R. 1981. The Mammals of North America. John Wiley and Sons, Inc., New York, 600 pp.

McCracken, G. F., M. K. McCracken and A. T. Vawter. 1994. Genetic structure in migratory populations of the bat *Tadarida brasiliensis mexicana.* Journal of Mammalogy 75(2): 500-514.

McCracken, G. F. 1996. Bats aloft: a study of high-altitude feeding. Bats 14:7-10.

Pitts, R. M. and J. J. Scharninghausen 1986. Use of cliff swallow and barn swallow nests by the cave bat, *Myotis velifer,* and the free-tailed bat, *Tadarida brasiliensis*. Texas Journal of Science 38(3):265-266.

Wilkins, K. T. 1989. *Tadarida brasiliensis.* Mammalian Species 331:1-10.

Whitaker, J. O., Jr., C. Neefus, and T. H. Kunz 1996. Dietary variation in the Mexican free-tailed bat (*Tadarida brasiliensis mexicana*) during evening and morning feeding bouts. Journal of Mammalogy 77(3):716-724.