

**STRUCTURAL SURVEYS FOR BATS**  
**FOR THE**  
**MARIN MUNICIPAL WATER DISTRICT**  
**MT. TAMALPAIS WATERSHED**

*Prepared for:*

Marin Municipal Water District  
220 Nellen Avenue  
Corte Madera, CA 94925

*Prepared by:*

Garcia and Associates (GANDA)  
1 Saunders Avenue  
San Anselmo, CA 94960

November 4, 2003

Job 377



# TABLE OF CONTENTS

Executive Summary .....	1
Introduction.....	1
Methods .....	2
Literature and Database Review .....	2
Field Surveys .....	2
Results.....	3
Species and Roost Locations .....	3
Species-specific Results.....	10
Discussion.....	13
Management Recommendations.....	14
Conclusion .....	14
Literature Cited.....	16

## Tables

Table 1. Bat species known or suspected to occur on the Marin Municipal Water District. ....	4
Table 2. List of roosts used by sensitive bat species in MMWD structures. ....	5
Table 3. Results of visual inspection of structures by month. ....	6

## Figures

Figure 1. Townsend’s big-eared bat roosting in the interior roof of the Alpine Dam chlorinator building. ....	10
Figure 2. Small group of pallid bats roosting in the interior roof of the Alpine Dam chlorinator building. ....	11
Figure 3. Solitary big brown bat roosting in the interior roof of the Phoenix Lake pump house.	12

## Appendices

Appendix A: Natural History, Status and Distribution of Bat Species	
---	--

---

## Executive Summary

Approximately 50 structures on the Marin Municipal Water District (MMWD) lands associated with the Mt. Tamalpais watershed were inspected to determine their use by bats. Bats were observed in relatively small numbers occupying 21 structures. Five species were observed roosting inside buildings: Townsend's big-eared bat (*Corynorhinus townsendii*), pallid bat (*Antrozous pallidus*), California myotis (*Myotis californicus*), big brown bat (*Eptesicus fuscus*), and Mexican free-tailed bat (*Tadarida brasiliensis*). A sixth species suspected to be Yuma myotis (*Myotis yumanensis*) was observed in a bridge. Three of these species, Townsend's big-eared bat, pallid bat, and Yuma myotis, have federal or State special status. Bats used structures as roosting habitat during the day and at night and were observed foraging over reservoirs and creeks. Two buildings and a bridge have evidence of relatively larger populations of California myotis or other myotis species, which may include reproductive colonies. Based on these findings, recommendations are provided to avoid or minimize impacts to bats that could result from maintenance activities, building demolition or construction. These include limiting maintenance activities in these structures or attempts to exclude bats from these structures to periods outside the maternity season (April to September).

## Introduction

GANDA wildlife biologists conducted surveys for bats occupying MMWD structures associated with the Mt. Tamalpais watershed on June 2-3, August 14-16, and October 2-3, 2003. A list of approximately 50 priority structures was provided to GANDA by MMWD. The primary goal of these surveys was to determine if any sensitive bat species, specifically Townsend's big-eared bat and pallid bat, were roosting in MMWD structures. The surveys were conducted by GANDA bat specialist Heather L. Johnson, assisted by wildlife biologists Chloe Scott (June) and Kevin Wiseman (August), and MMWD park ranger Phil Johnson.

Man-made buildings and bridges are commonly used by bats as roosting habitat, especially those close to water features such as reservoirs and lakes. Bat roosting habitat is found in structures that provide crevices or cave-like spaces that are usually dark and protected from air movement, constructed of heat-retentive materials such as concrete and wood, and often have little or no human use such as abandoned buildings. Building features that bats commonly roost in include darkened interiors, attics, overhanging eaves, porches, and crevices in window and door frames, under siding, roofing materials, and behind gutters and loose trim. Bridge and spillway features that offer roosting habitat include expansion joints, recesses near abutments, and maintenance spaces (Davis and Cockrum, 1963).

Roosting habitat is critical to bats as they spend over half their lives in the roost environment (Kunz, 1982a). Roosts provide a safe location with the proper thermal and moisture conditions and must be in the vicinity of foraging and drinking habitats (Campbell *et al.*, 1996). During the day bats are inactive in the roost in order to conserve energy; at night, bats roost in order to rest and keep warm in between periods of feeding. When bats are inactive both during the day and at night, they often become torpid. Torpor is a state of physiological dormancy in which the heart rate, breathing rate, body temperature, and metabolism are lowered. When torpid bats are

disturbed, up to 15 minutes may be required for the bat to arouse (awaken and warm until movement is possible). During arousal, the bat begins to stir, shivers and increases fuel metabolism to generate heat, and takes flight when a sufficiently high body temperature is reached.

A structure may be used as either a day or night roost, or both. During the reproductive season (April through September), female bats gather in maternity colonies to give birth, and their roost sites are especially important refuges during pregnancy and lactation. Mother bats leave the flightless young behind in the roost while foraging; but return periodically to nurse. Males may be solitary during the reproductive season. In the fall, the young are independent and the colonies usually disperse. Bats may remain active year round, migrate, or hibernate. Structures with suitable humidity and temperature regimes may be used as hibernation sites.

All the bat species that occur on the Mt. Tamalpais watershed are insectivorous and will forage for insects amongst vegetation, over water surfaces, in the open air, and on the ground. Foraging habitat observed on the Mt. Tamalpais watershed includes the surface of still or slow-moving open water in the reservoirs and creeks, open grassland, riparian corridors, conifer and mixed deciduous forests, canyons, and edge habitats where trees and shrubs border water bodies or meadows. In addition to an abundance of suitable water features, overall the Mt. Tamalpais watershed supports a landscape mosaic of structurally diverse vegetation communities, which is expected to provide diverse habitats for bats. A relatively diverse bat fauna can be expected to occur in this high-quality habitat.

## **Methods**

### **Literature and Database Review**

A list of potential bat species occurring on the Mt. Tamalpais watershed was compiled from Museum of Vertebrate Zoology (MVZ), UC Berkeley database query results, and review of unpublished reports, journal articles, and range maps resulting from a bat workshop (Ecology, Conservation and Management of Western Bats, Western Bat Working Group Workshop, Reno, Nevada, 1998).

### **Field Surveys**

The best methods for surveying bats utilize a combination of techniques including inspection of day and night roost areas, monitoring of free-flying bats, and capture of bats for examination. Species identification and characterization of bat use of structures is based on direct observation whenever possible. Most of the structures found occupied by bats during the surveys permitted direct observations. In some instances, access to structures where bats were roosting was limited and/or the bats were hidden or absent at the time of the survey. In such cases, indirect evidence, such as bat sign, was used to determine a narrow range of possible species and to characterize use. Bat sign consists primarily of urine stains and guano deposits, which are often identifiable to taxonomic groups, or sometimes species.

In addition to field surveys, MMWD employees were interviewed regarding bat observations. MMWD park ranger Phil Johnson, who assisted with bat observations, demonstrated proficiency in detecting bats roosting on open surfaces, and received training on detecting bats hidden in building features.

### Visual Inspections

The interior and exterior of structures were investigated during the day as part of visual searches for bats and their sign (guano and urine staining). Structural features that provide potential roosting sites include building interiors and attics, and exterior features such as narrow spaces under corrugated roof and wall materials, in window louvers, door runners, and between gutters and fascia boards. Potential roosting sites were closely examined visually with the aid of spotlights and a digital camcorder with auxiliary infrared light, and biologists listened for audible squeaking of roosting bats. Some structures that contained bats or guano were monitored at sunset to observe and count emerging bats (Thomas and LaVal, 1988).

### Acoustic Sampling

A broadband ultrasonic detector (Anabat II, Titley Electronics, Inc., New South Wales, Australia) was used to listen for echolocation calls of bats inside structures. Open air areas near selected structures were monitored for an hour past sunset or longer to record echolocation calls of free-flying bats to aid in inventorying the species present (O'Farrell *et al.*, 1999). Echolocation calls were monitored using the detector in conjunction with Anabat6 software (Chris Corben, Rohnert Park, California) on a portable laptop to record sonograms of the calls of passing bats for real time review. Sonograms were also recorded on the hard drive for later analysis. Townsend's big-eared bats are difficult to detect acoustically; therefore, visual inspections were the only means of finding this species. Pallid bats are detectable using the Anabat system.

## **Results**

### **Species and Roost Locations**

Based on the literature and database review, 13 species of bats were determined likely to occur within the Marin Municipal Water District Mt. Tamalpais watershed (Table 1). Of these species, at least five were confirmed occupying MMWD structures and a sixth species is suspected to be present. The species are Townsend's big-eared bat, pallid bat, big brown bat, Mexican free-tailed bat, California myotis, and Yuma myotis.

Species presence and identification were confirmed based on acoustic recordings, visual observations of roosting bats, carcasses, and the appropriate habitat and behaviors (roosting and foraging). The first three species listed were readily observed and identified by their appearance while roosting in open spaces in building interiors. The Mexican free-tailed bat and California myotis were initially suspected to be present based on acoustic recordings of foraging bats, and subsequently confirmed present when a free-tailed bat carcass was found inside the SoulaJoule pump house and a pair of California myotis carcasses were found inside the Porteous workshop.

**Table 1.** Bat species known or suspected to occur on the Marin Municipal Water District. Status categories are U.S. Fish and Wildlife Species of Concern (FSC), and California Department of Fish and Game Species of Special Concern (CSC). An asterisk (\*) indicates this status is proposed.

Species	Status	MVZ Records	Likelihood of Presence
Townsend's big-eared bat <i>Corynorhinus townsendii</i>	FSC, CSC	1.3 mi SE Inverness and Olema	Confirmed visually.
Pallid bat <i>Antrozous pallidus</i>	CSC	Bolinas Ridge, 1.3 mi SE Inverness, and Pt. Reyes	Confirmed visually.
Big brown bat <i>Eptesicus fuscus</i>		Inverness, Olema, and Pt. Reyes	Confirmed visually and acoustically.
Silver-haired bat <i>Lasionycteris noctivagans</i>		1 mi S Inverness	Likely based on habitat; usually roosts in tree crevices and cavities.
Red bat <i>Lasiurus blossevillii</i>	CSC*	San Rafael, 1 mi SE Inverness, and Olema	Likely based on habitat; roosts in foliage.
Hoary bat <i>Lasiurus cinereus</i>		Nicasio, Pt. Reyes, and 1 mi SE Inverness	Likely based on habitat; roosts in foliage.
Fringed myotis <i>Myotis thysanodes</i>	FSC, CSC*	1.3 mi SE Inverness, Olema, and Pt. Reyes	Likely based on habitat.
Yuma myotis <i>Myotis yumanensis</i>	FSC	1.3 mi SE Inverness and Pt. Reyes	Likely based on habitat. Known for close association with reservoirs.
California myotis <i>Myotis californicus</i>		Camp Taylor 2 mi WNW Lagunita, Inverness, Olema, and Pt. Reyes	Confirmed based on acoustic recording, foraging behavior, and carcasses found.
Little brown myotis <i>Myotis lucifugus</i>		None	Possible based on range and habitat. Known for close association with reservoirs.
Long-legged myotis <i>Myotis volans</i>	FSC, CSC*	Specimen reported in Pierson <i>et al.</i> 2002	Likely based on range and habitat. Barbour and Davis 1969
Long-eared myotis <i>Myotis evotis</i>	FSC	None	Likely based on range and habitat. Barbour and Davis 1969
Mexican free-tailed bat <i>Tadarida brasiliensis</i>		Nicasio School and Pt. Reyes	Confirmed; carcass and acoustic recording.

The skulls from the California myotis carcasses were prepared to aid identification (Barbour and Davis, 1969). The bats occupying Shafter Bridge are likely to be Yuma myotis due to that species' abundance and affinity for roosting in manmade structures over water.

Three of the species detected in the survey, Townsend's big-eared bat, pallid bat, and Yuma myotis, have federal or State special status. Table 2 lists the structures and roost locations where one or more of these sensitive species were detected.

**Table 2.** List of roosts used by sensitive bat species in MMWD structures.

The roosts listed for each structure were used by any one or more of the species in the corresponding species column. The numbers column gives a general estimate based on the amount of sign present with the number actually observed in parentheses by species.

Structure	Location of Roost(s)	Species Detected	Numbers
Alpine Dam Chlorinator (aka Weir Building)	Interior roof Penstock valve houses Exterior wall cavities	Townsend's big-eared bat Pallid bat Big brown bat <i>Myotis</i> spp. bats	1-2 individuals (2) Unknown (7) Unknown (1) Unknown
Alpine Dam Storage Barn (aka Alum House)	Interior roof Inside door window frame	Townsend's big-eared bat Big brown bat	1-2 individuals (1) Small groups (1)
Phoenix Lake Log Cabin	Interior roof	Townsend's big-eared bat <i>Myotis</i> spp. bats	1-2 individuals (1) Unknown
Phoenix Dam Pump House	Interior roof	Townsend's big-eared bat Big Brown bat	1-2 individuals (1) Small groups (1)
Phoenix Dam Residence	Roof of basement	Townsend's big-eared bat	1-2 individuals
Phoenix Lake Porteous Workshop	Interior roof	Townsend's big-eared bat California myotis	1-2 individuals (1) Small groups (2)
Lake Lagunitas Weir House	Interior roof Penstock basement	Townsend's big-eared bat <i>Myotis</i> spp. bats	1-2 individuals (1) Unknown
Air Force Base Residences	Interior	Townsend's big-eared bat	1-2 individuals
Air Force Base Furnace Building	Interior roof	Townsend's big-eared bat Big Brown bat	1-2 individuals (1) 1-2 individuals (1)
Shafter Bridge	Expansion joint	<i>Myotis</i> spp. (probably Yuma and/or Little Brown myotis)	40 counted, suitable habitat for more and size of urine stains indicates larger numbers
Soulajoule Residence	Porch	Pallid bat Big Brown bat <i>Myotis</i> spp. bats	Unknown- night roosting bats observed by Phil Johnson- no bats present daytime survey
West Point Inn	Roof of basement	Townsend's big-eared bat	1-2 individuals (1)

The bat species present in MMWD facilities varied during the survey period (Table 3). For example, Townsend's big-eared bat was observed in the Alpine Dam chlorinator building in June, August, and October, while the pallid bat and big brown bat were only observed there in August. Reports from park ranger Phil Johnson on roost use at the Soulajoule residence varied on a nightly basis. The bats also showed fidelity to day roost sites, especially Townsend's big-eared bat. The survey results and observations of each species detected follows in Table 3.

**Table 3.** Results of visual inspection of structures by month.

<b>Structure</b>	<b>June 2-3</b>	<b>August 14-16</b>	<b>October 2-3</b>
Alpine Dam Chlorinator (aka Weir Building)	<i>Myotis</i> spp. and other species guano in piles on ground in SE section, decades of use by unknown numbers; solitary Townsend's present (flew from interior roof to roost inside inaccessible cavern in chlorinator/penstock level).	7 pallids, 1 big brown, 2 solitary Townsend's present interior roof. One Townsend's flew into cavern in chlorinator/penstock level and observed roosting in cave-like space adjacent to penstock valves.	Two Townsend's observed flying around interior, and roosting inside cave-like space adjacent to valves on the chlorinator/penstock level. One also roosted in the wooden valve shed just off the main chlorinator building. Sign that mid-sized bats (probably big brown and/or pallid) roost in cave-like space on south exterior wall. Night acoustic survey on top of slope adjacent to pool at base of dam.
Alpine Dam Storage Barn (aka Alum House)	Solitary Townsend's present in roof; very little guano observed.	Solitary Townsend's present interior roof, 1 big brown roosting interior recessed window of door.	No bats observed but recent Townsend's guano present.
Alpine Dam	Not accessible to survey.	Entered 4 short maintenance passages and 1 long passage that led to catacombs- no bat sign observed.	Not surveyed.
Alpine Dam Residence/Garage	Not accessible to survey.	No bat sign house exterior, garage interior or exterior.	Not surveyed.
Phoenix Lake Log Cabin	<i>Myotis</i> spp. guano present in interior, possibly more than one species. Townsend's guano on and behind refrigerator. Night acoustic survey on shore below.	Not surveyed.	Solitary Townsend's present in ceiling over refrigerator. No other bats observed. <i>Myotis</i> guano present in interior, possibly more than one species. Possible big brown guano on porch, west side entrance (night roost?).
Phoenix Lake Pump House (adjacent to log cabin)	<i>Myotis</i> spp. guano on window louvers and in various spots on exterior. Interior not surveyed.	Not surveyed.	<i>Myotis</i> spp. guano on window louvers and in various spots on exterior. Interior not surveyed.
Phoenix Dam Pump House	Solitary Townsend's present in rear of building, very little guano observed in accessible areas of interior.	Not surveyed.	Solitary big brown observed roosting in ceiling. No Townsend's observed in rear of building however MMWD employee reported having recently seen it. Old and recent Townsend's guano present in multiple locations on stairs leading up to roof door.
Phoenix Dam Residence	A few pieces of Townsend's guano under house.	Not surveyed.	Not surveyed.

<b>Structure</b>	<b>June 2-3</b>	<b>August 14-16</b>	<b>October 2-3</b>
Phoenix Lake Porteous Residence	Not surveyed.	Not surveyed.	No bat sign or observed exterior or interior.
Phoenix Lake Porteous Workshop	Not surveyed.	Solitary Townsend's present interior roof, 2 dead California myotis (skulls prepared).	No bats observed but recent Townsend's guano observed.
Phoenix Lake Spillway	No sign of bats under raised spillway or under overpass.	Not surveyed.	Not surveyed.
Natalie Coffin Green Bridge	No sign of bats and does not appear to provide suitable habitat.	Not surveyed.	Not surveyed.
Several additional bridges in picnicking areas	No sign of bats and does not appear to provide suitable habitat.	Not surveyed.	Not surveyed.
Lake Lagunitas Sign Shop	Occasional night roosting on exterior under porch roof by a small number of <i>Myotis</i> spp. No sign of bats in interior.	Not surveyed.	Occasional night roosting on exterior under porch roof by a small number of <i>Myotis</i> spp. Interior not surveyed.
Lake Lagunitas Residence	<i>Myotis</i> spp. night roost under house in cellar, occasional use by a small number of bats.	Not surveyed.	Not surveyed.
Lake Lagunitas Weir House	Day and night roosting in roof and interior ( <i>Myotis</i> spp. and Townsend's). Night acoustic survey for outflight; Townsend's observed flying around interior and roosting in penstock basement level.	Solitary Townsend's roosting in roof just inside door. No bats present in penstock basement level. Unable to determine amount of guano present due to wet conditions.	Not surveyed.
Lake Lagunitas Weir House Annex	No bat sign observed.	Not surveyed.	Not surveyed.
Lake Lagunitas Picnic Shelter	Guano indicates that mid-sized bats night roost over a picnic table (probably big brown).	Not surveyed.	Guano indicates that mid-sized bats night roost in ceiling, probably big brown.
Lake Lagunitas Air Force Base Pump House	No bat sign exterior or interior and does not appear to provide suitable habitat.	No bat sign exterior or interior and does not appear to provide suitable habitat. Night acoustic survey on nearby shore.	Not surveyed.

<b>Structure</b>	<b>June 2-3</b>	<b>August 14-16</b>	<b>October 2-3</b>
Lake Lagunitas Spillway	No bat sign observed under platform or under spillway structure; does not appear to provide suitable roosting habitat.	Not surveyed.	Not surveyed.
Lake Lagunitas Rock Bridge at picnic ground	No bat sign observed; does not appear to provide suitable roosting habitat.	Not surveyed.	Not surveyed.
Lake Lagunitas Bathroom Buildings (3) and Kiosks	No bat sign observed.	Not surveyed.	No bat sign observed.
Sky Oaks Seed Shed	No bat sign observed.	No bat sign observed.	Not surveyed.
Sky Oaks "SAC Shack"	Not surveyed.	No bat sign observed.	Not surveyed.
Sky Oaks Facility	Not surveyed.	No bat sign observed exterior.	Not surveyed.
Sky Oaks Residence/Garage	Not surveyed.	No bat sign observed house exterior, garage interior or exterior, or garage attic.	Not surveyed.
Marin Stables Arena	Possible roosting habitat between rain gutters and fascia board along one side of roof.	Not surveyed.	Several sites along roof edge had mid-sized bat guano sign. Single big brown observed roosting between fascia board and wire mesh screen underneath. Bat observed foraging in arena.
Marin Stables Main Building	No bat sign observed.	Not surveyed.	Not surveyed.
Marin Stables Stalls and Tack Rooms	No bat sign observed.	Not surveyed.	Not surveyed.
Air Force Base Residences	Not surveyed.	<i>Myotis</i> spp. guano exterior easterly house, one piece Townsend's guano interior westerly house, much of interior not accessible to survey.	Not surveyed.
Air Force Base Other Structures	Not surveyed.	<i>Myotis</i> spp. day roosting between roof edge and fascia board of bowling alley, <i>Myotis</i> spp. day roosting in window louvers of communications building, solitary Townsend's and big brown in large furnace building. No bat sign observed in pool buildings.	Not surveyed.

<b>Structure</b>	<b>June 2-3</b>	<b>August 14-16</b>	<b>October 2-3</b>
Shafter Bridge	Not surveyed.	40 <i>Myotis</i> spp. day roosting in one expansion joint under deck. Possible night roosting near ceiling on abutments.	Not surveyed.
East Portal Pine Mtn Tunnel	Not accessible to survey.	No suitable habitat for bats.	Not surveyed.
Five Corners Tunnel	Not accessible to survey.	Not surveyed.	Investigated at entrances but not entered. No sign observed but good habitat and potential site for hibernation.
Bon Tempe flowline tunnel	Not accessible to survey.	Surveyed 75' into tunnel- <i>Myotis</i> spp. sign along floor and pipeline and in one spot on floor. Probably night roost.	Not surveyed.
Soulajule Residence	Not surveyed ( <i>Myotis</i> spp., big brown, and pallid reported).	<i>Myotis</i> spp. and big brown guano observed.	Not surveyed.
Soulajule Reservoir Pump house	Not surveyed.	<i>Myotis</i> spp. guano and Mexican free-tailed carcass found.	Not surveyed.
Soulajule Reservoir Other Facilities	Not surveyed.	None found to survey.	Not surveyed.
Nicasio Reservoir Pump House	Not surveyed.	No bat sign observed and low potential for habitat.	Not surveyed.
West Point Inn	Not surveyed.	Solitary Townsend's observed and up to two reported present in basement.	Not surveyed.
West Point Inn Cabins	Not surveyed.	Cursorily surveyed (cabins occupied by people); low potential for bat habitat.	Not surveyed.

## Species-specific Results

### Townsend's Big-eared Bat

Solitary individuals were found roosting in the Alpine Dam chlorinator building, Alpine Dam storage barn, Phoenix Dam pump house, Phoenix Lake log cabin, Phoenix Lake Porteous workshop, Lake Lagunitas weir house, the large furnace building at the Air Force Base, and in the basement of the West Point Inn (Figure 1). The guano of this species was found under the Phoenix Lake residence and in the westerly Air Force Base residence. The amount of guano found suggested rare to occasional use of both residences, however most of the Air Force Base residence was inaccessible to survey due to piles of building materials inside, and the interior of the easterly house was inaccessible.



**Figure 1.** Townsend's big-eared bat roosting in the interior roof of the Alpine Dam chlorinator building.

### Pallid Bat

Pallid bats were found roosting in two buildings on the Mt. Tamalpais watershed. A cluster of five bats and a nearby pair were found day roosting in the interior roof of the Alpine Dam chlorinator in cavities formed by rafter joints (Figure 2). When disturbed by the spotlight the pair of pallid bats near the cluster retreated into crevices behind the rafters. Large amounts of guano present on the floor suggest long-term use, possibly by greater numbers. Pallid bat guano was indistinguishable from big brown bat guano in the Alpine Dam chlorinator building therefore estimates of numbers is not possible without further study. Pallid bats also night roost

on the porch of the Soulajoule residence based on evidence of guano and discarded prey remains observed by resident park ranger Phil Johnson.



**Figure 2.** Small group of pallid bats roosting in the interior roof of the Alpine Dam chlorinator building.

### Big Brown Bat

Big brown bats were detected roosting in concrete and wooden buildings, and probably trees. Solitary big brown bats were found in the Alpine Dam weir building, Alpine Dam storage barn, the large furnace building at the Air Force Base, the Marin Stables Arena, and the Phoenix Lake pump house (Figure 3). The individual observed in the Air Force Base building was in a corner of the ceiling where a crossbeam meets the wall and the guano on the floor suggested that this is its usual roost site. During the nighttime acoustic survey beside the Air Force Base pump house on the shore of Lake Lagunitas, big brown bats emerged from the forest right at sunset suggesting that they are roosting in trees.



**Figure 3.** Solitary big brown bat roosting in the interior roof of the Phoenix Lake pump house.

*Myotis* spp.

Two dead California myotis were found in the Porteous workshop near Phoenix Lake and the Yuma myotis is suspected to be occupying an expansion joint in Shafter Bridge. Both California myotis and Yuma myotis emit echolocation calls with characteristic frequencies around 50 kHz (O'Farrell) and the two species are distinguished by foraging behavior and capture and examination in the hand. During acoustic monitoring sessions at Lake Lagunitas, Phoenix Lake, and Alpine Dam calls from 50k kHz myotis dominated the bat activity. Observations of behavior (foraging higher over the water near the vegetation at the edge of the reservoir) indicated that the species was California myotis.

Myotis species are using at least 15 structures on the Mt. Tamalpais watershed. Myotis guano is identifiable to genus but usually not to species. The amount of guano deposited in these structures indicates that most roosts are utilized by small numbers of bats, except in the Alpine Dam chlorinator building, Lake Lagunitas weir house, and Shafter Bridge. Large deposits of guano in these three structures indicate that they provide habitat for relatively larger populations, possibly maternity colonies.

Mexican free-tailed bat

Echolocation calls attributable to a Mexican free-tailed bat were recorded during a brief (90 min) acoustic monitoring session on the shore of Lake Lagunitas. A dead Mexican free-tailed bat was found inside the Soulajoule pump house, which appears to be used as a night roost by multiple

species (based on guano present) in relatively small numbers (<100). Mexican free-tailed bats occur in large colonies therefore large populations may occur in the vicinity of these reservoirs.

## **Discussion**

Thirteen species are likely to occur on the Mt. Tamalpais watershed; three of which typically roost in trees/foilage (Table 1). Of the ten species that may roost in manmade structures, five were found in MMWD facilities in relatively low numbers. A focal species of the survey, Townsend's big-eared bat, was found roosting as solitary individuals in 20% of the MMWD structures surveyed.

Solitary Townsend's big-eared bats may be "bachelor" males and their presence during the reproductive season suggests a maternity colony of females and young is nearby (Fellers pers. comm., 2003) perhaps within a few kilometers (Fellers and Pierson, 2002). Disturbance in roost sites has long been known to be a significant threat to this species, however exceptions occur. It is presumed that the individual roosting in the Phoenix Lake log cabin is not present often enough to coincide with human use, although it may tolerate disturbance or leave when the cabin is in use. The amount of guano deposited below its roost site between June and October suggested occasional use. The individuals in the Phoenix Lake pump house, Porteous workshop, the Alpine Dam buildings, and the basement of the West Point Inn are disturbed occasionally according to accounts by MMWD personnel and the innkeeper. Therefore disturbance in the roost is not considered a management concern for this species. The long-term viability of the roost sites in abandoned buildings is a concern.

Bats are primarily utilizing abandoned or infrequently-used buildings on the Mt. Tamalpais watershed. Bat colonies are not interfering with workspaces nor co-existing with humans and therefore are not usually a management issue. However, maintenance activities, building demolition or construction may result in impacts to bats. Impacts may be avoided or minimized by implementing the recommendations outlined in the following section.

### Air Force Base

The abandoned Air Force buildings may be slated for removal. Bats were found roosting in the interior of the large furnace building and the westerly residence, and the exterior of the communications building, easterly residence, and bowling alley. Observations of roosting bats and their sign indicated that solitary individuals or small groups utilize these buildings. Park ranger Phil Johnson assisted on the Air Force Base surveys and has firsthand knowledge of bat roosting locations.

Since Townsend's big-eared bats roost in exposed locations on rafter beams and in ceiling corners it should be relatively easy to ascertain the presence of any individuals prior to demolition. In the westerly residence, bat sign was located in the hallway on the uppermost wall. The remainder of the residence should be surveyed when access is available (i.e., stored materials removed). In the large furnace building, the observed individual was on the ceiling near the wall, similar to the individual in Figure 1.

Three myotis were observed roosting in a narrow crevice behind the rain gutter on a corner of the bowling alley roof. The guano deposited on the ground below suggested long-term use by a small group. These bats may be California myotis since individuals were spatially separated (Pierson *et al.*, 2002) and there is no water nearby as may be expected for a Yuma myotis roost. To flush the bats the rain gutters should be pried open and/or removed manually. In the abandoned residences a few myotis roost behind the plywood boards covering the windows, and under the metal window louvers of the communications building. Roosting bats may be torpid and should be gently, tactilely disturbed and allowed time to arouse (raise heart and breathing rates and body temperature to enable flight) before they can escape.

## **Management Recommendations**

These recommendations are intended to minimize impacts to sensitive and common bat species that are known or likely to occur on the Mt. Tamalpais watershed, based on knowledge of the natural history and behavior of these species. More information on the biology of these species is provided in Appendix A.

- Continue to protect special-status bats from disturbance by preventing public access to buildings known to harbor these species.
- Schedule construction, maintenance and/or demolition activities in Alpine Dam chlorinator building, Lake Lagunitas weir house, and Shafter Bridge to avoid the maternity season (April through September).
- Survey the remainder of the westerly Air Force residence for Townsend's big-eared bat and other bat species when access is available (i.e., stored materials removed).
- Bats should be determined to be absent or flushed from roost locations prior to demolition of buildings. Torpid bats must be allowed time to completely arouse and fly away.
- If exclusion of bats from buildings is necessary, it should be conducted outside the maternity season (April through September) and monitored by a qualified biologist.
- When flushing bats from roost locations, move structures carefully to avoid harming individuals. The rain gutters on the bowling alley roof should be pried open and/or removed manually to flush the bats.

## **Conclusion**

Questions remain regarding the presence of reproductive and over-wintering bat populations in MMWD structures. Additional surveys conducted during the reproductive season could determine whether or not maternity roosts are present. The numbers of bats occupying the Alpine Dam chlorinator, Lake Lagunitas weir house, and Shafter Bridge have yet to be determined. Additional winter surveys may find hibernating bats in structures. The Five

Corners tunnel appeared to be a potential hibernation roost due to its structural similarity to a cave or mine and noticeable cold air movement.

MMWD provides outdoor recreation opportunities to the public and park rangers were observed answering questions regarding wildlife use of watershed resources. Park rangers and most of the MMWD employees encountered in the course of these surveys viewed bats in a positive light and were enthusiastic to learn more about them. The results of this survey will inform MMWD personnel (especially park rangers) of the bat species present in the watershed. Exact locations of bat roosts should not be revealed to the public (American Society of Mammalogists, 1992). The rangers should include bats in their wildlife interpretation for the public, emphasizing the role of bats in the healthy forest ecosystem by noting the beneficial role bats play by controlling insect populations and spreading nutrients gained from aquatic systems to the more nutrient-poor forests and meadows.

## Literature Cited

- American Society of Mammalogists. 1992. Guidelines for the protection of bat roosts. *Journal of Mammalogy*, 73(3):707-710.
- Barbour, R. W., and W. H. Davis. 1969. *Bats of America*. University of Kentucky Press, Lexington, KY.
- Bogan, M. A., E. W. Valdez, and K. W. Navo. 1998. Long-legged myotis *Myotis volans*. Species account resulting from the Ecology, Conservation and Management of Western Bat Species, Western Bat Working Group Workshop, Reno, Nevada.
- Bolster, B. 1998. Hoary bat *Lasiurus cinereus*. Species account resulting from the Ecology, Conservation and Management of Western Bat Species, Western Bat Working Group Workshop, Reno, Nevada.
- Bradley, P., and M. Ports. 1998. Fringed myotis *Myotis thysanodes*. Species account resulting from the Ecology, Conservation and Management of Western Bat Species, Western Bat Working Group Workshop, Reno, Nevada.
- Campbell, L. A., J. G. Hallet, and M. A. O'Connell. 1996. Conservation of bats in managed forests: use of roosts by *Lasionycteris noctivagans*. *Journal of Mammalogy*, 77:976-984.
- Davis, R., and E. L. Cockrum. 1963. Bridges utilized as day-roosts by bats. *Journal of Mammalogy*, 44(3):428-430.
- Fellers, G. M., and E. D. Pierson. 2002. Habitat use and foraging behavior of Townsend's big-eared bat (*Corynorhinus townsendii*) in coastal California. *Journal of Mammalogy*, 83(1):167-177.
- Hermanson, J. W., and T. J. O'Shea. 1983. *Antrozous pallidus*. Mammalian Species Account No. 213, 8 pgs.
- Krutzsch, P. 1954. Notes on the habits of the bat, *Myotis californicus*. *Journal of Mammalogy*, 35(4):539-545.
- Kunz, T. H. 1982a. Roosting ecology. Pp. 1-55, in *Ecology of bats* (T. H. Kunz, ed.). Plenum Publishing, New York.
- Kunz, T. H. 1982b. *Lasionycteris noctivagans*. Mammalian Species Account No. 172, 5 pgs.
- Kunz, T. H., and R. A. Martin. 1982. *Plecotus townsendii*. Mammalian Species Account No. 175, 6 pgs.
- Kurta, A. and R. H. Baker. 1990. *Eptesicus fuscus*. Mammalian Species Account No. 356, 10 pgs.

- O'Farrell, M. J., and W. L. Gannon. 1999. A comparison of acoustic versus capture techniques for the inventory of bats. *Journal of Mammalogy*, 80(1):24-31.
- O'Farrell, M. J., B. W. Miller, and W. L. Gannon. 1999. Qualitative identification of free-flying bats using the Anabat detector. *Journal of Mammalogy*, 80(1):11-23.
- Ormsbee, P. C., and W. C. McComb. 1998. Selection of day roosts by female long-legged myotis in the central Oregon Cascade Range. *Journal of Wildlife Management*, 62(2):596-603.
- Pierson, E. D., and W. E. Rainey. 1998. Distribution, Status, and Management of Townsend's Big-eared Bat (*Corynorhinus townsendii*) in California. Bird and Mammal Conservation Program Technical Report Number 96-7, California Department of Fish and Game.
- Pierson, E. D., M. C. Wackenhut, J. S. Altenbach, P. Bradley, P. Call, D. L. Genter, C. E. Harris, B. L. Keller, B. Lengus, L. Lewis, B. Luce, K. W. Navo, J. M. Perkins, S. Smith, and L. Welch. 1999. Species conservation assessment and strategy for Townsend's big-eared bat (*Corynorhinus townsendii townsendii* and *Corynorhinus townsendii pallescens*). Idaho Conservation Effort, Idaho Department of Fish and Game, Boise, Idaho.
- Pierson, E. D., P. W. Collins, W. E. Rainey, P. A. Heady, and C. J. Corben. 2002. Distribution, Status and Habitat Associations of Bat Species on Vandenberg Air Force Base, Santa Barbara County, California. Santa Barbara Museum of Natural History Technical Reports- No. 1.
- Shump, Jr., K. A., and A. U. Shump. 1982. *Lasiurus cinereus*. Mammalian Species Account No. 185, 5 pgs.
- Simpson, M. R. 1993. *Myotis californicus*. Mammalian Species Account No. 428, 4 pgs.
- Thomas, D. W., and R. K. LaVal. 1988. Survey and Census Methods. Pg. 77-87, in *Ecological and Behavioral Methods for the Study of Bats*, T.H. Kunz, ed. Smithsonian Institution Press, Washington, D.C. 533 pgs.
- Vonhof, M. J. 1999. [Abs.]. Patterns of tree use, group composition, and group stability in silver-haired bats: Implications for forest management. *Bat Research News*, 40(4):199.
- Waldien, D. L., J. P. Hayes, and E. B. Arnett. 2000. Day-roosts of female long-eared myotis in western Oregon. *Journal of Wildlife Management*, 64(3):785-796.
- Warner, R. M., and N. J. Czaplewski. 1984. *Myotis volans*. Mammalian Species Account No. 224, 4 pgs.
- Weller, T. J., and C. J. Zabel. 2001. Characteristics of fringed myotis day roosts in northern California *Journal of Wildlife Management*, 65(3):489-497.

## **Personal Communications**

Fellers, Gary M. 2003. Email discussions regarding life history and behavior of Townsend's big-eared bat in Marin County.

Pierson, Elizabeth D. 1998. Species-specific group discussion at the Ecology, Conservation and Management of Western Bat Species, Western Bat Working Group Workshop, Reno, Nevada

## **Appendix A**

### **Natural History, Status and Distribution of Bat Species**

#### Townsend's big-eared bat

The Townsend's big-eared bat occurs in a variety of habitat types including woodlands, grasslands, riparian communities, and active agricultural areas. Roost sites are in cavern-like spaces with open flyways found in caves, mines, tunnels, and less often in buildings and bridges. Sometimes rock crevices and hollow trees are used as roosts. The distribution of this species appears to be constrained primarily by two factors: availability of suitable roosting sites and degree of human disturbance at roosts (Pierson and Rainey, 1998). The Townsend's big-eared bat is sensitive to disturbance and roost abandonment may result if they are repeatedly disturbed. During the reproductive period in spring and summer roost abandonment may cause mortality of the young. If MMWD personnel enter buildings to monitor occupancy by this species it is recommended that surveys occur once or twice a year (Pierson and Rainey, 1998; Pierson *et al.*, 1999); at most once per season (G. Fellers pers. comm., 2003).

Foraging associations for the Townsend's big-eared bat include edge habitats along streams and areas adjacent to and within a variety of wooded habitats. They forage in the air mostly along forest edges (Kunz and Martin, 1982) and have been observed using forest edge habitat in the Olema Valley (Fellers and Pierson, 2002). Townsend's big-eared bats feed principally on moths and butterflies but they will prey on other insects such as flies and small beetles (Kunz and Martin, 1982). The wing scales from digested moths and butterflies are shed in the guano usually resulting in a characteristic golden color that crushes into a fine dust. This species is not known to migrate long distances, and probably hibernates within about 25 miles of its summer roosts (Pierson *et al.*, 2002). The Townsend's big-eared bat is a California Department of Fish and Game (CDFG) Species of Special Concern and U.S. Fish and Wildlife Service (USFWS) Species of Concern.

#### Pallid bat

The pallid bat is characteristically a species of arid and semiarid, lowland habitats such as oak woodlands, grasslands, active agricultural areas, and desert scrub. Roost sites include crevices and cavities in cliffs, rocks, trees, caves, bridges, a variety of vacant and occupied buildings, and mines (Hermanson and O'Shea, 1983). Foraging habitat includes grasslands and woodlands. Radio-tracking studies have shown that pallid bats generally feed within 3-4 miles of their roost in regularly occupied feeding areas (Pierson *et al.*, 2002). This species feeds on large arthropods such as crickets, grasshoppers, and wood beetles and is known for its ability to hunt on the ground.

Pallid bats are not known to migrate and presumably in winter they hibernate close to their summer roosts (Pierson *et al.*, 2002). This species is gregarious, and often roosts in colonies of up to several hundred individuals. Reproductive colonies are formed in spring and summer and are highly vulnerable to disturbance. Young are generally weaned in mid-to-late August, and maternity colonies disband between August and October. The pallid bat is a CDFG Species of Special Concern.

### Big brown bat

The big brown bat occurs in a wide variety of habitats from desert scrub to high elevation conifer forest. It is well known for its propensity to roost in buildings, mines, and bridges, but is also found in caves, cliff faces, and tree hollows in forested landscapes. In northern California radio-tracking studies suggest that this species forages along watercourses not traveling more than a few kilometers from their roosts (Pierson *et al.*, 2002). Insect prey is primarily beetles.

The big brown bat is a colonial species that hibernates in winter in buildings, caves, and mines. This species is not known to migrate large distances although some elevational migration may occur. Potential threats to the big brown bat include roost disturbance and destruction, particularly eradication of building dwelling colonies by pest control operations (Kurta and Baker, 1990). This species does not have special management status.

### Silver-haired bat

The silver-haired bat is characteristically found in conifer/mixed hardwood forest habitat at higher elevations. This species is known to roost almost exclusively in crevices and cavities in trees, for example in woodpecker holes and under flaking bark. They are occasionally found roosting in buildings therefore it is highly unlikely but possible that this species would roost in an MMWD structure. Silver-haired bats live in small colonies and move their roost sites among trees in a given area (Vonhof, 1999). Foraging habitat includes forest canopy, forest clearings, and riparian zones and insect prey is primarily moths (Kunz, 1982b). Potential threats to the silver-haired bat include loss of roosting habitat due to forest management practices that do not provide for clusters of large diameter dead and dying trees. This species does not have special management status.

Acoustic monitoring over foraging habitat would be the best method for detecting this species on the MMWD (O'Farrell and Gannon, 1999). The silver-haired bat is expected to occur in suitable habitat and a museum record for a specimen collected 1 mile south of Inverness. This species is migratory and during summer silver-haired bats are generally thought to be concentrated in northern California (Pierson *et al.*, 2002).

### Red bat

The majority of records for this species in California are from the coastal areas from the San Francisco Bay area south, plus the Central Valley and bordering foothills (Pierson *et al.* 2002). The red bat is characteristically found in riparian habitat at lower elevations, especially Central Valley cottonwood, sycamore, and willow riverine galleries. The red bat roosts solitarily, hanging pendent in the foliage of trees and shrubs. Loss of riparian zones, primarily due to agricultural conversion and creation of water storage reservoirs has reduced both roosting and foraging habitat of this species (Pierson *et al.*, 2002). The red bat is a proposed California Species of Special Concern.

Suitable habitat is present on the MMWD and museum records exist for specimens collected in San Rafael, 1 mile southeast of Inverness, and in Olema. The red bat is migratory and may occur in Marin primarily in spring and fall. During migration red bats may occur in groups. Acoustic monitoring over foraging habitat (riparian zones) would be the best method for detecting this species on the MMWD.

#### Hoary bat

The hoary bat is highly associated with forested habitats throughout California. This species roosts solitarily in foliage of both coniferous and deciduous trees, near the ends of branches, 3-12 m above the ground (Bolster, 1998). The hoary bat is highly migratory and may occur on the MMWD primarily in the spring and fall. This species is known to prefer moths but also eats beetles, flies, grasshoppers, wasps and dragonflies (Shump and Shump, 1982). There are no breeding records for this species in California (Pierson *et al.*, 2002). The hoary bat does not have special management status.

Acoustic monitoring over foraging habitat (forest canopy, forest clearings, and riparian zones) would be the best method for detecting this species on the MMWD (O'Farrell and Gannon, 1999). Suitable habitat is present and museum records exist for specimens collected in Nicasio, Pt. Reyes, and 1 mile southeast of Inverness.

#### Fringed myotis

The fringed myotis appears to be rare and uncommon throughout its range (Bradley and Ports, 1998) and is very sensitive to disturbance in the roost (D. Pierson pers. comm., 1998). This species is associated with forested habitats at higher elevations in California but is known to range down to the sea on the west coast (Barbour and Davis, 1969). The fringed myotis is a colonial species that roosts in caves, rock crevices, tree snags, tree stumps in clearings, and mines, buildings, and bridges. Forest management practices that would benefit this species include the retention of large numbers of tall snags in early to medium stages of decay (Weller and Zabel, 2001). Hibernation has only been documented in buildings and underground mines (Bradley and Ports, 1998). Foraging habitat includes stream channels (Weller and Zabel, 2001) and forest edges and insect prey includes beetles and moths. The fringed myotis is a proposed California Species of Special Concern and USFWS Species of Concern.

This species is expected to occur on the MMWD in suitable habitat. Museum specimens were collected from 1.3 mile southeast of Inverness, Olema, and Pt. Reyes. Acoustic monitoring and capture of foraging bats would be the best means of detecting the presence of this species. The Bon Tempe flowline tunnel is a potential roost for fringed myotis.

#### Yuma myotis

The Yuma myotis occurs in a variety of habitats throughout the State and is closely associated with foraging areas at water sources such as reservoirs, rivers, streams, and ponds. This species

typically forages over ponds and streams just a few inches above the surface of the water (Barbour and Davis, 1969). Roost sites include buildings, bridges, mines, and caves. Females give birth to one young from mid-spring to mid-summer in maternity colonies that may range in size up to several thousand. Maternity colonies are highly vulnerable in spring and summer. The Yuma myotis is relatively widespread and common in California but is a USFWS Species of Concern.

The colony in the Shafter Bridge is likely Yuma myotis based on the coloration of the bats and the proclivity of this species to roost in bridges over water. Museum specimens have been taken from 1.3 miles southeast of Inverness and Pt. Reyes.

### California myotis

The California myotis is a common and widespread species in California occurring in a wide variety of habitats. It typically roosts alone or in small groups (<25) in crevices in rocks, under bark, or in manmade structures (Simpson, 1993). Colonies may change composition and location frequently (Kruttsch, 1954). Females give birth to one young and roost singly in small groups. This species characteristically forages near vegetation often circling around trees (Kruttsch, 1954) preying on small insects such as flies, moths, and beetles. The California myotis does not have special management status.

### Little brown myotis

The little brown myotis occurs primarily at higher elevations in forested areas in northern California, often in proximity to water. This species seems to prefer foraging over water (Barbour and Davis, 1969) and will eat gnats, crane flies, wasps, and beetles. Little brown bats are known for occupying buildings, usually in hot attics, and can be found beneath bridges (Barbour and Davis, 1969). Little brown myotis form large maternity colonies and produce one young. In winter they may migrate to caves and mines to hibernate where the temperature remains above freezing and the humidity is high. The little brown myotis does not have special management status.

Suitable habitat is present on the MMWD and this species may occur in the area. The colony in the Shafter Bridge is likely Yuma myotis but little brown myotis is also a possibility and a mix of the two species within the same roost site is also possible. Acoustic monitoring of foraging bats near the bridge is the best means of determining which species is present. Little brown myotis emit echolocation calls with characteristic frequencies around 40 kHz and the Yuma myotis characteristic frequency is around 50 kHz (O'Farrell *et al.*, 1999). Distinguishing between these two species by capture and examination in the hand is difficult and subject to error, however information on sex and reproductive condition of the resident bats could determine if a maternity colony is present.

### Long-legged myotis

The long-legged myotis occurs primarily in coniferous forest habitat at higher elevations, usually 2,000 to 3,000 m (Warner and Czaplewski, 1984). Pierson *et al.* (2002) cite a MVZ record for

this species in Marin County although it was not available on the MVZ website and Barbour and Davis (1969) state that it “ranges down to sea level” on the coast. Long-legged myotis roost primarily in large snags but also in live trees, rock crevices (Ormsbee and McComb, 1998), and under bridges. This species feeds primarily on moths although it is known to consume a variety of other insects including flies, termites, lacewings, wasps, bugs, leafhoppers, and small beetles (Warner and Czaplewski, 1984). The long-legged myotis is a proposed California Species of Special Concern and a USFWS Species of Concern.

This species is expected to occur on the MMWD in suitable habitat. Acoustic monitoring and capture of foraging bats would be the best means of detecting the presence of long-legged myotis. The Bon Tempe flowline tunnel is a potential roost for this species.

#### Long-eared myotis

The long-eared myotis is highly associated with forested habitat at higher elevations although it is known to occur in coastal forests (Barbour and Davis, 1969). This species roosts in crevices and cavities in trees (Waldien *et al.*, 2000) and in caves, mines, cliffs, and rocky outcrops on the ground. They also sometimes roost in buildings and under bridges (Bogan *et al.*, 1998). Long-eared myotis forage among trees and over woodland ponds and streams and eat moths and small beetles, flies, lacewings, wasps and bugs (Bogan *et al.*, 1998). The long-eared myotis is a USFWS Species of Concern.

This species is expected to occur on the MMWD in suitable habitat. Acoustic monitoring and capture of foraging bats would be the best means of detecting the presence of long-eared myotis. The Bon Tempe flowline tunnel is a potential roost for this species.

#### Mexican free-tailed bat

The Mexican free-tailed bat is numerous and widespread throughout California occurring in a variety of habitats. Roost sites include crevices and cavities in buildings, bridges, caves, and cliff faces. Mexican free-tailed bats are one of the species most commonly found in manmade structures. This species is highly gregarious and often roosts in large numbers makes it especially vulnerable to human disturbance and habitat destruction. Foraging habitat is usually open air over water features, woodlands, and meadows. The Mexican free-tailed bat does not have special management status.