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Bat Inventory of the Descanso District of the Cleveland National Forest, San Diego County, California

Townsend's Big-eared Bat ***Corynorhinus townsendii*** (left)
and Western Red Bat ***Lasiurus blossevillii*** (right)

Final Report 2004
Prepared for:
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U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY
WESTERN ECOLOGICAL RESEARCH CENTER

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Abstract

The US Geological Survey conducted a bat species inventory of the Descanso District of the Cleveland National Forest in San Diego County, California. The study began in the early summer of 2002 and terminated in the fall of 2003. A variety of bat survey techniques including use of bat detectors, mist-nets, hand-nets, unaided ears, and spotlights were used to document both foraging and roosting bats within and immediately adjacent to the forest. We conducted a total of 28 surveys at 14 foraging bat sites and roost surveys of 5 potential bat roosting sites. A total of 14 bat species including three Forest Service Sensitive species were detected at various sites within the forest. Just over 7 bat species were detected on average per foraging bat site. 6 bat species were found during roost surveys. All 14 bat species detected during this study were detected using the Anabat II bat detector at foraging bat sites. Mist-netting at foraging bat sites resulted in captures of 97 bats representing 11 of the 14 detected bat species. Mist-netting and hand-netting at roost sites resulted in captures of 21 bats representing 4 bat species. Audible and visual observations of bats were made during various surveys for foraging and roosting bats to compliment netting and use of bat detectors. Distributions of Forest Service Sensitive species are mapped and recommendations for bat management and long-term monitoring strategies are presented.

Introduction

Bats are a diverse group of mammals representing approximately one-third of the mammals found in San Diego County. There are 23 species that have been documented in the county (Bond 1977, Constantine 1998, Miner and Stokes 2003). Bats make use of a wide variety of habitats and typically have large home ranges. As a group, they are good indicators of ecosystem health at a landscape level through their diverse life history needs (Ball 2002). Though they are diverse and fairly widespread, bats have always been difficult to study as a result of their life history and ecology. As a result, local land and resource managers have had very little information available to them from which to make management decisions regarding bats. Recent advances in technology such as ultrasonic bat detectors have allowed biologists to more efficiently and thoroughly survey for bats (Kunz et al. 1996b, Pierson 1998). Elucidation of basic information about bats is valuable to land and resource managers as they can consider bats in management activities and possibly have insight into the overall health of the ecosystem they manage (Ball 2002).

The management of non-game biological resources has become a high priority for land and resource managers during a time of significant habitat alteration in southern California. The United States Geological Survey (USGS) was contracted by the USFS to conduct a two year-long bat species inventory of the Descanso District of the Cleveland National Forest (DD-CNF). The goals of the study were to 1) document as many bat species as possible including Forest Service Sensitive (FSS) species occurring within the DD-CNF, 2) to map the distribution of FSS species, 3) to make recommendations for long term monitoring of bats, 4) identify roosts and other habitat features important to bat conservation and 5) to make recommendations on how to best manage for bats. Management recommendations would be based upon a combination of the data obtained through this study and available ecological information on bats in the literature. The four bat species considered to be sensitive by the USFS at this time are the California Leaf-nosed Bat (*Macrotus californicus*), the western Red Bat (*Lasiurus blossevillii*), the Townsend's Big-eared Bat (*Corynorhinus townsendii*), and the Pallid Bat (*Antrozous pallidus*).

Historical information regarding bats exists for the study area from bat research done by Phillip Henry Krutzsch in the 1930's and 40's (Krutzsch 1948). This thesis provides information obtained by Krutzsch, as well as other naturalists working in the County before him. His thesis states that nine species were found within the DD-CNF area. A 1996 USFS radio telemetry bat study (Miner and Brown 1996) resulted in the detection of an additional six bat species. Cumulatively, 15 bat species have been detected within or adjacent to the DD-CNF area prior to this 2002-2003 USGS bat species inventory effort, including two FSS species, the Pallid Bat and Townsend's Big-eared Bat (Table 1).

Study Area

The Descanso District of the Cleveland National Forest is located in the southern portion of San Diego County (outlined in yellow - see Figure 1). The topographic regions encompassed by the study area are primarily foothills and mountains. Vegetation communities found within the study area include primarily chaparral, a fair amount of oak and coniferous woodland, and a limited amount of grassland and coastal sage scrub. There are several rivers with portions of their watersheds found within the study area including the San Diego River, the Sweetwater River, and the Tijuana River. There are numerous artificial drinking sources in the form of cattle ponds and troughs. There is an extensive amount of exposed rock and a fair number of abandoned mines found in the study area. Our work focused on the Sweetwater and Tijuana River systems due to the habitats represented and their accessibility. We targeted reaches and tributaries of these rivers, as well as various cattle troughs and cattle ponds to survey for foraging bats. Various man-made structures and other potential roost sites were surveyed for roosting bats.

Methods

Multiple bat survey techniques are needed to thoroughly document a diversity of bat species during an inventory study (Pierson 1993). For this study, acoustic, visual, hand-net, and mist-net capture techniques were used to observe and detect bats. These techniques were used in concert during two types of surveys: 1) foraging bat surveys and 2) roosting bat surveys. Survey locations are listed in Table 2 and mapped in Figure 1.

Foraging Bat Surveys

When surveying for foraging bats, an Anabat II bat detector (Titley Electronics, New South Wales, Australia) was utilized to detect and record bat echolocation signals. The Anabat II bat detector is a directional ultra-sonic microphone that, when connected to a laptop computer, allows for real-time monitoring and recording of bat vocalizations. Bat vocalizations can be identified to the species level during real-time monitoring. Usually, bat vocalizations are reviewed in the laboratory after field data collection and species identifications are made at that time. Although it is directional, the Anabat II has a cone of reception that varies in size and sensitivity based on several factors including specifications of each individual Anabat II and environmental conditions during use in the field (O'Farrell et al. 1999).

At foraging bat survey sites the Anabat II was placed on a small table approximately 0.5 meters tall and was propped up at a 45 degree angle to maximize sound reception. The Anabat II was oriented such that it was facing towards areas where bats were expected to be foraging such that the probability of detecting and recording bat vocalizations was maximized. The Anabat was used at foraging sites for a period of three hours beginning approximately at sunset. Recorded bat vocalizations were then analyzed and identified to the species level. For each survey site a bat species list was created from analysis of the recorded bat vocalizations. Not every bat vocalization was identified to the species level; only the best representative vocalizations recorded during a night were used. Also, general bat activity was measured and quantified as the number of files recorded with the Anabat during the three hour monitoring period. Anabat files typically contain only a single bat vocalization sequence, but sometimes there are multiple vocalization sequences within a single file. Unfortunately, trying to quantify the true number of bat vocalization sequences contained within the recorded files would be overly time consuming and would have resulted in unreasonable direct labor costs for this project. The total Anabat recording effort for this study was 84 hours (3 hours x 28 survey nights – see Table 3). Identification of bat calls using the Anabat II bat detector was a subjective process that required a fair amount of experience and/or access to a reference library of 'known' bat calls for comparative purposes. During this study, bat call identification was carried out by the primary field investigator, Drew Stokes, who had over seven years of bat call identification experience at the time of analysis and access to a reference library of 'known' bat calls that was developed during USGS bat research in 2002 and 2003.

The unaided ear was also used to detect audible bat echolocation and social vocalizations, which were also identifiable to the species level in most cases. This technique was used primarily to detect western mastiff bats (*Eumops perotis*) and secondarily to detect pallid bats. There was no quantification of audible bat passes, if an audible bat species was heard it was documented as present at the survey site. Visual techniques (i.e. a spotlight, unaided eyes) were often used simultaneously with acoustic techniques to observe foraging bats, which typically aided in species identification.

Mist-netting was conducted simultaneously with acoustic techniques during all foraging bat surveys. Mist-nets are made of fine nylon mesh and are used to capture bats in flight. Mist-nets were usually placed in areas where they are likely to intercept flying bats, such as over relatively small bodies of water and in vegetation flyways (Kunz et al. 1996a). We used from one to five mist-nets of various dimensions at foraging sites to capture bats. The dimensions of the mist-nets we used were 2.6 meters tall by 2.6 meters, 6 meters, 9 meters, 12 meters, and 18 meters long. Mist-nets were used for a period of three hours beginning approximately at sunset. The total mist-netting effort for this study was 279 mist-net hours (3 mist-net hours x 93 mist-nets used) and the average mist-net effort was 9.96 mist-net hours per survey night (279 mist-net hours/28 survey nights). Captured bats were processed and then released immediately. The information recorded during processing included the species, age, tooth wear (estimate of age), sex, reproductive status, parasite load, general measurements, and anything else noteworthy. In most cases, a digital camera was used to document the captured bat. In most cases, the bat was also recorded with the Anabat II bat detector as it was released. The recorded vocalization was then placed into a reference library of 'known' bat vocalization call sequences.

General Surveys

General foraging bat surveys were conducted with the intent to document as many species as possible in one survey night. Eleven sites were surveyed in this manner (Table 3). Foraging bat survey sites were chosen based on the presence of a mosaic of habitat features that foraging bats are associated with in a southern Californian landscape. These habitat features include open surface water (creeks, rivers, ponds, cattle troughs), woodland (willows, cottonwoods, sycamores, oaks, conifers), scrub vegetation (chaparral, coastal sage scrub), and grassland (D. Stokes pers. obs.). Due to the amount of equipment used to conduct foraging bat surveys access was limited to survey sites located within approximately one kilometer of roads accessible by a vehicle.

Single Species Focused Surveys

There were several foraging bat sites surveyed with the intent to document a single species, the pallid bat (a Forest Service Sensitive species). A few of these sites were not actually located within the DD-CNF boundaries but instead were located on land immediately adjacent to the DD-CNF. The pallid bat was expected to occur at these sites based on historical records (Krutzsch 1948). By surveying sites adjacent to the DD-CNF it was hoped we could document the pallid bat in the area. The sites surveyed outside of the DD-CNF were 1) Highway 79 Pond, 2) Japatul Pond, and 3) Hulburd Grove (Table 3 and Figure 1).

Multi-Visit Survey Sites

One foraging bat site, the Laguna Ranch, was surveyed nine times at regular intervals across seasons over the two year survey periods. Two other foraging bat sites, the Cibbets Flat Campground and Upper Pine Creek, were surveyed once each in 2002 and on three visits each in 2003. The goals of the repeat surveys were to observe how bat richness might change over seasons and to document rare species such as the long-legged myotis (*Myotis volans*) that might be missed during a single survey visit.

Roost Surveys

Some bat species are more easily detected at roost sites than foraging sites (i.e. American leaf-nosed bats belonging to family *Phyllostomatidae*) so this technique was used to supplement foraging bat surveys (D. Stokes, pers. obs.). Also, locating, characterizing, and monitoring roosts are all extremely important to efforts to conserve and manage for bats in a given landscape (Ball 2002, Pierson 1998). Roost surveys must be conducted cautiously as many bat species are very sensitive to disturbance at roost sites (Kunz et al. 1996b). Habitats targeted for roost surveys included rocky cliffs and outcrops, buildings, bridges, and mines. Types of roost surveys conducted included 1) diurnal internal inspections of roosts used during the day and/or night by bats, 2) nocturnal internal inspections of roosts used at night by bats, and 3) external surveys of roosts inaccessible to people where bats were observed as they exited or entered roosts used during the day or night. Techniques used to survey for roosting bats included 1) visual observations of roosting bats using unaided eyes and eyes assisted by flashlights during internal and external roost surveys, 2) unaided ears to listen for audible species at roosts during external surveys, 3) use of the Anabat II to record bat vocalizations at roosts during external surveys, 4) use of mist-nets to capture bats at roosts during external surveys, and 5) use of hand-nets to capture bats at roosts during internal surveys. Roost surveys were conducted at five suspected roosting sites within the DD-CNF (Table 4): 1) Lyons Peak (external survey of suspected western mastiff bat roost site using Anabat II and unaided ears and eyes, 2) Old Highway 80 bridge (internal nocturnal inspection of suspected night roost using eyes aided by flashlight and hand-net), 3) Lucky Chuck Mine (external survey of suspected day/night roost using Anabat II, unaided ears, eyes aided by flashlight, and mist-nets), 4) Boiling Springs Pumphouse in Agua Dulce Canyon (internal nocturnal inspection of known night roost using eyes aided by flashlight and hand-net) and, 5) Guatay Cabin (internal diurnal inspection of suspected day/night roost using eyes aided by flashlight).

Results and Discussion

Summary

The USGS was able to detect a total of 14 bat species within and immediately adjacent to the Descanso District of the Cleveland National Forest (DD-CNF). Three of the 14 species were considered Forest Service Sensitive (FSS) at the time of the study. The three FSS species detected within and/or immediately adjacent to the DD-CNF boundaries during the USGS 2002-2003 study were; 1) the western red bat, 2) the Townsend's big-eared bat, and 3) the pallid bat. A fourth FSS species, the California leaf-nosed bat, was detected on land less than 10 kilometers from the DD-CNF boundary during a USGS bat inventory of the San Diego County Multiple Species Conservation Program area that was conducted simultaneous to this study (USGS unpublished data).

The bat species detected at the greatest number of sites during this study were the small-footed myotis (*Myotis ciliolabrum*), the western pipistrelle (*Pipistrellus hesperus*), the big brown bat (*Eptesicus fuscus*), and the western mastiff bat. They were detected at 100% of foraging bat sites. Other bat species detected at a large number of foraging bat sites include the California myotis (*Myotis californicus*) detected at 79% of sites, the pocketed free-tailed bat (*Nyctinomops femorosaccus*) detected at 71% of sites, the long-eared myotis (*Myotis evotis*) detected at 64% of sites, and the Mexican free-tailed bat (*Tadarida brasiliensis*) and the Yuma myotis (*Myotis yumanensis*) detected at 57% of sites. Bat species detected only at a small percentage of sites included the Townsend's big-eared bat detected at 36% of sites, the hoary bat (*Lasiurus cinereus*) and western red bat detected at 21% of sites, the fringed myotis (*Myotis thysanodes*) detected at 14% of sites, and the pallid bat detected at 7% of sites. A summary of bat species detections by site and date is found in Appendix 1.

The results of bat surveys are presented in the following sections: 1) foraging bat surveys, 2) roosting bat surveys, 3) demographics, reproduction, and injuries of captured bats, 4) seasonal bat activity patterns, and 5) single survey visits v. multiple survey visits.

Foraging Bat Surveys

Foraging bat surveys resulted in the detection of all 14 bat species detected during this study.

Anabat

In 84 Anabat hours a total of 4073 files were recorded that contained at least one bat vocalization sequence (Table 3). The average number of Anabat files recorded per night was 145.46 (4073 files/28 survey nights) and the average number of Anabat files recorded per Anabat hour was 48.49. All 14 bat species detected during this study were detected with the Anabat. There were three bat species recorded with the Anabat in this

study that were not captured: the Mexican free-tailed bat, pocketed free-tailed bat, and western mastiff bat. Representative sonograms of all bat species recorded with the Anabat in this study can be viewed in appendixes IIa-n. The sonograms shown are screenshots taken from the bat vocalization analysis program Analook 4.8p. The average number of bat species detected per survey night with the Anabat was 6.5, which is considerably greater than the average number of species detected per survey night using mist-nets (1.6 species/survey night). The success of the Anabat in detecting bat species compared to mist-netting has been reported in other studies (O'Farrell and Gannon 1999, Remington 2000, 2003).

Audible

The use of the unaided ear as an audible survey technique was used at all foraging sites in conjunction with mist-netting and the Anabat. Only one bat species, the western mastiff bat, was readily detectable with the unaided ear. Western mastiff bats were heard on 18 of 28 foraging bat survey nights at 12 of the 14 foraging bat survey sites. During the seasonal foraging bat surveys conducted at the Laguna Ranch, the western mastiff bat was detected during all six of the summer/early fall surveys of 2002 and 2003. It was not detected during any of the three winter/early spring surveys of 2003-2003. However, this species has been detected virtually year-round elsewhere in San Diego County (Krutzsch 1948, D. Stokes unpublished data).

Visual

Visual techniques (use of unaided eyes and a spotlight) were used at all foraging sites in conjunction with mist-netting, the Anabat, and audible techniques to document foraging bats. Visual techniques were used simply to observe bats as they were detected acoustically. Occasionally, bats that are recognizable in flight (i.e. western red bats, hoary bats, big brown bats) were observed simultaneous with Anabat recordings. When this occurred, the recorded bat vocalizations attributed to the visually observed bats were copied into a reference library containing 'known' bat vocalization sequences.

Mist-netting

At foraging sites, the mist-netting portion of this study resulted in captures of 97 bats representing 11 species (Table 3). Representative digital images of the 11 bat species captured in this study can be viewed in figures 2-13. The average capture rate per night was 0.4 bats/mist-net hour (97 bats/279 mist-net hours). While this rate appears low compared to local mist-netting efforts for birds, an average of 0.6 birds/mist-net hour (B. Kus pers. comm.), it is greater than the capture success rate for another recent southern Californian bat study conducted in Orange County, California, which averaged only 0.02 bats/mist-net hour (Remington 2003). As no bats were marked, recapture rates were not known. An average of 1.6 bat species were detected per night based only on mist-net captures.

Species-Rich Foraging Sites

Bat foraging sites surveyed within the DD-CNF where at least nine bat species were detected include Boulder Oaks campground, Laguna Ranch, Upper Pine Creek, and Water of the Woods. These sites are characterized by the presence of a mosaic of habitat types including open surface water on-site or very nearby, one or more woodland types (oaks, conifers, or riparian trees), chaparral vegetation, and grassland. It is suspected that, in southern California, the habitat types most supportive of a rich foraging bat community are: 1) open surface water and 2) woodland/scrub or grassland edge interface (D. Stokes, pers. obs). However, an important variable potentially influencing the number of bat species detected at any given foraging site is the juxtaposition of the site relative to appropriate roosting habitat(s). Although this variable was not measured during this study, the four sites listed above are within known commute distances of appropriate roosting habitats of a variety of bat species (Miner and Brown 1996, Pierson 1998, Fellers and Pierson 2002).

Bat Activity at Foraging Sites

Bat activity across all species measured by the Anabat (number of files recorded per survey night) varied from night to night and site to site (Table 3). It also varied from season to season at the only site surveyed across seasons, the Laguna Ranch. Bat activity was highest (>250 files per night) at a number of sites; 1) Highway 79 Pond, 2) Filaree Flat, 3) Laguna Ranch and 4) Water of the Woods.

Roosting Bat Surveys

Roosting bat surveys conducted on single visits to five different suspected or known roost sites resulted in the detection of six bat species (Table 4). The surveyed roosts were identified as to how they were thought to be used by bats at the time of the surveys. They were identified as roosts that were occupied by bats during the day (day roosts), roosts occupied during the night (night roosts), or both.

Documented Bat Roosts

Several bat roosts were located during this study (Table 4). One roost documented during this study was a bridge on Old Highway 80. Approximately 25 big brown bats were observed on June 20, 2002 night roosting under this bridge. One individual was captured using a hand-net, a pregnant female. It was not known if this structure was also used as a day roost. Another night roost surveyed during this study (and the previous 1996 USFS bat study) was the Boiling Springs Pumphouse in Agua Dulce Canyon. On August 22, 2002 a visit to this night roost revealed the presence of two bat species: a non-reproductive female Townsend's big-eared bat and a non-reproductive male small-footed myotis. Several species were previously observed using this structure as a night roost during the 1996 USFS bat study including the rare long-legged myotis. This species was not detected during any of the 2002-2003 USGS surveys. The Lucky Chuck mine was surveyed on July 18, 2002 for roosting bats. One Townsend's big-eared bat was

observed flying within the horizontal tunnel (adit) portion of the mine, one big brown bat was detected acoustically outside the vertical shaft portion of the mine, and 17 small-footed myotis and two long-eared myotis (including lactating and post-lactating individuals of both species) were captured in a mist-net placed in front of the horizontal tunnel portion of the mine. Most of the bats captured in the mist-net were captured early in the evening as they attempted to enter the mine entrance rather than while exiting the mine. The horizontal tunnel portion of the mine had a flow of open surface water. At the time of the survey, San Diego County was experiencing a significant drought and the surrounding area was very dry. This open surface water within the mine was likely serving as a valuable drinking source for bats. An acoustic survey of a suspected western mastiff bat roosting area, Lyons Peak in Jamul, was conducted on May 15, 2002. Lyons Peak is characterized by steep exposed rock outcrops, the favored roosting substrate of the western mastiff bat (Barbour and Davis 1969, Pierson and Rainey 1998). Western mastiff bats have been heard (audible echolocation call) in the vicinity of Lyons Peak on several occasions during past bat surveys in the Jamul area. However, the survey conducted on May 15, 2002 did not result in the detection of multiple western mastiff bats early in the evening as would be expected if a roost did occur there. One western mastiff bat was heard late in the evening coming from east of Lyons peak and one western pipistrelle was visually observed and recorded with the Anabat near sunset as it emerged from a rocky area on the hillside. Western pipistrelles often roost in areas of exposed rock but usually are solitary and are suspected to have low roost site fidelity (Barbour and Davis 1969). Finally, one of the cabins permitted by USFS in the Guatay area was visited during the day on July 3, 2003. A single Townsend's big-eared bat was observed day roosting in the garage portion of this cabin. The cabin owner mentioned that there were often several bats that used the garage as a day roost and even a greater number of bats that used various areas of the cabin as a night roost.

Suspected Bat Roosts

There are many areas within the Descanso District of the Cleveland National Forest that could potentially support roosting bats. There are several areas where bat roosts likely occur based on data collected during this study, the previous USFS 1996 study, and other bat surveys conducted near the DD-CNF. Multiple western mastiff bats were heard at the Boulder Oaks campground coming from the La Posta Creek area located to the northeast of the campground suggesting that a colony exists in the area. Another area where multiple western mastiff bats have been heard early in the evening is near Loveland Reservoir. It is suspected that there is a colony of this species located either just below or just above the Loveland Reservoir. The hills known as 'Middle Mountain' and 'Bell Bluff' are likely candidate areas because of their south-facing steep granitic rocky outcrops. There are also a number of hills in the same area that are characterized by exposed granitic outcrops that could be supporting a western mastiff bat colony. Morena Butte, near Hauser Canyon, is another area characterized by steep, exposed granitic outcrops and multiple western mastiff bats have been heard near this area early in the evening. It is possible the bats detected are actually roosting nearer the southern arm of Barrett Reservoir, an area that has supported roosting western mastiff bats for many years (Krutzsch 1948, K. Miner pers. comm.). Another area of the DD-CNF that has

previously supported roosting bats and likely still does is Noble Canyon. There are a number of mines in Noble Canyon, several of which were known to support Townsend's big-eared bats, including a known maternity site in recent history (K. Miner pers. comm.). Mines are commonly used by bats as roost sites, particularly by obligate cave roosting species such as the Townsend's big-eared bat and California leaf-nosed bat. There is the potential that any mine within the DD-CNF supports roosting bats at some time of the year or another. It is likely that mines in the vicinity of open water and foraging habitat, such as riparian trees and oak and/or conifer woodland, are preferred roosting sites over those away from feeding and drinking sources. However, mines that are regularly visited and entered by humans may be avoided by bats regardless of the mines characteristics (Pierson 1998).

Demographics, reproduction, and injuries of captured bats

A total of 118 bats representing 11 species were captured in mist-nets and/or hand-nets at foraging and roosting sites during this study (Table 5). Of the 118 individual bats captured, 91% were adults and 9% were juveniles. 71% were females and 29% were males. 60% of the female bats were found in breeding condition (pregnant, lactating, or post-lactating). 15% of male bats were found in breeding condition (testes descended). There were nine bat species that showed indications of breeding (either males or females): the pallid bat, Townsend's big-eared bat, big brown bat, hoary bat, California myotis, small-footed myotis, long-eared myotis, Yuma myotis, and western pipistrelle. Recruitment of juveniles was observed for four bat species: the big brown bat, California myotis, long-eared myotis, and Yuma myotis. No bats showed signs of any serious injuries; however, the single pallid bat captured near Hulburd Grove on August 28, 2003 was very emaciated, had many holes in both its wing and ear membranes, and had an unusually heavy ectoparasite load. Pallid bats are often found with a few holes in their membranes and a relatively large number of ectoparasites, likely as a result of their near-ground and on-the-ground foraging strategy (D. Stokes pers. obs., Orr 1954). The most unusual observation we made was a big brown bat captured at Upper Pine Creek on October 8, 2003. It had very light colored fur and membranes relative to other observed individuals of this species in San Diego County (Figure 9).

Seasonal Patterns of Bat Richness and Activity

One survey site, the Laguna Ranch, was surveyed nine times at fairly regular intervals over the two year study: three visits during summer/early fall of 2002, three visits during winter/early spring 2002-2003, and three visits during summer/early fall 2003. Bat species richness was relatively high during the three summer/fall 2002 surveys (mean = 9, sd = 1). Richness was lower during the three winter/spring surveys 2002-2003 (mean = 2.7, sd = 1.2). Richness was relatively high again during the three summer/early fall surveys 2003 (mean = 7.3, sd = 2.1). It should be noted that the second summer/early fall 2003 survey (5 detected bat species) was conducted on an evening following a day of cool temperatures and precipitation, which may have negatively affected bat richness and activity. Detected bat species richness was greater during the summer/fall 2002 visits as compared to the winter/spring visits 2002-2003. Richness was also greater during

summer/fall 2003 compared to winter/spring 2002-2003. A species accumulation curve showed that most of the species were detected during the first two survey visits with one more species added during one of the winter/spring period survey visits (Figure 14). The newly detected species, the hoary bat, is migratory and appears to be most detectable in San Diego County during the fall, winter, and spring (Krutzsch 1948, D. Stokes unpublished data, USGS unpublished data). This indicates the importance of year-round surveys to thoroughly document all or the majority of potentially occurring species at a particular location. The California myotis was detected during every survey visit to this site regardless of time of year. The pocketed free-tailed bat was detected on all but one survey visit to this site. During one of the winter surveys (January 22, 2003), the measured ambient temperature was below freezing (-0.2 ^{o} C) and both the California myotis and pocketed free-tailed bat remained active. These bat species appear to be tolerant of fairly extreme winter temperatures and remain active virtually year-round within the DD-CNF and other parts of San Diego County (USGS unpublished data).

At the Laguna Ranch, measured bat activity was consistently high during the three summer/early fall surveys of 2002 (mean = 279.3 files/night, sd = 26.4). Activity was much lower at this site during the three winter/early spring surveys of 2002-2003 (mean = 26.3 files/night, sd = 24.4). Bat activity increased again during the summer/early fall surveys of 2003 (mean = 94.7 files/night, sd = 48.0) but was much not nearly as high compared to the summer 2002 surveys. The summer/fall 2002 activity was greater than the winter 2002-2003 activity ($p < 0.001$). The summer/fall 2002 activity was also greater than the summer/fall 2003 activity ($p = 0.009$). In general, it would be expected that bat activity would be greater during the summer than the winter at any particular site. It is suspected that the high bat activity measured in the summer/early fall of 2002 compared to summer/early fall 2003 is a result of the extreme drought of 2002 that resulted in a concentration of bat activity at sites such as the Laguna Ranch, where open surface water was still present though surrounding areas were dry.

Single Survey Visits vs. Multiple Survey Visits

Two survey sites, the Cibbets Flat Campground and Upper Pine Creek were both surveyed on a single visit during the summer of 2002 followed by three survey visits during the summer of 2003 (Figures 15 and 16). The single summer 2002 survey visit resulted in the greatest number of bat species detections at both sites on one night (8 and 11 species respectively). The cumulative total of bat species detected at the Cibbets Flat Campground over the three summer 2003 survey visits was slightly greater than the single summer 2002 survey visit (9 species vs. 8 species). At Upper Pine Creek, the cumulative total of detected bat species over the three summer 2003 survey visits was slightly less than the single summer 2002 survey visit (10 species vs. 11 species). At both of these survey sites the single summer 2002 survey visit accounted for at least 89% of the cumulative total number of bat species detected during multiple summer 2003 survey visits. These observed patterns could be a result of the 2002 drought. Both of these survey sites had open water on-site during the 2002 survey visits while most of the surrounding areas were dry. This may have resulted in a concentration of bats at these sites. During each of the summer 2003 survey visits at both sites the number of bat

species detected during any single survey was usually less than the cumulative total of bat species detected over the multiple survey visits. However, a large percentage of the cumulative total number of bat species was detected during most of the single summer survey visit at these sites. This suggests that single survey visits to sites with open surface water during the summer may be fairly effective for detecting the majority of bat species that are occurring in any given area within the forest, especially during drought years.

Conclusions and Management Recommendations

General

The increased number of bat species detections during the USFS 1996 study and this study compared to historical observations is most likely a result of modern survey techniques (i.e. Anabat and mist-nets) that are more effective at detecting bats than the techniques used historically (i.e. visual observations, shotguns, hand-nets). It is unlikely that species not detected historically have expanded their range into the Descanso District of the Cleveland National Forest in the past 60 years or so. One exception may be the pocketed free-tailed bat. This species was found historically in San Diego County based on only two records (Krutzsch 1948). However, this species now appears to be relatively widely distributed in San Diego County based on the work of various researchers (Constantine 1998, Miner and Stokes 2003, USGS unpublished data). This could be an artifact of recent advances in acoustic survey techniques (i.e. bat detectors) and increased availability of bats to researchers via public health agencies but could also be a result of other factors including climate change (Constantine 1998). One species detected during the USFS 1996 study that was not detected during this study was the long-legged myotis. The one species detected during this study that was not detected during the USFS 1996 study was the pallid bat. There were no surveys focused on locating this species during the USFS 1996 study. One pallid bat was captured during this study on a survey (8/28/03 near Hulburd Grove) that targeted this species.

Distribution of Non-Forest Sensitive Species

There is a portion of species within the bat community that appear to have fairly widespread distributions within the forest. These species include the big brown bat, California myotis, small-footed myotis, pocketed free-tailed bat, western pipistrelle, western mastiff bat, long-eared myotis, Mexican free-tailed bat, and the Yuma myotis. However, a few of these species, the bats belonging to the free-tailed bat family *Molossidae*, potentially have large foraging ranges and are easily detected so may be overrepresented and appear more widespread relative to other species (Miner and Stokes 2003).

The other detected non-forest service sensitive bat species had more limited distributions within the forest based on this study. These species included the hoary bat and fringed myotis. Hoary bats are migratory and are most commonly found in southern California during the fall, winter, and spring. Some individuals spend their summers in the high elevations of southern California, but the majority of individuals are suspected to migrate to northern latitudes during the summer (Cryan 2003, Krutzsch 1948, Vaughan and Krutzsch 1954). We observed hoary bats in the spring, summer, and fall during this study. The fringed myotis appears to be fairly rare in San Diego County (Miner and Stokes 2003). All records for this species in San Diego County are from the mountains

except for a single record from the Dulzura area (Krutzsch 1948, Miner and Stokes 2003). Historically, this species was found by Krutzsch (1948) to have a similar distribution to that of the long-eared myotis. In our study, however, the long-eared myotis was found at nine sites while the fringed myotis was found at only two sites. It could be this species is more difficult to detect using current survey techniques. However, it is also possible that this species is declining in the local mountains. One factor influencing the apparent changing distribution of this species could be climate change.

There were no confirmed observations of the long-legged myotis during this study. One individual was found night roosting in the Boiling Springs Pumphouse during the USFS 1996 study. Observations of this species in San Diego County are rare (Miner and Stokes 2003). Also, this species is difficult to confirm with the Anabat alone because its vocalization resembles that of a more commonly observed bat species, the small-footed myotis. Other species that may occur within the DD-CNF that are rare or difficult to detect include the spotted bat (*Euderma maculatum*), the silver-haired bat (*Lasionycteris noctivagans*), and the big free-tailed bat (*Nyctinomops macrotis*).

Forest Service Sensitive Species

At the time of this study, four bat species were known to inhabit San Diego County that were considered Forest Service Sensitive; the western red bat, Townsend's big-eared bat, pallid bat, and the California leaf-nosed bat. The first three species listed above were detected in or immediately adjacent to the DD-CNF during this study. Detailed discussions of FSS species follow:

Western red bat (*Lasiurus blossevillii*)

The western red bat is a solitary obligate foliage-roosting species that roosts by hanging from the limbs of native broadleaf deciduous trees (Bolster 1998). This species is also known to roost in non-native trees and large shrubs such as those associated with orchards and landscaped gardens. It typically feeds along woodland edges. In San Diego County, this species is usually observed foraging in riparian areas (D. Stokes, pers. obs.). It is present year-round in San Diego County and has been detected every month of the year during foraging bat surveys (USGS unpublished data). During this study, the western red bat was detected on five different foraging bat surveys at three sites: Agua Dulce Canyon, Hauser Canyon, and Upper Pine Creek (Figure 5). All three sites were characterized as riparian systems where potential roost trees and foraging habitat were found. Due to its apparent strong association with riparian habitats, this species would likely be best managed by preserving and maintaining healthy riparian systems where large riparian trees occur. This species was never caught at artificial drinking sources (i.e. metal or concrete cattle troughs) in this study. It is suspected that this species may not be able to maneuver well enough to utilize small artificial troughs as drinking sources. Therefore, it is likely dependent on larger sources of open water for drinking such as river and creek reaches and large artificial ponds (i.e. Upper Pine Creek, Water of the Woods). There is evidence to suggest that foliage-roosting bats and other bat species

bury themselves in leaf-litter during exceptionally cold winter periods (Moorman et al. 1999, Saugey et al. 1998). Thus, the western red bat could be vulnerable to mortality during winter prescribed burns where leaf-litter is affected by the burn.

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

The Townsend's big-eared bat is an obligate cave-roosting species whose distribution is strongly associated with the presence of natural caves and/or artificial cave-like structures such as mines (Sherwin 1998). It is colonial and usually occurs in San Diego County in relatively small groups of up to approximately 50 individuals (D. Stokes pers. obs.). It is the most common and characteristic bat found in abandoned mines in San Diego County and appear to be located wherever there are historic mining districts, including in the Descanso District of the Cleveland National Forest. While the use of mines by this species has been widely documented, only recently has there been detailed research on the dynamics and variability of roosting behavior of this species in mines. It has become apparent that the use of specific mines by this species is highly unpredictable and may vary from season to season and year to year (Sherwin et al. 2000). It has also been documented that the Townsend's big-eared bat is vulnerable to and intolerant of human disturbance at roost sites (Sherwin 1998). The Townsend's big-eared bat is considered to be a moth specialist. It feeds by foraging close to vegetation and possibly gleans some insects directly from the branches of shrubs and trees. It is known to forage in a variety of habitats, but in California prefers oak woodland, ironwood forests, and riparian woodland while avoiding grazed grasslands. It has been documented making one-way commute distances of 5-13 km on foraging ventures (Brown et al. 1994, Fellers and Pierson 2002).

During this study, the Townsend's big-eared bat was detected during foraging bat surveys conducted at two sites: Boulder Oaks Campground and Laguna Ranch. It was also observed day and/or night roosting at three locations: the Lucky Chuck Mine, the Boiling Springs Pumphouse, and a cabin in Guatay (Figure 6).

Foraging Townsend's big-eared bats were caught over a concrete cattle trough at the Laguna Ranch during this study and were captured at several artificial water troughs during the USFS 1996 study. This species appears able to maneuver well enough to obtain drinking water from artificially created troughs and tanks. Preservation of these troughs would undoubtedly benefit this species and other species such as Myotis species that are able to maneuver well enough to drink from these structures. These troughs likely become more important as sources of drinking water during drought years such as 2002, when most natural open water sources were dry. Some specific troughs that serve as drinking sites for bats include those at the Laguna Ranch, one located just southeast of Water of the Woods, one located at the north end of Laguna Meadow, several located near Old Miners Road, one in Indian Springs, and at Penny Pines located near Filaree Flat. These were troughs identified during bat research studies. There may be more troughs that could be used as bat drinking sources that we are unaware of.

Ensuring the protection/preservation of the Townsend's big-eared bat populations that occur in the DD-CNF would require a dedicated management strategy focusing primarily on the protection of both potential summer and winter roost sites. Any mine could be used by this species as a roost site. However, it is suspected that mines located near open surface water and appropriate foraging habitats (oak and riparian woodland) would more likely support maternity colonies, which would be present during the late spring and summer. The winter roosting requirements for this species are different than their summer requirements. They prefer caves and mines with stable cool, humid environments to meet their winter roosting requirements (Pierson and Rainey 1994). There is not enough information currently available to be able to identify all of the specific mines that should be considered for protection, but there are specific areas where mines occur that would warrant further investigation and/or immediate protection measures. Some of these areas include Noble Canyon, the mines off of Old Miners Road (Deer Park Road), and the mines in Hauser Canyon. As the population of San Diego County continues to increase, the chance of humans visiting mines and disturbing bat populations becomes greater. It is fairly expensive and labor intensive to adequately protect mines (i.e.install 'bat-friendly' gates, remove mines from recreation maps, block roads and trails leading to mines). Therefore, it is highly recommended that a study is conducted that focuses on the long-term use of mines by the Townsend's big-eared bat within the Cleveland National Forest so that the right mines and/or mining areas can be protected.

Based on this study it is clear various types of buildings are also being used as roosts. The Boiling Springs Pumphouse is one example of a building that has been used as a night roost by this and a variety of other species dating back to the USFS 1996 study and is still being used based on our recent observations. It is located within foraging habitat (riparian, oak, and conifer woodland) and is found not too far from open water sources such as Water of the Woods and the Laguna Ranch Cattle troughs. The preservation of this structure as a night roost is recommended. If it can be preserved it would likely continue to serve as a favored night roost for Townsend's big-eared bats and other species. At least one of the cabins on land in Guatay permitted by USFS is serving as both a day roost and potentially a night roost for the Townsend's big-eared bat. It is possible that more of these cabins are also being used as roost sites. There is potential for conflict between the humans and bats that occupy the cabins. The USFS should consider a management strategy that either allows the bats to continue to roost in the cabins or ensures that the bats are excluded from these structures in a humane way if necessary (see section below on bat roosts in man-made structures).

Pallid bat (*Antrozous pallidus*)

The pallid bat is considered a multiple habitat-roosting species. It is found in a variety of crevice and/or cavity-type situations such as rock crevices, caves, tree hollows, mines, buildings, and bridges (Sherwin 1998). This species has even been found roosting in crevices and cracks at ground level (P. Brown pers. comm.). Colonies of this species are often found roosting in rural man-made structures such as barns and other unused buildings. In San Diego County roosts of this species are known to support up to

approximately 80 individuals (D. Stokes pers. obs.). The pallid bat is unique among North American bat species in that it forages on terrestrial arthropods that it tackles on the ground (Orr 1954). It feeds on flying insects as well but is thought to feed fairly extensively on ground dwelling invertebrates and even small vertebrates such as lizards and rodents. One of its preferred prey items in San Diego County is the Jerusalem cricket (*Stenopelmatus* spp.). The culled legs and other parts of Jerusalem crickets are often found beneath pallid bat night roosting areas in the county (D. Stokes pers. obs.). In western San Diego County, the pallid bat is usually found foraging in oak savannah-type habitats, grassy oak-lined river terraces, native grasslands, and sparsely vegetated scrublands (Krutzsch 1948, D. Stokes pers. obs.).

The pallid bat was detected on only one foraging bat survey at a single site near Hulburd Grove along the Sweetwater River (Figure 7). Pallid bats were found historically in this same area by Krutzsch (1948). However, there have been no pallid bat detections any where else near the DD-CNF with the exception of the Palo Verde area of Alpine. At this location an incidental observation was made during summer 2002 of guano and culled insect parts (including Jerusalem cricket parts) belonging to one or a few pallid bats. Based on the presence of appropriate foraging habitat, this species possibly also occurs on or very near the DD-CNF in the vicinity of Viejas Indian Reservation, Lake Morena, and Japatul.

The pallid bat appears to have suffered a significant population decline in San Diego County (P. Brown pers. comm., Miner and Stokes 2003, USGS unpublished data). In southern California, the pallid bat is vulnerable to extirpation at roost sites that are in man-made structures. Colonies will readily roost in man-made structures and because these bats are large in size, found in relatively large numbers, and a foul odor is often associated with their droppings, they are usually fairly obvious to people that may occupy these structures. Many people view bats as pests and when a bat colony is found in a structure frequented by people the bats are often eradicated (D. Stokes pers. obs.). There is the potential that pallid bat colonies exist in man-made structures on USFS land. Any bat colony in a man-made structure on USFS land should be afforded immediate assessment and possibly protection.

In woodland settings pallid bats likely forage for terrestrial arthropods over the leaf-litter layer. Therefore, prescribed burns that result in the reduction of leaf-litter would likely adversely affect pallid bats ability to forage in the short term. The real effects or grazing on the pallid bat are not known. Pallid bats probably have greater success catching terrestrial prey items from sparsely vegetated areas. It is possible that some grazing may benefit pallid bats in areas where a thick exotic grass layer would otherwise dominate.

California leaf-nosed bat (*Macrotus californicus*)

The California leaf-nosed bat is an obligate cave-roosting species. It typically roosts in natural caves but will readily use cave-analogs such as abandoned mines. It forages on large-bodied arthropods which it typically gleans from off of vegetation and occasionally the ground. It does not crawl on the ground like the pallid bat, however. This species is

thought to have excellent night vision and rely on it heavily while foraging. This species appears to be incapable of entering torpor and instead seeks out warm roosting areas during the winter, a time period in which it remains active (Anderson 1969). There were no observations of California leaf-nosed bats during this study. However, there were observations of this species during USGS bat research conducted in coastal, inland valley and foothill habitats of southwestern San Diego County during 2002 and 2003. The observations were made at a site near Cottonwood Creek south of Barrett Reservoir. This site is less than 10 kilometers from the DD-CNF. It is possible this species occurs on USFS land most likely along the Tijuana River watershed between the Morena and Barrett Reservoirs. The protection of cave and mine roosts would be the main management action for this species. First of all, as mentioned in the Townsend's big-eared bat section above, it is recommended that the USFS conduct a thorough study of the use of mines by bats on their land to determine which mines or mining areas are supporting significant bat populations including California leaf-nosed bats.

Efficacy and Limitations of Survey Techniques

The ecology of bats is such that no single survey method is effective at detecting all bat species (Pierson 1993). The use of multiple survey techniques in concert has proven to be fairly effective at detecting a variety of bat species. Bats that roost in different habitats or in different locations often can be found foraging at the same foraging locations. This results in a higher likelihood of detecting multiple bats at foraging sites rather than roosting sites during any single survey visit. However, not all bat species are readily detected at foraging sites either because they are able to avoid mist-nets or produce a vocalization that is difficult to detect acoustically or difficult to identify (i.e. California leaf-nosed bats). These species are usually more readily detected at roost sites.

Roost sites are also extremely important to the existence of bats so being able to locate and identify roosts is very important for bat management. In San Diego County, bat roosts are usually occupied by five or fewer species (Krutzsch 1948, D.Stokes pers. obs.). Also, roost surveys can be extremely time consuming and labor intensive. The result is roost surveys are much less efficient at inventorying bat species and often are cost-prohibitive. For a bat inventory study such as this, focusing our survey efforts primarily on foraging bats was more effective with supplementing foraging bat surveys with roosting bat surveys. Indeed, all of the 14 bat species detected during this study were detected during foraging bat surveys. Only five bat species were detected during roost surveys but the roost surveys provided important information to the USFS for management.

During foraging bat surveys there were several techniques used. Use of an Anabat bat detector used in combination with a laptop computer allowed us to actively monitor and record bat vocalizations that we could also review at a later time in the laboratory. This technique alone was responsible for the detection of all 14 bat species detected during this study. An average of 6.5 bat species was detected per survey night using the Anabat. It is a very powerful survey tool for detecting bats but has some major limitations.

Several species produce vocalizations that can appear identical or very similar such that they are indistinguishable to the researcher (see Appendix II). Most of the myotis species fit into this category. Hoary bats often produce vocalizations that appear similar to other bat species including pocketed free-tailed bats, Mexican free-tailed bats, and big brown bats. Pallid bats sometimes produce vocalizations that appear similar to those of big brown bats and long-eared myotis. Yuma myotis produce vocalizations that sometimes resemble those of western red bats. These examples are not exhaustive. There is enough overlap between vocalizations of various bat species that even an experienced bat/Anabat biologist can sometimes have difficulty making distinctions. Another limitation of the Anabat is the fact that some bats produce low intensity calls that do not always trigger the threshold of the Anabat microphone and, therefore, do not get recorded. These species may often be missed at survey sites where the Anabat is used and may be underrepresented. Some species that fit into this category include the Townsend's big-eared bat, fringed myotis, and long-eared myotis. Another limitation of the Anabat is that, while it is possible to make species identifications from recorded bat vocalizations it is not possible at this time to determine any other information about the recorded bat such as its age, sex and reproductive status. Estimates of bat abundance can not be made using the Anabat, either. It can be used to quantify bat activity because it records and saves bat vocalizations into files that can be reviewed and counted. However, it cannot determine how many bats produced the recorded bat vocalizations. It is possible that all recorded vocalizations for each recorded species were produced by a single bat or it is possible that each vocalization was made by different individuals.

Due to the limitations of the Anabat it has been recommended that Anabat surveys should be conducted simultaneous with mist-netting (Pierson 1993, O'Farrell and Gannon 1999). Capturing bats in mist-nets provides definitive proof of species occurrences, provides information about the age, sex, and reproductive status, and provides information about the bat's overall health condition. Also, captured bats can be photo-documented for reports and publications. Captured bats' vocalizations can be recorded with the Anabat as they are released from the hand. This results in obtaining a vocalization from a known bat species that can be used as a reference for making identifications in the future. During this study, 11 of the 14 bat species detected were captured in mist-nets. The three species that were not captured in mist-nets belong to the free-tailed bat family *Molossidae*. These species typically fly high above the level of standard mist-net placements so are unlikely to ever be captured, at least at foraging sites. Mist-netting for bats also has limitations. First of all, mist-nets sample such a small percentage of the air space available to flying bats that the likelihood of catching bats can be low. An average of only 1.6 bat species were detected per survey night compared to 6.5 species detected per survey night using the Anabat. Bats have the ability to detect mist-nets using echolocation so they are often able to avoid being caught. Additionally, it is suspected that bats learn to avoid mist-nets once they have been caught resulting in low recapture rates. This makes it virtually impossible to make estimates of bat abundance using mist-nets at foraging sites.

A third technique used to survey for foraging bats is the use of the unaided ear to listen for audible bat vocalizations. There is one species in particular, the western mastiff bat,

which produces an audible echolocation vocalization that is of high intensity such that it is loud enough for all to hear but those with hearing difficulties. The western mastiff bat typically forages at relatively high altitudes but can still be heard most of the time. However, the Anabat often does not record this species unless one is flying unusually close to the detector. Remington (2003) found that, during 84 western mastiff bat audible observations during her research in Orange County, only on five occasions were the vocalizations recorded with the Anabat. When learned, the western mastiff bat vocalization is fairly recognizable to people. The use of the unaided ear appears to be the most effective method for detecting western mastiff bats. This tool is effective even for non-bat specialists once they have heard what western mastiff bat vocalizations sound like. The big free-tailed bat, which appears to be much rarer than the western mastiff bat in California, produces a vocalization that is similar but higher pitched and fainter sounding. The pocketed free-tailed bat also produces an echolocation vocalization audible to people with good high frequency hearing. There is another bat species, the pallid bat, which sometimes produces an audible social vocalization while foraging. This vocalization is also fairly distinct but only to the trained observer. Pallid bat observations in southern California are fairly rare, and hearing pallid bat social vocalizations is an even rarer event. Therefore, the use of the unaided ear to document foraging pallid bats is only effective when used by a bat-specialist or one trained to hear the vocalization.

Long-term Monitoring Strategies

Development of a long-term bat monitoring strategy that encompasses all of the aspects of effective bat monitoring and is statistically powerful is beyond the scope of this technical report. However, based on knowledge of available survey techniques and data collected during this study we can make general recommendations for a long-term bat monitoring strategy for the DD-CNF. Due to the amount of experience required to utilize bat survey techniques effectively, our first recommendation is that a bat specialist must be used to carry out or closely advise/supervise any bat monitoring efforts.

The use of the Anabat to record bat vocalizations at foraging sites was the single most effective survey tool during our research. The use of the Anabat does not require any permits and is essentially a passive monitoring tool such that there are minimal disturbances or impacts to the bats being surveyed. It is the simplest and most effective survey tool for bats but is limited to only determining species richness and bat activity levels. It is also dependent on having a bat/Anabat specialist make identifications of recorded bat vocalizations. Therefore, it is recommended that long-term bat monitoring efforts include the use of the Anabat at foraging sites, as long as a bat/Anabat specialist is available for the identification process. During our research we had success detecting a rich bat population with the Anabat at primarily riparian reaches and woodland/scrub (or grass) edges, usually with open surface water nearby. These are the habitats that will likely continue to be productive for a variety of bat species.

The use of mist-nets at foraging sites was also effective at detecting species overall, though not necessarily on a night to night basis. The use of mist-nets provided insight into bat demographics and reproductive states including recruitment of juveniles. Mist-

nets also allowed for the gathering of bat vocalizations of known species from hand-released bats contributing to a bat vocalization reference library. For purposes of long-term monitoring, the use of mist-nets in conjunction with the Anabat at foraging sites is recommended so that valuable information regarding bat demographics and reproduction can continue to be collected. This information is important to understanding the overall health of the bat population and cannot be obtained efficiently in any other way. The use of mist-nets at a variety of netting locations is suggested. There was success capturing larger bodied species such as big brown bats and hoary bats only at larger bodies of water or creek reaches such as the Highway 79 pond and Upper Pine Creek. At smaller bodies of water such as the creek at Cibbets Flat Campground, the Laguna Ranch cattle troughs, and Penny Pines troughs at Filaree Flat smaller bat species such as the fringed myotis, long-eared myotis, California myotis, and small-footed myotis were captured successfully. In order to be able to catch a variety of species it is essential to mist-net different sized bodies of water.

Finally, roost surveys resulted in the documentation and confirmation of certain structures and general roosting areas. They also elucidated information about potential roosting areas. For purposes of long-term bat monitoring, the documentation and characterizations of roosts including making standardized counts of bats at roosts would be a great way to supplement foraging bat surveys. The establishment of baseline data of bat species richness and activity levels at foraging sites combined with documentation of roosts and estimates of population sizes at roosts may allow the USFS to begin to monitor trends in the USFS bat populations. The fact that bats are possibly good indicators of environmental health, observed trends or changes in the bat population may very well provide insight into changes in environmental health of USFS land.

It is recommended that future bat monitoring efforts follow a pattern of timing similar to this study. For documenting species richness, surveys should be conducted primarily during the summer. This study indicated that the majority of bat species occurring at sites were detectable during a single summer survey visit but multiple survey visits are recommended. Migratory species may be more likely detected during the fall, winter, and spring. Therefore, summer surveys should be supplemented with fall, winter, or spring surveys to ensure documentation of migratory species such as the hoary bat.

Recommended long-term monitoring foraging and roost sites and their characteristics can be found in Table 6. Background information regarding suggested survey protocols for western bat species exists at the Western Bat Working Group website (www.wbwg.org).

Bat Roosts in Man-made Structures

The use of man-made structures as roosting sites by bats within the forest has been documented by this study and the USFS 1996 telemetry study. Some of these structures are on USFS land, some are on land that is leased by private parties from the USFS, and some are on USFS land but are under the jurisdiction of other agencies such as Cal-Trans. The prevalence of bats in man-made structures on USFS land cannot be underestimated

nor can the importance of these roost sites to the USFS bat populations. It is highly recommended that the USFS adopt a management strategy that includes 1) an assessment of the true prevalence of bats in man-made structures on USFS lands (i.e. focused surveys for bat roosts in man-made structures on USFS lands), 2) an assessment of the potential for conflicts between people and bats (and implications) using these structures or the potential that these structures will be altered in the near future, and 3) devise a management plan to ensure that significant bat colonies in these man-made structures are protected. There are multiple levels of protection that could be offered to bat colonies in man-made structures on USFS land: Level 1: the bats are allowed to stay in the structure without any alteration of their roosting situation. Level 2: the bats are allowed to stay in the structure but there are minor alterations to their roosting situation. Level 3: The bats are properly excluded from the structure but are offered an on-site or near-site alternative roosting situation such as a batbox. Level 4: the bats are properly excluded from the structure but are not offered an alternative roosting site. Information regarding proper exclusions of bats is available at Bat Conservation International's website (www.batcon.org).

Effects of 2003 Cedar Fire

The full effects of the Cedar fire on bats found on the DD-CNF are not known. Very little is known about the effects of fire on bats in southern California. A large percentage of the DD-CNF did not burn in the Cedar Fire but adjacent land did, mainly, Cuyamaca Rancho State Park. The DD-CNF has likely now accommodated bats displaced by the fire but the effects of this displacement are not known. Only one of our survey sites potentially burned, the Hulburd Grove site, which is not actually located on the DD-CNF. It is possible that future research on the DD-CNF will elucidate information such as changes in bat species richness and activity that are a result of the Cedar Fire.

Summary of Management Recommendations

1. Further research – Arguably, the highest management priority for bats is protection of important roosts. Therefore, the highest priority for future bat research on USFS land is to conduct focused studies for the documentation and characterization of bat roosts, particularly mines, on USFS land. Many bat species use mines as roosts including sensitive species such as the Townsend's big-eared bat and California leaf-nosed bat. As human populations increase locally the chance of disturbance at roosts such as mines increases. The USFS has the opportunity to be pro-active about locating and protecting important mines used as bat roosts. This can be accomplished by gating identified mine roosts with 'bat-friendly' gates that allow bats to pass through but not people. Along with installation of gates it is recommended that educational signs be posted at gated mines emphasizing bat roost protection measures in order to deter vandalism.

In this study, the portion of the San Diego River that exists within the Descanso district was not surveyed. This was due to difficulties with access and an overall focus on other watersheds (Sweetwater and Tijuana Rivers) that comprise the core of the Descanso district. This is one of the areas affected by the 2003 Cedar fire. We recommend the USFS conduct bat surveys along the San Diego River above El Capitan Reservoir. Forest Service Sensitive species such as the western red bat, Townsend's big-eared bat, and pallid bat likely were found in this area prior to the fire. It would be interesting to know what species are occurring there now and how bat richness and activity levels compare to other areas of the Descanso District.

Some historical information regarding bats exists for Palomar Mountain. However, there has been very little recent bat survey work around Palomar Mountain and the Palomar district of the Cleveland National Forest resulting in a significant data gap for bats in this part of San Diego County. We recommend that the USFS consider conducting a bat inventory of the entire Palomar district of the Cleveland National Forest using survey strategies similar to this study. This information would be valuable to the USFS as well as local and regional bat mapping, management, and conservation efforts.

As a follow up to this and future bat inventories we recommend the USFS continue to monitor bats within the Cleveland National Forest. Future monitoring efforts will undoubtedly reveal important information about bats and trends within the bat populations found on USFS lands.

2. Protect roosts in man-made structures – there are several structures identified during the USFS 1996 study and this study that warrant protection:
    a. Boiling Springs Pumphouse in Agua Dulce Canyon - this structure is serving as a night roost for a variety of bat species including rare and/or sensitive species such as the Townsend's big-eared bat, fringed myotis, and long-legged myotis. At the very least, this structure provides the opportunity to monitor for these species. The effects of the removal of this structure are not known.
    b. Old Highway 80 bridge - this structure is being used as a night roost by a breeding colony of big brown bats. Although this species has no sensitivity status, any breeding colony of bats should be considered as a sensitive and valuable resource. Any change to this bridge's design could result in an unfavorable roosting situation for the bats. It is recommended that this bridge be left unchanged. If there is work needed on this bridge, it is recommended that the work be limited to the months of November through February when the bats are likely not active and using the bridge as a roost.
    c. Guatay Cabin(s) – one of these cabins (#18) is serving as a day and night roost for a small group of Townsend's big-eared bats. It is possible that other cabins are also serving as bat roosts. The USFS should provide educational material to cabin owners/inhabitants about

the potential use by bats. If the use of the cabins as roosts by bats is unacceptable to either the occupants or the USFS, the bats should be humanely excluded and there should be consideration for providing bats with an alternate roost such as a bat box. Information regarding bat exclusions and bat boxes can be found at a variety of websites including Bat Conservation International's at www.batcon.org. In this case, an artificial bat house would have to be of a design that would support obligate cave-roosting bats such as the Townsend's big-eared bat.

d. Laguna Ranch – there were two structures at the Laguna Ranch that were occupied by a small breeding colony of long-eared myotis during the USFS 1996 study. Based on captures of breeding females of this species at one of the Laguna Ranch troughs during this study it is suspected that one or both of the previously identified structures may still be used as a roost site. This colony needs protection. Either the bats should be allowed to stay and the current human residents informed about the situation or the bats should be excluded and provided with an alternate roost such as a batbox.
e. Lucky Chuck Mine – during the time of the single survey visit to this site this mine was being used as a day roost for at least one individual of one species, the Townsend's big-eared bat. It was also serving as a night roost and/or drinking source for two species, the long-eared and small footed myotis. This mine has the potential of serving as a hibernation site (site where bats spend some or all of winter in torpor) and possibly a maternity site (site where breeding females congregate to have and raise young). Further research would be required to determine the full extent of use of this mine by bats.

3. Maintenance of bat drinking sources – a number of artificial cattle troughs are serving as sources of drinking water and are providing foraging opportunities for a variety of bats including sensitive species such as the Townsend's big-eared bat and fringed myotis. These troughs likely become extremely important to bats during times of drought. Additionally, these water sources have provided and will continue to provide excellent opportunities for the collection of bat data. It is recommended that these drinking sources be maintained with water even if they are no longer serving their original purpose as drinkers for cattle. Bats and other wildlife such as birds and large mammals (deer, coyotes, bobcats, lions) have potentially become dependent on these troughs as water sources. However, if maintaining these troughs means pumping water away from natural sources where other plants and animals are dependent (breeding amphibians, for example) then the USFS should assess other impacts of continuing this action in addition to the benefits of maintaining artificial troughs.

4. Prescribed fire – the biggest threats to bats from prescribed fires are when they are roosting in snags and/or dying trees that may be burned directly or

targeted for removal for hazard abatement. Also, the burning or loss of leaf-litter may negatively impact bats that might spend cold winter periods buried in the litter (western red bats, hoary bats) and bats that potentially forage over leaf-litter (pallid bats). It is recommended that snags that have been in existence for several years be considered as potential bat roosts. Also, the burning of leaf-litter should be avoided during exceptionally cool weather and there should be an effort to minimize loss of this important habitat feature.

Acknowledgments

The US Geological Survey is grateful to US Forest Service biologist Kirsten Winter for her interest in bats and providing the funding necessary to carry out this bat inventory study. US Forest Service biologist Gale Bustillos provided advice regarding potential survey sites, access to sites, and helped in the field on several occasions. US Geological Survey biologist Cheryl Brehme provided study design advice for this research; she was the primary field assistant; and she provided valuable comments on this technical report. US Geological Survey biologists who also assisted in the field during this research included Daniel Palmer, Denise Clark, Allan Hebert, and Brian Yang. US Geological Survey biologists Stacie Hathaway and Carlton Rochester also helped with various aspects of this project. Additionally, Bat Conservation International's Dan Taylor and his son, Ty Taylor, also assisted in the field on several occasions.

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Table 1. Bat species known to occur in San Diego County including family, scientific name, common name, 4-letter species code, legal status, and occurrence within the Descanso District of the Cleveland National Forest historically and recently.

Bat Species (23 known from San Diego County)				Legal Status*	Detected Bat Species/Bat Survey		
Family	Scientific name	Common name	4-letter Species Code	CSC, FSS, BLM	Krutzsch (1948) and prior	1996 USFS Study	2002-2003 USGS Study
Phyllostomatidae	*Macrotus californicus*	California leaf-nosed bat	MACA	CSC, FSS, BLM			
	Choeronycteris mexicana	Mexican long-tongued bat	CHME	CSC			
	Leptonycteris curasoae	Lesser long-nosed bat	LECU	FE			
Vespertilionidae	*Myotis yumanensis*	Yuma myotis	MYYU	BLM	MYYU	MYYU	MYYU
	Myotis lucifugus	Little brown bat	MYLU	none			
	Myotis evotis	Long-eared myotis	MYEV	BLM	MYEV	MYEV	MYEV
	Myotis thysanodes	Fringed myotis	MYTH	BLM	MYTH	MYTH	MYTH
	Myotis volans	Long-legged myotis	MYVO	CSC*, BLM		MYVO	
	Myotis californicus	California myotis	MYCA	none	MYCA	MYCA	MYCA
	Myotis ciliolabrum	Western Small-footed myotis	MYCI	BLM	MYCI	MYCI	MYCI
	Lasionycteris noctivagans	Silver-haired bat	LANO	none			
	Pipistrellus hesperus	Western pipistrelle	PIHE	none		PIHE	PIHE
	Eptesicus fuscus	Big brown bat	EPFU	none	EPFU	EPFU	EPFU
	Lasiurus blossevillii	Western red bat	LABL	CSC*, FSS		LABL	LABL
	Lasiurus xanthinus	Yellow bat	LAXA	CSC*			
	Lasiurus cinereus	Hoary bat	LACI	none		LACI	LACI
	Euderma maculatum	Spotted bat	EUMA	CSC, BLM			
	Corynorhinus townsendii	Townsend's big-eared bat	COTO	CSC, FSS, BLM	COTO	COTO	COTO
	Antrozous pallidus	Pallid bat	ANPA	CSC, FSS, BLM	ANPA		ANPA
Molssidae	*Tadarida brasiliensis*	Mexican free-tailed bat	TABR	none	TABR	TABR	TABR
	Nyctinomops femorosaccus	Pocketed free-tailed bat	NYFE	CSC		NYFE	NYFE
	Nyctinomops macrotis	Big free-tailed bat	NYMA	CSC			
	Eumops perotis	Western mastiff bat	EUPE	CSC, BLM		EUPE	EUPE

* Legal status categories include California Species of Special Concern (CSC), species proposed to become California Species of Special Concern (CSC*, Betsy Bolster pers. comm.), Federally Endangered (FE), Forest Service Sensitive (FSS), and Bureau of Land Management Sensitive (BLM).
Source: Calif. Dept. of Fish and Game, Special Animals List, July 2002.

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Table 2. Survey sites of field surveys in 2002-2003. Includes dates, survey type, approximate coordinates, and datum.

Location #	Survey Sites	Survey Dates	Survey Type	Lattitude (dec. deg.)	Longitude (dec. deg.)	Datum
1	79 Pond	7/24/03	Foraging bats	32.83103	116.62242	WGS84
2	Agua Dulce Canyon	8/22/02	Foraging/Roosting bats	32.87735	116.4435	WGS84
3	Boulder Oaks Campground	6/19/02	Foraging bats	32.73245	116.4848	WGS84
		7/15/02	Foraging bats			
4	Cibbets Flat Campground	6/18/03	Foraging bats	32.77808	116.44802	WGS84
		8/21/03	Foraging bats			
		10/15/03	Foraging bats			
5	Filaree Flat	7/17/03	Foraging bats	32.9108	116.46275	WGS84
6	Gutay Cabin	7/3/03	Roosting bats	32.8462	116.54615	WGS84
7	Hauser Canyon	9/19/02	Foraging bats	32.67253	116.56757	WGS84
8	Hulburd Grove	8/28/03	Foraging bats	32.87242	116.61398	WGS84
9	Japatul Pond	7/10/03	Foraging bats	32.79967	116.64292	WGS84
		6/27/02	Foraging bats			
		8/19/02	Foraging bats			
		9/24/02	Foraging bats			
		12/5/02	Foraging bats			
10	Laguna Ranch	1/22/03	Foraging bats	32.86458	116.45875	WGS84
		4/10/03	Foraging bats			
		5/21/03	Foraging bats			
		8/20/03	Foraging bats			
		9/24/03	Foraging bats			
11	Lower Pine Creek	9/11/02	Foraging bats	32.75421	116.64825	WGS84
12	Lucky Chuck Mine	7/18/02	Roosting bats	32.88693	116.52388	WGS84
13	Lyons Peak	5/15/02	Roosting bats	32.70702	116.76502	WGS84
14	Noble Spring	7/9/03	Foraging bats	32.89877	116.47983	WGS84
15	Old Highway 80 Bridge	6/20/02	Roosting bats	32.78867	116.49725	WGS84
16	Sweetwater River	5/22/02	Foraging bats	32.80335	116.74613	WGS84
		6/13/02	Foraging bats			
17	Upper Pine Creek	7/3/03	Foraging bats	32.83307	116.54645	WGS84
		8/19/03	Foraging bats			
		10/8/03	Foraging bats			
18	Water of the Woods	8/15/02	Foraging bats	32.8748	116.46663	WGS84

Table 3. Foraging bat sites and data including dates, mist-net information for each site (mist-net hours, number of bats captured, number of species captured), Anabat information for each site (Anabat hours, number of species recorded, number of Anabat files recorded), and total number of species detected at each site.

		Mist-nets			Anabat			Total
Site Name	**Date(s)**	**Mist-net Hours (No. of nets x 3)**	**No. of bats captured**	**No. of species detections**	**Anabat hours**	**No. of species detections**	**No. of Anabat files**	**No. of Species**
79 Pond	7/24/03	15	17	2	3	7	436	7
Agua Dulce Canyon	8/22/02	12	0	0	3	7	231	7
Boulder Oaks Campground	6/19/02	15	1	1	3	8	68	9
Cibbets Flat Campground	7/15/02	12	13	3	3	6	80	8
Cibbets Flat Campground	6/18/03	15	4	2	3	6	53	7
Cibbets Flat Campground	8/21/03	15	3	2	3	5	52	6
Cibbets Flat Campground	10/15/03	15	1	1	3	5	60	6
Filaree Flat	7/17/03	6	5	3	3	6	282	7
Hauser Canyon	9/19/02	12	3	2	3	7	213	8
Hulburd Grove	8/28/03	15	1	1	3	5	43	6
Japatul Pond	7/10/03	12	6	3	3	4	91	5
Laguna Ranch	6/27/02	3	8	3	3	8	301	8
Laguna Ranch	8/19/02	3	4	4	3	10	250	10
Laguna Ranch	9/24/02	3	3	2	3	9	287	9
Laguna Ranch	12/5/02	3	0	0	3	2	8	2
Laguna Ranch	1/22/03	3	0	0	3	2	17	2
Laguna Ranch	4/10/03	3	0	0	3	4	54	4
Laguna Ranch	5/21/03	6	2	1	3	8	114	8
Laguna Ranch	8/20/03	3	1	1	3	5	40	5
Laguna Ranch	9/24/03	3	0	0	3	8	130	9
Lower Pine Creek	9/11/02	12	0	0	3	5	132	6
Noble Spring	7/9/03	15	0	0	3	4	79	4
Sweetwater River	5/22/02	9	0	0	3	7	62	8
Upper Pine Creek	6/13/02	15	6	3	3	10	127	11
Upper Pine Creek	7/3/03	15	5	3	3	9	148	9
Upper Pine Creek	8/19/03	12	3	1	3	7	205	7
Upper Pine Creek	10/8/03	15	7	4	3	9	198	10
Water O' Woods	8/15/02	12	4	2	3	9	312	9
	Totals	279	97	44	84	182	4073	197
	Means	9.96	3.46	1.57	3.00	6.50	145.46	7.04

Table 4. Roost survey sites including date, roost type, survey techniques, observed species (4-letter code), and additional comments.

Site Name	Date	Survey Visit Time	Survey Type	Survey Techniques	Observed Species (No. Observed)	Comments
Lyons Peak	5/15/02	1949-2101 hours	External	Anabat, Audible, Visual	EUPE (1), PIHE (1)	EUPE not roosting, passed by late in evening
Old Highway 80 Bridge	6/21/02	0015-0045 hours	Nocturnal Internal	Visual, Hand-net	EPFU (25)	1 captured - a pregnant female
Lucky Chuck Mine	7/18/02	1800-0000 hours	External	Mist-net, Anabat, Visual	COTO (1), EPFU (1), MYEV (2), MYCI (17), EUPE (1)	COTO, MYCI, MYEV documented inside or at entrance, EUPE, EPFU passed by
Boiling Springs Pumphouse	8/22/02	2100-0015 hours	Nocturnal Internal	Visual, Hand-net	COTO (1), MYCI (1)	COTO, MYCI found night roosting inside
Gutay Cabin	7/3/03	1655-1730 hours	Diurnal Internal	Visual	COTO (1)	COTO day roosting in garage, multiple bats observed during day, night by owner

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Table 5. Captured bats including mist-net and hand-net captures at both foraging and roosting bat sites. Bat species are represented by 4-letter species codes. Table includes their age, sex, reproductive states, and total number. The reproductive states for males are testes abdominal (non) or descended, for females lactating, pregnant, and post-lactating. The term 'juv' refers to juveniles, 'non' refers to non-reproductive.

Bat Species (4-letter code)	Age	Sex	Status	Total
ANPA*	Adult	Male	Testes descended	1
COTO*	Adult	Female	Lactating	1
			Non	2
EPFU	Adult	Female	Lactating	6
			Non	3
			Post-lactating	7
			Pregnant	2
			Unknown	1
		Male	Testes abdominal	6
			Testes descended	2
	Juv	Female	Non	5
		Male	Non	3
LABL*	Adult	Female	Non	1
LACI	Adult	Male	Testes abdominal	3
			Testes descended	1
MYCA	Adult	Female	Lactating	5
			Non	4
			Pregnant	3
			Unknown	3
		Male	Testes abdominal	3
	Juv	Female	Non	1
MYCI	Adult	Female	Lactating	6
			Non	6
			Post-lactating	9
		Male	Testes abdominal	4
MYEV	Adult	Female	Lactating	6
			Non	3
			Post-lactating	1
			Unknown	1
		Male	Testes abdominal	7
			Testes descended	1
	Juv	Female	Non	1
MYTH	Adult	Male	Testes abdominal	1
MYYU	Adult	Female	Lactating	1
			Non	2
			Post-lactating	1
	Juv	Male	Non	1
PIHE	Adult	Female	Post-lactating	2
		Male	Testes abdominal	1
Total				118
* Forest Service Sensitive bat species				

Table 6. Recommended survey sites for long-term monitoring. Suggestions include survey types, length of surveys, seasonal timing of surveys, and justification of site selection for long term monitoring.

Survey Site	Survey Type	Survey Methods	Length of Survey	Timing of Survey(s)	Justification
Laguna Ranch	Foraging Bat	A single 6m x 2.6m mist-net over one or both troughs Anabat II bat detector and unaided ear	Sunset + minimum 3 hours	June - August, October - April	several small bat species can be caught successfully at this site: COTO, MYTH, MYEV, MYCA, etc. A variety of species can be detected acoustically
Penny Pines Troughs: Filaree Flat	Foraging Bat	One or two 9m x 2.6m nets placed covering both troughs Anabat II bat detector and unaided ear	Sunset + minimum 3 hours	June - August, October - April	several small bat species can be caught successfully at this site: COTO, MYTH, MYEV, MYCA, etc. A variety of species can be detected acoustically
Water of the Woods	Foraging Bat	From 1-5 mist-nets covering as much available surface water as possible Anabat II bat detector and unaided ear	Sunset + minimum 3 hours	June - August, October - April	Both small and large bats potentially captured at this site: EPFU, MYsp, PIHE, LABL, LACI, etc A variety of species can be detected acoustically
Upper Pine Creek	Foraging Bat	From 1-5 mist-nets covering as much available surface water as possible Anabat II bat detector and unaided ear	Sunset + minimum 3 hours	June - August, October - April	Both small and large bats potentially captured at this site year-round: EPFU, MYsp, PIHE, LABL, LACI, etc A variety of species can be detected acoustically
Cibbets Flat Campground	Foraging Bat	From 1-5 mist-nets covering as much available surface water as possible Anabat II bat detector and unaided ear	Sunset + minimum 3 hours	June - August, October - April	several small bat species can be caught successfully at this site: MYEV, MYCA, MYCI, etc. A variety of species can be detected acoustically

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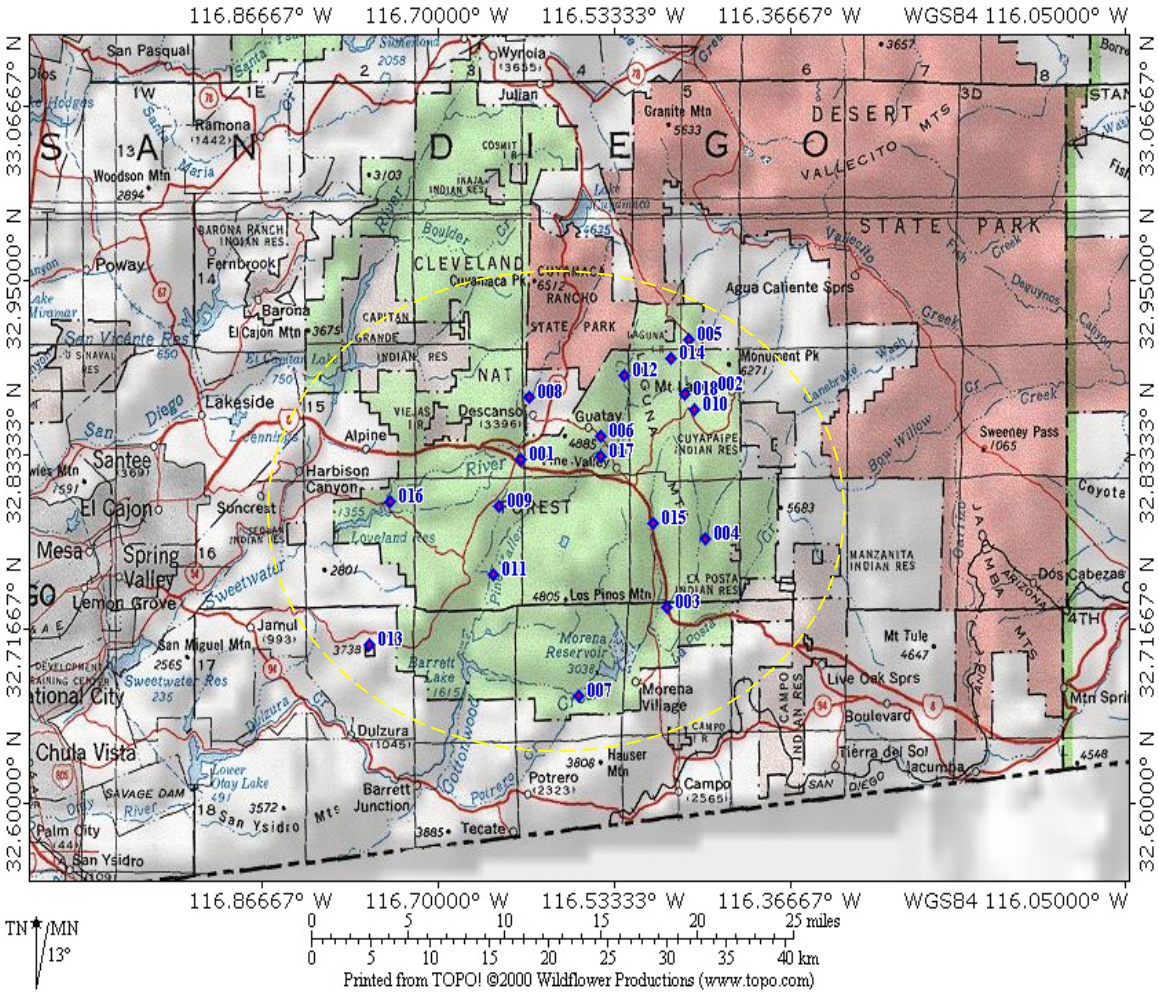


Figure 1. Map of the study area. The Descanso District of the Cleveland National Forest is represented by the green shaded area found roughly within the yellow dashed-line oval. Survey sites are represented by numbered blue diamonds (refer to Table 2 for names and characteristics of survey sites).

Figure 2. Photo of a Yuma myotis (*Myotis yumanensis*). Photo from Japatul Pond adjacent to the CNF. Photo taken by Cheryl Brehme.

Figure 3. Photo of a long-eared myotis (*Myotis evotis*). Photo from Cibbets Flat Campground in the CNF. Photo taken by Drew Stokes.

Figure 4. Photo of a fringed myotis (*Myotis thysanodes*). Photo from Laguna Ranch in the CNF. Photo taken by Cheryl Brehme.

Figure 5. Photo of a California myotis (*Myotis californicus*). Photo from Cibbets Flat Campground in the CNF. Photo taken by Cheryl Brehme.

Figure 6. Photo of a small-footed myotis (*Myotis ciliolabrum*). Photo from Boiling Springs pumphouse in the CNF. Photo taken by Cheryl Brehme.

Figure 7. Photo of a western pipistrelle (*Pipistrellus hesperus*). Photo from Japatul Pond near the CNF. Photo taken by Cheryl Brehme.

Figure 8. Photo of a big brown bat (*Eptesicus fuscus*). Photo from Filaree Flat in the CNF. Photo taken by Cheryl Brehme.

Figure 9. Photo of a pale big brown bat (*Eptesicus fuscus*). Photo from Upper Pine Creek in the CNF. Photo by Cheryl Brehme.

Figure 10. Photo of a western red bat (*Lasiurus blossevillii*). Photo from Upper Pine Creek in the CNF. Photo by Cheryl Brehme.

Figure 11. Photo of a hoary bat (*Lasiurus cinereus*). Bat with right wing out-stretched. Photo from Upper Pine Creek in the CNF. Photo by Cheryl Brehme.

Figure 12. Photo of a Townsend's big-eared bat (*Corynorhinus townsendii*). Photo from Laguna Ranch in the CNF. Photo by Cheryl Brehme.

Figure 13. Photo of a pallid bat (*Antrozous pallidus*). Photo from Hulburd Grove area near the CNF. Photo by Daniel Palmer.

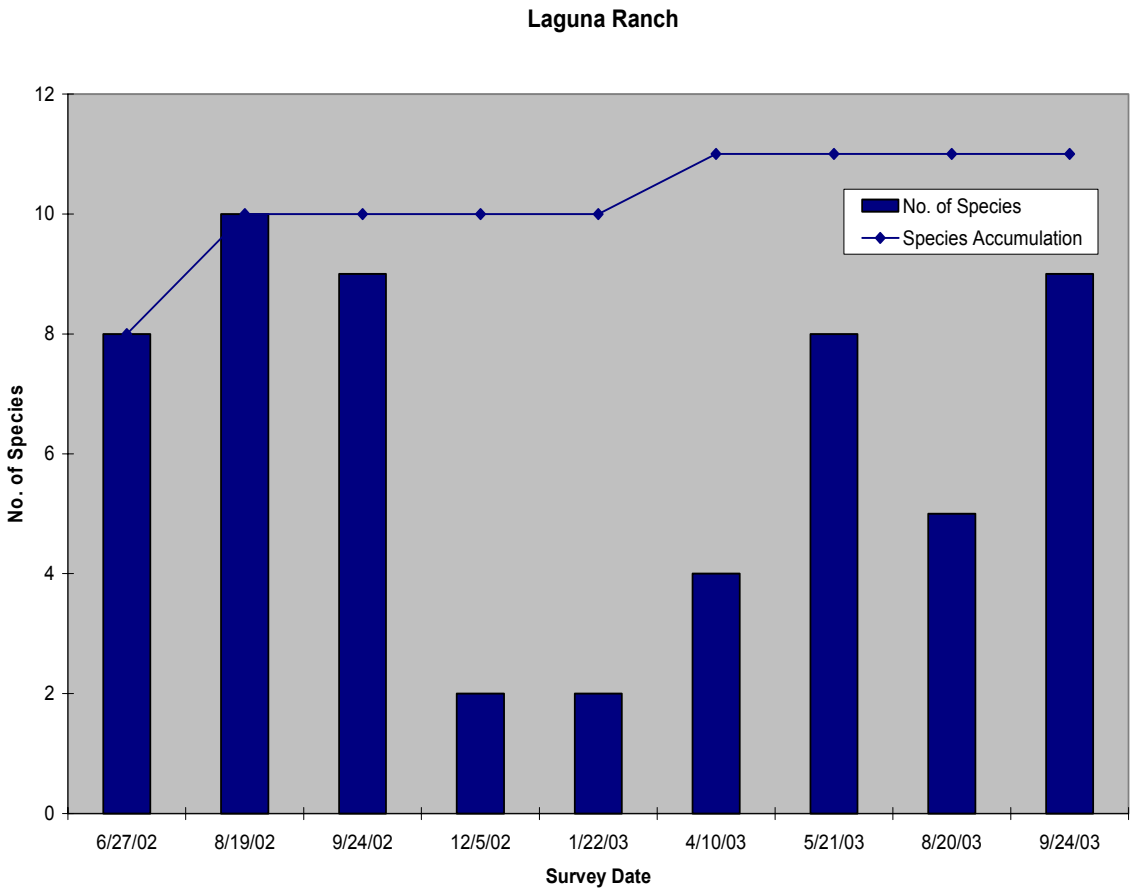


Figure 14. Chart of seasonal bat activity at Laguna Ranch. Chart represents changes in detected bat species richness at the Laguna Ranch over the course of nine survey visits: three summer/fall 2002 visits, three winter/spring 2002-2003 visits, and three summer/fall 2003 visits. The columns represent the number of bat species detected on each survey visit. The line represents the accumulation of detected species. Eight of eleven species were detected during the first summer/fall 2002 visit. Two additional species were detected on the second summer/fall 2002 visit. A third additional species was detected during the third winter/spring 2002-2003 visit.

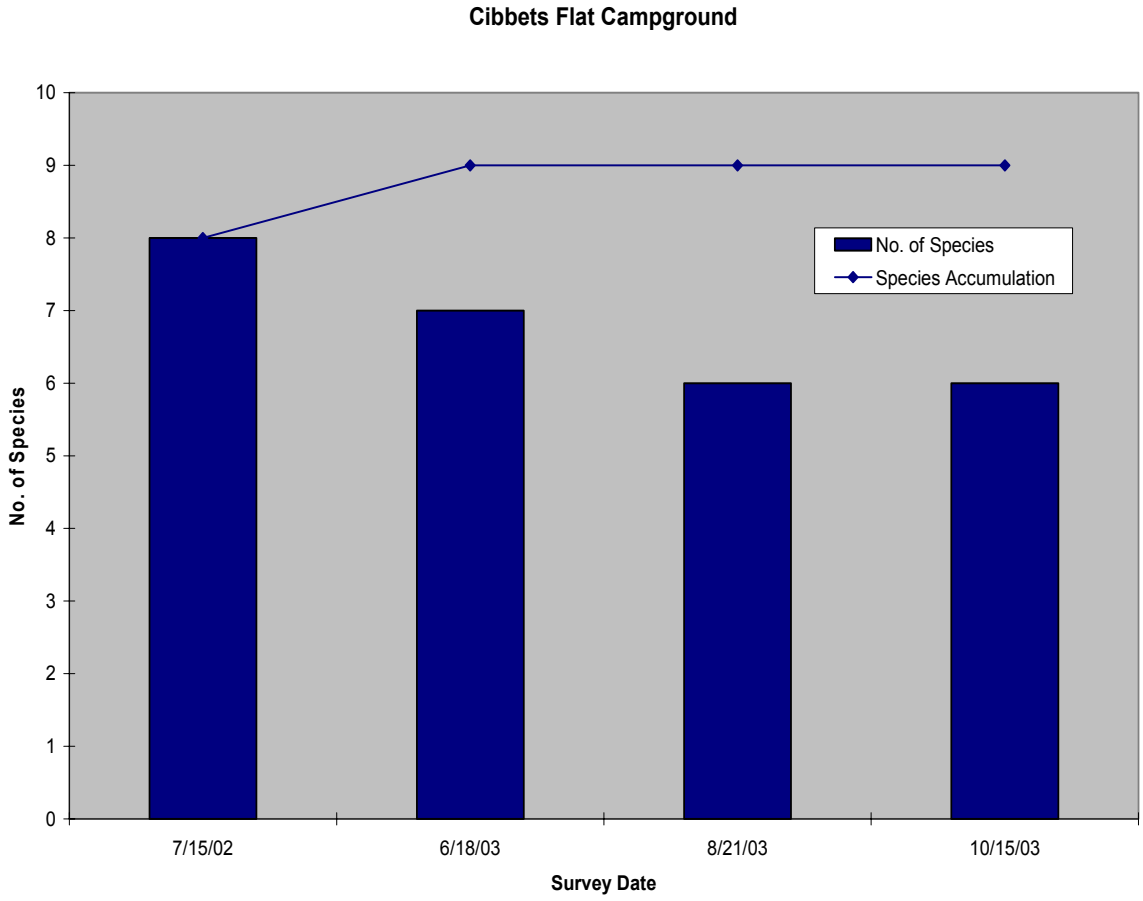


Figure 15. Chart of multi-visit surveys at Cibbets Flat Campground. Chart represents changes in detected bat species richness at the Cibbets Flat Campground over the course of four survey visits: one summer 2002 visit and three summer/fall 2003 visits. The columns represent the number of bat species detected on each survey visit. The line represents the accumulation of detected species. Eight of nine species were detected on the only survey visit in summer 2002. Only one additional species was detected in summer/fall 2003, on the first survey visit.

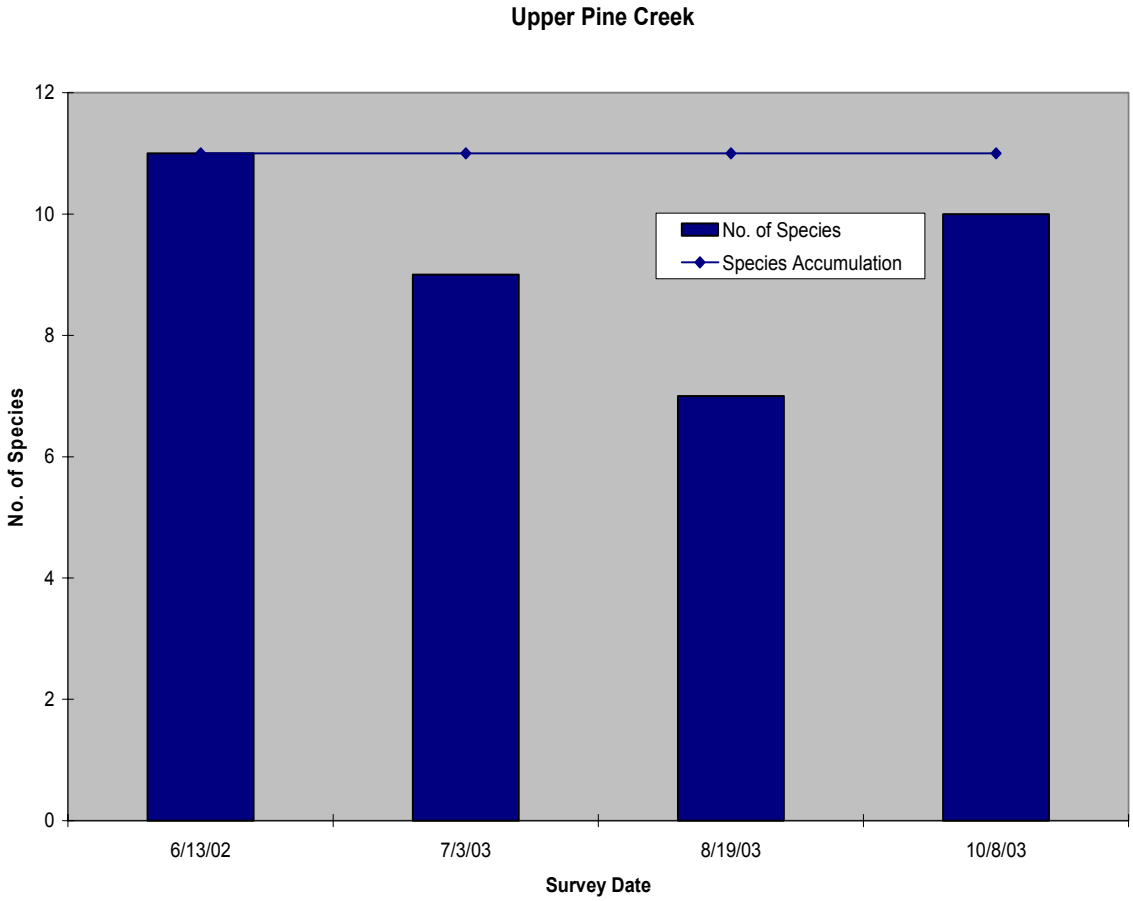


Figure 16. Chart of multi-visit surveys at Upper Pine Creek. Chart represents changes in detected bat species richness at Upper Pine Creek over the course of four survey visits: one summer 2002 visit and three summer/fall 2003 visits. The columns represent the number of bat species detected on each survey visit. The line represents the accumulation of detected species. All eleven species detected at this site were detected on the survey visit in summer 2002. No additional species were detected during the three summer/fall survey visits in 2003.

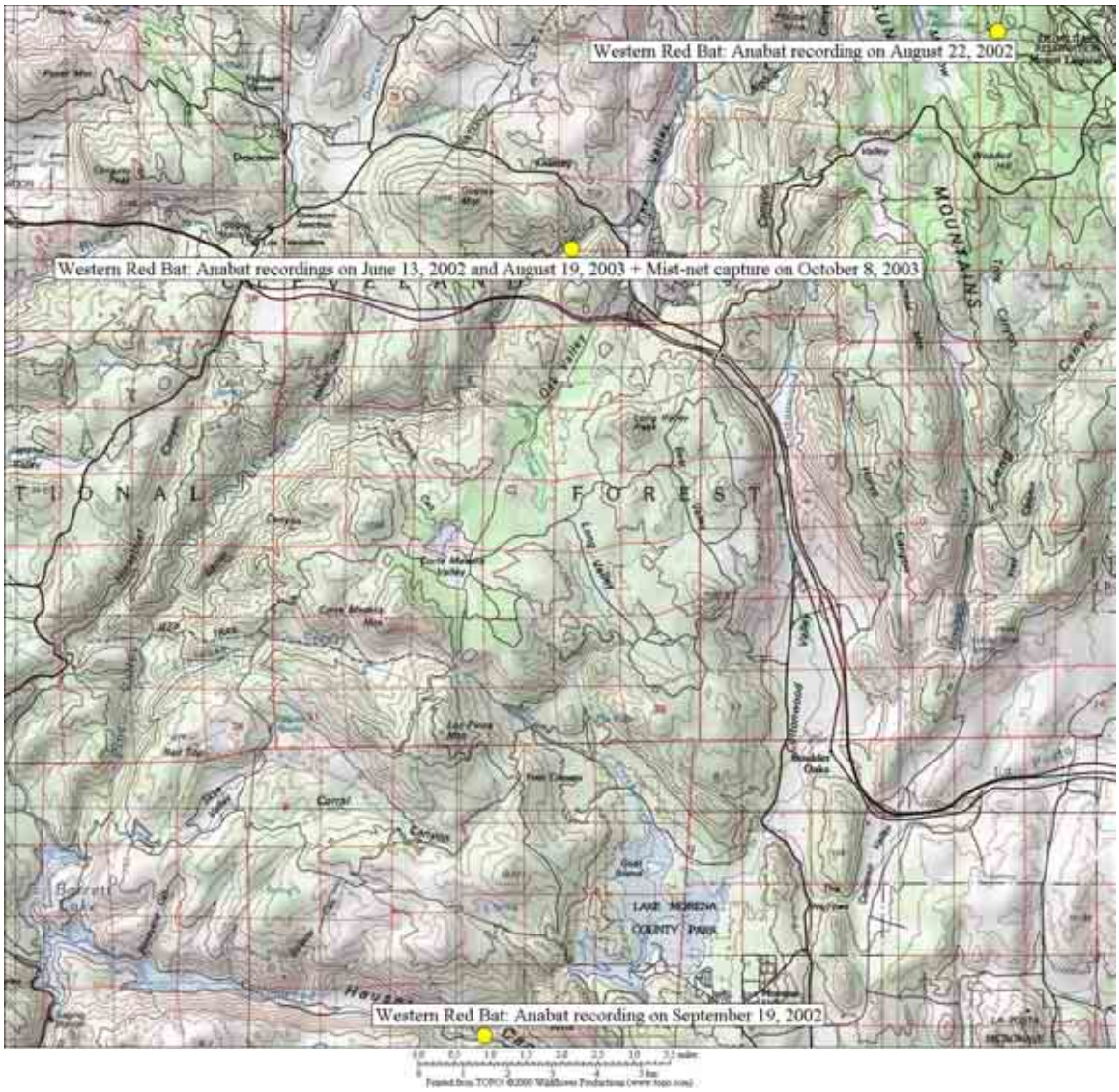


Figure 17. Map representing Forest Service Sensitive western red bat (*Lasiurus blossevillii*) detection sites. Labels include dates and methods of detection.

Figure 18. Map representing Forest Service Sensitive Townsend's big-eared bat (*Corynorhinus townsendii*) detection sites. Labels include dates and methods of detection.

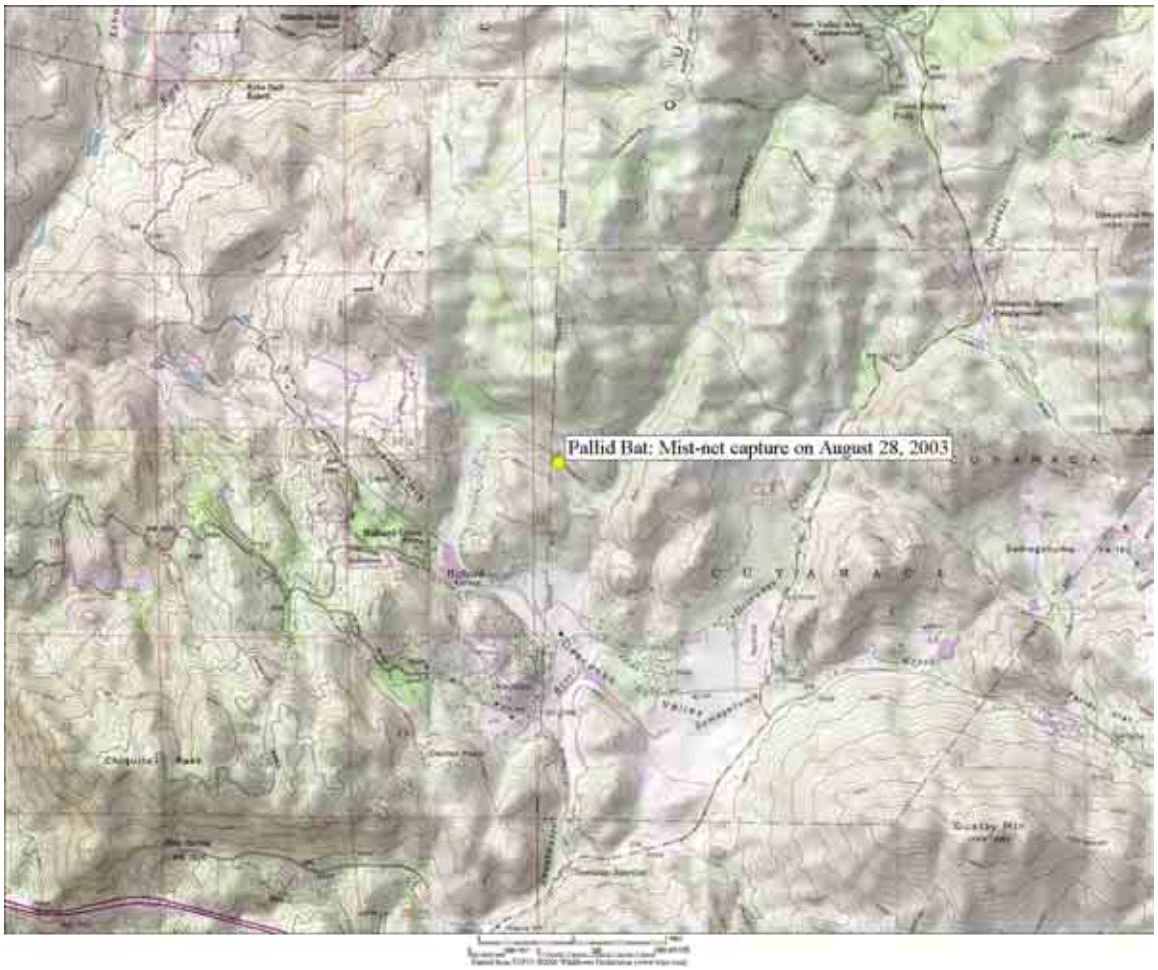
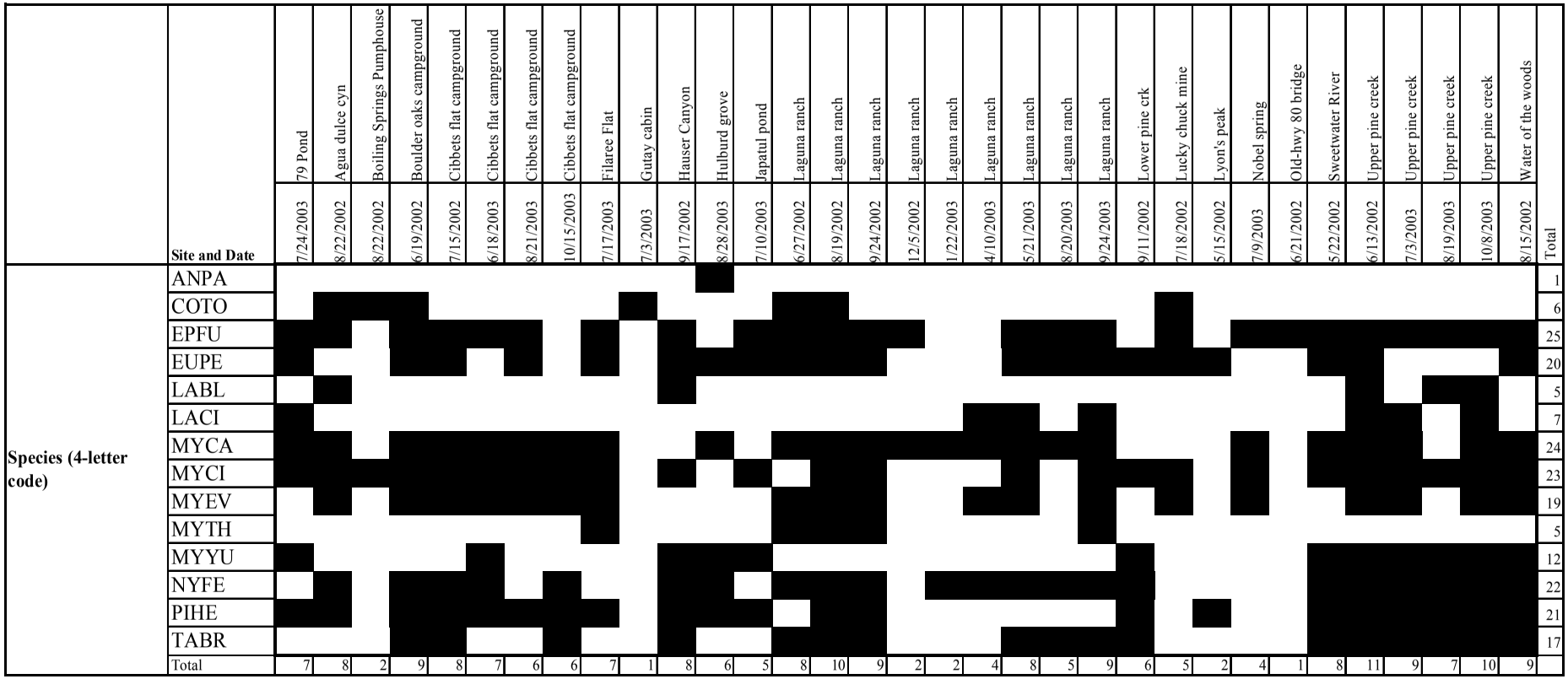


Figure 19. Map representing Forest Service Sensitive pallid bat (*Antrozous pallidus*) detection site. Label includes date and method of detection.

Appendixes I & II.



Appendix I. All bat species detections by site and date. Bat species are represented by 4-letter species codes and are listed alphabetically. Sites are also listed alphabetically.

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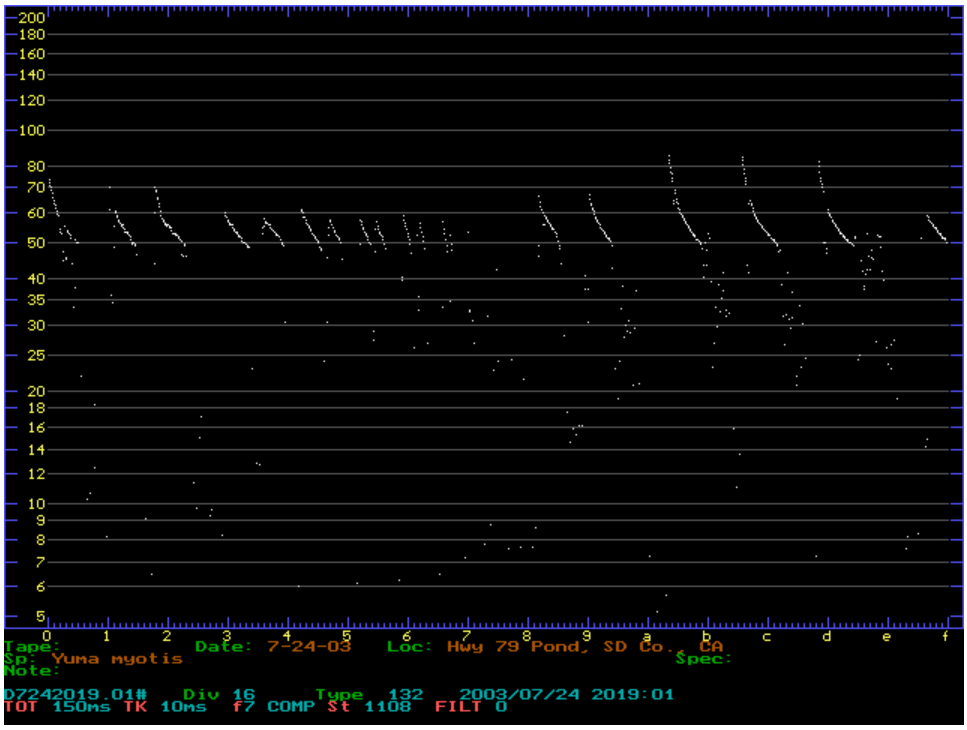
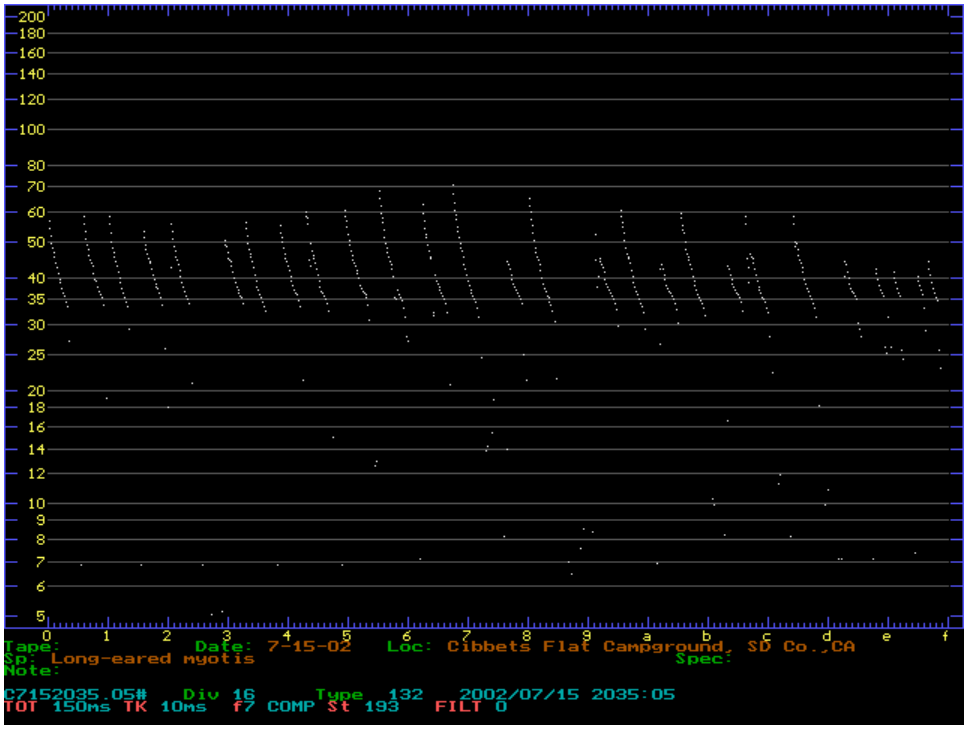
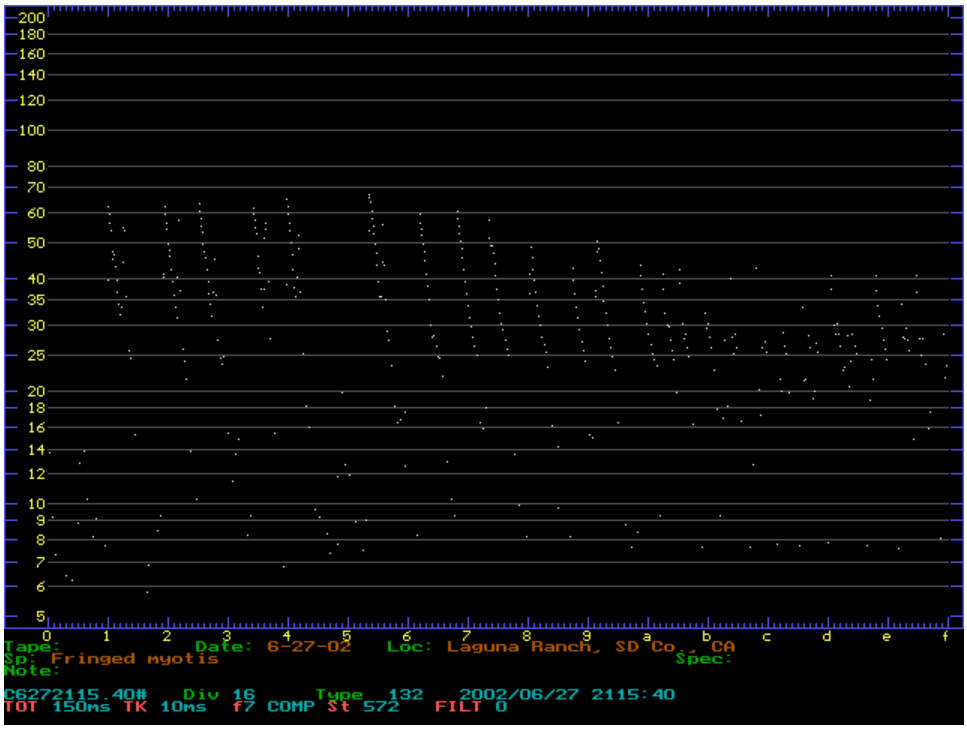
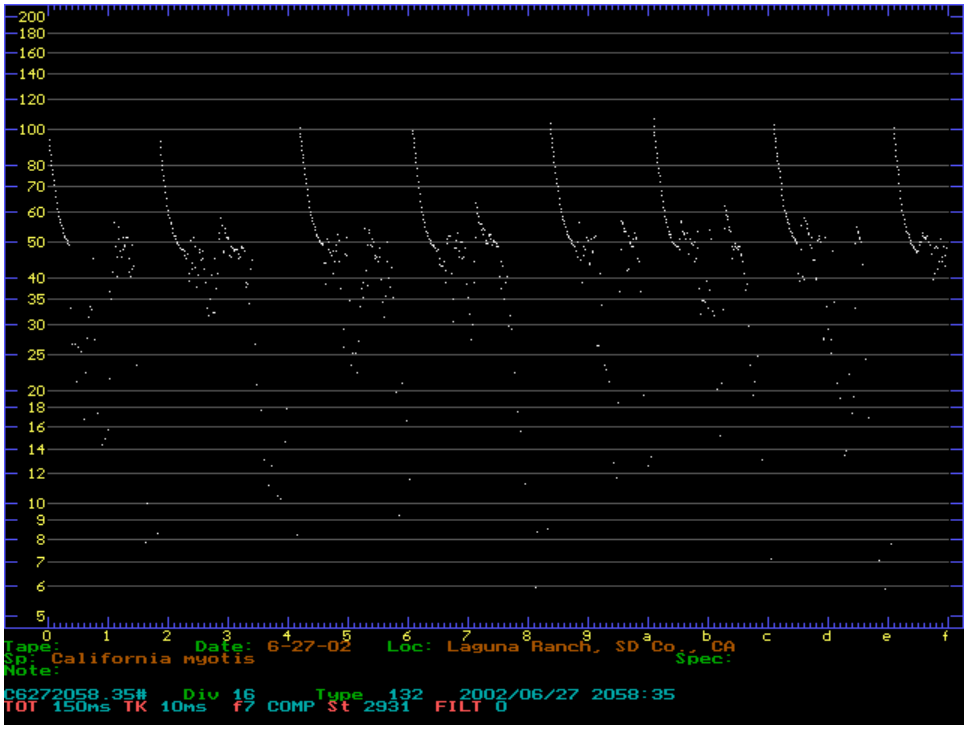


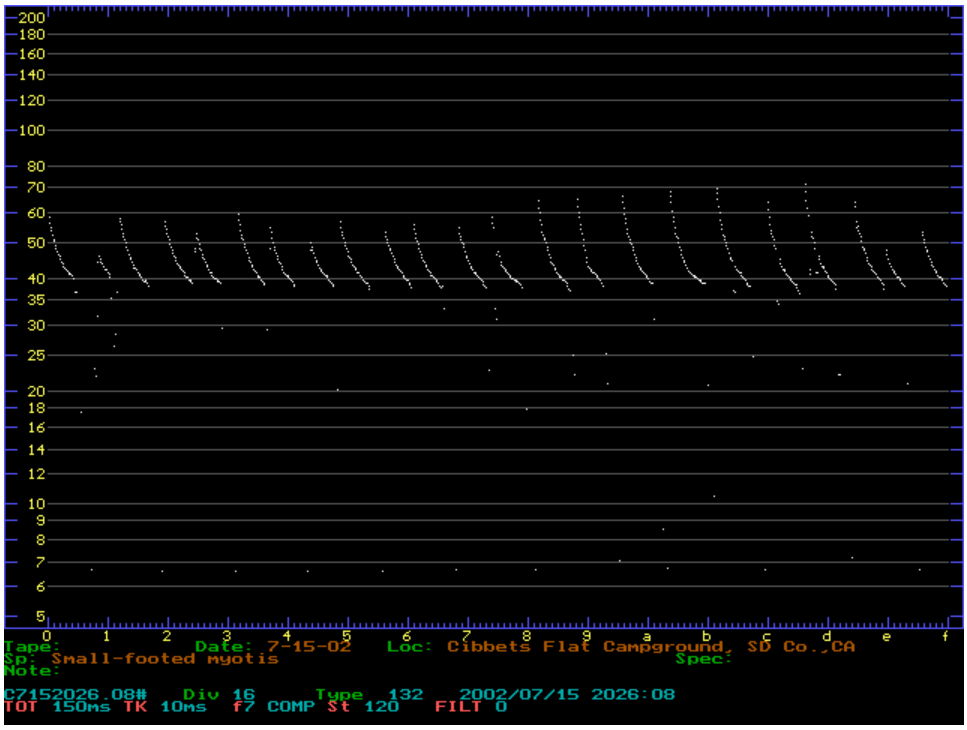


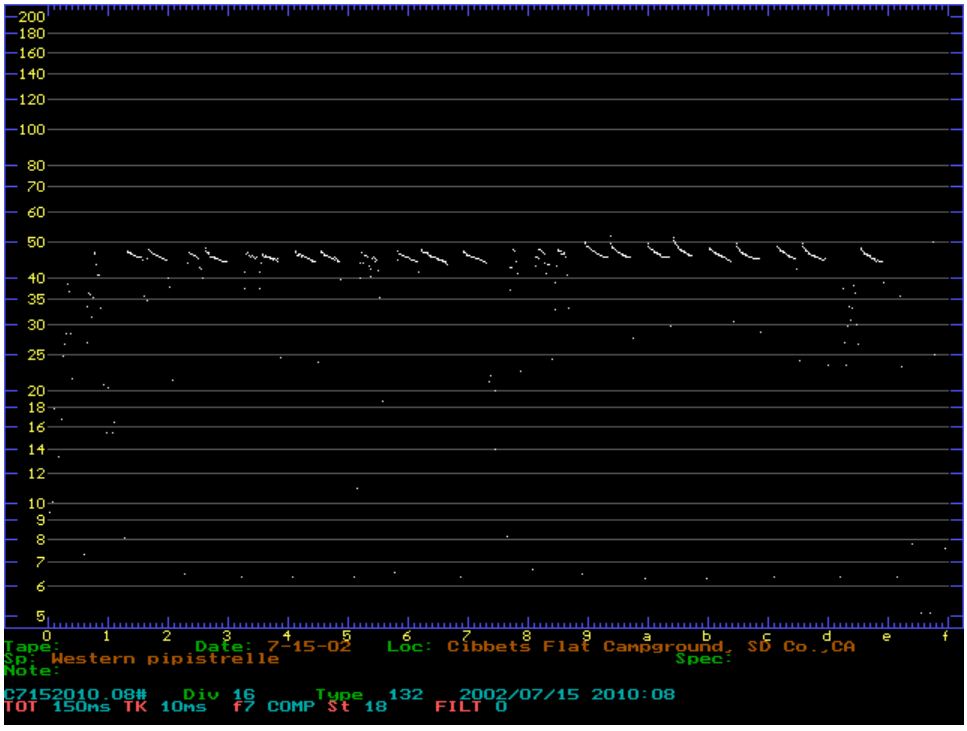
A (top) Bat vocalization identified as a Yuma myotis (*Myotis yumanensis*) recorded at the Highway 79 Pond.
B (bottom) Bat vocalization identified as a long-eared myotis (*Myotis evotis*) recorded at Cibbets Flat Campground.



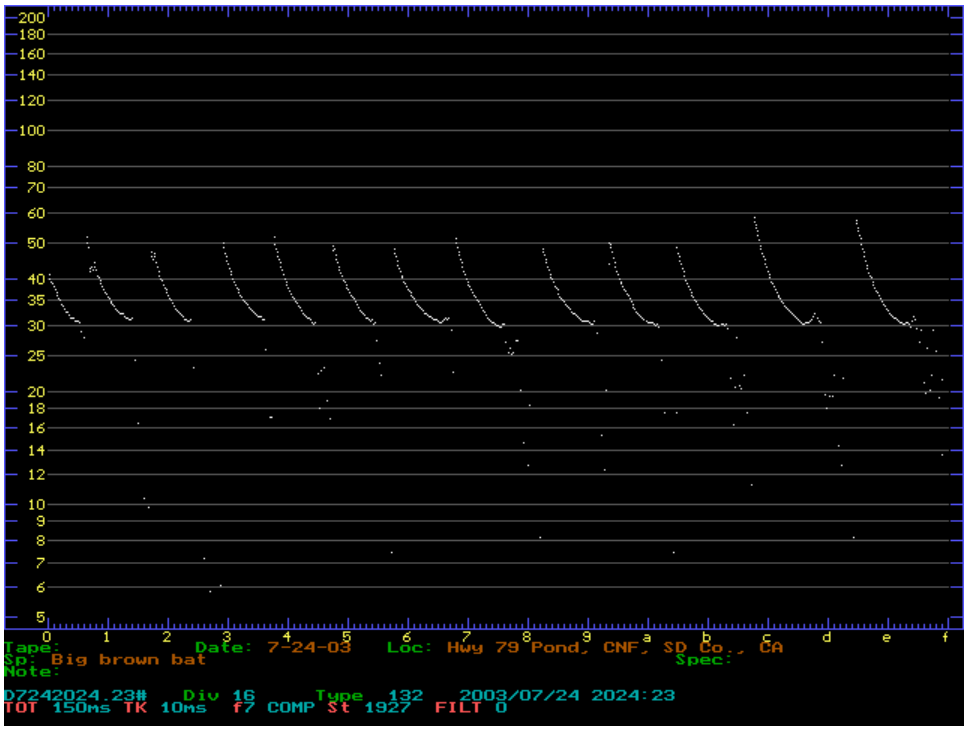


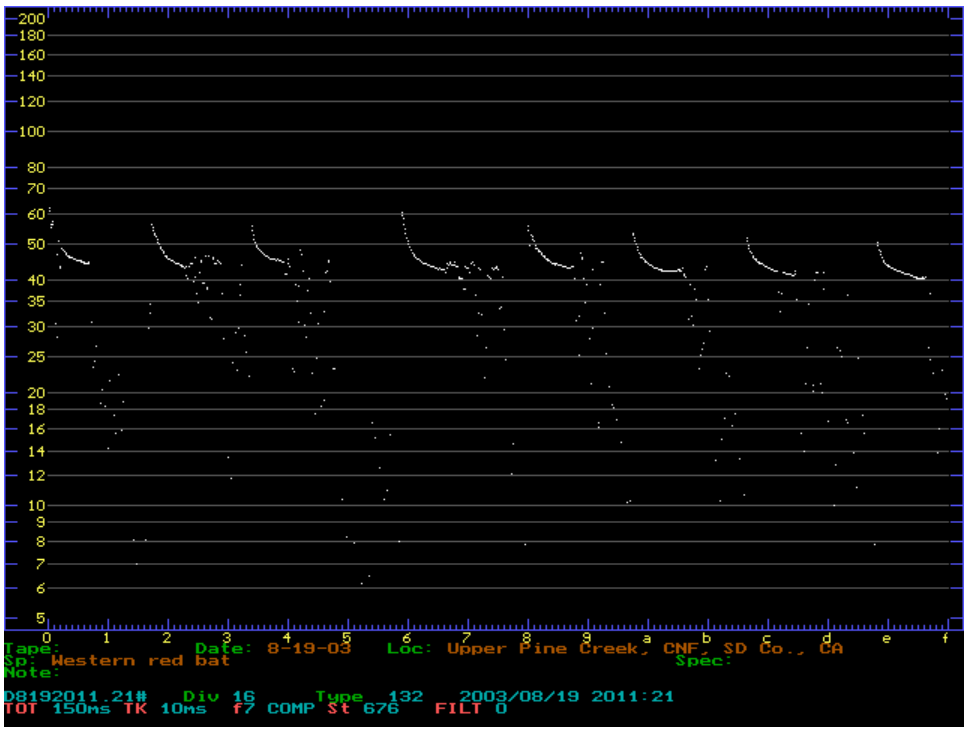
C (top) Bat vocalization identified as a fringed myotis (*Myotis thysanodes*) recorded at Laguna Ranch.
D (bottom) Bat vocalization identified as a California myotis (*Myotis californicus*) recorded at Laguna Ranch.



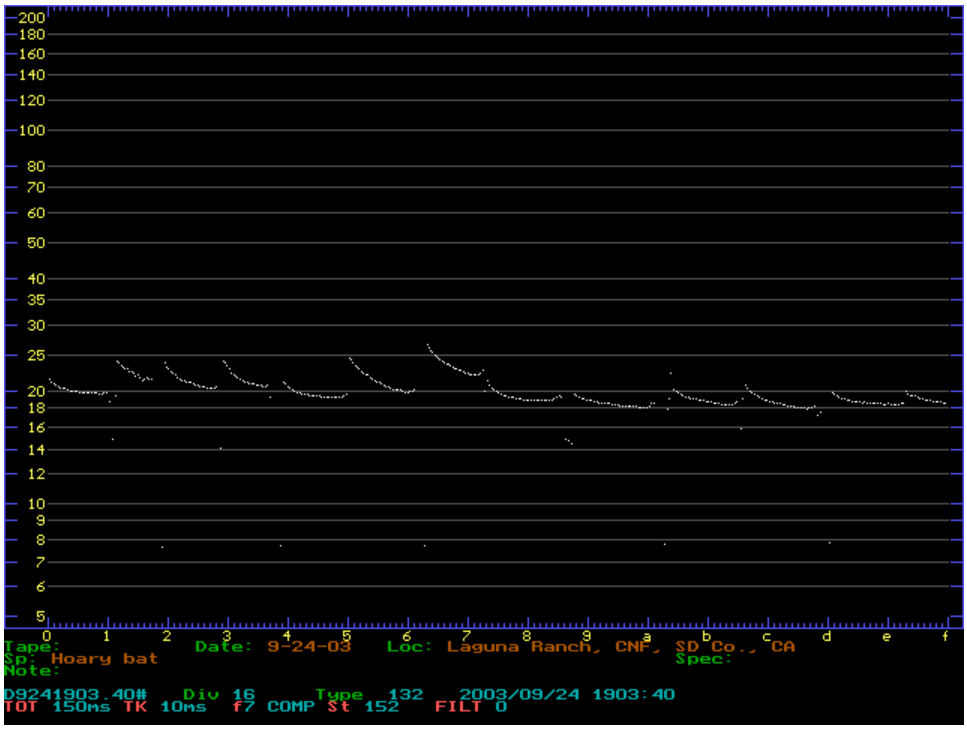


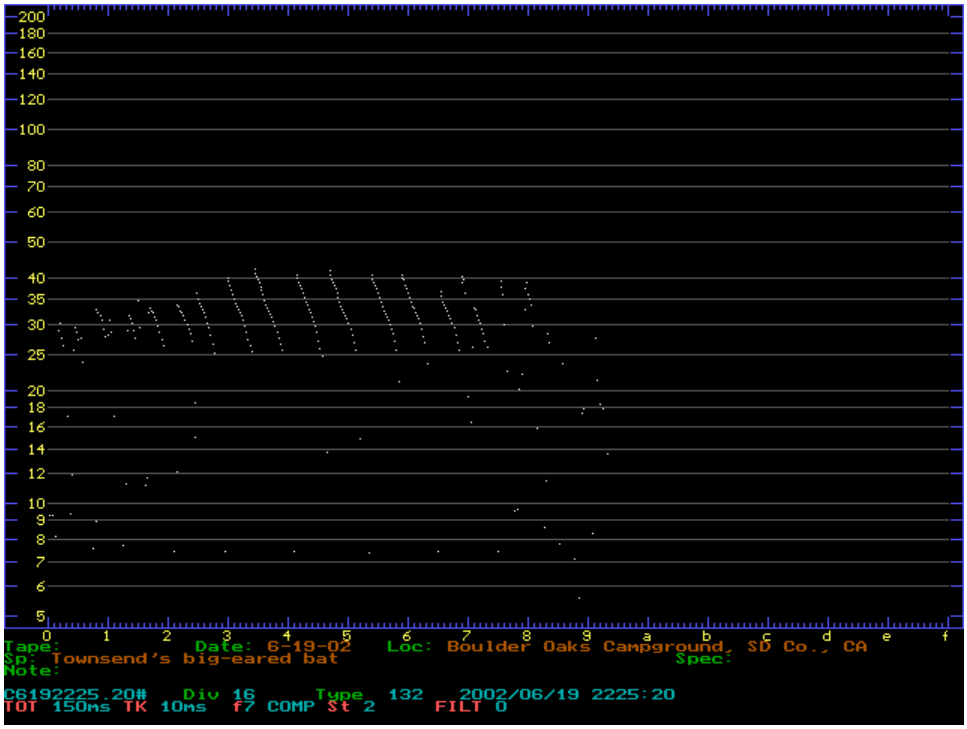
E (top) Bat vocalization identified as a small-footed myotis (*Myotis ciliolabrum*) recorded at Cibbets Flat Campground.
F (bottom) Bat vocalization identified as a western pipistrelle (*Pipistrellus hesperus*) recorded at Cibbets Flat Campground.



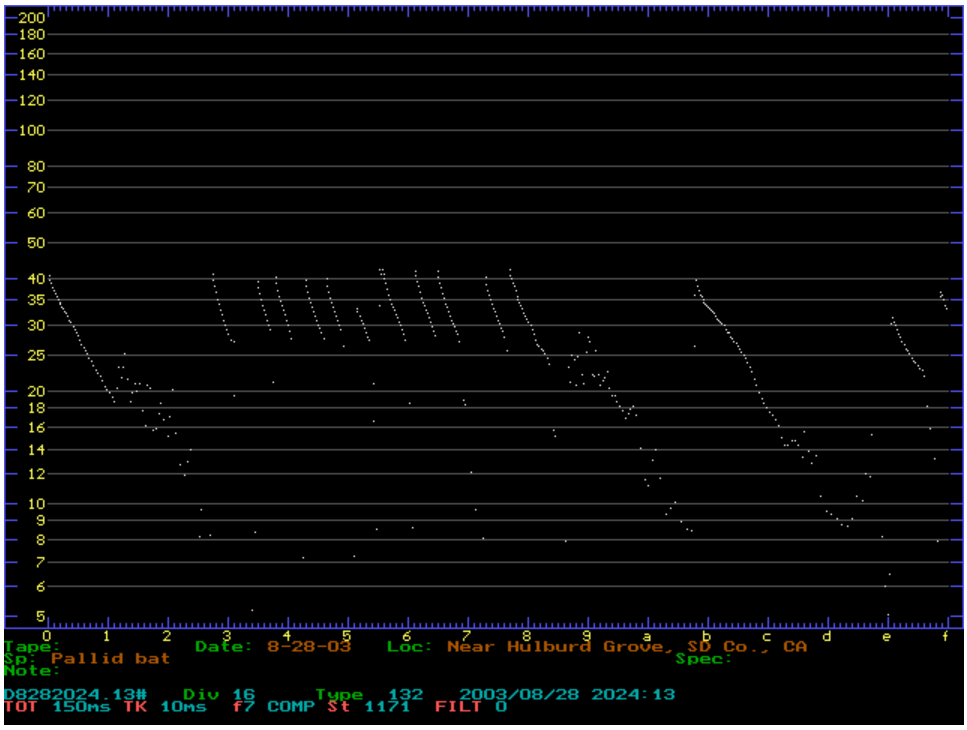


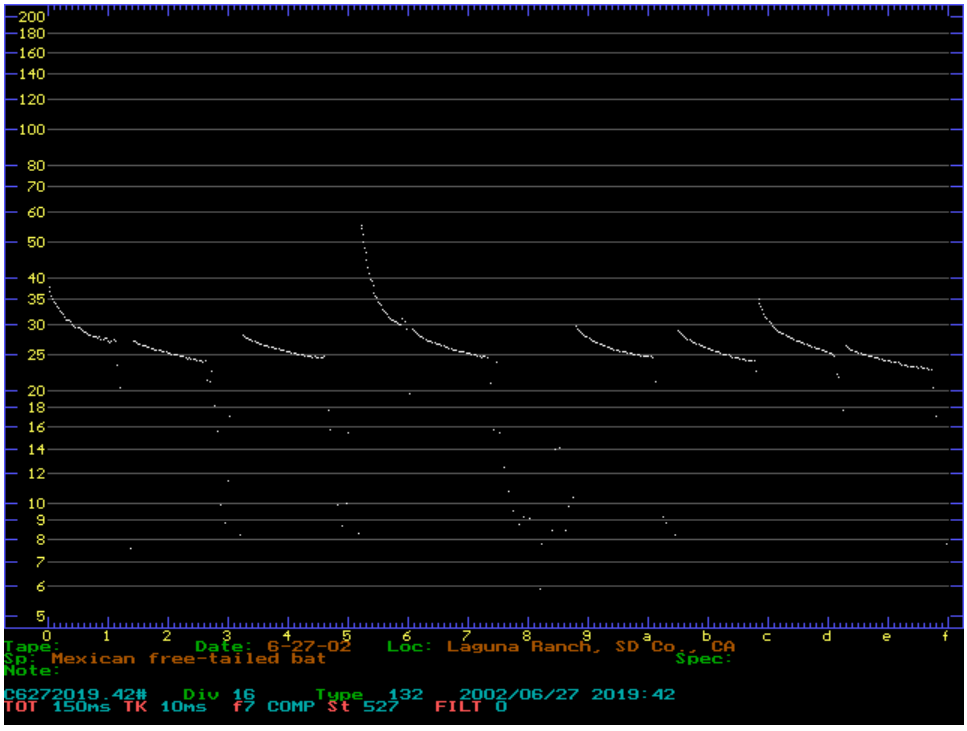
G (top) Bat vocalization identified as a big brown bat (*Eptesicus fuscus*) recorded at the Highway 79 Pond.
H (bottom) Bat vocalization identified as a western red bat (*Lasiurus blossevillii*) recorded at Upper Pine Creek.



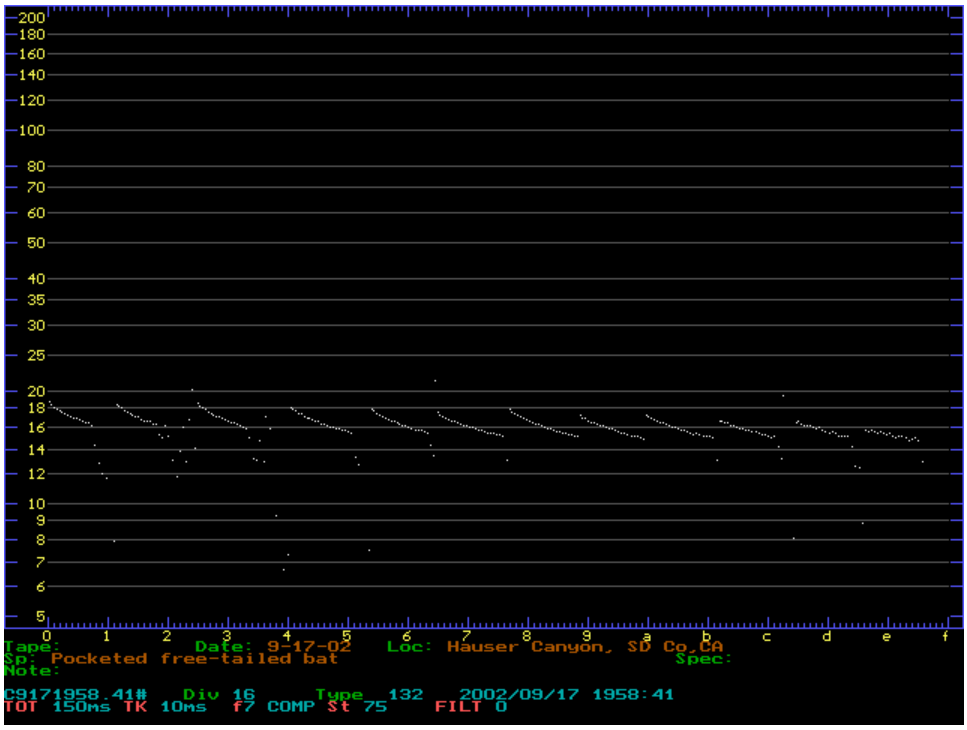


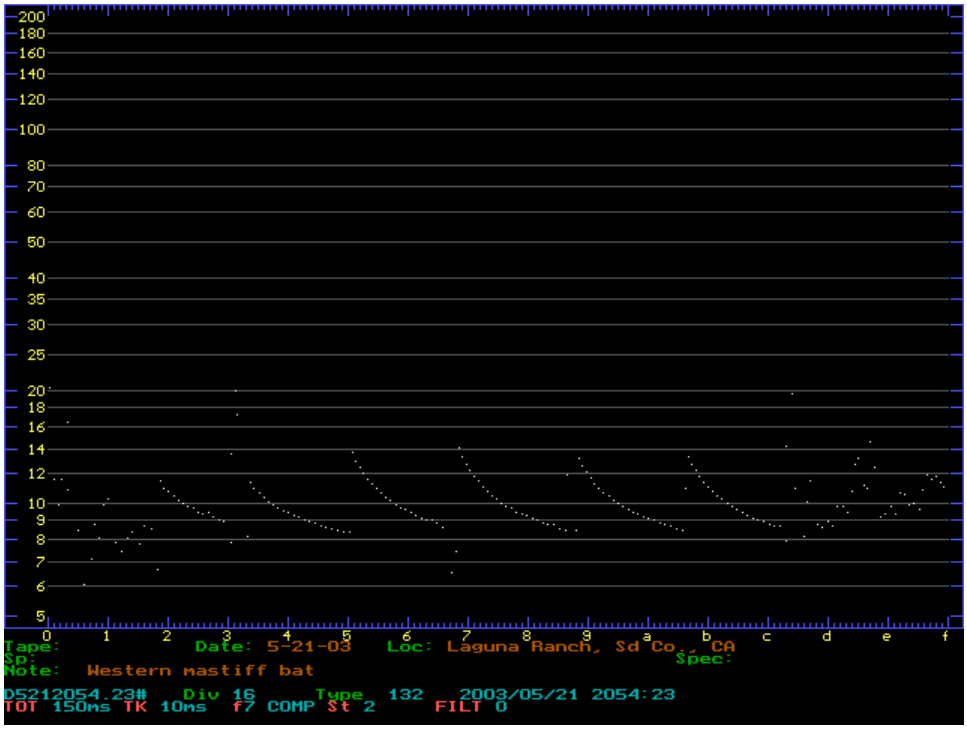
I (top) Bat vocalization identified as a hoary bat (*Lasiurus cinereus*) recorded at Laguna Ranch.
J (bottom) Bat vocalization identified as a Townsend's big-eared bat (*Corynorhinus townsendii*) recorded at Boulder Oaks Campground.





K (top) Bat vocalization identified as a pallid bat (*Antrozous pallidus*) recorded near Hulburd.
L (bottom) Bat vocalization identified as a Mexican free-tailed bat (*Tadarida brasiliensis*) recorded at Laguna Ranch.





M (top) Bat vocalization identified as a pocketed free-tailed bat (*Nyctinomops femorosaccus*) recorded in Hauser Canyon.
N (bottom) Bat vocalization identified as a western mastiff bat (*Eumops perotis*) recorded at Laguna Ranch.