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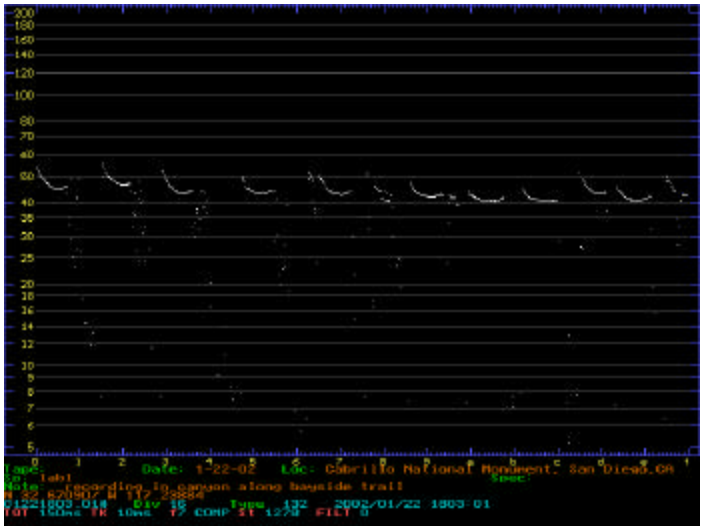
Bat Inventory of the Point Loma Peninsula Including the Cabrillo National Monument



Final Report

Prepared for:

Cabrillo National Monument
National Park Service

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 inventory on the Point Loma peninsula including the Cabrillo National Monument in San Diego County, California from January to September of the year 2002 as part of an effort to begin an inventory/monitoring program of various plant and animal taxa on National Park Service lands. The techniques used to survey for bats during this study included 1) acoustic, including use of electronic broadband zero-crossing type bat detectors and audible listening for bats, 2) visual, including use of spotlights, 3) roost searches, and 4) mist-netting. During the 2002 bat inventory of the Point Loma peninsula four bat species were detected with varying confidence: the Western Red Bat (*Lasiurus blossevillii*), the Big Brown Bat (*Eptesicus fuscus*), the Mexican Free-tailed Bat (*Tadarida brasiliensis*), and the Big Free-tailed Bat (*Nyctinomops macrotis*). Recommendations for management and long term monitoring of bats were made.

INTRODUCTION

Inventory and monitoring of native plant and animal species has become a priority for the National Park Service in an effort to conserve natural resources on these lands. At the Cabrillo National Monument, inventorying and monitoring of several plant and animal taxa has already begun. In recognition of the lack of information about bat species occurring at Cabrillo National Monument, it was identified that a bat inventory study was needed. The United States Geological Survey was contracted by the National Park Service to conduct a bat inventory of the Point Loma peninsula including the Cabrillo National Monument. The goal of this study was to document as many bat species as possible occurring on the Point Loma peninsula while working during the allotted time period (January through September, 2002) and within the financial limits of the contract. We focused our research efforts across this time frame in areas where bats most likely occurred and where they were detectable using bat inventory methods (see methods section). The information gathered during this study is useful not only to the Cabrillo National Monument but also to regional efforts focusing on the current status and distribution of bat species.

Presently, 23 bat species representing 3 families have been documented in San Diego County (Miner and Stokes, in prep.). However, two of these species, the Lesser long-nosed Bat (*Leptonycteris curasoae*) and the Little Brown Bat (*Myotis lucifugus*), are known only from single records (Constantine 1998, Bond 1977), and are likely vagrants. Therefore, 21 species are thought to reside in the County on a year-round basis, on a seasonal basis, or simply pass through during migration (Table 1).

Historically (prior to 1950), three bat species were documented from the Point Loma peninsula. The three species found were the Hoary Bat (*Lasiurus cinereus*), the Western Red Bat (*Lasiurus blossevillii*), and the California Myotis (*Myotis californicus*) (Krutzsch 1948). A more recent bat survey of the Point Loma peninsula conducted from 1994 to 1995 detected the presence of only a single bat species, the Western Mastiff Bat (*Eumops perotis*) (P. Brown pers. comm.). And, a Pocketed Free-tailed Bat (*Nyctinomops femorosaccus*) was found outside the Cabrillo National Monument visitor's center on October 1, 1998 (D. Stokes, unpub. data).

The relatively low number of bat species found historically on the Point Loma peninsula is probably to be expected based on the lack of suitable habitat features present that a rich bat population is apparently associated with in southern California. These features include native trees (such as cottonwoods, sycamores, oaks, willows, native palms, and conifers), riparian scrub vegetation, native scrub and grasslands, open fresh water, and exposed, fractured granitic and

meta-volcanic rocky outcrops (D. Stokes, pers. obs.). Although these habitats are absent from the Point Loma peninsula, historically there was connectivity to lands where these habitats were and are still present. Currently, Point Loma is isolated from these habitats as a result of urbanization. The nearest properties with a diversity of natural habitat features that are contiguous with a large area of undeveloped land occur approximately 15 kilometers away (Miramar Marine Corps Air Station/Mission Trails Regional Park).

STUDY AREA AND METHODS

Study Area

The Point Loma peninsula is located in southwestern San Diego County and is surrounded by the Pacific Ocean to the west, south, and east, and by urbanization to the north. The Cabrillo National Monument is the terminal point of the Point Loma peninsula and is part of the Point Loma Ecological Reserve. The predominant native plant communities found on the Point Loma peninsula include maritime succulent scrub, coastal sage scrub, and chaparral. There are also non-native shrub and tree species of varying size and structure found occurring on the Point Loma peninsula. Other habitat features found on the peninsula that may influence the presence of bat species include sandstone cliffs and caves, and man-made structures (such as historical observation bunkers and buildings, and artificial lights).

Methods

A total of 12 survey day/nights were spent at 21 sites on the Point Loma peninsula surveying for bats (Table 2; Figure 1). Three types of survey methods were used during this bat inventory: acoustic surveys, mist-net surveys, and roost searches. All data was collected on a hand-help computer. During acoustic and mist-net surveys weather data such as cloud cover, wind speed, air temperature, and relative humidity were recorded at the start and end of the surveys.

Acoustic Surveys

Acoustic surveys were used to detect and identify foraging or commuting bats. An Anabat II bat detector combined with a zero crossing analysis interface module (zcaim) connected to a laptop computer was utilized to record bat echolocation signals (O'Farrell et al. 1999). Monitoring for foraging bats using the Anabat was accomplished by placing an Anabat bat detector on a small table approximately 0.5 meters tall with the detector propped up at a 45-degree angle. The detector was placed facing towards an area of the surrounding habitat where bats were likely to be foraging or passing through; ideally, within the effective range of the detector (up to 30+ meters). The detector was connected to a laptop computer that allowed the researcher to view bat echolocation and social calls in real time through specialized Anabat software. The bat calls were recorded to the computer hard-drive and subsequently viewed and analyzed at a later time in the laboratory. The recorded calls were identified to the species level based on comparing the calls to a reference library of known calls. Known calls were obtained prior to this study by several ways: 1) by recording captured bats as they were released, 2) by recording previously identified bats as they exited from roosts, and 3) by visually observing bats that were identifiable on the wing while they were recorded with the bat detector. A detection confidence level was provided when making identifications based on echolocation calls. Several species produce calls that are readily identifiable by a researcher experienced with bat call analyses. These species can usually be identified with a high level of confidence unless the call sequence recorded is short and/or

fragmentary. Some species are not easily identified by their calls and several species have similar echolocation calls. These species are usually identified with a medium or even low confidence level unless there is other evidence to help bolster the identification confidence such as a visual observation of the bat while it is recorded with the bat detector (Corben and O'Farrell 1999). The unaided ear was also used to detect audible bat echolocation and social calls, which were also identifiable to the species level. Monitoring for foraging bats using the unaided ear was conducted simultaneously with the Anabat monitoring.

Acoustic surveys were conducted for a minimum period of three hours beginning at approximately sunset on 10 nights at three sites: the Bayside Trail bench, the Fort Rosecrans Cemetery, and the Coast Guard Station (Table 2). These three sites are relatively shielded from the electronic interference that is pervasive around the Point Loma peninsula. This interference originates from somewhere on the San Diego Bay side of the Point Loma peninsula, such as North Island Naval Air Station. This electronic "noise" interferes with the Anabat bat detector's ability to detect and record bat calls making it impossible to survey for bats in areas where the interference exists. Whether or not this interference affects bats' ability to echolocate is not known, but it is suspected that it does not. The interference is most likely electromagnetic in origin which does interfere with electronic equipment (such as bat detectors that are not properly shielded) but probably does not affect bats which are echolocating using sound waves.

Mist-net Surveys

Mist-nets are made from a mesh of fine synthetic materials (monofilament nylon, braided nylon, or braided Dacron polyester) supported by a framework of braided nylon or Dacron and a variable number of horizontal shelf cords. When properly deployed, a mist-net forms a capture area perpendicular to the ground that consists of the mesh area divided by the horizontal shelf cords that form long, horizontal net pockets. Bats are captured when they fly into the net and fall into one of the net pockets. Bats can be caught most effectively while exiting roost sites or when flying in confined spaces. If roost sites don't exist or are unknown within the survey area then netting effort should be directed toward areas where bats are expected to be commuting, foraging, or drinking (Kunz et al. 1996b). Mist-nets effectively sample only a small area of the space available to flying bats and some species rarely fly low enough to be captured. However, these high-flying species usually produce high amplitude echolocation calls that are readily detected acoustically. These complimentary techniques used together provide for an effective means of inventorying for bats (O'Farrell and Gannon 1999). Captured bats are processed and then immediately released. The information recorded during processing includes the species, age, tooth wear (estimate of age), sex, reproductive status, parasite load, general measurements, and any thing else noteworthy. In most cases, a digital camera is used to document the captured bat.

A single 2.6m x 18m mist-net was put up across the draw where the Bayside Trail bench is located (Table 2). It was left in place and monitored continuously for a three hour period, which began at approximately sunset.

Roost Searches

This technique was used primarily to document bat species that may be difficult to detect acoustically or via mist-net capture. Each search was conducted by looking into or entering potential bat roosts (usually using a flashlight) with the intent of finding roosting bats or bat "sign" including guano, culled insect parts, and urine staining. Certain bat species are more easily detected at roost sites (e.g., Mexican long-tongued bat [*Choeronycteris mexicana*]) than at commuting, foraging, or drinking sites (D. Stokes, pers. obs.). Therefore, this technique is used to

supplement acoustic and mist-netting survey methods, thus, resulting in a more thorough and complete bat inventory. Also, due to the significance of roosting sites to bat populations, locating, characterizing, and monitoring roosts are all critical factors contributing to bat conservation and management (Pierson 1998). Roost searches were conducted cautiously since roosting bats may be very sensitive to human disturbance (Kunz et al. 1996a). 18 different potential roost sites were surveyed at Point Loma on six dates covering two seasons: winter and summer (Table 2).

RESULTS

Acoustic Surveys

Acoustic surveys resulted in the detection of four bat species, the Western Red Bat (*Lasiurus blossevillii*), Mexican Free-tailed Bat (*Tadarida brasiliensis*), Big Brown Bat (*Eptesicus fuscus*), and Big Free-tailed Bat (*Nyctinomops macrotis*) (Table 3). Printed bat calls representative of the recorded species can be viewed in appendices 1-8. Digital images of the first three bat species listed above taken at other USGS survey sites in San Diego County can be viewed in figures 2-4. A digital image of the fourth bat species, the Big Free-tailed Bat, is not available as none have been captured during USGS county-wide surveys.

The Western Red Bat was recorded and identified with high confidence using the Anabat bat detector at the Bayside Trail bench on January 22, 2002 (Appendix 1). This species was also observed with a spotlight simultaneously as it was recorded with the bat detector at this site on this date. The Western Red Bat was also recorded and identified with high confidence at the Fort Rosecrans Cemetery on April 25 (Appendix 2), June 26 (Appendix 3), and August 14 (Appendix 4), 2002. On these three survey visits the Western Red Bat was also visually observed (in corona of fixed spotlights used to illuminate U.S. flag on site) while recorded with the Anabat. The Western Red Bat may also have been recorded with the Anabat at the Coast Guard Station on August 1, 2002 (Appendix 5), but was identified with a low confidence level based on the fact that only a very short call sequence (single call only) was recorded and no simultaneous visual observation was made.

A second species, the Mexican Free-tailed Bat, was recorded and identified with high confidence at the Fort Rosecrans Cemetery on August 14 (Appendix 6) and September 26 (Appendix 7), 2002. This species was also visually observed (in corona of fixed spotlights used to illuminate U.S. flag on site) while recorded with the Anabat.

A third species, the Big Brown Bat, may have been recorded at the Coast Guard Station on August 1, 2002 (Appendix 8). The call sequence recorded was relatively fragmented and no simultaneous visual observation of the bat was made, therefore, the species identification was made with low confidence.

Finally, a fourth species, the Big Free-tailed Bat, was heard with the unaided ear at the Bayside Trail bench on August 28, 2002. This bat was not recorded with the Anabat, nor was it observed visually while being detected audibly. This species' call resembles that of the Western Mastiff Bat (D. Stokes, pers. obs.), an audible species that has been heard during a previous bat survey of the Point Loma peninsula (P. Brown pers. com.). However, these two species' calls differ enough to distinguish them apart, especially when at close range (D. Stokes, pers. obs.). The bat heard during the 2002 survey was at a relatively close range and was identified as the Big Free-tailed Bat. However, it was identified with low confidence since it was not recorded with the Anabat

simultaneously and its call is similar enough to that of the Western Mastiff Bat that they could be confused with one another especially without being able to see the call represented graphically.

Mist-net Surveys

A single 2.6m x 18m net was employed at the Bayside Trail bench site on May 29, 2002 simultaneous with acoustic monitoring techniques (Table 4). The net was stretched across the canyon where the trail has a horseshoe bend in it. No bats were captured in the mist-net, nor were any detected acoustically at this site on this date.

Roost Surveys

The majority of the accessible man-made structures within the study area that might serve as bat roosts were inspected for the presence of roosting bats or indications that bats have roosted in them previously in the form of bat guano and urine staining (Table 5). These structures were visited at least once during the winter and at least once during the summer. No roosting bats were found in any of the surveyed structures during any visits. There were a few small droppings that contained insect parts found during the summer visit (August 28, 2002) to the generator station located along the Bayside Trail. These droppings may have been deposited by a bat, but it is possible they were deposited by a rodent that had eaten insects.

DISCUSSION

The bat species richness detected during this inventory of bats on the Point Loma peninsula was low (four of 21-23 species), but comparable to the richness known historically (Krutzsch 1948). The methods used during this study do not allow for accurate estimates of bat abundance. However, it is possible to make inferences about bat abundance in some instances.

The Western Red Bat belongs to the family vespertilionidae and the genus *Lasiurus*. Lasiurine bats are solitary, obligate foliage-roosting species that typically roost in various types of trees including non-native species. Lasiurines forage along wooded edges, often in riparian areas, and will feed opportunistically at artificial lights. They eat a variety of flying insect types but apparently predominately eat moths (Barbour and Davis 1969). The Western Red Bat is thought to reside year round in the County with most records occurring in the lower elevations on the western slopes (Krutzsch 1948, D.Stokes, unpub. data). Another Lasiurine bat, the Hoary Bat, is migratory but has been detected in San Diego County year round, though records from July and August are known only from upper elevations (Simons et al., in prep). A third bat from the genus *Lasiurus*, the Western Yellow Bat, typically roosts in the skirts of fan palm trees and is usually found in the deserts of San Diego County where the native fan palm *Washingtonia fellifera* occurs. However, the Western Yellow Bat has recently been detected in western parts of the County (Constantine 1998). It is likely that landscape use of fan palm species has created usable habitat for the Western Yellow Bat outside its normal range. All three of these tree-roosting species have been observed in urban and sub-urban areas of San Diego County and are apparently somewhat urban-adapted (D. Stokes unpub data). It is possible that these bats are presently occurring in the urban landscape that isolates Point Loma from the undeveloped, contiguous lands nearby.

While neither Hoary Bats nor Western Yellow Bats were detected during this inventory they both could possibly occur at Point Loma, but perhaps only sporadically and seasonally. The Western Red Bat was detected during this study at a minimum of two locations between January and August. The majority of the observations of this species (visual and acoustic) were made at the Fort Rosecrans Cemetery. At this site there are a variety of non-native tree species of different sizes and structure. There is also artificial lighting in the form of three fixed spotlights located on the ground that project beams of light upward illuminating a pole-mounted U.S. flag. The Western Red Bat was observed on several occasions (April 25, June 26, and August 14 2002) foraging around the spotlight beams for fairly extensive periods making numerous passes in pursuit of insects drawn to the artificial light. The other site where the Western Red Bat was detected with confidence was along the Bayside Trail. This trail winds its way along the contour of the southeastern side of the Point Loma peninsula and bends into a large draw where the native scrub vegetation is lush and of high structural diversity. Observations of the Western Red Bat were made here on one visit (January 22, 2002) in the form of three recorded echolocation sequences over a period of a few minutes; a visual observation with a hand-held spotlight occurred simultaneous with one of the Anabat recordings. The bat flew down the draw, briefly sallied for prey, and continued down the draw until it went out of sight. Based on all the Western Red Bat observations, combined with some knowledge of its ecology, it is thought that this species may utilize and possibly even be supported entirely by various habitats year-round on the Point Loma peninsula. This includes foraging over native scrub vegetation and at artificial lights to possibly roosting in large native shrubs and non-native trees. No more than one individual was observed at a time at any survey site when visual observations were possible. However, residents at the Coast Guard facility reported seeing two reddish colored bats, likely Western Red Bats, flying along Cabrillo Road just before sunrise one morning prior to this study. The low number of Western Red Bats observed at any one time at Point Loma and the limited available space and habitats on the Point Loma peninsula suggest that very few individuals of this species co-occur within the study area simultaneously.

The Big Brown Bat is a colonial species in the family vespertilionidae that roosts in a variety of habitat situations including man-made structures such as buildings and bridges. Big Brown Bats usually roost tucked into crevices or small cavities. They feed in a variety of habitats but seem to be highly associated with native woodlands in southern California (D. Stokes pers. obs.). They eat a variety of flying insects but apparently prefer flying beetles (Barbour and Davis 1969). The Big Brown Bat has been observed in urban and sub-urban environments in San Diego County (D. Stokes, unpub. data), but evidence suggests that this species might not persist in small, isolated fragments in Orange County (Remington 2000). It is possible that Big Brown Bats are presently occurring in the urban landscape that isolates the Point Loma peninsula from the undeveloped, contiguous lands nearby.

The Big Brown Bat was possibly detected (low confidence identification from Anabat recording) at the Coast Guard Station on August 1, 2002. While usually found foraging in native woodlands, this species' foraging needs may be partially or entirely supported by native scrub, non-native trees, and artificial lights. There is a Big Brown Bat colony that roosts seasonally in a building located approximately 15 kilometers from the Point Loma peninsula (D.Stokes, unpub data). It is possible that bats from this roost site (or another, unknown location) forage at the Point Loma peninsula periodically. No estimate of Big Brown Bat abundance at the Point Loma peninsula can be provided.

The other two bat species detected during this inventory, the Mexican Free-tailed Bat and Big Free-tailed Bat, along with the two species detected most recently at the Point Loma peninsula prior to this study, the Western Mastiff Bat, and Pocketed Free-tailed Bat, belong to the family

Molossidae or free-tailed bats. These species are morphologically and ecologically similar. They are all colonial species that typically roost in rock crevice and cliff habitats, though they are known to also occupy buildings. They have relatively long, narrow wings that are adapted for swift, long distance flight (Barbour and Davis 1969). They are known to forage in a variety of habitats and often feed over open areas including expanses of native scrublands (Pierson and Rainey 1998, K. Miner pers. comm.) and even at artificial lights (D. Stokes, pers. obs.). Molossids eat a variety of insects but generally prefer moths. The seasonal occurrence of these species in San Diego County is not fully understood; it is possible that all four occur year-round though most Big Free-tailed Bat observations are from fall, winter, and spring. During various other field studies in the County, the molossid species most frequently detected has been the Mexican Free-tailed Bat, whereas the least frequently detected species has been the Big Free-tailed Bat. The Pocketed Free-tailed Bat and Western Mastiff Bat have both been detected fairly frequently (Miner and Stokes, in prep). The Mexican Free-tailed Bat has been frequently observed in urban and sub-urban environments and appears to be one of the most urbanization-tolerant species in San Diego County. There is a Mexican Free-tailed Bat colony that exists approximately 15 kilometers from the Point Loma peninsula (D.Stokes, unpub data).

The observations of the free-tailed bats made during this inventory include high confidence detections (acoustic and visual) of the Mexican Free-tailed Bat on two different dates (August 14 and September 26 2002) at the Fort Rosecrans Cemetery, and a low confidence detection (acoustic) of the Big Free-tailed Bat at the Bayside Trail bench on a single date (August 28 2002). The Mexican Free-tailed Bat was visually observed at the Fort Rosecrans Cemetery foraging on insects drawn to the artificial light source on site (fixed spotlights). This species, like the Western Red Bat, foraged for extensive periods at the light source making numerous passes in pursuit of flying insects and was never seen in numbers greater than one. There were no Big Free-tailed Bat visual observations. A single individual of this species was heard echolocating continuously, coming from east of the Bayside Trail bench and flying up the draw until it was out of audible range. Observations of molossids at the Point Loma peninsula, combined with some knowledge of molossid ecology, indicate that some of the habitats present on the peninsula are supportive of these species. No more than one free-tailed bat individual was observed at any given time, indicating that, as with the Lasiurines, only a few individuals are likely to co-occur in the study area at any given time.

The lack of detections of any other bat species at the Point Loma peninsula, including the historically occurring California Myotis, may be simply a result of the limited scope and duration of this inventory effort. However, it is possible that the California Myotis and any other undetected bat species are either not supported by habitats found on the peninsula or are intolerant of urbanization and are not able to make the commute across the urban landscape to get to the Point Loma peninsula from undeveloped, contiguous areas found inland.

CONCLUSIONS

In summary, there are a variety of habitats occurring on the Point Loma peninsula that could support the roosting and foraging needs of bats. Habitats that could support roosting bats include natural features such as sandstone cliffs and caves, a limited amount of exposed granite, and large native shrubs, as well as artificial features created by man such as observation bunkers, buildings, and non-native trees. Foraging bats could be supported at Point Loma by naturally occurring habitats such as native scrub vegetation and artificially occurring habitats such as non-native plants, non-native trees, and artificial lights.

Although Point Loma is isolated from undeveloped, contiguous lands where a diversity of natural habitats occur there are certain species (Western Red Bat, Mexican Free-tailed Bat, Big Brown Bat) that appear to be urban adapted and are likely roosting and foraging in the urban landscape that connects Point Loma to those undeveloped lands. Other bat species that are less likely to roost in the urban landscape (Pocketed Free-tailed Bat, Big Free-tailed Bat, Western Mastiff Bat) are probably able to reach Point Loma during foraging commutes from inland roost sites. From a local perspective, Point Loma appears to serve as an important coastal haunt for a limited number of bats. From a larger perspective, Point Loma may serve as an important coastal stopover for migratory bat species such as the Hoary Bat and Silver-haired Bat (*Lasionycteris nocivagans*).

The results of this bat inventory of limited scope and duration conducted at the Point Loma peninsula indicate that there are a few bat species occurring there (Western Red Bat, Big Brown Bat, Mexican Free-tailed Bat, and Big Free-tailed Bat) and that they are making use of some habitats (artificial lights and native scrub). However, due to the limited scope and duration of this study, and the limitations of the bat survey methods employed, it is important to realize that some bat species may have gone undetected at the Point Loma peninsula. Furthermore, bat use of particular habitats may have gone unnoticed. To thoroughly know what bat species occur on the Point Loma peninsula, and better understand how they utilize available habitats, research of greater intensity and duration is needed.

FURTHER RESEARCH NEEDS

In order to have a better understanding of the bats that occur at Point Loma including how and when they might utilize the different habitats available to them it is recommended that several complimentary bat research methodologies are employed at Point Loma on a regular basis and over an extensive duration. The recommended methods and a tentative schedule of their use are described in the text that follows:

Acoustic methods

It is recommended that acoustic techniques be employed on a regular and standardized basis. Audibly listening for and identifying bats is a valuable technique that can provide for the detection and identification of bat species often undetected by bat detectors. However, use of this technique requires a person with bat expertise to be in the field the entire survey duration. Using an electronic bat detector such as an Anabat to monitor and record bat echolocation and social calls actively (or passively when connected to a memory storage device such as tape recorder, laptop computer, or even a compact flash memory card) is also a valuable technique used to survey for bats. Active monitoring with a bat detector also requires a person with bat expertise to be in the field the entire survey duration. Passive monitoring with a bat detector is limited to the use of a unit that allows for passive monitoring (i.e. Anabat), a power source for the detector/recording unit, memory space of the recording device, need for protection from exposure to water and extreme temperatures, and the need for a person with bat expertise to analyze any recorded bat calls. At the Point Loma peninsula, use of electronic bat detectors may also be limited to areas where the detectors are shielded from the electronic interference whose source is apparently bayside. Based on the powers and limits of these acoustic techniques the following procedures are recommended:

1. A passive monitoring device should be constructed. It is recommended that an Anabat II bat detector/zcaim with compact flash card unit powered by a deep cycle rechargeable

12-volt battery be placed in a waterproof box with a bent piece of pvc pipe connected to the box allowing for placement of detector microphone (O'Farrell 1998). It is recommended that the Anabat be set at the 16-division ratio, at a sensitivity of 8, and a volume level of 1 for passive monitoring. The compact flash zcaim can be set to turn the entire device on and off at particular times. This device (combination of equipment) can be placed in the field under a variety of environmental conditions and programmed to turn on at sunset and turn off at sunrise. It will record bat calls automatically limited only by a power source and memory space. Bat calls recorded to the compact flash card can then be downloaded to a computer and stored for future analysis For species identification, it is recommended that someone with at least three years of experience with the Anabat system analyze any recorded bat calls. Bat activity based on recorded bat calls can be quantified and nightly, seasonal, and habitat use patterns of bats can be determined if monitoring is scheduled appropriately.

2. The passive monitoring device(s) should be placed out in the field in a strategic location for recording bat calls. These locations can vary depending on what the research interests are. If trying to simply document bats, these locations should be in areas where bats are expected to be echolocating, such as foraging habitats (including artificial lights and native and non-native vegetation), and potential or known roost sites. If habitat use patterns of bats are of interest, then the placement of multiple devices in various habitats monitoring simultaneously could be effective. It is important that these areas are tested for electronic interference beforehand. The devices should not be placed where they detect interference or they will likely record nothing but interference.

3. Periodically, it is recommended that someone with experience with audible bat calls accompany the passive monitoring device in the field to determine if audible bats are present and if they are being recorded or undetected by the passive monitoring device.

Roost Searches

Periodic, regular inspections of potential bat roosts such as the observation bunkers and unused buildings present at the Point Loma peninsula are recommended. This is to 1) document bat species that may be occurring on site but are not detectable using other techniques and to 2) determine which of these structures, if any, are important to roosting bats and require management consideration. Roost searches can be accomplished by looking for roosting bats or bat sign (i.e. bat guano and urine staining) in accessible structures with a flashlight during the day or night. If bat droppings are found, plastic sheeting can be laid down to catch any future droppings and, if checked periodically and regularly, a use pattern can be determined. A person with bat experience is recommended for this duty since he/she will be able to recognize bats or bat sign. Some potential roosts, such as sandstone cliffs, will not be accessible to visual inspection. Without high-tech video recording equipment that can be left unattended these roost types can only be effectively surveyed by having a person actively monitor the potential roost site with their eyes (preferably using night vision equipment) to be able to visually verify that bats are actually exiting or entering the potential roost. Monitoring with an Anabat would also help the observer to identify any roosting bats as they exit or enter the roost.

Mist-nets and Harp traps

Both of these methods can be employed to catch bats and provide for accurate identification of species. Other information about bats such as age, sex, reproductive condition, and overall health of individuals, which are impossible to determine currently using acoustic techniques, can be obtained through capture. Mist-nets must be monitored continuously but harp traps can be deployed at sunset, left alone, and checked near sunrise. Use of capture techniques, however, requires that researchers be permitted by the California Department of Fish and Game to catch and handle bats. Therefore, it is recommended that capture techniques be employed only if a permitted, experienced bat researcher is available to do so on a periodic, regular basis. There are only a limited number of locations where use of capture techniques would likely be effective.

Periodic, regular, and standardized use of one or all three methods described above in future bat research efforts at Point Loma may reveal bat species and patterns of bat use that have gone undetected so far. A recommended survey schedule for use of the three methods is outlined below:

1. Passive monitoring devices should be placed at pre-determined locations and left to monitor from sunset to sunrise for four consecutive nights on a once-a-month basis; this can be done by staff or volunteers with some knowledge of effective use of bat detectors. Bat calls should be downloaded from the zcaim memory card to a computer hard drive after each retrieval of the device(s). This schedule will allow nightly and seasonal bat use patterns to be determined while being within limits of equipment (power source, memory space) and local staff's ability to operate (deploy, retrieve) equipment.

2. Listening for audible bat species while accompanying a passive monitoring device should be conducted by an experienced bat researcher for a minimum period of three hours beginning at sunset on a once-a-month basis, if available to do so. If once-a-month audible monitoring is not possible than another regular schedule should be chosen (once every two months, once every four months, etc) but it should always coincide with deployment of passive monitoring devices.

3. Roost searches of all accessible potential roosts should be conducted either by staff or volunteers but ideally by an experienced bat researcher. This should be done on a periodic, regular schedule such as once a month, once every three months, etc. The more frequent the visits the more likely bats will be detected and important roosts and seasonal roost use patterns identified.

4. The use of mist-nets and harp traps is recommended only if an experienced bat researcher is available to do so. This should be done for a minimum of three hours beginning at sunset on a once-a-month or similar basis (once every two months, every three months, etc).

All data should be collected, ideally, on a hand-held computer in a format compatible with the data collected during this inventory.

Future survey efforts should focus at least on habitats and areas surveyed during the USGS 2002 bat inventory of the Point Loma peninsula. There are other habitats and areas of the peninsula where future bat surveys would be warranted. The tree-roosting Lasiurine bats could possibly utilize any areas where trees or large shrubs are present, and so it is recommended that passive monitoring devices be placed to monitor potential bat activity in those areas. Free-tailed bats will forage over open scrub habitats (Pierson and Rainey 1998). The placement of passive monitoring devices in native scrub habitats is recommended to aid in documentation and monitoring free-

tailed bats at the Point Loma peninsula. Several types of insectivorous bat species can be found foraging at artificial lights in San Diego County (D. Stokes, pers. obs.). Therefore, it is recommended that passive monitoring devices be placed near artificial lights to monitor for foraging bats. It is suspected that the Mexican Long-tongued Bat feeds on the nectar and pollen of the blooms of the Shaw's Agave in San Diego County. This bat species is also known to roost in man-made structures (Krutzsch 1948). Therefore, it is recommended that the Cabrillo National Monument park staff monitor the Shaw's Agave on Point Loma for blooming activity. When the agaves are in bloom a passive monitoring device should be placed near the largest concentration of plants that are in bloom to monitor for feeding Mexican Long-tongued Bats. Ideally, a person should also watch (using night vision or sufficient back-lighting) for feeding bats at agaves since it is possible the bats could go undetected by bat detectors alone. Roost searches of man-made structures in the vicinity of blooming agaves are also recommended as part of the effort to document and locate Mexican Long-tongued Bats at the Point Loma peninsula.

There are a number of other research topics relating to bats in southern California that warrant investigation (Miner and Stokes, in prep.). Topics that have application at the Point Loma peninsula include the effects of artificial lights, habitat fragmentation, and non-native vegetation on bats. Radio telemetry studies of the Western Red Bat and the Mexican Free-tailed Bat are recommended to determine the extent of the use of habitats found at the Point Loma peninsula by these species and how their habitat use might compare or contrast with habitat use by these and other species outside the Point Loma peninsula. Continued monitoring of bats at the Point Loma peninsula will aid in the determination of status and distribution of bats locally and within a larger regional context.

MANAGEMENT RECOMMENDATIONS

One of the most important actions to help manage and conserve the bats of the Point Loma peninsula would be to educate all Cabrillo National Monument park staff (rangers, biologists, volunteers, maintenance workers, etc) and any contractors (construction workers, tree-trimmers, etc) about bats. They should be made aware of the fact that bats do occur at the Point Loma peninsula and specimens (alive or dead) may be encountered around the park and should be considered as valuable finds. For example, tree-trimmers often encounter Lasiurine bats (Western Red Bats, Hoary Bats, Western yellow Bats) when trimming trees and, out of fear and ignorance, the trimmers will kill or injure the bats they encounter. Any found specimen would be a valuable record to the Park database and should be handled carefully and stored appropriately so it can be identified and processed (assessment of age, sex, repro. status, collection of genetic material, etc) by a bat biologist. If a bat is found alive it should be collected carefully using thick gloves, a towel, or cloth rag and put in a small, covered but breathable cardboard box (i.e. shoe box) with some cloth material used as cover for the bat. A dead bat should be collected in the same manner but placed into a clear plastic bag and stored in a freezer. In no instances should any bat (dead or alive) be handled such that the person's bare skin comes into contact with the bat's teeth or claws because it could be rabid (if anyone is bitten or scratched by a bat the bat would have to be put down and tested for rabies by the County veterinarian and the person would likely have to undergo a post-exposure rabies vaccination series). Information regarding the date and location where the bat was found should be recorded. A bat biologist should then be contacted to identify/process the bat. The U.S. Geological Survey (USGS) is currently monitoring bats within the ecoregion and any information about bats gathered at Point Loma would be a valuable addition to the USGS bat database.

If bats were ever found in any of the observation bunkers or buildings at Point Loma then these structures would warrant immediate protection and management consideration. Most, if not all, of these structures are inaccessible to the public so there should not be any conflicts with bats and the public. However, these structures may need to be accessed by park staff or contractors. Information about the use of a particular structure by bats would have to be obtained in order to design an appropriate management plan that would facilitate protection of bats while allowing Park staff or contractors to carry out their duties.

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We are grateful to National Park Service staff members Samantha Weber and Andrea Compton for securing funding for our bat research at Point Loma and the Cabrillo National Monument. We are also thankful for field assistance provided by National Park Service staff members Andrea Compton, Tiffany Luas, Rebecca Clark, and Emily Jones and US Geological Survey field technicians Allan Hebbert and Denise Clark. This technical report benefited from comments provided by US Geological Survey biologist Chris Haas.

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Table 1. The Bats of San Diego County.
This table represents the four bat species detected at Point Loma during 2002 surveys of the 21 bat species known to occur in San Diego County.

The Bats of San Diego County

Bat Species			Legal Status*	Primary Detection Method at CNM		
Scientific name	Common name	Species Code	CSC, FSS, BLM	Capture	Visual	Acoustic
Macrotus californicus	California leaf-nosed bat	MACA	CSC, FSS, BLM			
Choeronycteris mexicana	Mexican long-tongued bat	CHME	CSC			
Myotis yumanensis	Yuma myotis	MYYU	BLM			
Myotis evotis	Long-eared myotis	MYEV	BLM			
Myotis thysanodes	Fringed myotis	MYTH	BLM			
Myotis volans	Long-legged myotis	MYVO	CSC*, BLM			
Myotis californicus	California myotis	MYCA	none			
Myotis ciliolabrum	Small-footed myotis	MYCI	BLM			
Lasionycteris noctivagans	Silver-haired bat	LANO	none			
Pipistrellus hesperus	Western pipistrelle	PIHE	none			
Eptesicus fuscus	Big brown bat	EPFU	none			X
Lasiurus blossevillii	Red bat	LABL	CSC*, FSS		X	X
Lasiurus xanthinus	Yellow bat	LAXA	CSC*			
Lasiurus cinereus	Hoary bat	LACI	none			
Euderma maculatum	Spotted bat	EUMA	CSC, BLM			
Corynorhinus townsendii	Townsend's big-eared bat	COTO	CSC, FSS, BLM			
Antrozous pallidus	Pallid bat	ANPA	CSC, FSS, BLM			
Tadarida brasiliensis	Mexican free-tailed bat	TABR	none		X	X
Nyctinomops femorosaccus	Pocketed free-tailed bat	NYFE	CSC			
Nyctinomops macrotis	Big free-tailed bat	NYMA	CSC			X
Eumops perotis	Western mastiff bat	EUPE	CSC, BLM			

* Legal status categories include California Species of Special Concern (CSC), species proposed to become California Species of Special Concern (CSC*, Betsy Bolster pers. comm.), Forest Service Sensitive (FSS), and Bureau of Land Management Sensitive (BLM). Source: Calif. Dept. of Fish and Game, Special Animals List, January 2000.

Table 2. Bat survey points.
This table represents the 2002 bat survey points at Point Loma including survey type, location name, approximate coordinates, and survey dates.

Survey Site Information			Approx. Coordinates (dec./deg., datum=WGS84)		
Point #	Survey Type	Location name	Lattitude	Longitude	Survey Dates (2002)
1	Roost	Battery Calef	32.67484	-117.23788	Jan 8, Aug 28
2	Roost	Battery Wilkerson	32.67484	-117.23788	Jan 8, Aug 28
3	Roost	Battery Woodward	32.67096	-117.24188	Jan 8, Aug 28
4	Roost	Battery Grant	32.67096	-117.24188	Jan 8, Aug 28
5	Roost	Battery Humphries	32.6706	-117.24145	Jan 8, Aug 28
6	Roost	Battery Mcgrath	32.67405	-117.23886	Jan 8, Aug 28
7	Roost	Billy Goat Bunkers	32.66825	-117.23749	Jan 8, Aug 28
8	Roost	Generator Station	32.67091	-117.23897	Jan 8, Aug 28
9	Roost	CNM maintenance building	32.67744	-117.24208	Jan 8, Aug 28
10	Roost	Sandstone Cave	32.67091	-117.23827	Jan 8, Aug 28
11	Roost	Searchlight bunker # 18	32.67044	-117.23845	Jan 8, Aug 28
12	Roost	Searchlight bunker # 19	32.67112	-117.23768	Jan 8, Aug 28
13	Roost	Battery Ashburn	32.67326	-117.24205	Jan 9, Aug 28
14	Roost	Coastguard-overlook bunkers	32.66798	-117.24062	Jan 9, Aug 28
15	Roost	Reflector Tower bunkers	32.69979	-117.2525	Jan 9 only
16	Roost	Woodward Road bunker	32.70033	-117.2537	Jan 9, Sep 26
17	Roost	Gatchell Road bunker	32.68718	-117.24808	Jan 22, Sep 26
18	Roost	Tidepool Road bunkers	32.66813	-117.2431	Jan 22, Sep 26
19	Acoustic	Coastguard Station	32.66585	-117.24212	Feb 19, Mar 19, Aug 1
20	Acoustic	Ft Rosecrans Cemetery	32.6886	-117.24543	Apr 25, Jun 26, Aug 14, Sep 26
21	Acoustic, Mist-net*	Bayside Trail Bench	32.67082	-117.23888	Jan 22, May 29*, Aug 28

Table 3. Acoustic surveys.
This table represents the acoustic surveys conducted at Point Loma including dates, locations, survey times, detected species, detection method, detection times, and detection confidences.

Survey date	Survey Location	Survey Type	Start Time	End Time	Bats Detected	Audible?	Visual?	Anabat?	Anabat File Time	Detection Confidence
Jan 22 2002	Bayside Trail Bench	Acoustic	1730 hrs	2030 hrs	Western red bat	No	Yes	Yes	1803.01	High
Feb 19 2002	Coastguard Station	Acoustic	1740 hrs	2055 hrs	none	n/a	n/a	n/a	n/a	n/a
Mar 19 2002	Coastguard Station	Acoustic	1810 hrs	2130 hrs	none	n/a	n/a	n/a	n/a	n/a
Apr 25 2002	Ft Rosecrans Cemetery	Acoustic	1945 hrs	2325 hrs	Western red bat	No	Yes	Yes	2047.43	High
May 29 2002	Bayside Trail Bench	Acoustic	1935 hrs	2302 hrs	none (Nighthawk observed)	n/a	n/a	n/a	n/a	n/a
June 26 2002	Ft Rosecrans Cemetery	Acoustic	1947 hrs	2300 hrs	Western red bat	No	Yes	Yes	2123.45	High
Aug 1 2002	Coastguard Station	Acoustic	1931 hrs	2251 hrs	Western red bat	No	No	Yes	1955.41	Low
Aug 1 2002	Coastguard Station	Acoustic	1931 hrs	2251 hrs	Big Brown Bat	No	No	Yes	2035.55	Low
Aug 14 2002	Ft Rosecrans Cemetery	Acoustic	1935 hrs	2313 hrs	Western red bat	No	Yes	Yes	2057.57	High
Aug 14 2002	Ft Rosecrans Cemetery	Acoustic	1935 hrs	2313 hrs	Mexican free-tailed bat	No	Yes	Yes	2223.29	High
Aug 28 2002	Bayside Trail Bench	Acoustic	1932 hrs	2232 hrs	Big free-tailed bat	Yes	No	No	n/a (audible at 2045)	Low
Sep 26 2002	Ft Rosecrans Cemetery	Acoustic	1845 hrs	2156 hrs	Mexican free-tailed bat	No	Yes	Yes	2047.04	High

Table 4. Mist-net surveys.
This table represents the mist-net surveys conducted at Point Loma including dates, locations, net dimensions, netting times, and captured bats including their age, sex, and reproductive status.

Pt Loma/Cabrillo National Monument Bat Mist-net Surveys

Survey date	Survey Location	Mist-net #	Net Dimensions	Start Time	End Time	Bats Captured	Age	Sex	Repro. Status
May 29 2002	Bayside Trail bench	1	2.6m x 18m	2000 hrs	2302 hrs	none	n/a	n/a	n/a

Table 5. Roost surveys.
This table represents the roost surveys conducted at Point Loma including dates, locations, survey type, survey results, and additional comments.

Pt Loma/Cabrillo National Monument Bat Roost Surveys

Survey Date	Survey Location	Survey Type	Survey Results	Additional Comments
Jan 8 2002	Battery Calef	Day Search	No bats or bat sign found	
Jan 8 2002	Battery Wilkerson	Day Search	No bats or bat sign found	
Jan 8 2002	Battery Woodward	Day Search	No bats or bat sign found	
Jan 8 2002	Battery Grant	Day Search	No bats or bat sign found	
Jan 8 2002	Battery Humphries	Day Search	n/a	Not accessible
Jan 8 2002	Battery Mcgrath	Day Search	No bats or bat sign found	
Jan 8 2002	Billy Goat Bunkers	Day Search	No bats or bat sign found	only 1 accessible
Jan 8 2002	Generator Station	Day Search	No bats or bat sign found	rodent droppings present
Jan 8 2002	CNM maintenance building	Day Search	No bats or bat sign found	
Jan 8 2002	Sandstone Cave	Day Search	No bats or bat sign found	
Jan 8 2002	Searchlight bunker # 18	Day Search	No bats or bat sign found	rodent droppings present
Jan 8 2002	Searchlight bunker # 19	Day Search	No bats or bat sign found	rodent droppings present
Jan 9 2002	Battery Ashburn	Day Search	No bats or bat sign found	
Jan 9 2002	Coastguard-overlook bunker	Day Search	No bats or bat sign found	
Jan 9 2002	Reflector Tower bunkers	Day Search	No bats or bat sign found	
Jan 9 2002	Woodward Road bunker	Day Search	No bats or bat sign found	
Jan 22 2002	Gatchell Road bunker	Day Search	No bats or bat sign found	carnivore scat present
Jan 22 2002	Tidepool Road bunkers	Day Search	No bats or bat sign found	Neotoma nests present
May 29 2002	Sandstone Cave	Day Search	No bats or bat sign found	
May 29 2002	Sandstone Cave	Night Search	No bats or bat sign found	
Aug 28 2002	Battery Calef	Day Search	No bats or bat sign found	
Aug 28 2002	Battery Wilkerson	Day Search	No bats or bat sign found	
Aug 28 2002	Battery Woodward	Day Search	No bats or bat sign found	
Aug 28 2002	Battery Grant	Day Search	No bats or bat sign found	
Aug 28 2002	Battery Humphries	Day Search	n/a	Not accessible
Aug 28 2002	Battery Mcgrath	Day Search	No bats or bat sign found	
Aug 28 2002	Billy Goat Bunkers	Day Search	No bats or bat sign found	
Aug 28 2002	Generator Station	Day Search	No bats or bat sign found	small, insect-filled droppings present
Aug 28 2002	Sandstone Cave	Day Search	No bats or bat sign found	
Aug 28 2002	Searchlight bunker # 18	Day Search	No bats or bat sign found	rodent droppings present
Aug 28 2002	Searchlight bunker # 19	Day Search	No bats or bat sign found	rodent droppings present
Aug 28 2002	Battery Ashburn	Day Search	No bats or bat sign found	
Aug 28 2002	Coastguard-overlook bunker	Day Search	No bats or bat sign found	
Sep 26 2002	Woodward Road bunker	Day Search	No bats or bat sign found	
Sep 26 2002	Gatchell Road bunker	Day Search	No bats or bat sign found	carnivore scat present
Sep 26 2002	Tidepool Road bunkers	Day Search	No bats or bat sign found	Neotoma nests present

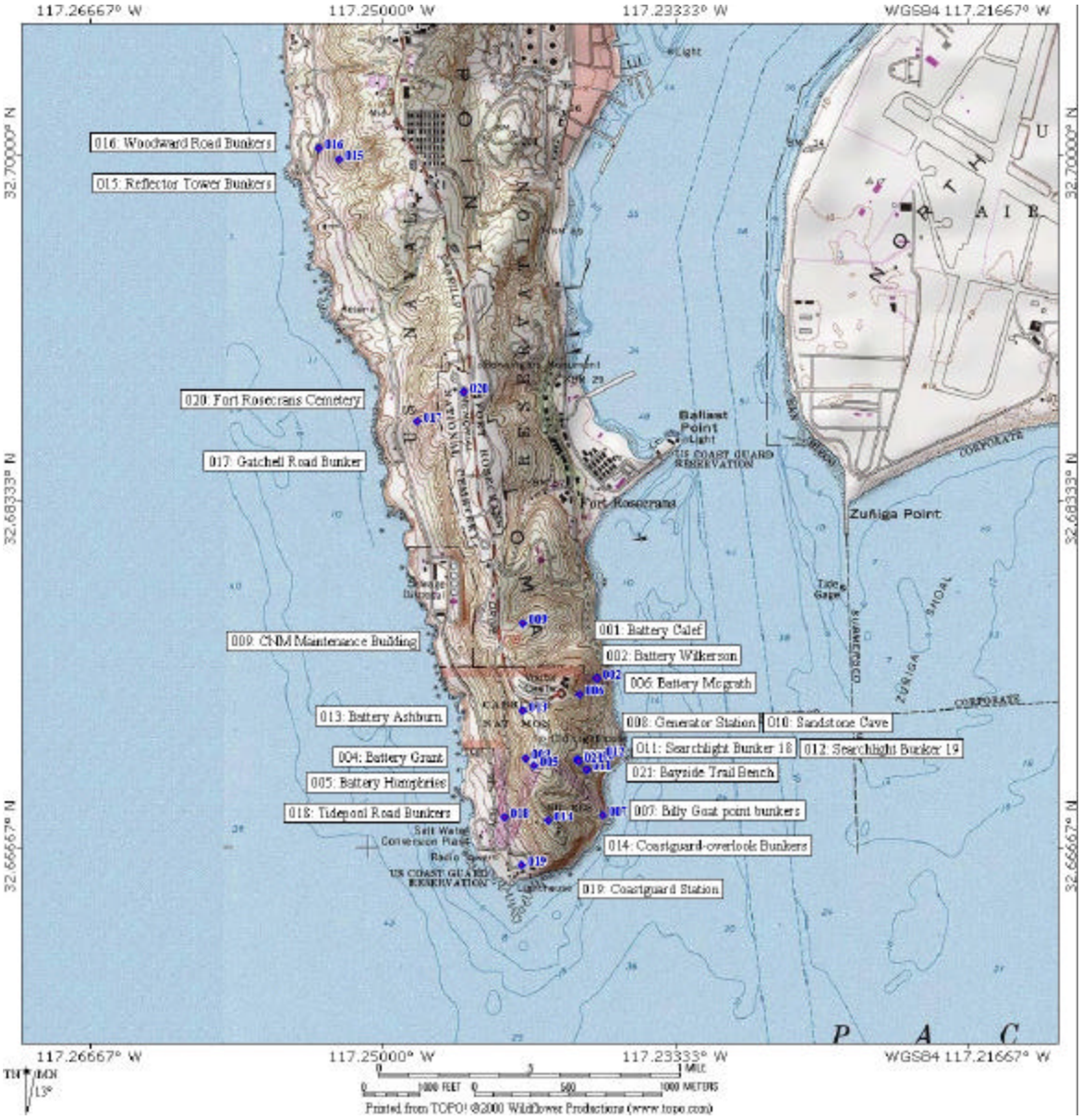
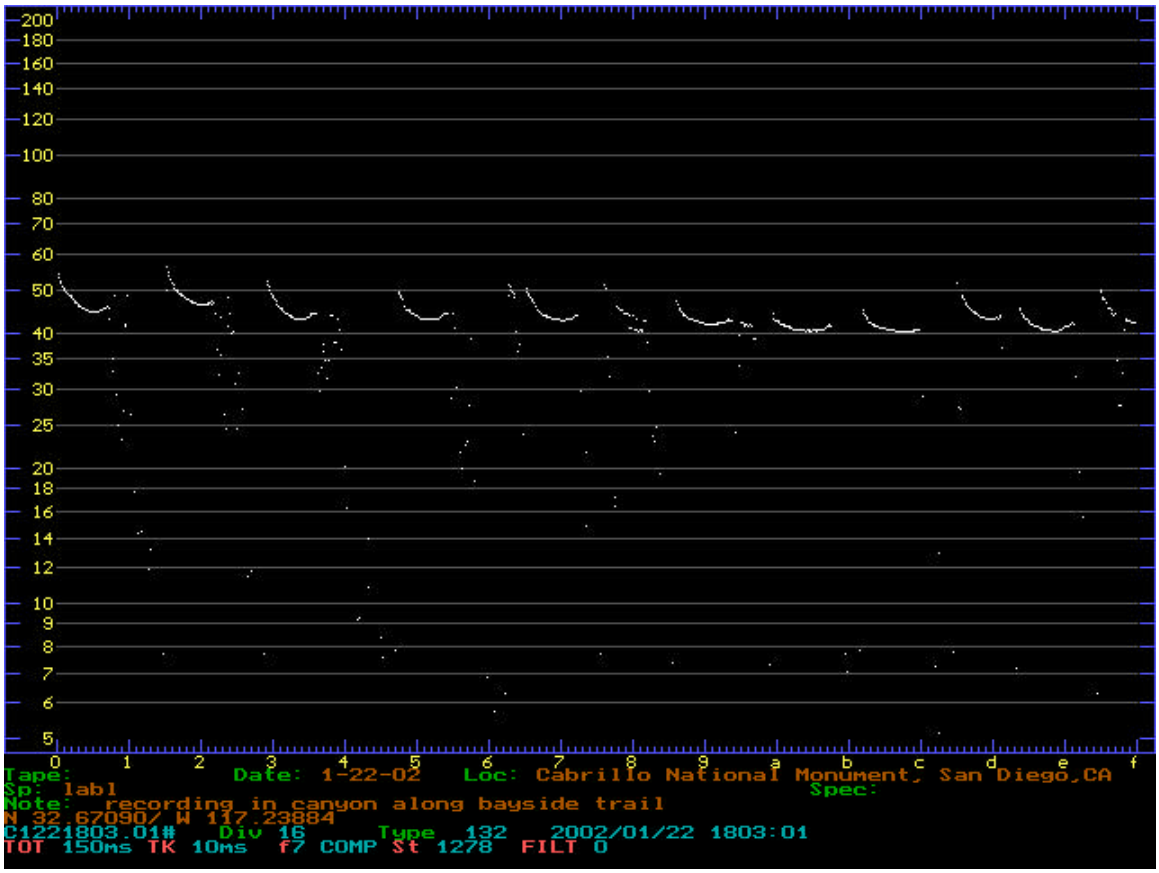


Figure 1. Map of 2002 Point Loma bat inventory area.

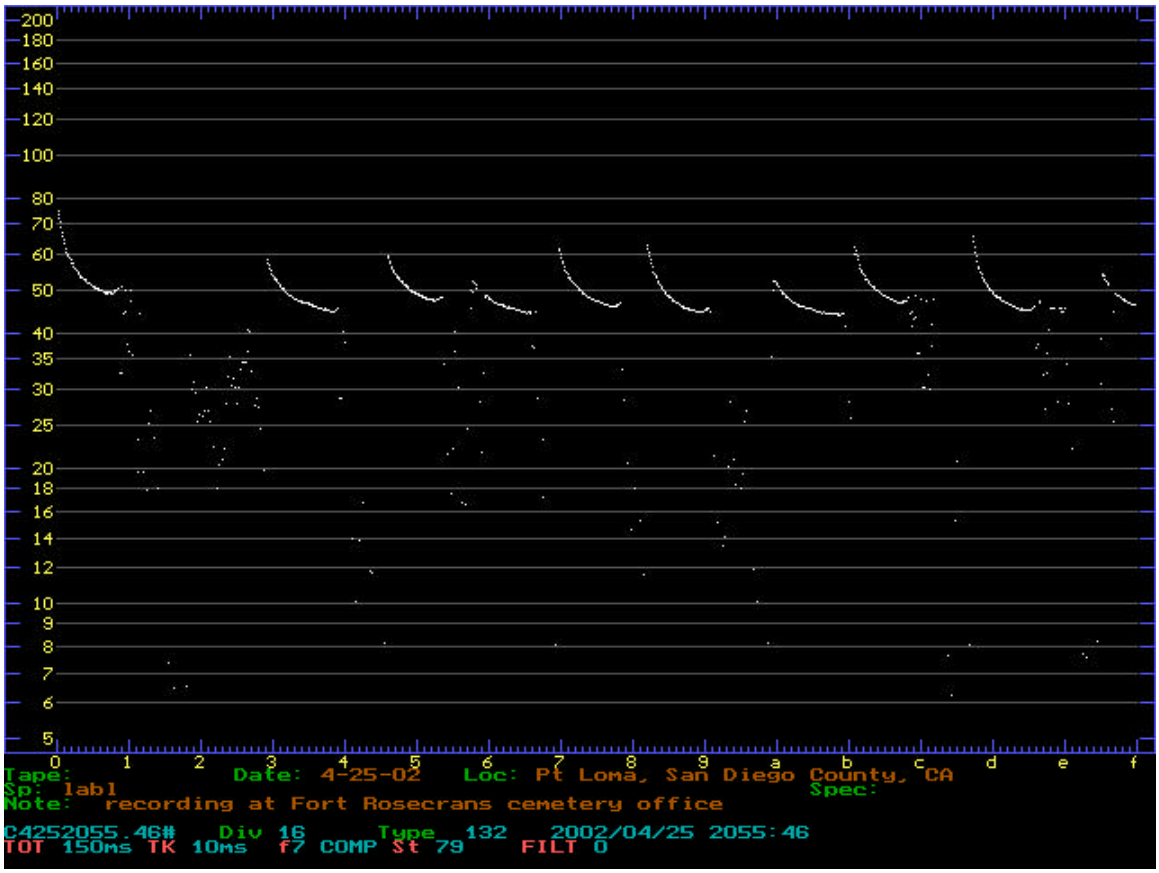
Figure 2. A photo of a Western Red Bat *Lasiurus blossevillii* taken by Cheryl Brehme/USGS

Figure 3. A photo of a Big Brown Bat *Eptesicus fuscus* taken by Cheryl Brehme/USGS.

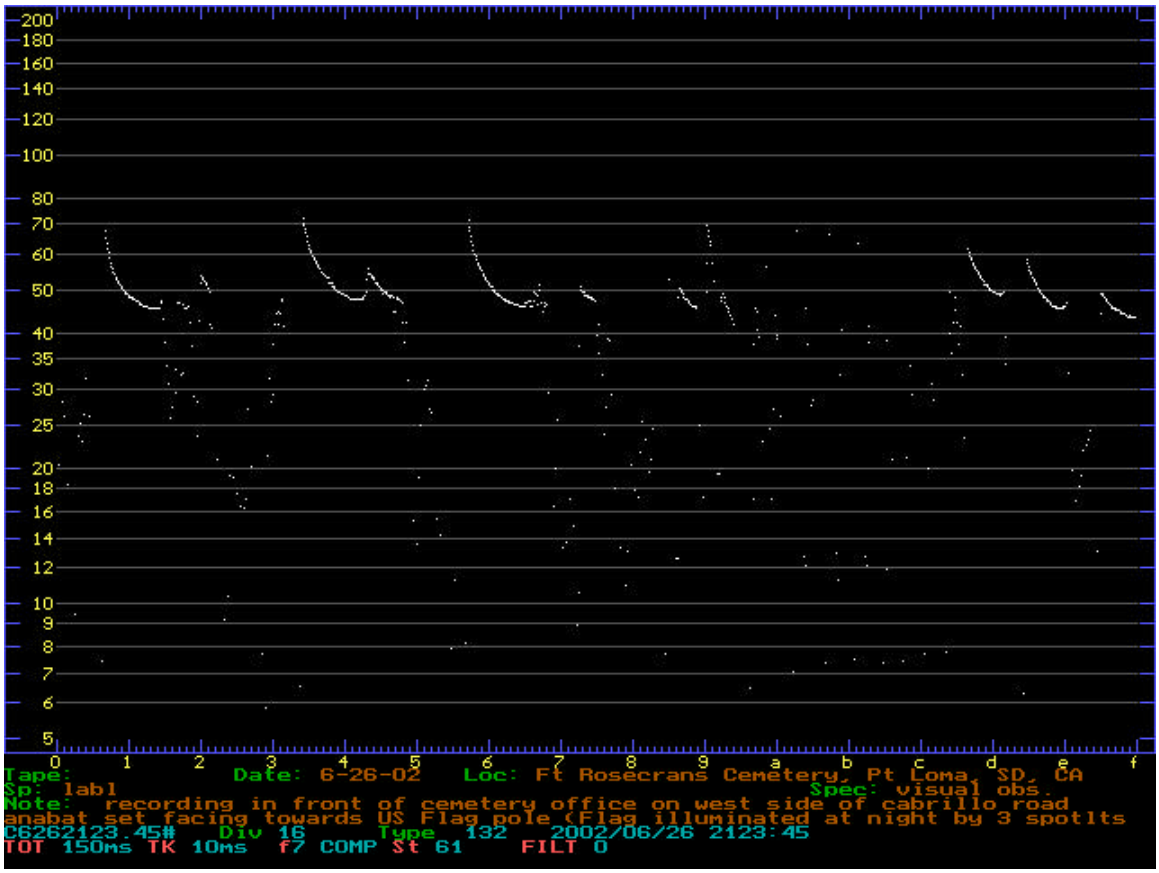
Figure 4. A photo of a Mexican Free-tailed Bat *Tadarida brasiliensis* taken by Drew Stokes/USGS.



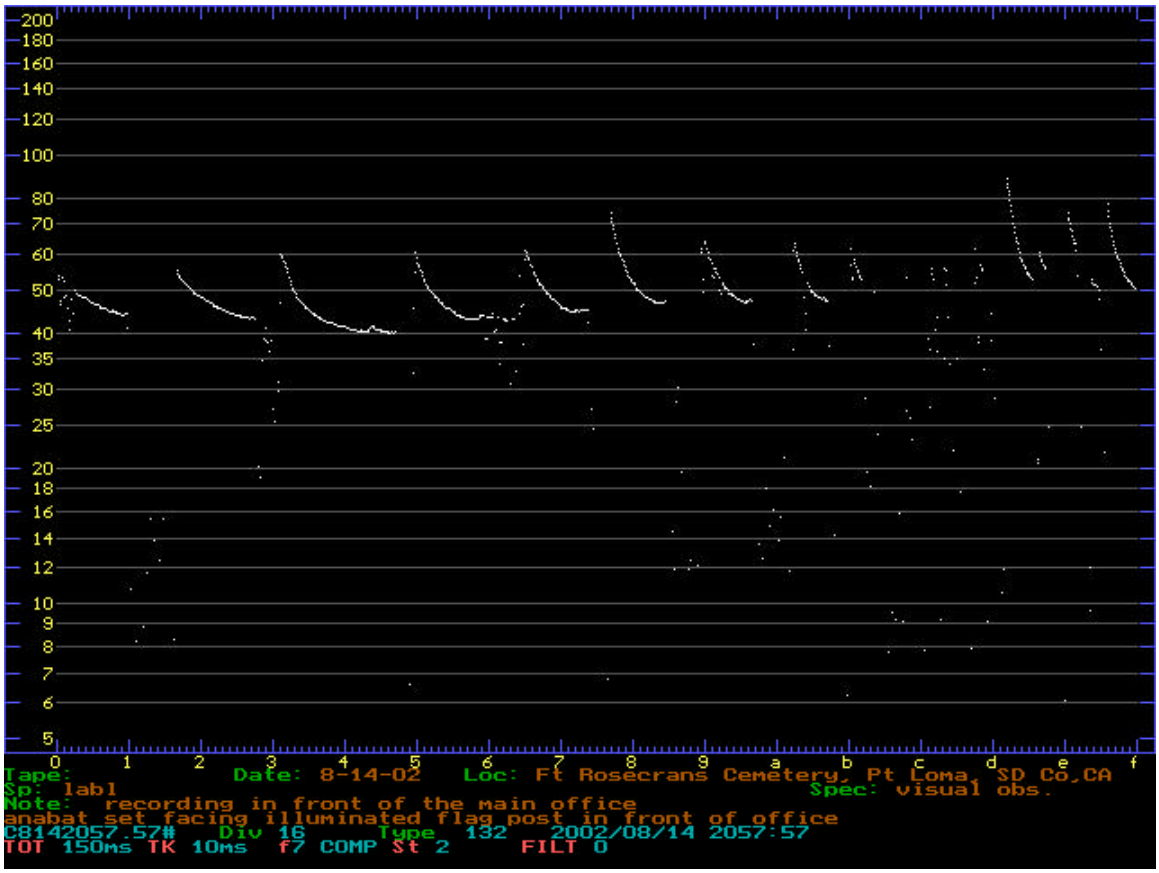
Appendix 1. A screenshot of a Western Red Bat call sequence.
Sequence recorded with an Anabat II bat detector at the Bayside Trail bench on January 22, 2002. This screenshot was taken from the call analysis program Analook version 4.8p.



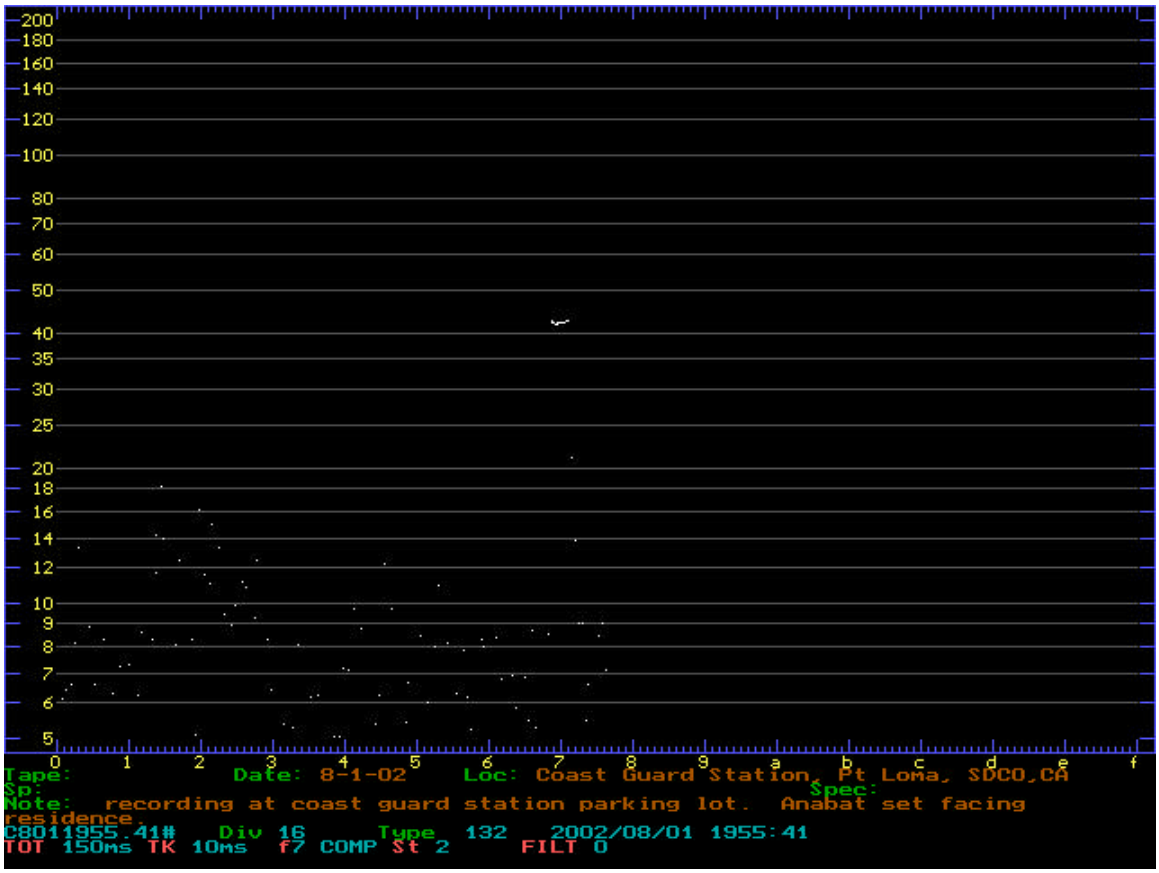
Appendix 2. A screenshot of a Western Red Bat call sequence.
Sequence recorded with an Anabat II bat detector at the Fort Rosecrans Cemetery on April 25, 2002. This screenshot was taken from the call analysis program Analook version 4.8p.



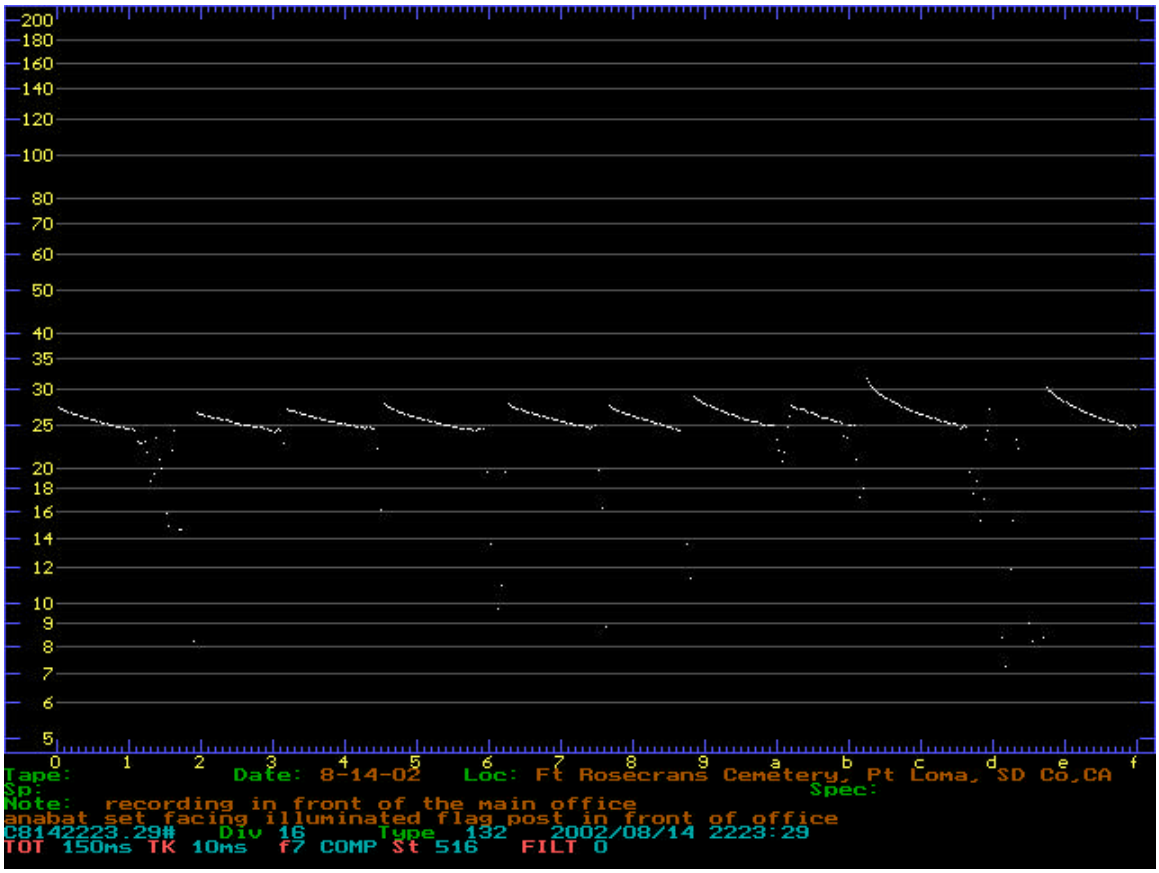
Appendix 3. A screenshot of a Western Red Bat call sequence.
Sequence recorded with an Anabat II bat detector at the Fort Rosecrans Cemetery on June 26, 2002. This screenshot was taken from the call analysis program Analook version 4.8p.



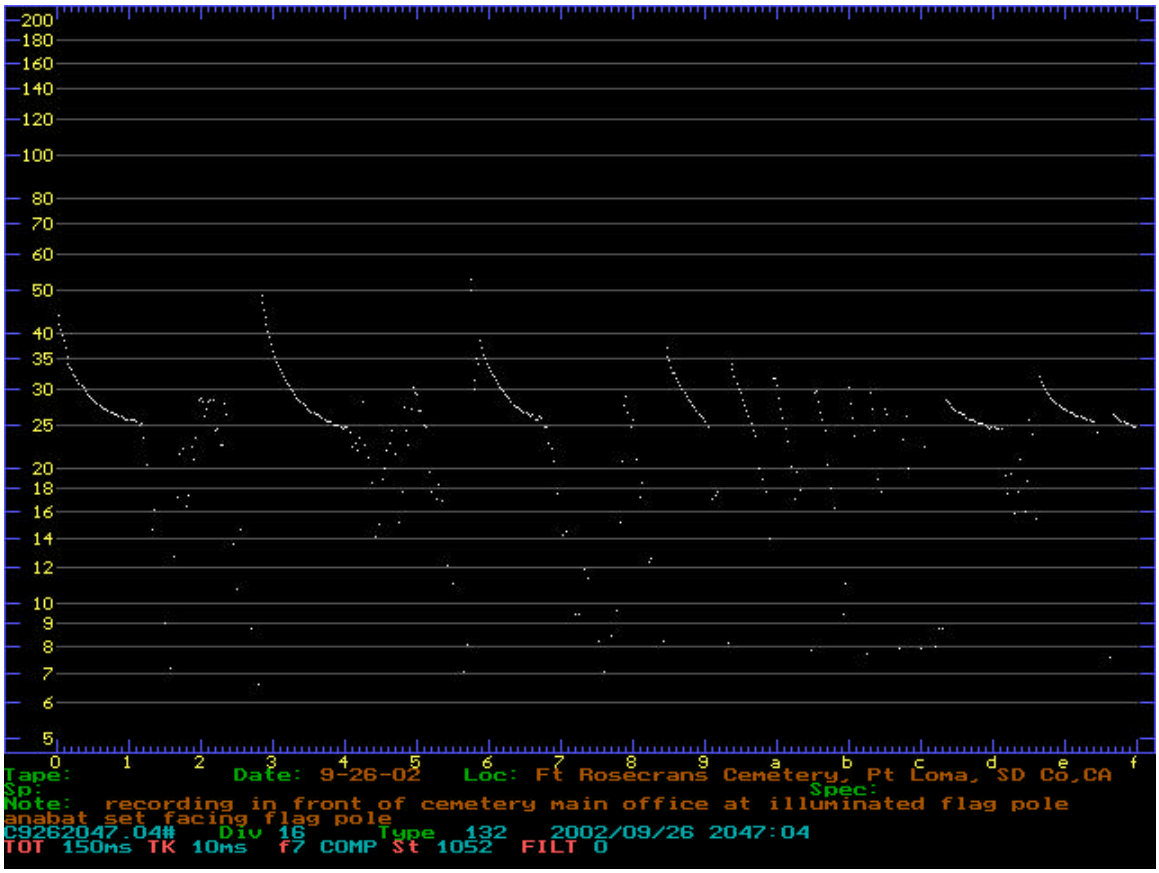
Appendix 4. A screenshot of a Western Red Bat call sequence.
Sequence recorded with an Anabat II bat detector at the Fort Rosecrans Cemetery on August 14, 2002. This screenshot was taken from the call analysis program Analook version 4.8p.



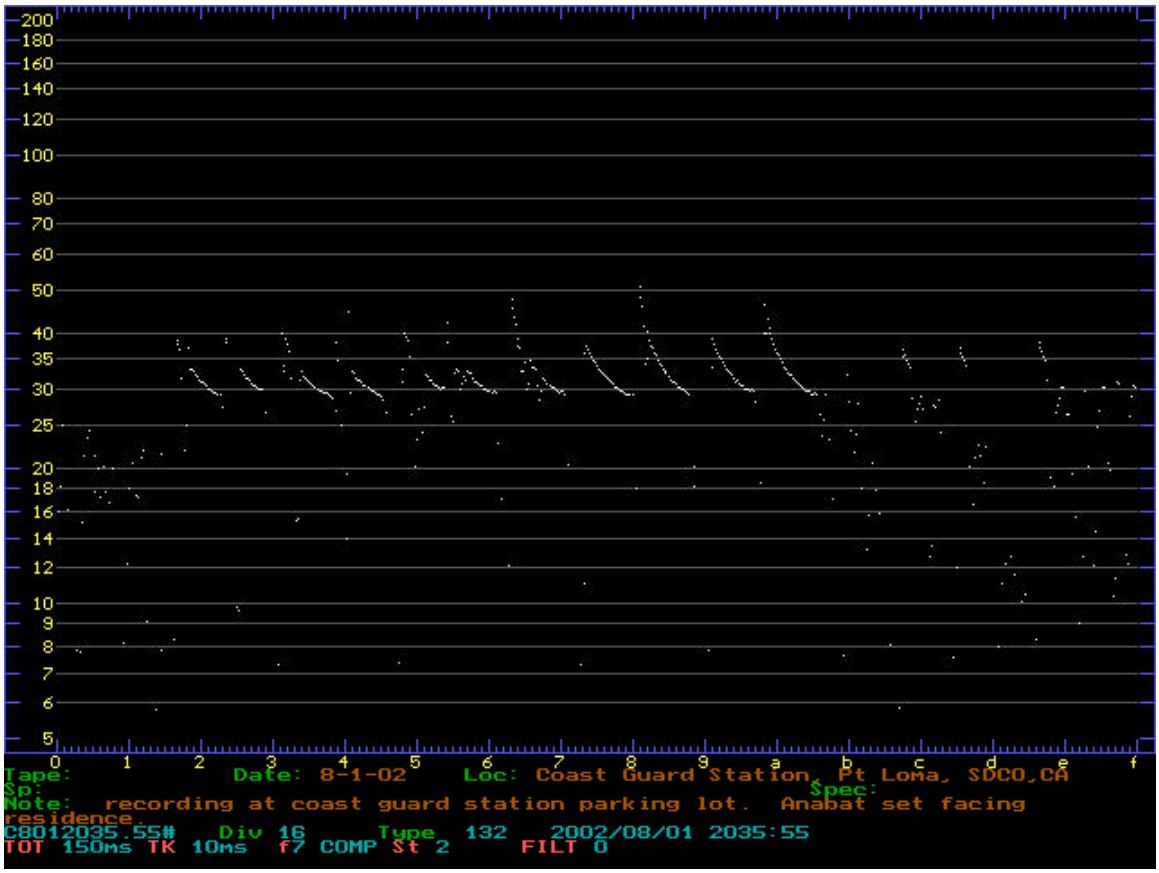
Appendix 5. A screenshot of what could be a single Western Red Bat call.
Call recorded with an Anabat II bat detector at the Coastguard Station on August 1, 2002. This screenshot was taken from the call analysis program Analook version 4.8p.



Appendix 6. A screenshot of a Mexican Free-tailed Bat call sequence.
Sequence recorded with an Anabat II bat detector at the Fort Rosecrans Cemetery on August 14, 2002. This screenshot was taken from the call analysis program Analook version 4.8p.



Appendix 7. A screenshot of a Mexican Free-tailed Bat call sequence.
Sequence recorded with an Anabat II bat detector at the Fort Rosecrans Cemetery on September 26, 2002. In this sequence the approach phase, "feeding buzz" phase, and search phase portions of the bats' call are represented in order. This screenshot was taken from the call analysis program Analook version 4.8p.



Appendix 8. A screenshot of a suspected Big Brown Bat call sequence.
Sequence recorded with an Anabat II bat detector at the Coastguard Station on August 1, 2002. This screenshot was taken from the call analysis program Analook version 4.8p.