

**PRELIMINARY SURVEYS FOR BAT SPECIES AT
DEVILS POSTPILE NATIONAL MONUMENT**

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10 June 2002

1.0 INTRODUCTION

A review of existing literature (Allen 1919, Barbour and Davis 1969, Constantine 1998, Dial et al. 1979, Grinnell 1913, 1916 & 1918, Hall 1981, Lengas and Bumpus 1992 & 1993, Pierson and Heady 1996, Pierson and Rainey 1998b) and museum records for the Sierra Nevada reveals that there are very few bat records for the portions of this mountain range that include Sequoia and Kings Canyon National Parks and Devils Postpile National Monument. Joseph Grinnell's extensive work in the 1920's focused on transects through Yosemite and Lassen National Parks (Grinnell and Storer 1924, Grinnell et al. 1930), and did not include the southern Sierra Nevada. Since these early faunal surveys did not have the current survey tools (e.g., mist nets, bat detectors, night vision devices) available to them, and were largely based on shooting at dusk with a shotgun, the number of bats collected was relatively limited. On the Yosemite transect, for example, only nine species were collected (Grinnell and Storer 1924).

Based on what is known regarding the distribution and habitat of California's twenty-five species, seventeen would be expected to occur in Sequoia and Kings Canyon National Parks, and between thirteen and seventeen in Devils Postpile National Monument (Table 1).

This document provides the results of initial bat surveys conducted at Devils Postpile National Monument on 23 and 24 August 2001. These surveys were intended to provide baseline information necessary for designing and implementing a more comprehensive inventory of the bat fauna in the Monument. Recommendations regarding additional surveys are provided.

2.0 METHODS

2.1. MUSEUM AND LITERATURE RECORDS

To examine background information on the recent and historic distribution of bat species in the vicinity (within a 30 km radius) of Devils Postpile National Monument, we reviewed literature on bat distribution in this region of California (Grinnell 1918, Pierson and Rainey 1998a,b & c, O'Farrell 1981, Rainey and Pierson 1996, Szewczak et al. 1998), and examined the records for 39 museum collections in the United States and Canada.

2.2. STUDY SITE

Devils Postpile National Monument is a 324-ha (798-acre) park, located near the Sierra Nevada crest in Madera County. Elevations range from ca. 2,200 to ca. 2,500 m. The Middle Fork San Joaquin River flows through the Monument, from north to south, forming a fairly narrow valley dominated by red fir and lodgepole pine. Along the Middle Fork of the San Joaquin River, typical montane riparian vegetation dominates, represented by quaking aspen, black cottonwood, alder and willows. Both dry and wet montane meadows occur in the Monument, as do scattered shallow ponds.

2.4. MIST NET SURVEYS AND CAPTURE TECHNIQUES

Mist net surveys followed the procedures outlined by Kunz and Kurta (1988) -- 1.5 inch mesh black nylon or polyester mist nets of a size appropriate to the location (heights of 7' or 10'; lengths of 18', 30', 42' and 60') were set on sectional poles in foraging areas. Given that near ground bat activity is typically greatest in association with slowly moving or still surface water (Grindal et al. 1999, Pierson et al. 2001), mist nets were set primarily over water sources (the river, a sag pond, and a wet meadow), or in potential flyways (along trails or in openings in the riparian corridor). Geographical coordinates for sampling sites were collected in decimal degrees (Datum: NAD27 CONUS), using hand-held GPS units (Garmin 12XL).

On-site processing of netted bats involved species identification (see van Zyll de Jong 1985 for keys); measurement of the forearm with digital calipers; assessment of age class (adult, juvenile) from ossification of the metacarpal phalangeal joints (Anthony 1988); determination of sex and reproductive condition. For females reproductive condition was evaluated by examining nipples for evidence of recent or current lactation (e.g., nipple development, presence of milk [by expression], and loss of hair). For males, characterization of reproductive condition involved examination of the testes and checking epididymal tissue for pigmentation or distention.

2.5. ACOUSTIC SURVEYS

2.5.1. Acoustic Equipment

Acoustic sampling was conducted by using broad band frequency dividing Anabat detectors (Titley Electronics, Ballina, NSW, Australia) coupled to laptop computers via zero-crossing analyzers (zcaims). Because bat species echolocating in the audible range were likely to be present, the detectors were fitted with low frequency transducers that are more sensitive in the upper audible range than the normal transducers. Ultrasound detections were stored as files on the computer hard drive for later analysis. Additional acoustic data was gathered at selected sites and at releases of captured bats with a Pettersson D980 detector recording both the frequency division and time expansion outputs on DAT tapes.

2.5.2. Survey Design

Two recent acoustic studies (Hayes 1997, Ballantyne and Sherwin 1999) indicate that night to night variation in bat activity is sufficiently high that valid comparative data can be obtained only by many nights of repeat sampling at the same sites or by establishing multiple survey points that are sampled concurrently. Given the limited prior data and budget/time constraints for this study, we chose the latter approach, sampling a relatively large number of sites (5 to 10) simultaneously for two consecutive nights (Appendix I).

Acoustic stations were established in the vicinity of potential roost sites (e.g., the Postpile and below the Buttresses), and in expected foraging areas (e.g., river, pond, wet meadow, forest edge). Remote monitoring stations were started prior to sunset, and run for 3 to 5 hours after sunset. Monitoring time was measured from sunset (when the detector was set up prior to sunset) or from actual deployment time (if after sunset) until the time the detector was collected.

2.5.3. Acoustic Identification of Species

The effectiveness of acoustic surveys for locating and identifying bats depends on two parameters: 1) how readily a bat can be detected, and 2) with what degree of reliability it can be identified once detected. Detectability is a function of call frequency, call intensity and distance. In general, those species with low frequency, high intensity calls will be detected at the greatest distance. Detection of bat species which call in the audible range (<20 kHz) is lessened, however, by filters in the detectors designed to reduce extraneous noise from insects, wind, etc.

Identifying bat species based on echolocation calls relies on analysis of a number of call parameters including base frequency, call shape (slope as measured in octaves per second and overall pattern), pattern of calls within a sequence, interpulse interval, and call duration.

For some species, particular combinations of call characteristics allow them to be readily distinguished from all other taxa that might occur in a survey area. Basic knowledge of the species expected is important because some species could be readily distinguished from all other local species in one area and not in another.

Conducting bat acoustic surveys generally requires knowledge not only of the species specific call characteristics, but also of the biology and ecology of the species involved. For the 17 species that were most likely to occur in the study area, there are nine that can typically be identified from Anabat call sequences alone, and 8 for which identification is frequently problematic. Of the nine that can be identified, there are two species for which bat detectors are relatively less effective: *Corynorhinus townsendii* because the detection radius for their low intensity calls is limited, and *Euderma maculatum* because their calls are of sufficiently low frequency that the Anabat system with a normal transducer may fail to detect or recognize them. The seven species that can be readily identified using the Anabat system are: *Antrozous pallidus*, *Eumops perotis*, *Lasiurus blossevillei*, *Lasiurus cinereus*, *Myotis evotis*, *Myotis thysanodes*, and *Pipistrellus hesperus*. While *E. perotis* is also an audible frequency bat, its call is of sufficiently high intensity that it is commonly detected even with the low frequency roll-off of the normal Anabat transducer.

Identification based solely on echolocation calls is problematic for three sets of taxa. *Eptesicus fuscus*, *Lasionycteris noctivagans*, and *Tadarida brasiliensis* produce similar echolocation calls in a frequency range of between 20 kHz and 30 KHz. Although all three (especially *T. brasiliensis*) do produce some sequences that are diagnostic, a large percentage of calls in this frequency range cannot be assigned to a species using Anabat unless the animal has also been visually observed.

Likewise, *Myotis californicus* and *Myotis yumanensis*, both of which give echolocation calls with a characteristic frequency of ca. 45-50 KHz, can be difficult to distinguish based on call structure alone, although some calls of each species appear to be diagnostic. If visual observation is possible, differences in flight style and foraging behavior often serve to distinguish these species -- e.g., *M. yumanensis* commonly forage by skimming the water surface and *M. californicus* often forage along an irregular flight path in close association with vegetation, often at canopy height. No attempt was made to distinguish between these two species for passive

acoustic data. However, since most of 50 kHz calls were obtained by detectors aimed near the water surface, we presume that nearly all of these calls were *M. yumanensis*.

Another currently unresolved group includes three *Myotis* species (*M. ciliolabrum*, *M. lucifugus*, and *M. volans*) that have characteristic frequencies of 35-45 KHz. Although visual observations of body size and flight behavior can sometimes serve to distinguish these species, all three are sufficiently poorly known in California that there are many situations in which positive identification of animals in flight is also very difficult. In this study it was sometimes possible to identify *M. volans* by its flight patterns. Nevertheless, for the purposes of acoustic analysis, all echolocation calls in the 40 kHz range are treated as 40 kHz *Myotis*.

2.5.4. Analysis of Acoustic Data

Acoustic data were collected primarily with Anabat detectors, using a frequency division ratio of 16. Outputs were processed in real time by a zero crossing analyzer coupled to the parallel port of a battery powered laptop computer running under DOS. The signals were stored as Anabat6 files. Signal capture was either triggered manually by an active observer or passively by an adjustable call recognition algorithm in the software. The algorithm, as used, requires recognition of two bat calls to save a sequence file. Under low to moderate levels of bat activity, a file ends five seconds after the last bat call or 15 seconds after the initial call. A single file may contain two to a few hundred individual bat calls from one or more bats.

Anabat sequence files currently have a fixed maximum size, so that under intense bat activity that file size may be reached in less than 15 seconds (e.g., ten sequences per minute rather than 6). Thus while numbers of sequence files are a convenient measure of relative detection rates among species and localities, time duration of the sampling unit may vary with bat activity. For more detailed activity level comparisons, the program Analook can be used to display and visually count individual calls (or pulses) or the program will count calls based on user-constructed filters which include criteria for call traits (frequency, slope, duration, etc.)

For this analysis we have visually examined and manually entered assignments to individual taxa (or multi-species acoustic categories) for all sequence files except that sequence file counts of 40 and 50 kHz *Myotis* were obtained by software filters. Numerical values in subsequent comparisons are based on numbers of sequence files.

3.0 RESULTS AND DISCUSSION

3.1. OVERALL BAT DIVERSITY

3.1.1. Existing Records

A survey of the literature and existing museum records revealed no bat records for Devils Postpile National Monument (Table 1). We identified 19 records for eight species in an area within an approximately 30 km radius of the monument (Table 1, Appendix II). Ten of these records identify the locality as Mammoth or Mammoth Lakes. The two localities closest to the

Monument are for *Eptesicus fuscus* from Cascade Valley and the San Joaquin River, 12 miles WNW of Mammoth.

3.1.2. This Study

Ten bat species were identified in a two night survey conducted on 23-24 August 2001 (Table 2). Seven were captured in mist nets; three others were identified only acoustically. This assemblage constitutes 59 % of the species that are expected to occur in the Monument. Five species have special concern status with California Department of Fish and Game, the U.S. Forest Service, or the U.S. Fish and Wildlife Service (Table 1): the spotted bat, *Euderma maculatum* (MSSC, SC); the western mastiff bat, *Eumops perotis* (MSSC, SC); the long-eared myotis, *Myotis evotis* (SC); the long-legged myotis, *Myotis volans* (MSSC*, SC); and the Yuma myotis, *Myotis yumanensis* (SC).

An additional special status species, the pallid bat, *Antrozous pallidus* (FSS, MSSC) was tentatively identified as occurring at the site based on an acoustic record.

3.1.3. Capture Surveys

Table 3 summarizes the capture data for mist net surveys. Three habitats were sampled: the river (2 sites), a shallow pond, and a wet seep. The shallow pond was the most productive site, yielding 73 % of all animals captured.

Seven of the 10 species known to occur in the project area were captured. The big brown bat, *Eptesicus fuscus*, was by far the most commonly encountered (52 % of all captures). Sample sizes were too small in this preliminary survey to comment on relative abundance of the other six species. Multiple individuals were captured for all except the hoary bat, *Lasiurus cinereus*.

Table 4 provides age and reproductive data on all captured animals. Post-lactating females were identified for 4 species: *Eptesicus fuscus*, *Lasiurus cinereus*, *Myotis evotis*, and *Myotis lucifugus*. Juveniles were present for four species: *E. fuscus*, *M. lucifugus*, *Myotis volans* and *Myotis yumanensis*. Only adult males were captured for *Lasionycteris noctivagans*.

This study was conducted too late in the season to determine how many of these species have maternity roosts in this area. A study that followed an altitudinal transect from Oakdale to Tioga Pass (along SR120 and Tioga Road [Pierson et al., 2001]) found indications that some species move upslope in the late summer and early fall, after the young are flying and relatively independent. The most significant capture record was the post-lactating *L. cinereus*. There are no records for this species raising young in California, and very few records of reproductive females. Studies conducted in southern California (Vaughan and Krutzsch 1954), along the coast (Tenaza 1966), in the Central Valley (Pierson et al. 2000) and along the Pit River (Pierson and Rainey 2001) have documented that this species migrates from north to south through California, beginning in mid to late August. This individual most likely was in migration.

The majority of animals captured (73 %) were males. These results are consistent with those of other studies in finding a male bias in the sex ratio at higher elevations (Barclay 1991, Cryan et al. 2000, Grindal et al. 1999, Pierson et al. 2001, Storz and Williams 1996, Thomas 1988).

3.1.4. Acoustic Surveys

We operated 16 acoustic stations in the two nights of survey, and were able to confirm from acoustic files the presence of nine species (Table 5). *T. brasiliensis*, *E. fuscus*, *L. cinereus*, and *M. evotis* were the most widely distributed in the study area (Fig. 1). *E. maculatum*, while not heard at any of the sampling stations, was heard by several investigators while processing data in the parking lot.

There were three species that were detected acoustically and never captured: *E. maculatum*, *E. perotis*, and *T. brasiliensis*. *E. maculatum* appears to be relatively rare throughout its distribution in California (Pierson and Rainey 1998c), and is likely rare in this habitat as well. This species is also adept at avoiding mist-net capture. Thus, it is not surprising it was not captured. The other two species are aerial foragers and often fly at considerable height above the ground (> 20 m), well above the height of standard mist nets. These two species are vulnerable to capture when coming to water sources to drink, but are far more likely to be detected acoustically than captured in mist nets.

4.0 CONCLUSIONS AND RECOMMENDATIONS

Although more surveys are needed before assessments can be made regarding the number of species at Devils Postpile and their relative abundance, this brief effort illustrates the importance of conducting both netting and acoustic surveys. Three species, not captured in nets, were detected acoustically, and one of them, *Tadarida brasiliensis*, was the only species encountered at all sixteen acoustic stations. Thus, despite its absence in mist net captures, it is likely one of the most abundant species in the Monument. Similarly, the hoary bat, which was represented by only one individual in the netting surveys, was one of the most widely distributed acoustically. At the same time, the netting surveys provided demographic data, and information on those species that are difficult to identify acoustically (and thus likely under-represented in our species assignments for acoustic detections) -- e.g., *Lasionycteris noctivagans*, the 40 kHz *Myotis* (*M. ciliolabrum*, *M. lucifugus*, and *M. volans*) and the 50 kHz (*M. californicus* and *M. yumanensis*).

Based on these initial surveys we recommend additional surveys be conducted earlier in the summer (mid-July and early August) and later in the fall (mid-September) to obtain information on seasonal distribution and reproductive status of as many species as possible. Also, we propose to conduct targeted surveys for those species that were not detected. More extensive mist-netting combined with acoustic surveys (accompanied by spot-light observations of flying animals) should pick up *Antrozous pallidus*, *Myotis californicus*, *Myotis ciliolabrum*, *Myotis thysanodes*, and *Pipistrellus hesperus* if they are present. Targeting of cliff/exposed rock habitat would favor detection of *A. pallidus* and *P. hesperus*, and *E. maculatum*. Oak habitat would be expected to favor *A. pallidus*, and cottonwood or willow riparian to favor *Lasiurus blossevillii*.

Based on findings in Yosemite National Park (Pierson et al. 2001, Pierson et al. 2002), *L. blossevillii* would be most likely to be detected in September. The species most difficult to detect if present is *Corynorhinus townsendii* (Pierson et al. 1999) This species avoids net capture and has a whispering echolocation call that makes it difficult to detect acoustically (although its call is distinctive if detected). The most effective method for detecting this species is roost surveys (Pierson et al. 1999, Sherwin et al. 2000). It roosts clinging to exposed surfaces in caves,

abandoned mines, or other cave-like spaces. It has been found in shallow rock shelters. Looking for roosts in areas without previously identified caves or mines would be labor intensive, and outside the scope of this inventory.

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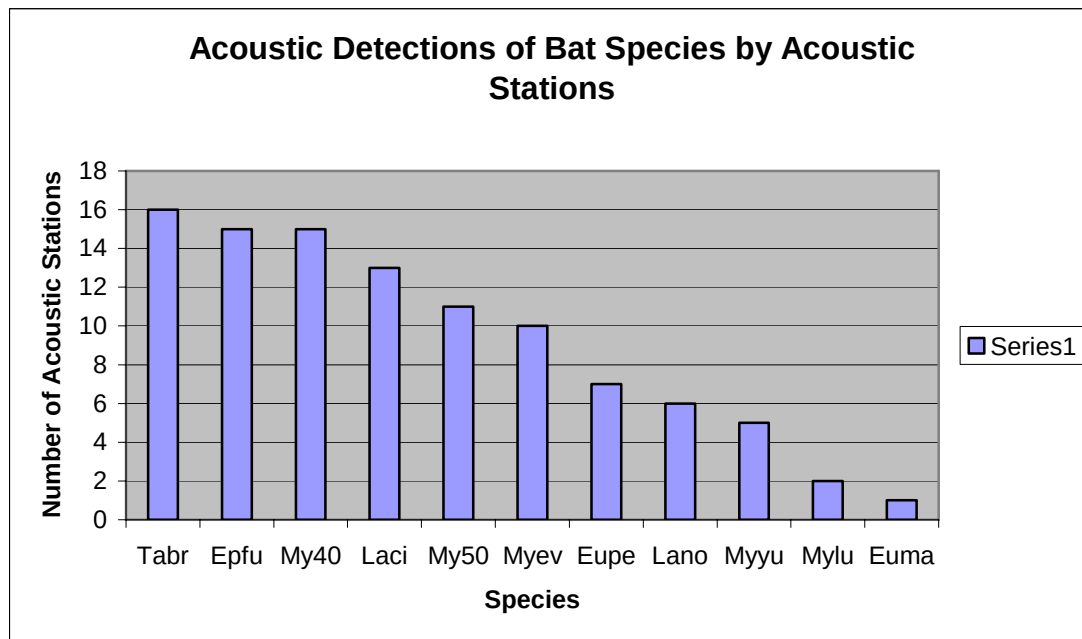
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Figure 1. Bar graph showing number of sampling stations at which particular bat species were detected.



Tabr= *Tadarida brasiliensis*, Mexican free-tailed bat

Epfu= *Eptesicus fuscus*, Big brown bat

My40= *Myotis* at 40 KHz (could be *M. ciliolabrum*, *M. lucifugus*, and/or *M. volans*)

Laci= *Lasiurus cinereus*, Hoary bat

My50= *Myotis* at 50 KHz (Could be *Myotis californicus* and/or *Myotis yumanensis*)

Myev= *Myotis evotis*, Long-eared myotis

Eupe= *Eumops perotis*, Western mastiff bat

Lano= *Lasionycteris noctivagans*, Silver-haired bat

Myyu= *Myotis yumanensis*

Mylu= *Myotis lucifugus*, Little brown bat

Euma= *Euderma maculatum*, Spotted bat