Acoustic Inventory and Monitoring of Bats at Golden Gate National Recreation Area

Final Report

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The bat monitoring program is designed to collect data on the presence of bats in National Park Service (NPS) areas in the San Francisco Bay Area. In addition to creating a species list, data will be analyzed to evaluate bat activity throughout each night, as well as on each night throughout the year. By comparing data from several monitoring stations, it will be possible to look for trends related to habitat, location within a park, and regional patterns throughout the bay area parks. This report provides a preliminary summary of the work done at Golden Gate National Recreation Area from July 2004 through July 2005.

Acoustic Monitoring Stations

The first long-term bat monitoring station was setup in December 1999 at the Bear Valley headquarters of Point Reyes National Seashore. It has been in continual operation ever since. In 2002, twelve additional bat-monitoring stations were installed. Three of these were established at Golden Gate NRA in the summer of 2004. The location of all stations is shown in Appendix 1, and the UTM coordinates are given in Appendix 2.

All monitoring stations were setup in buildings with 110v power. This power supply allowed for more reliable operation of the monitoring equipment, and the buildings provided a secure location. Whenever possible, bat monitoring stations were chosen so they were near apparently good bat habitat, and also near a source of water that bats might use (e.g. pond, small stream).

Bat vocalizations are detected using an Anabat bat detector (Fig. 1). Each bat detector is adjusted to a standardized signal so sensitivity between detectors is identical. Vocalizations are stored on Compact Flash card. Figures 2-4 show the three monitoring stations at GOGA.

Identification of Calls

The Anabat bat detector records ultrasonic sounds and lowers them into a frequency range that can 1) be heard by the human ear, and 2) can be conveniently stored on a computer hard drive. The Analook software displays these sounds in a graphic format that is similar to a sonogram that is typically used for analysis of bird vocalizations (e.g. frequency versus time). The typical call of a Mexican free-tailed bat is shown in Figure 5. Typical of most bat calls, each vocalization sweeps down in frequency (pitch). The slope of this sweep, and the lowest frequency are important features that assist in identification of bat vocalizations.

Since each call is separated by a longer period of silence (during which time the bat is listening for echoes), it is convenient to display bat vocalizations with the intervening “dead space” removed so that the display is a closely

spaced series of calls. Figure 6 shows the same bat call with the time between each vocalization removed; this also results in more calls in the sequence being displayed. The calls of this species are characterized by a relatively low frequency and a fairly flat slope.

The calls of silver-haired bats (Fig. 7) and big brown bat (Fig. 8) are quite different. The figure legends point out some of the diagnostic features. Not all bat calls are so distinct, and the characteristics of a call can change a great deal, depending on what the bat is doing. For example, an individual bat will tend to produce lower pitched calls that sweep through a small range of frequencies when the bat is flying in the open. If the bat flies through the more cluttered understory of a forest, the calls increase in pitch, tend to sweep through a wider range of frequencies, and occur more frequently. All these changes function to provide the bat with more information about the environment in which it is flying. Calls also change when a bat detects a flying insect.

Search phase call, feeding buzzes, and social vocalizations can be played from the Western Ecological Research Center, USGS, web site. Visit: http://www.werc.usgs.gov/bats/batstudiesnorth.html.

The variability in vocalizations within each species means that not all calls are easily assignable to one species. The prototype software (being developed by Chris Corben as part of this project) examines 8-10 features of each call and compares the characteristics to those of calls from known species of bats. Calls that are a close match are assigned to a particular species. We use fairly conservative criteria so that we have a high level of confidence that a call assigned to a given species is correct. As we refine our species-specific filters, we should be able to assign more calls to particular bat species.

Results

Table 1 shows the number of calls recorded at each of the three monitoring sites. These differences are likely due to 1) the number of

individual bats in the vicinity of the detector, and 2) the activity of a few bats that might be foraging (e.g. flying back and forth) in the vicinity of the detector.

Table 2 shows the species of bats detected at each of the monitoring sites. Some bats were detected at all stations, e.g. Mexican free-tailed bat, red bat, hoary bat. Two of the most common bats in the San Francisco area (California myotis and Yuma myotis) are somewhat difficult to distinguish acoustically, so they are lumped together in the first column. This species pair was detected at Ft Funston and Tennessee Valley, but not Ft Baker. It is likely that we will be able to sort out the calls of these two species as we further develop and refine our call filters.

One moderately uncommon bat (long-eared myotis) that we thought might be in the area was not detected anywhere. The other species listed in the table were found in some, but not all sites. It is likely that the number of species detected at each site will increase as monitoring continues.

Table 1. Number of bat calls detected at each of the monitoring sites, July 2004 - July 2005.

	Days in Operation	**Calls Recorded**
Ft Baker 2004	129	10,201
Ft Baker 2005	189	1,765
Ft Funston 2004	128	76,359
Ft Funston 2005	189	133,263
Tennessee Valley 2004	128	80,140
Tennessee Valley 2005	192	59,579
Totals	**955**	361,307

Table 2. Species of bats detected at each of the monitoring sites, July 2004 - July 2005. * symbol indicates Federal Species of Management Concern.

	California or Yuma Myotis*	Little Brown Myotis	Long-eared Myotis*	Fringed Myotis*	Big Brown Bat	Siler-haired Bat	Red Bat	Hoary Bat	Mexican Free-tailed bat
	Myotis yumanensis	*Myotis lucifugus*	*Myotis evotis*	*Myotis thysanodes*	*Eptesicus fuscus*	*Lasionycteris noctivagans*	*Lasiurus blossevillii*	*Lasiurus cinereus*	*Tadarida brasiliensis*
Fort Baker	N	Y	N	N	N	N	Y	Y	Y
Fort Funston	Y	Y	N	Y	Y	Y	Y	Y	Y
Tennessee Valley	Y	N	N	Y	Y	Y	Y	Y	Y

Figure 1. Anabat bat detector inside a waterproof box, ready to mount. A multistrand wire is used to power to the detector and to bring the signal back to a computer inside the building.



Figure 2. Location of bat detector at Fort Baker, Golden Gate National Recreation Area. Red arrow shows location on bat monitoring box.



Figure 3. Location of the bat detector at Fort Funston, Golden Gate National Recreation Area. Red arrow shows location on bat monitoring box.



Figure 4. Location of the bat detector at Tennessee Valley, Golden Gate National Recreation Area. Red arrow shows location on bat monitoring box.



Figure 5. Sample recording of a Mexican free-tailed bat showing two vocalizations from a series of calls. The Y-axis is frequency (pitch) in kilohertz (kHz), and the X-axis along the bottom is time with each major mark denoting 25 milliseconds.

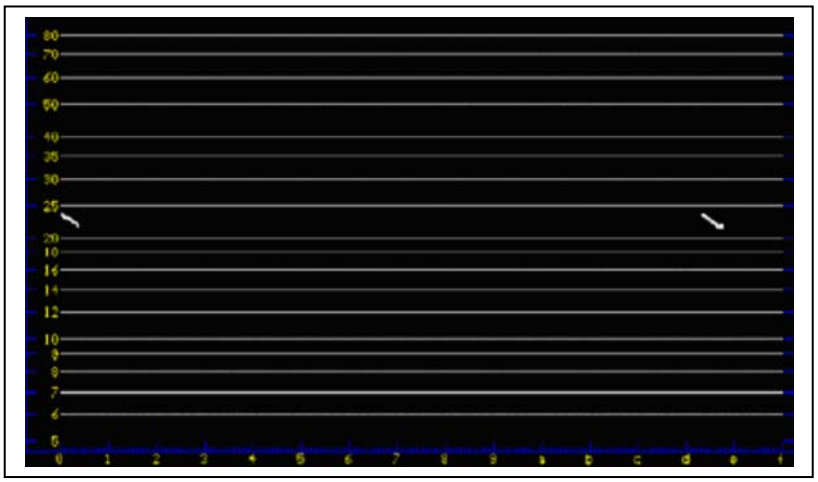


Figure 6. Sample recording of a Mexican free-tailed bat showing a series of vocalizations with the time between each call removed.

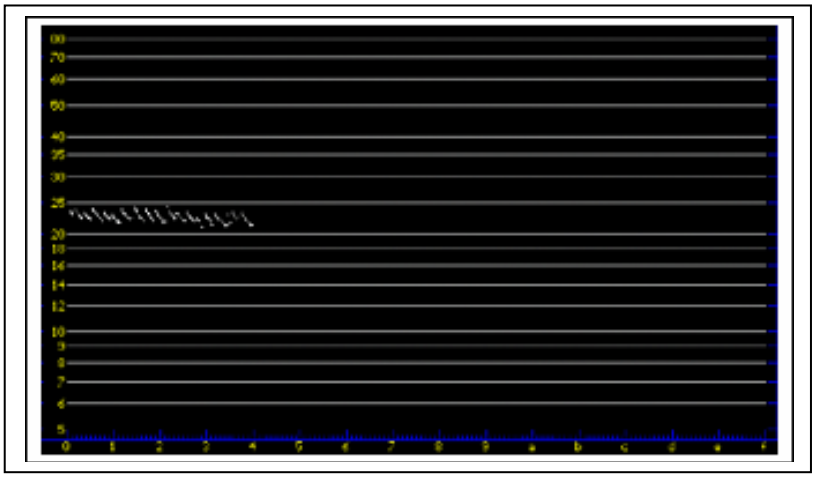


Figure 7. Sample vocalization of a silver-haired bat showing a series of vocalizations with the time between each call removed. Note that each vocalization sweeps down to about 20-25 kHz, but that the lowest frequency is quite variable.

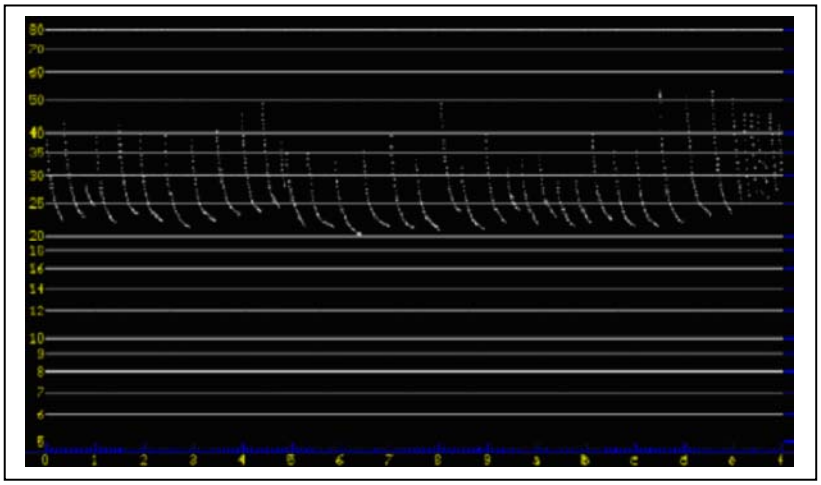
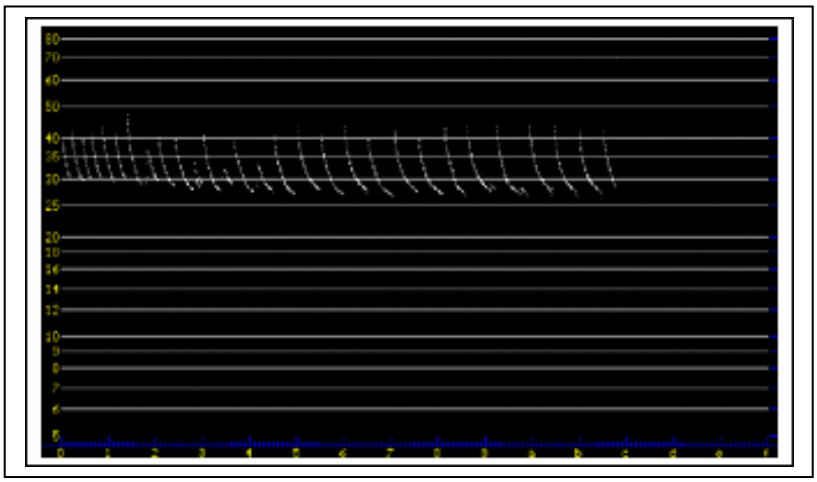


Figure 8. Sample vocalization of a big brown bat showing a series of vocalizations with the time between each call removed. Note that each vocalization sweeps down to about 25-30 kHz and the lowest frequency is fairly consistent from one call to another.



Appendix 1. Location of bat monitoring stations at Golden Gate National Recreation Area.



Appendix 2. Coordinates for bat monitoring stations based on NAD27 projection.

	UTM Easting	**UTM Northing**
Fort Baker	545973	4187735
Fort Funston	544248	4173824
Tennessee Valley	540749	4189174