Acoustic Monitoring of Bats in Southeast Alaska: Development of the Wireless Sensor Array and Analysis of Prior Recordings

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ABSTRACT

The most recent and extensive effort to document the occurrence of bats in Alaska confirms that five species inhabit certain parts of the state for at least a portion of the year. However, much remains uncertain about the geographic range, seasonal distribution, and population size and dynamics of these northern bats. This project aims to clarify these uncertainties by building upon that which is already known about bats in Southeast Alaska. Within the next two years, the investigators will develop a robust, sophisticated bat sensor system capable of monitoring bat activity for extended periods of time. This bat detector array will employ a software program capable of automatically identifying bats by their calls. For this component of the study, in addition to the development of the bat detector system, bat calls recorded in Southeast Alaska by D. Parker *et al.* (1997) have been analyzed in order to determine what sounds are likely to be recorded during the bioacoustical monitoring of the region. In particular, the sounds on the tapes were investigated and classified, the different types of identified signals were processed and described using Raven 1.2 Beta, and a preliminary investigation of the parameters that can be used to identify different species of bats in Southeast Alaska by their echolocation calls was conducted. Two factors, duration and frequency of maximum power, were found to be useful in discriminating between sound types. Although measurement and consideration of these factors alone theoretically make automated call identification possible, further statistical analysis may be necessary to ensure more accurate sorting.

INTRODUCTION

Five species of bat, *Myotis lucifugus, M. keenii, M. californicus, M. volans,* and *Lasionycteris noctivagans*, all members of the suborder Microchiroptera, are known to be part of the regular fauna of Southeast Alaska, accounting for about 13% of all regional species of terrestrial mammal. In the past, projects based on the use of bat detectors have been limited in scope for several reasons. The recording equipment can require researchers to revisit a site each day data is collected and can be difficult to maintain in the field, making long term studies especially arduous. Other problems such as limited battery power and sensitive electronics can be problematic everywhere, but require special attention in the harsh Southeast Alaskan environment. The researchers working on this project hope to develop a bat detection system that will be able to be left in the field for long periods of time without the need for frequent visitation for repairs and data recovery. This detection system is being designed to automatically collect information that can be used to describe bat activity in Southeast Alaska, leading to an improved understanding of the bat population in the area.

In the Summer of 2004, tapes collected by Parker *et al.* (1997) for the most recent survey of the Alaskan bat population were analyzed in order to discover what types of sounds were represented in typical recordings of bat echolocation collected in Southeast Alaska. This information was collected for use in a computer program designed to automatically discern bat calls from other sound types during a new echolocation study of bats in Southeast Alaska.

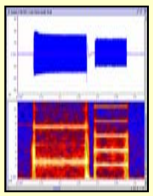
FUTURE RESEARCH

The two characteristics of bat calls considered in this study, duration and frequency of maximum power, seem to be useful parameters for distinguishing between bat sounds and non-bat sounds. In the future, other parameters including the start frequency, end frequency, mid-call (or mid-sound) frequency, and inter-call interval could be added to increase the accuracy of the sorting process based upon the findings of past researchers, and later be expanded to allow for species identification.

The software that is being developed based on the analysis in the poster will be deployed on a network of remote long-duration sensors based on low-power computers with wireless networking. The components of the new system are shown at left with a blue pocketknife also shown for scale.

METHODS

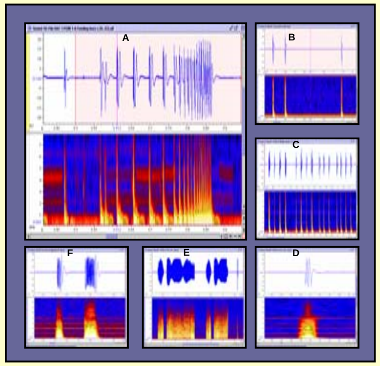
D. Parker McNeill's tapes of bat echolocation calls had been recorded using the Titley Anabat II system at 24 different sites in Southeast Alaska throughout 1993. The recordings were transferred from approximately 35 cassette tapes onto Digital Audio Tapes (DATs) using an AIWA ADS-950 tape deck with pitch control calibration, and a Sony DS-7 DAT walkman recorder.



Tapes were digitized using a Tascam DA-302 DAT deck and processed using Raven 1.2 Beta (developed by the Cornell Bioacoustics Research Program). Raven, the successor to the popular signal processor Canary, was used to visualize and measure the different sound types identified in the recorded material. The data obtained during measurement was transferred to spreadsheets and delay speed was corrected based upon recorded calibration tones.

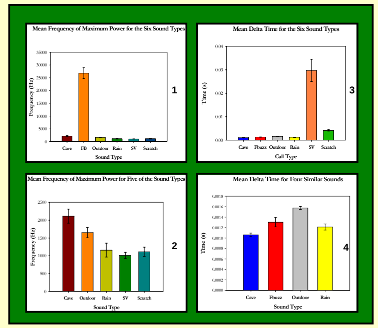
The habitat use of bats in the Juneau area was investigated through interviews with local residents and through personal exploration of potential foraging sites. This information is being used to determine where the bat sensors will be placed.

RESULTS



Raven was used to visualize and measure the different sound types. Sounds were visualized and measured using the waveform views (top graph in each image), spectrogram views (bottom graph in each image) and spectrogram slice views (not pictured). The most common sounds found in the recordings included bat feeding buzzes (A), bat calls emitted while in caves (B), outdoor non-feeding buzz calls (C), raindrops (D), equipment-related sound artifacts (E), and "scratch" sounds caused by rubbing and possibly sensitivity problems with the Anabat II (F). These six types of sound were analyzed in the study. The waveform and spectrogram shown in the Methods section correspond to a calibration tone used to correct for variations in tape speed.

The frequency at which the greatest intensity occurred during a unit of sound was shown with one-way ANOVA and t-tests to be statistically unique for feeding buzzes for this data set (Figures 1 and 2). This parameter can be used to distinguish between feeding buzzes and all other sound types. This was also the case for outdoor calls and call duration (Figures 3 and 4), with the exception that bat calls recorded in caves and bat calls recorded outside of caves were could not be distinguished from each other using either of these statistics, nor with the consideration of several other parameters measured with Raven.



CONCLUSIONS

•The statistical information collected from the bat echolocation tapes should help other researchers working on the bat project to design a software program that can distinguish bat calls from other types of sound that might be recorded during an echolocation survey in Southeast Alaska.

•A potential scheme that could be used for the identification of bat calls might follow a number of steps in order to determine whether a sound recorded by one of the bat detector array microphones is relevant.

•Step 1: Sounds that consist of only one pulse will be eliminated to reduce the possibility that rain may be part of the data slated for further experimentation.

•Step 2: The sound types which have a mean delta time within the range that describes outdoor calls and cave calls will be marked as probable bat calls and saved to a database used to store bat echolocation sounds (location of microphone will be taken into consideration if cave and outdoor calls must be separated).

•Step 3: If the frequency of maximum power matches that of a typical feeding buzz, that recorded sound will be saved as such.

•The rest of the data may be retained and used for quality control purposes in order to make sure that usable bat calls are not being rejected with any regular pattern .

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