



Klondike Gold Rush National Historical Park 2009 Bat Inventory

Pilot Study

Natural Resource Data Series NPS/AKR/NRDS—2013/520



ON THE COVER

Little Brown Myotis on Moore House Shed
Photograph by: Derrick Hartberger

Klondike Gold Rush National Historical Park 2009 Bat Inventory

Pilot Study

Natural Resource Data Series NPS/AKR/NRDS—2013/520

Dashiell Feierabend

PO Box 756100
Fairbanks, Alaska
99775

Dave Schirokauer

National Park Service
Denali National Park and Preserve
PO Box 9
Denali Park Alaska, 99755

August 2013

U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado

The National Park Service, Natural Resource Stewardship and Science office in Fort Collins, Colorado, publishes a range of reports that address natural resource topics. These reports are of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

The Natural Resource Data Series is intended for the timely release of basic data sets and data summaries. Care has been taken to assure accuracy of raw data values, but a thorough analysis and interpretation of the data has not been completed. Consequently, the initial analyses of data in this report are provisional and subject to change.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner.

This report received informal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data.

Views, statements, findings, conclusions, recommendations, and data in this report do not necessarily reflect views and policies of the National Park Service, U.S. Department of the Interior. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the U.S. Government.

This report is available from the Natural Resource Publications Management website (<http://www.nature.nps.gov/publications/nrpm/>). To receive this report in a format optimized for screen readers, please email irma@nps.gov.

Please cite this publication as:

Feierabend, D., D. Schirokauer. 2012. Klondike Gold Rush National Historical Park 2009 bat inventory: Pilot study. Natural Resource Data Series NPS/AKR/NRDS—2013/520. National Park Service, Fort Collins, Colorado.

Contents

	Page
Figures.....	v
Executive Summary	vii
Acknowledgments.....	vii
Introduction.....	1
Site	3
Methods.....	5
Results.....	9
Discussion	15
Recommendations	17
Literature Cited	19
Appendix A: Range Maps.....	21
Appendix B: Bat Monitoring Protocol.....	23
Standard Operating Procedure (SOP) # 1	23
Preparation	23
Equipment Test.....	25
Detector Installation.....	27
Site Selection	27
Timing.....	27
Equipment Setup	28
Management	34
Uninstallation.....	34
Appendix C: VisCam Protocol	35
Standard Operating Procedure (SOP) # 2	35
Overview.....	35
Spreadsheets	35
Call Data Transfer.....	36
Call Data Analysis	37

Contents (continued)

	Page
Recognizing Bat Calls	38
Images	39
Reports	39
Appendix D: Anabat SD1 Malfunction Report	41
Appendix E: Mist Netting Proposal	43

Figures

	Page
Figure 1. Nelson Slough monitoring site.	4
Figure 2. Nelson Slough bat detector.	5
Figure 3. Bat detector with housing and reflector.	6
Figure 4. Number of nightly bat call recordings at Nelson Slough Pond from March 30 to August 24, 2009.	10
Figure 5. Times of first and last bat recordings for each night between March 30 and August 24, 2009.	11
Figure 6. Difference in time between the first bat recording and sunset, and the last bat recording and sunrise, for each night of recording from March to October, 2008.	12
Figure 7. Difference in time between the first bat recording and sunset, and the last bat recording and sunrise, for each night of recording from March 30 to August 24, 2009.	13
Figure 8. Bat detector installation with detector housing and reflector.	29
Figure 9. Complete bat detector installation with detector, housing, reflector, and battery.	29
Figure 10. Detector in housing with microphone extruding from housing.	30
Figure 11. Detector with padding inside of housing.	30
Figure 12. Detector with padding inside of housing.	31
Figure 13. Detector inside of housing.	31
Figure 14. ZCAIM LED display.	31
Figure 15. ZCAIM LED display.	32
Figure 16. Detector interface.	32
Figure 17. Gel cell battery in housing.	33
Figure 18. Gel cell battery in housing.	33

Executive Summary

Few studies have been done on species distribution, phenology, and the natural history of bats in Alaska. Existing records show the greatest species diversity exists in the southeast where five species are likely to occur regularly. This study provides a first look at bat activity in Klondike Gold Rush National Historical Park and its vicinity, using passive acoustic monitoring techniques that are commonly employed in species surveys. Specifically, this report addresses the third season of monitoring in Dyea near Skagway, Alaska. Detections can be attributed to at least one of four species in the genus *Myotis*, as well as a non-*Myotis* species, but identification beyond the genus level was not possible for most recordings due to resource limitations. The continuation of this study would be more comprehensive with the addition of mist-netting efforts and active acoustic monitoring to more accurately define the species present.

Acknowledgments

We would like to thank Aaron Poe and the Forest Service in Girdwood, Alaska, for loaning us the bat detectors that enabled this project to take place. Special thanks also to Cori Lausen for her professional advice since 2007.

Introduction

An acoustic monitoring pilot study was initiated in the summer of 2007 to inventory the bat species occurring in Klondike Gold Rush National Historical Park (KLGO). Of the six species with ranges that most nearly approach Skagway, the Little Brown Bat (*Myotis lucifugus*) has the greatest likelihood of occurring in the park. It has the widest range of all bat species occurring in Alaska with sightings as far north as Fairbanks, and extending to King Salmon and Kodiak Island in the southwest. Specimens of *M. lucifugus* have been collected throughout southeast Alaska, from Ketchikan to Yakutat, as well as in Atlin, BC, and throughout the southern Yukon Territory. The other five species that may occur in the park are the Keen's Long-eared Bat (*M. keenii*), California Bat (*M. californicus*), Long-legged Bat (*M. volans*), Silver-haired Bat (*Lasionycteris noctivagans*), and Big Brown Bat (*Eptesicus fuscus*) (see Appendix C for range maps of all six species).

Only one specimen of the Big Brown Bat has ever been collected in Alaska (Parker 1997). Collected from a building in the state's interior, it is thought to have been incidentally transported by humans. A study of bat species distribution in Southeast Alaska by Parker in 1997 did not produce any recordings of the Big Brown Bat during echolocation surveys, suggesting that the species does not occur in KLGO.

The presence of the Silver-haired Bat in KLGO was suggested in 2008 by a single echolocation recording. Previously, the Taku River had been the northernmost site of documentation, 120 km to the southeast (Parker 1997). Other reports from as far north as Prince William Sound have not been substantiated. Several recordings from this year can be attributed to either the Silver-haired Bat or the Big Brown Bat, but because calls of these two species are nearly indistinguishable, it is unknown which species produced the recorded calls. Based on known species distributions, they were likely produced by the Silver-haired Bat.

The regular occurrence of the Keen's Myotis, California Myotis, and long-legged Myotis in Southeast Alaska is substantiated by several specimens of each species collected throughout the region. While Skagway would be the northernmost location in Alaska to find evidence of these species, their seasonal or permanent residence in the area is well within the realm of possibility. The long-legged Myotis has been found at comparable latitudes in Atlin, British Columbia; Keen's Myotis has been found within 160 km to the south; and the California Myotis occurs as close as the northern tip of Prince of Wales Island, approximately 375 km southeast of Skagway (Parker 1997).

The method of bat detection used in this study was passive acoustic monitoring, which calls for the installation of a bat detector in a location where it records ultrasound for a predetermined range of hours during the day. The detectors in this study were Anabat II models set to begin and end recording at approximately sunset and sunrise, respectively, these being the hours of the day when bats will be actively hunting and flight activity will be at its highest. While bats are not the only source of ultrasound in the natural environment, their echolocation calls are distinguishable from the ultrasound produced by insects and weather events, which are the two other sources most likely to be recorded.

As with any bat survey methodology, there are advantages and disadvantages to using passive acoustic monitoring as a means of inventorying bat species and their relative frequency of occurrence. When compared to active monitoring, its greatest benefit is in the time saved by unattended recording. It requires only installation, periodic data maintenance, and a reliable power source.

On the other hand, passive acoustic monitoring can result in a large quantity of extraneous “noise” in the data, which often demands a significant amount of processing time. The greatest disadvantage of passive monitoring is the lack of on-site (or in hand) visual observation that can be extremely useful, and is often necessary, in making accurate species identification. Passive monitoring by itself is also unable to collect the data needed to accurately gauge species abundance, because there is no way of knowing how many echolocation recordings belong to each individual bat that passes the detector. However, it may be possible to develop an activity index that could be used to quantify the number of individuals recorded by the detector.

Site

As in 2008, monitoring took place only at the Nelson Slough site (Figure 1), first established in 2007. It is riparian habitat where slough water collects in a pond, and then continues to drain through a channel of wetland that forms a short flying corridor. The slough is fed by the Taiya River, and the water level is therefore dependent on that of the river. It is not uncommon for the pond and slough to be dry for longer than a week, then to fill with six inches of water in a single day as the river rises. This can have significant effects on the number and type of insect prey available in the immediate area.

The slough contains primarily sedges, grasses, and sweet gale (*Myrica gale*) and is bounded by young Sitka spruce (*Picea sitchensis*). Wild flag (*Iris setosa*) and Nootka lupine (*Lupinus nootkatensis*) are also present in dense concentrations nearby. Large numbers of insects and an unobstructed flying space are conducive to high levels of bat activity found in the area. The site was selected for ease of access, known bat activity, and continuity with the location used in the past two years.



Figure 1. Nelson Slough monitoring site.

Methods

This pilot study used passive monitoring techniques to count passes and identify species using the echolocation calls emitted by flying bats. The detection equipment used in this study consisted of a single Anabat 2 detector (Titley Electronics, Sydney, Australia) paired with an Anabat ZCAIM recording unit (Figure 2). An Anabat SD1 with built-in ZCAIM function failed to perform properly in the field and was not used successfully. The Anabat 2 apparatus was installed in a single location for the full extent of the study period, where it was placed inside weatherproof housing and then attached to a small Sitka spruce using nylon utility straps. This allowed for an inconspicuous and unintrusive design that was quick to deploy and maintain.



Figure 2. Nelson Slough bat detector.

The weatherproofing of the detectors was based on a design suggested by Chris Corben, the bat biologist responsible for engineering the Anabat (<http://users.lmi.net/corben/>). The general concept is to keep the detector body and microphone head clear of harmful debris and rain while minimizing the impact on its capacity to detect ultrasound. This is achieved by orienting the microphone directly downward and placing a plastic board beneath it to reflect ultrasonic calls upward into the microphone (Figure 3). Placing the reflector at a 45 degree angle over level ground effectively makes the area of detection the same as if the microphone were facing a direction parallel to the ground. The main disadvantage of this design is the undesirable ultrasonic noise produced when rain or debris hits the reflector. The body of the detector was placed in plastic housing along with foam for cushioning. An external 12V gel cell battery was placed on the ground beneath each detector. This supplied sufficient power for 9 to 14 days of passive monitoring.

Passive recording began on 30 March when there was a considerable amount of snow around the site, and continued until November, at which point no bats had been recorded for several weeks and temperatures were regularly below freezing. This time frame ensured that the arrival and departure of migrating bats, or the initiation of and arousal from hibernation, was fully documented.



Figure 3. Bat detector with housing and reflector.

The detector was set to begin recording a minimum of 30 minutes before official sunset and end 30 minutes after official sunrise. This ensured that all nightly bat activity was recorded, including any shifts in feedings times due to shorter periods of darkness around the summer solstice.

The detector unit used a 512 MB CF storage card to store the call data for analysis at a later time. The card was checked and erased at minimum once every two weeks to ensure that the memory was never entirely filled. The recordings were converted into Analook sequence files by the AnalookW program, which automatically separates each call sequence into an individual file (see Appendix B for full details on data management).

Recordings were visually filtered in AnalookW to quantify the number and quality of bat detections. First, the noise files were separated from those that were recognized as having originated from a bat, regardless of their clarity. This was performed somewhat subjectively, using a combination of recording length, pixel density and group shape, and time intervals between pixels. The bat call files were then categorized as either of high enough quality to be used in species identification, or of poor quality and of no use for identification purposes. This process, too, was necessarily subjective without an automated means of filtration.

Due to the interspecific similarities and intraspecific variation in echolocation calls between certain bat species in other geographic regions, which can result in misidentification of call sequences (Betts, 1998; Barclay, 1999), the six species likely to be recorded were divided into two groups according to the minimum frequencies of their calls. The little brown Myotis, California Myotis, long-legged Myotis, and Keen's Myotis were placed in a 40 kHz Minimum Frequency Group (MFG), while the big brown bat and silver-haired bat were placed in a 25 kHz MFG. We suggest that NRDS reports loosely follow the basic scientific report format (i.e., following the Introduction, Methods, Results, etc. format), but authors may arrange major sections of the report as they see fit.

Results

Bat species from both MFG's outlined above were represented in this year's recordings. There were a total of 6,099 recordings, 2,386 of which were recognizable as being produced by a bat, and 1,740 of which were considered to be of high enough quality for use in species identification. Nineteen calls belonged to the 25 kHz MFG, and the remaining 2,367 calls were classified in the 40 kHz MFG. No calls could not be positively identified beyond genus due to the limitations of analysis tools and reference datasets available to the park. The one identifiable call in 2008 (file I5210116.36#) belonged to a silver-haired bat, a new record for the park and an extension to the bat's northern range as shown in Appendix A. The identification was made by Cori Lausen (www.batsRus.ca), a bat research biologist of British Columbia (personal communication, October 2, 2008).

Beyond the overlap in call parameters within the two frequency groups, there are further complications such as directionality, attenuation, and Doppler shift that can cause calls from the same individual in the same habitat to appear differently in the recordings. This, in combination with the potential for variation in an individual's call due to habitat, reinforces the need for mist-netting, reference dataset development, and discriminant function analysis in order to make consistently accurate identification to species level.

There were three spikes during the season when the number of nightly call recordings exceeded 100 (Figure 4), one at the beginning of May (n=119), one at the end of June (n=169), and one in mid July (n=218). Because the water level in the study site is directly influenced by the Taiya River, it is likely that many of the changes in the quantity of nightly call recordings are due to the change in river level and the subsequent change in water level in the slough.

The abundance of bats in the park could not be calculated with a strong degree of accuracy from the data gathered. However, it is apparent from the number of recordings collected that bats occur regularly in and around the park from April to mid-October, and that there is at least one non-Myotis species that occurs regularly in the area. The end of call recordings in October, well before the first snowfall, suggests either a seasonal shift in habitat use or the initial stages of hibernation.

With no recordings after October in this or any previous season, and no reported sightings from the community, there is currently no evidence of bats overwintering in the park

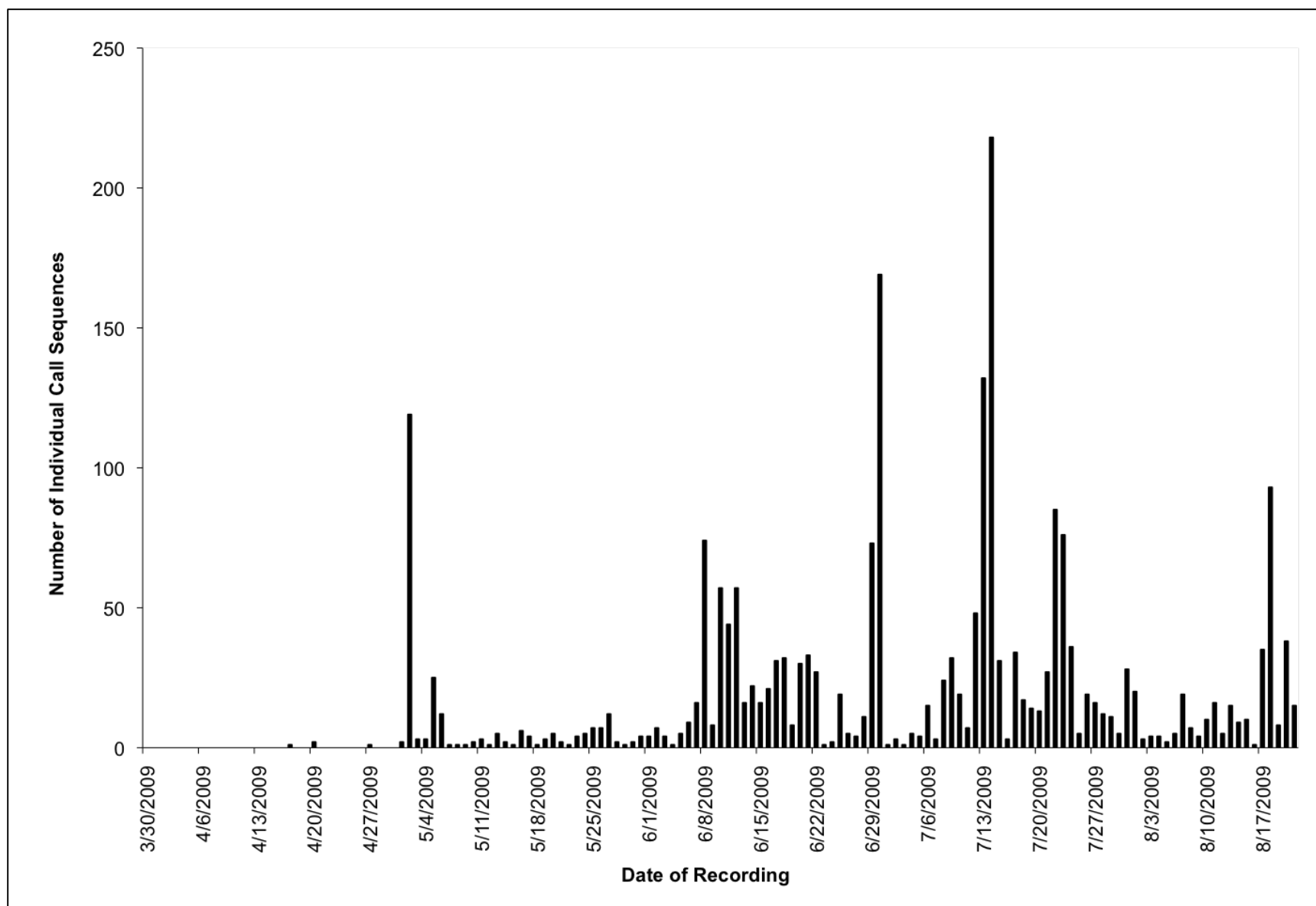


Figure 4. Number of nightly bat call recordings at Nelson Slough Pond from March 30 to August 24, 2009

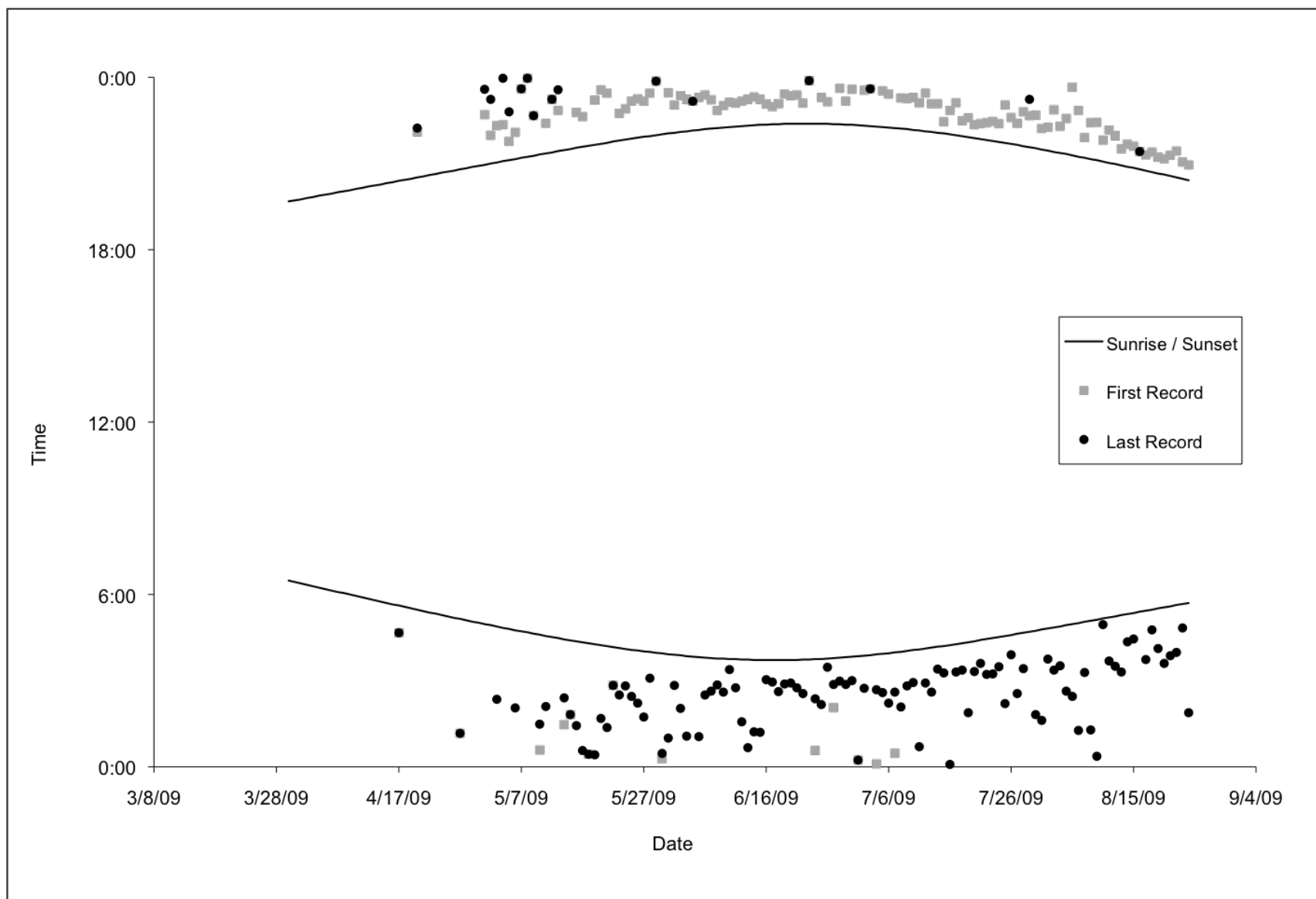


Figure 5. Times of first and last bat recordings for each night between March 30 and August 24, 2009.

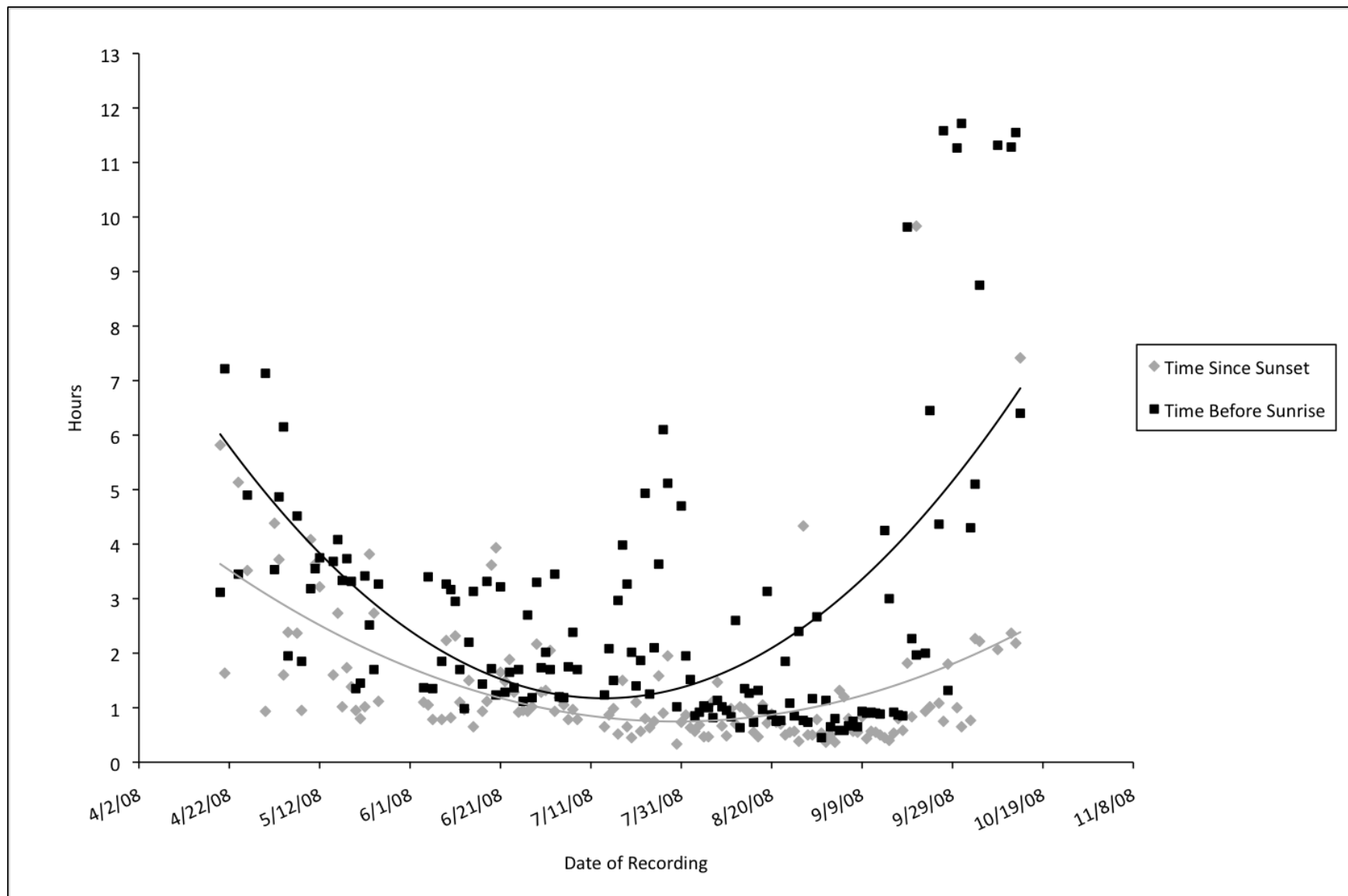


Figure 6. Difference in time between the first bat recording and sunset, and the last bat recording and sunrise, for each night of recording from March to October, 2008.

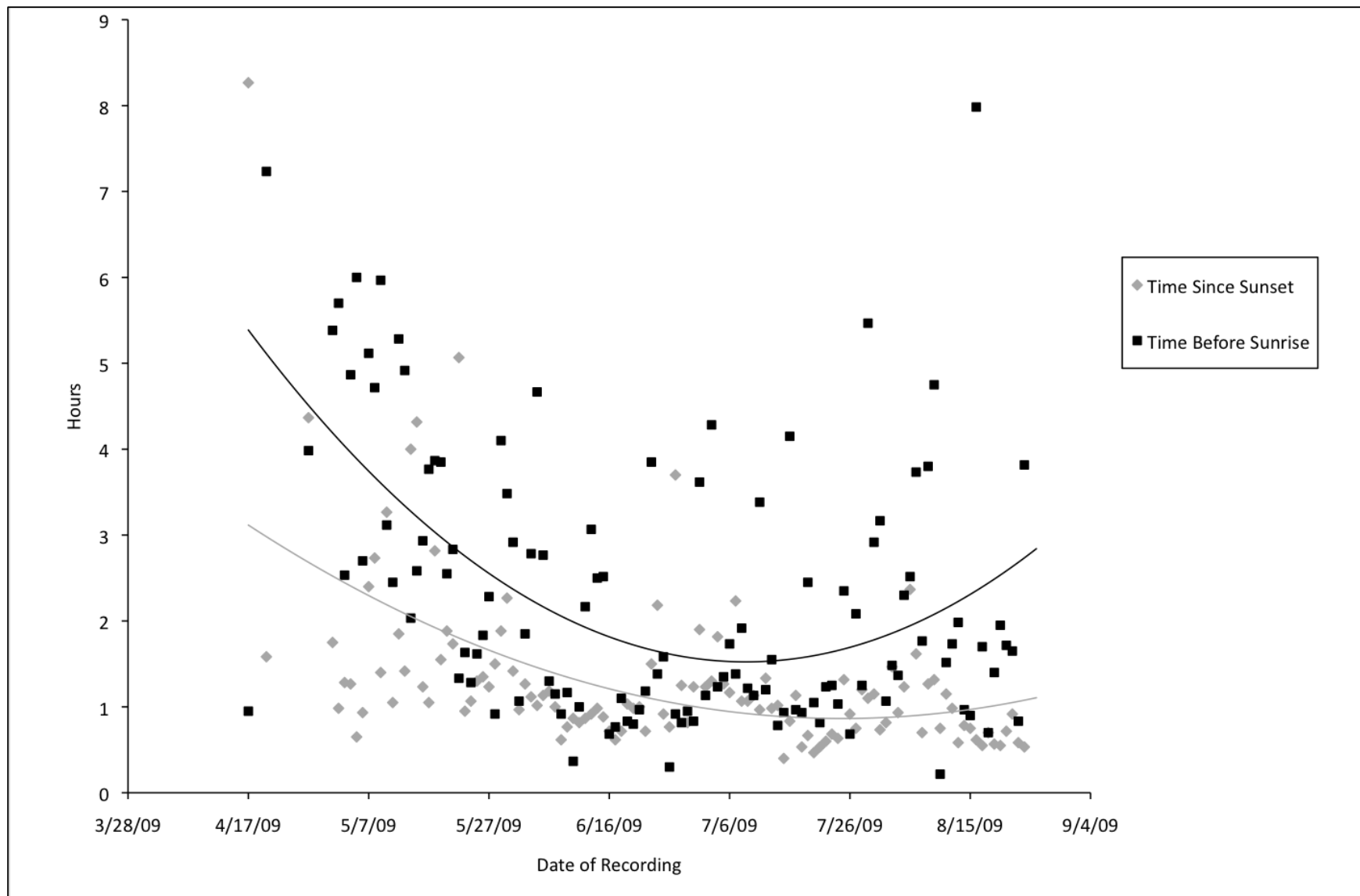


Figure 7. Difference in time between the first bat recording and sunset, and the last bat recording and sunrise, for each night of recording from March 30 to August 24, 2009.

Discussion

The significance of this pilot study is primarily the confirmation of the regular occurrence of at least two bat species in and around the park. Without investing in more sophisticated analysis tools and mist-netting efforts to develop a call reference library, it will not be possible to satisfactorily identify the species that make regular use of park land. However, with ultrasound detectors it may be feasible to gain a general idea of the habitats that harbor the greatest bat activity and to use that data to estimate the relative abundance of bats in different areas of the park throughout the year.

Discriminant function analysis is often needed for identification of calls to the species level, notably within the genus *Myotis*. This process sorts the unidentified calls into defined categories based on input parameters such as frequency sweep range, minimum frequency, maximum frequency, characteristic frequency, and characteristic slope. The parameter values are based on the calls in a reference call library for each species, recorded in the geographic region of study. There is currently no reference library available for the park's geographic region, and rectifying this should be a priority in the future. The park is also currently without a discriminant function analysis program or personnel trained in the use of such a program, so the call recordings from this season could only be grouped into two MFG's.

While none of the recordings could be positively identified to species in 2009, it is very likely that the majority of those in the 40 kHz MFG belonged to the little brown bat based on the range, common occurrence, and call characteristics of that species. The California *Myotis*, which is known to produce an echolocation call with a minimum frequency of 50 kHz, is distinguishable from the other three *Myotis* species in its frequency category. No recordings exhibited this feature, however, and the presence of this species could not be verified.

The unidentifiable calls in the 25 kHz MFG most likely belonged to the silver-haired bat, based primarily on the fact that the only published specimen record of the other non-*Myotis* species collected in Alaska, the big brown bat, was from the Alaskan interior and may have been an accidental occurrence. In addition, the one identifiable call was produced by a silver-haired bat. However, when using an Anabat detector as the recording device there is only a single call that can be used to distinguish the silver-haired bat from the big brown bat (C. Lausen, personal communication, May 31, 2008), thus neither species can be completely ruled out with the recordings obtained.

Although it has not been analyzed statistically, the call data from 2008 and 2009 suggest that bats in the Skagway region begin feeding sooner after sundown and closer to sunrise as the hours of night dwindle towards the summer solstice (see Figures 5, 6 and 7). While the call times are somewhat erratic at the beginning and end of the season, due to low numbers of bats using the monitoring site, they trend downward to a one hour difference by the end of the season. One possible reason may be that bats in northern latitudes have adopted this feeding strategy in order to consume sufficient prey in limited hours of darkness. Because these bats have evolved nocturnal habits in part to escape avian predation and to help dissipate heat produced during flight activity (Duvergé et al. 2000), the possible consequences of feeding closer to daylight hours are that they are more susceptible to diurnal predators, and they may suffer additional heat stress from slightly elevated air temperatures.

A single monitoring site was used this year due to limited resources. While it takes minimal effort to maintain the Nelson Slough site, little can be learned about the habitat use and distribution of bats in the park without sampling a variety of sites. The discovery of at least a second bat species in the park should encourage the revamping of the broad monitoring efforts made in 2007.

Recommendations

Due to the difficulty and unreliability of species identification using only echolocation calls for the bat species in the park, it is highly recommended that a mist-netting effort be made in the continuation of this study, along with the use of passive acoustic monitoring in a broader range of habitats. Active acoustic recording should accompany each instance of mist-netting so that a call library can be established for use in identifying the calls collected in passive acoustic monitoring.

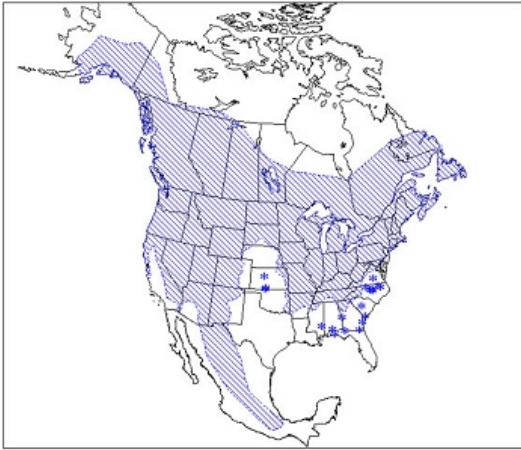
The results from the last three years concur with the literature on the finding that the number of calls recorded near water and open spaces is greater than in heavily wooded areas where high object clutter occurs. This suggests that recording and mist-netting be concentrated near water and open flyways where the capture rate should be higher, and the likelihood of recording all bat species in the area will be greatest, due to a greater number of active bats in the area. (See Appendix C for mist-netting project budget.)

Literature Cited

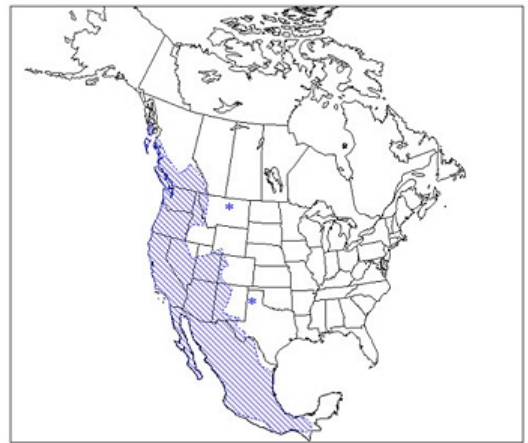
- Alaska Natural Heritage Program. California Myotis. 4 p. Available from:
http://aknhp.uaa.alaska.edu/akbats/pdfs/California_Bat_AKNHP_04_web.pdf
- Alaska Natural Heritage Program. Keen's Myotis. 5 p. Available from:
http://aknhp.uaa.alaska.edu/akbats/pdfs/Keens_Bat_AKNHP_04_web.pdf
- Alaska Natural Heritage Program. Little Brown Myotis. 6 p. Available from:
http://aknhp.uaa.alaska.edu/akbats/pdfs/Littlebrown_Bat_AKNHP_04_web.pdf
- Alaska Natural Heritage Program. Long-Legged Myotis. 5 p. Available from:
http://aknhp.uaa.alaska.edu/akbats/pdfs/Longlegged_Bat_AKNHP_04_web.pdf
- Alaska Natural Heritage Program. Silver-Haired Bat. 4 p. Available from:
http://aknhp.uaa.alaska.edu/akbats/pdfs/Silverhaired_Bat_AKNHP_04_web.pdf
- Barclay, Robert M. R. 1999. Bats Are Not Birds: A Cautionary Note on Using Echolocation Calls to Identify Bats: A Comment. *Journal of Mammalogy* 80:290-296.
- Bat Conservation International. 2008. Species Profiles. Available from: www.batcon.org
- Betts, Burr J. 1998. Effects of Interindividual Variation in Echolocation Calls on Identification of Big Brown and Silver-Haired Bats. *The Journal of Wildlife Management* 62:1003-1010.
- Duvergé, P. L., G. Jones, J. Rydell, and R. D. Ransome. 2000. Functional significance of emergence timing in bats. *Ecography* 23:32-40.
- Encyclopedia Britannica. 2009. Bat. *Encyclopedia Britannica Online*. 24 August 2009.
- Parker, D. L., B. E. Lawhead, J. A. Cook. 1997. Distributional Limits of Bats in Alaska. *Arctic* 50:256-2
- U.S. Forest Service (USFS). 1993. ECOMAP. National hierarchical framework of ecological units. U. S. Forest Service, Washington, D.C.

Appendix A: Range Maps

Little Brown Myotis



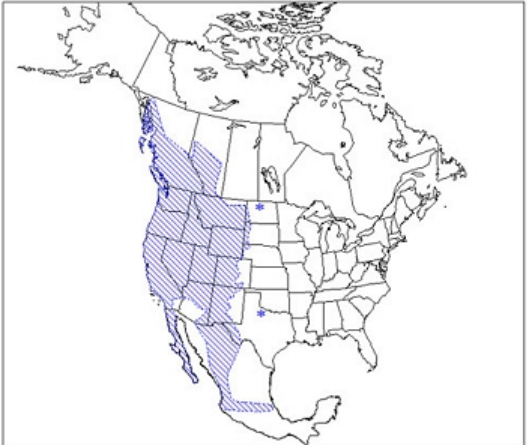
California Myotis



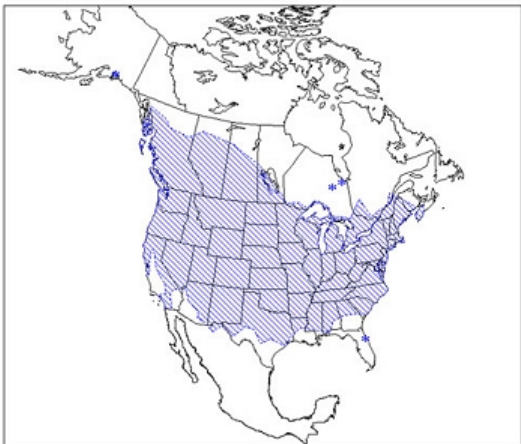
Keen's Myotis



Long-legged Myotis



Silver-haired Bat



Big Brown Bat



Appendix B: Bat Monitoring Protocol

Standard Operating Procedure (SOP) # 1

Installation of Passive Acoustic Monitoring Equipment

Version 1.00 (April 9, 2009)

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This SOP describes the installation of ultrasound detectors and monitoring equipment for passive acoustic monitoring of bats in Klondike Gold Rush National Historical Park, Skagway, Alaska.

Preparation

1. **Organize equipment.** An equipment list should be compiled, and equipment organized and made ready for the field season several weeks in advance. This allows time to make any necessary repairs and order equipment. The following is a list of recommended field equipment for a single monitoring site.
2. **Create a sound reflector.** The reflector will be used to redirect ultrasonic calls upward into the detector microphone. It will need to be suspended from the trunk of a tree, which will likely require the use of eyelet screws, hook screws, and nylon rope. It should have a smooth surface and be made of a material, such as thick plastic, that will not warp or change with weathering and that minimizes sound resulting from rainfall and debris coming into contact with it (do not use metal for this reason). A simple solution is to use a plastic cutting board. If doing so, drill two holes through the surface, one in each corner of one end of the board, so that nylon rope can be run through each. On the other end of the board, drill two more holes closer to the centerline of the board through which the hooks of the hook screws will pass.
3. **Create waterproof housing for the ultrasound detector.** It is imperative that the recording equipment not be exposed to rain, although ambient moisture in the air should not be a serious problem. The use of desiccant packets might be considered. One option is to use a plastic storage container, such as those found at hardware stores. This will require minor alterations to the container; namely, cutting a circular hole on one end through which the microphone of the detector will pass, and cutting a small notch through which the electrical cable will pass. The container should be just large enough to house the detector and cable connections. A small size will ease installation on a greater variety of trees and objects. If there is significant extra space

around the detector, it can be filled with foam sheets, foam blocks, or bubble wrap. If possible, the case should be painted to look inconspicuous in the location of its deployment.

Table 1.01.1. Field equipment list for passive acoustic monitoring.

Number Req.	Description
1	Anabat ultrasound detector (Anabat II + ZCAIM or Anabat SD1)
1	Plastic cutting board or other planar reflector
5'	Twine or nylon rope
1	Utility strap (at least 6' in length)
2	Eyelet screws
2	Hook screws
1	Waterproof housing for detector
1	Waterproof housing for battery
1	Leatherman multi-tool
1	Field computer (e.g. laptop)
1	CF card reader
1	CF card (512MB or larger)
1	12 volt gel cell battery (or 4-8 AA batteries for short term monitoring)
1	Electrical cable with terminal rings and adapter end (at least 7' in length)
1	Insect repellent
1	Sunscreen
1	First Aid kit

4. **Create waterproof housing for the battery.** If using a gel cell battery to power the detector, the battery should be stored in a waterproof container. A simple solution is to use a plastic storage container that can be found at a hardware store. The only modification needed will be a small notch for the power cable to pass through.
5. **Create a power cable.** For long term application, the detector will need to be connected to a larger power source such as a 12V gel cell battery. Speaker wire can be used with terminal rings spliced onto one end and an adapter for the detector 12V input spliced onto the other end. The cable should be at least seven feet long in most cases so that the detector can be placed five to six feet above the ground and the battery positioned at the base of the tree. *Test the charge being delivered on the adapter end before connecting to the detector. Improper wiring may destroy the detector!*
6. **Load software onto the field computer.** To use the detector as a passive monitoring system, it is necessary to provide it with monitoring time parameters using the CF card. This will require the executable CFCread.exe file. The field computer should also be populated with picload.exe in the case that firmware needs updating, and AnalookW.exe to view sequence files. All of these files can be found on the resources drive at T:\NRM\Mammals\Bats\Anabat\Software\Downloads

Equipment Test

Before installing the detector in the field it should be tested in the office for at least 24 hours.

1. Set the detector time.
 - With the detector powered off, connect the Anabat SD1 or Anabat II ZCAIM to the field computer using a 9 pin parallel serial cable with two female ends.
 - On the field computer, open the **CFCread.exe** file.
 - Power the detector on.
 - In CFCread, **Open** Port 1. If it does not recognize the detector in the Status window, try opening Port 2.
 - When a connection has been established, pressing **Get ID** should display information on the detector in the Status window.
 - Under **Time**, press the **Set** button. This will set the detector time to that of the field computer (make sure the field computer's time is correct!). The detector time should be checked occasionally during the season using the **Check** function under the **Time** field. Eventually, the detector's time will stray from that of the field computer.
 - When finished, press **Close** to properly end the connection with the detector.
2. Format the CF card.
 - Connect the CF card to the field computer using a CF card reader.
 - In the My Computer window, right click on the CF card drive and choose **Format**.
 - Choose FAT32 format option and press OK. The Quick Format box may be checked if desired.
 - Once successfully formatted, close the dialog box.
3. Initialize the CF card.
 - With the CF card still connected to the field computer via the card reader, open **CFCread.exe**
 - Press **Initialise CF** in order to format the card for use in the Anabat detector.
4. Set the CF card time parameters.
 - In CFCread, set the "**Monitoring begins at...**" and "**Monitoring ends at...**" time periods to those that will be used in the field. Similarly, if a "**Start delayed till...**" setting will be used in the field, test a delay time in the office. In order to write the information to the CF card, you must press **Erase** and make sure that the "**Activate**" check boxes are selected for the monitoring and delay times.
 - To confirm that the correct times have been written to the card, press **Check Card** and review the information displayed.
 - Once complete, press **Quit** in the CFCread window in order to properly close out of the program before disconnecting the CF card.
5. Install the CF card in the detector.
 - With the detector powered off, unscrew the card cover panel on the end of the detector (or ZCAIM with Anabat II) and insert the CF card fully, with the label facing upwards, until the card release button next to the slot is extended outward.
 - Secure the card cover panel with the indentation aligned over the card release button.
6. Connect the power cable.

- To prevent damage to the detector, first connect the cable to the gel cell battery. *Check the adapter end with a volt meter to ensure proper voltage before connecting to detector! Shorting or reversing the polarities can destroy the detector.*
 - Connect the adapter to the detector (and ZCAIM with Anabat II).
7. Power the detector on and choose detector settings.
- Press the power button on the SD1 detector. On the Anabat II, you will need to turn the volume knob clockwise on the detector as well as press the power button on the ZCAIM.
 - The detector should start in either standby mode or start delay mode, depending on the CF card settings. Check LEDs to confirm that it is in the correct mode. LEDs will remain lit only for a matter of seconds on the SD1 before it goes into power saving mode. Simply press the power button again to display the LEDs.
 - On the detector, you will need to set the volume, data division ratio, audio division ratio (Anabat SD1 only), and sensitivity. For passive monitoring, the volume should be on the lowest setting. On the Anabat II, turn the knob to the left until the point just before it clicks into the off position. Data division is ideally set to 8. Audio division is not used in passive monitoring, so the setting will not make a difference (leave it on 8). The sensitivity setting will vary slightly between sites depending on the ambient ultrasonic noise levels. It is optimal to set it just below the point at which ambient ultrasound is being recorded. This is often around 8. Turn the volume up when setting the sensitivity in order to listen for this point.
8. Run the detector for at least 24 hours in the office.
- Aim the detector microphone at electronics that will be running during the recording period. Computers, printers, speakers, and other electronics emit ultrasound that the detector should record if functioning properly.
9. Power the detector off.
- At the end of the monitoring period, check the LED display on the detector or ZCAIM to confirm that an error has not occurred, then power the detector off. On the SD1, this means pressing the power button once to turn the LEDs on, then, with the LEDs lit, holding the power button until the LEDs go out again.
10. Download the data.
- Remove the CF card from the detector and connect it to the field computer using the CF card reader.
 - Open **CFRead.exe** and press **Choose Input File**. Navigate to the CF card and press **OK**.
 - Press **Download**
 - In the **Download** window, keep the default **Auto Save Parameters**. The **Save Data File** and **Interpret Data** check boxes should be checked. The division ratio should be the same as that used in recording on the detector – in this case, it will be 8. Making a ZCA file and creating a different folder for each night of recording are optional. When done, press **OK**.
 - Create a new folder and label it TEST. Download the data to this folder by highlighting it and pressing **OK**.
 - Navigate to the TEST folder in Windows Explorer. It should contain a .dat file and at least a few sequence files (format is two numbers followed by the # symbol; e.g., .24#) that will consist of ultrasonic noise from sources in the office. If there are no sequence files, it is possible that the detector and/or CF card did not function properly.

- To clear the data from the CF card, press **Erase** in CFCread. **DO NOT** manually delete the files from the card in Windows Explorer. Some critical files must remain on the card and CFCread recognizes these files. Also, be mindful that pressing Erase will write the time parameters currently shown in the CFCread window to the card.
- Press **Quit** to close out of CFCread.

11. View the data.

- Open **AnalookW.exe**
- From the File menu in AnalookW, select **Open Anabat File**. Navigate to the TEST folder and open the first sequence file.
- There are many ways of customizing the data view, but for the purpose of the test the default setting is fine. You should see a series of dots in some kind of pattern in the data view.
- Close AnalookW.

Detector Installation

Site Selection

While a wide variety of monitoring sites can be used to successfully collect bat call data, there are certain characteristics that will make some more suitable than others for conducting a census of the species in the area and to calculate the relative abundance of each. Because all bat species documented in Alaska are insectivorous, it is best to install the detector in a location where insect abundance is relatively high and concentrated. Insectivorous bats are known to frequently feed over small bodies of water such as ponds, lakes, and sloughs, where there are large numbers of insects and few obstructions to flight. The perimeters of these water bodies are therefore the ideal locations for passive acoustic monitoring stations.

Attention should be paid to the microclimate of potential detector installation sites:

- The tree or object on which the detector will be attached must be large enough to securely support the equipment.
- The detector should have an unobstructed “view” of the open space in order to optimize call recordings.
- Areas containing open water are often subject to winds, which can create a lot of unwanted “noise” recordings from ambient ultrasound.
- Because the sound reflector will necessarily hang at approximately a 45 degree angle to the ground, direct rainfall has the potential to create noise files.
- If the detector will be checked with any frequency, it will need to be easily accessible, yet not so obvious or proximal to trail systems as to be jeopardized by recreationists.
- Care should be taken if the area is subject to seasonal fluctuations in water level.
- Foreign objects are often subject to the curiosity of bears and other wildlife.

Timing

In order to record the arrival of migrating bats in the spring, detectors should be installed on or before the first of April. Snow will probably be present at this time, but an early start date for monitoring will ensure that any shifts in migration phenology are documented. For sites that do

not have the goal of documenting migrational patterns, the time of season for monitoring will depend on other factors.

The detector should be set to begin monitoring, conservatively, a half hour before official (not civil) sunset and set to end a half hour after official sunrise. While the peak of activity tends to begin one to two hours after sunset, it is safest to set the monitoring period conservatively for the occasional early or late feeder.

Equipment Setup

1. **Install the detector and housing.** Begin the equipment setup by first attaching the detector and its housing to the selected tree using a utility strap. The microphone should face close to directly downward and should be positioned approximately five to six feet above the ground. If necessary, trim away any branches on the tree in order to correctly position the detector.
2. **Install the reflector.** The reflector should be installed very close to the detector microphone. First, install two hook screws on the tree below the detector and housing. They should be spaced so that the reflector will hang evenly on them. Next, install one or two eyelet screws above the detector and housing. Thread a length of nylon cord through one of the openings on the low end of the reflector and tie a knot on the underside of the reflector. Thread the other end of the cord through the eyelet(s) and back down through the second opening in the reflector, tying a knot on the underside of the reflector. The cord should be tied off at a length that allows the reflector to hang at approximately a 45 degree angle to both the ground and the detector microphone.
3. **Install the battery.** Place the gel cell battery inside of its housing at the base of the tree in which the detector is installed, allowing for maximum play in the power cable in case the battery is overturned by wildlife. Attach the power cable to the battery and then to the detector.
4. **Power the detector on.** Turn the detector on and confirm that the correct LEDs are lit, indicating proper functioning.
5. **Add information signage.** Place a sign on or near the detector tree that explains the monitoring being conducted, who is conducting it, and providing contact information for questions or misplaced equipment.



Figure 8. Bat detector installation with detector housing and reflector.



Figure 9. Complete bat detector installation with detector, housing, reflector, and battery.



Figure 10. Detector in housing with microphone extruding from housing.



Figure 11. Detector with padding inside of housing.



Figure 42. Detector with padding inside of housing.

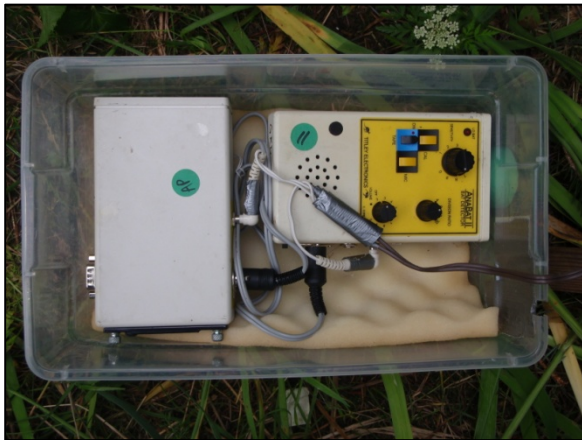


Figure13. Detector inside of housing.



Figure14. ZCAIM LED display.



Figure15. ZCAIM LED display.



Figure16. Detector interface.



Figure17. Gel cell battery in housing.



Figure18. Gel cell battery in housing.

Management

Ideally, the detector should be checked on a weekly basis. This is not always possible with more remote sites, but be aware that equipment malfunction or user error can result in several weeks worth of missing data if the equipment is not checked regularly.

At each site visit, the following should be done:

- Check that the detector is running properly.
- Power the detector off and download the CF card data.
- Briefly review the recorded data in AnalookW to check for “noise” files. If too many noise files are being recorded, consider turning the sensitivity setting down slightly.
- Check that the monitoring time settings are appropriate for the hours of sunset and sunrise.
- Erase the old CF card data using the CFCread program.
- Check the battery voltage. The battery should be exchanged for recharging once it reaches 11.5V, and it absolutely should not be allowed to fall below 11.0V.
- Power the detector back on and check that the proper LEDs are lit before leaving the site.

Uninstallation

Monitoring should end in late October or early November, depending upon a review of the previous years’ data. Remove the detector, battery, and housing. Leaving the reflector in place is optional for sites being reused the following season. However, this is not advisable considering foul weather conditions and the possibility of vandalism by people and wildlife.

After uninstallation, the detector should be stored in the Hern-Clipper office. Gel cell batteries, detector and battery housing, and any other materials should be stored in the Mascot garage.

Appendix C: VisCam Protocol

Standard Operating Procedure (SOP) # 2

Data Management

Version 1.00 (July 14, 2009)

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This SOP gives step-by-step instructions for the management of bat monitoring data.

Overview

Bat monitoring data includes Excel/Access spreadsheets containing site data, Anabat ultrasound recordings, images, and annual reports.

Spreadsheets

A new series of spreadsheets and charts should be made for each year of data, starting and ending on the calendar year. They should be labeled and organized with the following fields:

- Site [spreadsheet]
 - o Start Date of Recording (evening) [date]
 - o End Date of Recording (morning) [date]
 - o Time of Sunset (24 hour format; official, *not civil*) [time]
 - o Time of Sunrise (24 hour format; official, *not civil*) [time]
 - o Time of First Bat Recording (24 hour format) [time]
 - o Time of Last Bat Recording (24 hour format) [time]
 - o Sensitivity [text]
 - o Data Division Ratio [number]
 - o Species [text]
 - o Notes [text]
 - o Number of Recordings [number]
 - o Number of Bat Recordings [number]
 - o Number of Bat Recordings For Species Identification [number]

- First and Last Recording Times [chart]
 - o Start Date of Recording [x-axis]
 - o First Recording [y-axis]
 - o Last Recording [y-axis]
 - o Sunset [y-axis]
 - o Sunrise [y-axis]
- Bat Activity [chart]
 - o Start Date of Recording [x-axis]
 - o Number of Bat Recordings [y-axis]
- Difference Between Sunset and First Recording / Sunrise and Last Recording [chart]
 - o Start Date of Recording [x-axis]
 - o Time Difference between First Recording and Sunset (decimal format) [y-axis]
 - o Time Difference between Last Recording and Sunrise (decimal format) [y-axis]

Call Data Transfer

1. Download CF card data.
 - The CF card data should ideally be downloaded and analyzed on a weekly basis.
 - Press the power button the on SD1 to light the LEDs, then hold the power button until the LEDs turn off again. For the Anabat II, press the power button once on the ZCAIM and the LEDs should turn off.
 - Remove the CF card from the detector by pressing the release knob, and connect it to the field computer using the CF card reader.
 - Open **CFCread.exe** and press **Choose Input File**. Navigate to the CF card and press **OK**.
 - Press **Download**
 - In the **Download** window, keep the default **Auto Save Parameters**. The **Save Data File** and **Interpret Data** check boxes should be checked. The division ratio should be the same as that used in recording on the detector – in this case, it should be 8. Making a ZCA file and creating a different folder for each night of recording are optional. When done, press **OK**.
 - Create a new folder and label it YYYYMMDD_Site (e.g. 20091011_Nelson_Slough_Pond for data downloaded on October 11, 2009, at Nelson Slough Pond). Download the data to this folder by highlighting the folder and pressing **OK**.
 - Navigate to the TEST folder in Windows Explorer. It should contain a .dat file and at least a few sequence files (format is two numbers followed by the # symbol; e.g., .24#) that will consist of ultrasonic noise from sources in the office. If there are no sequence files, it is possible that the detector and/or CF card did not function properly, or that no electronics were on during the recording period.
 - To clear the data from the CF card, press **Erase** in CFCread. **DO NOT** manually delete the files from the card in Windows Explorer. Some critical files must remain on the card for it to function in the detector, and CFCread recognizes which files these are. Also, be mindful that pressing **Erase** will write the time parameters currently shown in the CFCread window to the card.
 - Press **Quit** to close out of CFCread.

2. Transfer data to office computer and network.
 - Call data should be stored on the Resources T drive where it can be backed up. Transfer the call data from the laptop computer to the network on the office computer via a USB flash drive.
 - The call data should be stored in the following folder system:

Mammals

Bats

Year (e.g., 2009)

Data

CF Data

Call Data Analysis

1. Open the Site spreadsheet corresponding to the year of the call data.
2. In the spreadsheet, enter the dates that recording began and ended.
3. Using a reference for official sunrise and sunset times (it is recommended that the website <http://aa.usno.navy.mil/cgi-bin/aa-rstablew.pl> be used), enter the times of sunrise and sunset for the days that recording took place.
4. Enter the sensitivity setting used on the detector during recording.
5. Enter the data division ratio used on the detector during recording.
6. Open the folder under T:\NRM\Mammals\Bats containing the call data and sequence files that will be analyzed.
7. Enter the total number of recordings for each night.
 - Beginning with the first night of recording, highlight all of the sequence files from that evening to the following morning in the Explorer window.
 - In the spreadsheet, enter the number of files selected, which can be found either in the left pane of the Explorer window, or by right-clicking on the highlighted files and selecting Properties.
8. Enter the time of first bat recording and time of last bat recording.
 - See the **Recognizing Bat Calls** section before proceeding.
 - Open the first sequence file in the folder by double-clicking on it. If this does not automatically open in AnalookW, choose AnalookW from the list of programs available to open the file by right-clicking on the sequence file.
 - Once the file has opened in AnalookW, check to see if it was made by a bat. If it was, enter the time of the recording as the time of first bat recording in the spreadsheet (the time can be found in the file name; for example, J5202334.49# was recorded on May 20 at hour 23, minute 34, second 49). If the first file wasn't made by a bat, move to the next file in the folder and decide if it was made by a bat (in AnalookW, the W key on the keyboard moves to the next file in the folder; the Q key moves to the previous file). Repeat this process for the recordings from that night until you have either found a bat call or reached the last recording. If no bats were recorded in a night, leave the field blank.

- Continue through all the call files for the same night of recording until you have identified the last file produced by a bat. Enter that time as the time of the last bat recording. If no bats were recorded in a night, leave the field blank. If there is only a single bat call in a night, enter the same time for both first and last bat recording.
- 9. Enter the total number of bat recordings.
 - Look at all the sequence files for a given night and enter the number of them that are recognizable as being produced by a bat.
- 10. Enter the number of bat recordings that could be used for species identification.
 - This is highly subjective and dependent on analysis experience. The quality of the sequence file is based on how solid, or “complete”, the line of each call appears to be, which reflects the proximity of the bat to the detector. Also, if a call sequence is very short, it may not contain enough information about the call to use for species identification.
- 11. Enter the species detected.
 - Without a call library and statistical programs that can run discriminant function analyses, it is virtually impossible to identify any of the calls to species level. However, they can easily be divided into two groupings: 1. Myotis species, and 2. Lasionycteris noctivagans/Eptesicus fuscus. These divisions are based on call frequencies. Myotis calls typically end between 40 and 35 kHz, while L. noctivagans and E. fuscus end between 30 and 25 kHz.
 - If all of the calls for the night fall in the Myotis category, enter “Myotis species” in the Species field; if in the Lasionycteris noctivagans/Eptesicus fuscus category, enter “Lasionycteris noctivagans/Eptesicus fuscus” and then write the recording times in the Notes field for future reference. If there are calls from both categories in the same night, enter “Lasionycteris noctivagans/Eptesicus fuscus, Myotis species” in the Species field and then write the recording times of the Lasionycteris noctivagans/Eptesicus fuscus in the Notes field for future reference.
- 12. Copy any non-Myotis sequence files to new folder.
 - Because there are relatively few non-Myotis recordings each season, a copy of each should be stored in a separate folder for quick reference.
 - Under T:\NRM\Mammals\Bats\Year\Data\CF Data create a folder named “non-Myotis”.
 - Copy each sequence file in the Lasionycteris noctivagans/Eptesicus fuscus species category and paste to this new folder.

Recognizing Bat Calls

In order to make even a basic analysis of call data, one must be able to differentiate between recordings produced by bats and those produced by other sources. Luckily, there are few other sources of ultrasound that get recorded, and the vast majority are weather related (resulting from wind and precipitation). Weather related ultrasound tends to produce shorter recordings that have the appearance of TV static; that is, they have either a vague shape or none at all. The frequencies also tend to fall below the range of most of the bat calls, which ends just below 35 kHz for Myotis species (25 kHz for *Eptesicus fuscus* and *Lasionycteris noctivagans*).

The other main source of non-bat ultrasound recordings are humans, or humans operating machinery. These recordings tend to have strong patterns that fall well below the frequency range of bat calls, usually in the human hearing range (below 20 kHz).

The best way to differentiate between call sources is to know what a bat call looks like. Study the calls from the 2009 season to get a feel for the general characteristics of bat calls, as well as the variety of qualities that they can come in. The first thing to notice is that they all contain groups of distinct, downward sweeping lines (falling from left to right). The clearest recordings should be easy to tell apart from any other ultrasound sources; the weak recordings are the difficult ones. Next, notice that the bat call sequences come in repetitions with silent breaks between each call in the sequence. Other sources of ultrasound typically produce a constant stream of sound. Finally, note the time of the recording. If almost every call in a night is easily recognized as having come from a bat, it is likely that one or two questionable files also came from a bat if they fall between the first and last recordings of bats. If the files in question fall *before* the first recognizable bat call, or *after* the last recognizable bat call in a night, look to see how much time spans the two files and consider the likelihood of human presence at the time of the recording. Human recordings are not uncommon before 9PM or after 5AM.

The next level in call analysis is identifying which species of bat produced a given recording. Unfortunately, without a call library and statistical software, it is nearly impossible to positively identify any recording to species level. With a great deal of experience, one could identify *L. noctivagans* by eyesight alone, but this level of knowledge is not expected of the average assessor. Instead, the calls should be categorized into two groupings: those belonging to the *Myotis* genus, and those belonging to either *L. noctivagans* or *E. fuscus*.

Images

Digital photographs should be taken for any new monitoring site, or if an existing monitoring site undergoes a drastic change during the monitoring period (e.g., a significant number of trees are cut or fallen). The images should document the detector on its mount, the field of “view” of the detector, and the surrounding area showing vegetation and potential flying corridors. Images should be stored under the folder containing documents for the year of study, such as T:\NRM\Mammals\Bats\2009\Data\Images. Please be economical and store only as many photos as are necessary for a site description.

Reports

An annual report should be written for each year that monitoring takes place. It should be written in the form of a scientific paper, containing a Cover Page, Abstract, Introduction, Site Descriptions, Methods, Results, Discussion, and References. It should include a summary of the call data entered into the Site spreadsheet for that year, map(s) of the study site(s), as well as any relevant graphs or images. The final version should be made into a PDF document and stored under T:\NRM\Mammals\Bats\Year\Report.

Appendix D: Anabat SD1 Malfunction Report

Since it was acquired in 2007, the Anabat SD1 bat detector has not functioned properly in the field. It was first field tested in the Commissary and Soapy Smith's Parlor in early winter of 2007, when temperatures were well below 0 C, and it did not appear to function correctly at either location. It was then tested in the field repeatedly in 2008 and 2009 without success. Curiously, it has functioned perfectly inside of the office, but when placed just outside of the office window while connected to a permanent power source, it gave the same error as when used in the field previously. The same settings and CF card were used in both instances.

Possible causes for the error included cold temperatures and humidity or moisture. The detector was returned to Titley Electronics in Australia in 2009 for repairs, where it reportedly functioned perfectly inside of a freezer below 0 C for weeks and nothing was found to be wrong.

The details of the error are as follows:

- The detector is installed outdoors in a weatherproof housing, connected to a 12V gel cell battery, just at the Anabat II has been.
- The CF card is formatted and initialized with the same time parameters as the Anabat II.
- The CF card is installed in the detector and the detector is powered on.
- The detector properly goes into Standby mode, presumably until the Start Time setting.
- When the detector is checked the following day, the Error LED is lit.
- When the CF card is downloaded, a single text file is written that reads
@ 2007/11/16 16:39:38.971250 Open Sector 600

Appendix E: Mist Netting Proposal

Equipment

The following is a comparison of equipment used in the capture of flying bats. *Not all of these items are needed.* Rather, they should be looked into further and matched with the appropriate capture methods for the study area.

6 mist net poles (enough for a single high mist net setup) = \$99.00 (www.batmanagement.com)

Forest Filter Mist Net System = \$650.00 (www.batmanagement.com)

Harp Trap 3' Cave Catcher = \$650.00, 6' Forest Strainer = \$950.00, Catch Bag = \$65.00
(www.batmanagement.com)

Avinet 2.6x2.6m = \$80, 2.6x6m = \$100, 2.6x9m = \$130, 2.6x12m = \$145, 2.6x18m = \$210
(Alana ecology)

6 mist net poles (26mm) = \$280 (Alana ecology)

6 mist net poles (19mm) = \$240 (Alana ecology)

Procedure

Open nets 30 minutes before sundown and leave up for at least three hours. It has been suggested that mist nets be checked continuously to achieve optimum capture rate, and no less frequently than every 10 minutes to minimize injury to bats. Also, it is recommended that four infrared lights be used per net to maximize detection of captured bats.

Between 30 and 200 reference calls should be used in Discriminant Function Analysis. If one bat of each resident species were successfully caught and processed on each netting effort, the total mist-netting efforts should be 30.

6 sites x 7 hours (4 for netting, 3 for travel and setup) x 5 nights x \$21/hour = \$4410

Passive monitoring will take place at six sites for approximately one month per site.

6 sites x 4 hours (3 for travel and site choice, 1 for setup) x \$21/hour = \$504

Data Management and Analysis

Discriminant Function Analysis software is needed for species identification. STATA 10 SE costs \$1550 with the base manual (add \$275 for complete set of manuals).

Hours per CF card download: 3 (1 for travel, 2 for analysis) x 25 x \$21 = \$1575

Hours on DFA: 20 x \$21 = \$420

Hours on miscellaneous tasks: 20 x \$21 = \$420

Management Total: \$2415

Safety

Those persons handling bats should receive full rabies prevaccinations at least one month prior to handling. It is also recommended that thick leather gloves be used in handling whenever possible, namely on the hand being used to hold the bat.

Resource	Cost
Mist Net Components (2x6m, 2x9m, 2x12m, 24 26mm poles)*	\$1870
Biotech Mistnetting	\$9000
Biotech Passive Monitoring	\$2000
Biotech Data Management, Analysis, and Reporting	\$6000
Discriminant Function Analysis Software (STATA 10 SE)	\$1550
Leather Gloves (3 pairs)	\$60
Rabies Prevaccination	\$250
Total	\$20,730

*This is a sample selection of mist net gear for versatility at a reasonable budget. Using a greater proportion of shorter nets costs more and requires the use of more poles. Using a greater proportion of longer nets limits versatility too much.