Notes

Effects of Orientation and Weatherproofing on the Detection of Bat Echolocation Calls

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Abstract

Ultrasonic detectors are powerful tools for the study of bat ecology. Many options are available for deploying acoustic detectors including various weatherproofing designs and microphone orientations, but the impacts of these options on the quantity and quality of the bat calls that are recorded are unknown. We compared the impacts of three microphone orientations (horizontal, 45°, and vertical) and two weatherproofing designs (polyvinyl chloride tubes and the BatHat) on the number of calls detected, call quality, and species detected by the Anabat II bat detector system at 17 sites in central Kentucky in May and June 2008. Detectors with BatHat weatherproofing recorded significantly fewer call sequences, pulses per file, species per site, and lower quality calls. Detectors in the horizontal position also tended to record fewer files, fewer species, and lower quality calls. These results illustrate potential impacts of deployment method on quality and quantity of data obtained. Because weatherproofing and orientation impacted the quality and quantity of data recorded, comparison of results using different methodologies should be made with caution.

Keywords: activity; Anabat; bats; orientation; weatherproofing

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Introduction

Monitoring of bat echolocation calls has greatly expanded our knowledge of bat ecology. Ultrasonic detectors permit nonintrusive sampling of the bat community and can be used to sample bats in habitats that are ineffectively sampled using traditional capture techniques (e.g., open fields, large rivers). Additionally, bat detectors can detect more species at a site than capture techniques (Murray et al. 1999; O'Farrell and Gannon 1999). Further, ultrasonic detectors can be deployed to passively record the echolocation calls of bats without an observer present, thereby allowing a small crew to sample multiple sites simultaneously and for long periods of time (e.g., Gorresen et al. 2008).

The Anabat II (Titley Electronics, Ballina, NSW, Australia) is an ultrasonic detection system that is widely used for the study of bats. Although the system allows for long periods of automated recording, the equipment is susceptible to damage from rain. To protect the equipment, researchers have developed two primary types of weatherproofing. The first protective measure involves a detector placed in a polyvinyl chloride (PVC) tube in a waterproof box so that sound enters the PVC tube, while the water drains out through a small hole in the bottom of the tube (O'Farrell 1998). The second system is comprised of the microphone enclosed in a PVC housing pointed down at an acrylic-glass plate used for call deflection (BatHat; EME Systems Inc., www.emesystems.com; Arnett et al. 2006). The ability to detect echolocation calls of bats can also be affected by the orientation angle of the detector. Depending on the height of the detector, detector orientation can significantly affect the number of bat detections (Weller and Zabel 2002).

While different weatherproofing methods and orientations have been extensively used by researchers, there is a lack of published data examining the effectiveness of the two most commonly used weatherproofing options, despite the importance of the potential impacts on the results and subsequent interpretation of the data. These impacts could affect the quantity of activity data collected or quality of the data, which may render species identification impossible in some circumstances. The objective of this study was to determine how common detector orientations and weatherproofing options affect the quantity and quality of bat calls recorded.

Methods

We conducted this study in two areas, one each in Franklin and Spencer counties, Kentucky. Both areas contained small woodlots dominated by oaks (*Quercus* spp.), elms (*Ulmus* spp.), and hickories (*Carya* spp.) interspersed with grazed pasture. We chose sampling sites within each area to represent the range of suitable sampling sites based on our experience with recording echolocation calls and included ponds, linear corridors (e.g., streams and roads), canopy gaps, and open fields.

We used Anabat II detectors connected to a compact flash-storage Zero-Crossings Analysis Interface Module, as well as the SD1 units, in which the detector and the storage Zero-Crossings Analysis Interface Module are contained in one unit (Titley Scientific; www.titley.com.au). Before sampling, we calibrated the detectors by following methods used by Larson and Hayes (2000). At each sampling site, we deployed five Anabat II systems side by side on tripods at 1.5 m. Each day of sampling we assigned a specific detector for each treatment. The five treatments included three detector orientations (0° [horizontal], 45°, and 90° [vertical]) and two weatherproofing options (a PVC tube and the BatHat). A schematic of the two weatherproofing options is shown in Figure 1. We randomly determined the relative position of each of the five treatments for each site. Sampling occurred in May and June 2008. We sampled each site for one night.

We set up detectors before dark and recorded the echolocation calls throughout the night. We only conducted sampling on nights with no heavy precipitation and when winds were light. We placed detectors to maximize detection at the recording site. The following morning, we gathered units and uploaded data to a laptop computer using the CFCread program (www.hoarybat.com). We placed data from each unit in a separate directory and scanned the data with a customized filter in Analook (Version 4.9j) to delete extraneous noise (Britzke 2003), with subsequent visual examination to ensure that only files with echolocation calls remained.

We used the scanFiles option in Analook to determine the number of files and the Countscan option to calculate the total number of pulses for each sequence. We then used a customized filter (modified from Britzke and Murray 2000) to extract parameters for those echolocation call sequences that were of sufficient quality (e.g., no broken pulses) to permit species identification. We saved the parameters to a text file and identified them by comparison to a known call library using a mixed Discriminant Function Analysis model in the statistical program R (v. 2.2.1; http://www.r-project.org; Duchamp 2006). Because species identification is probabilistic, we determined species presence using the methodology described in Britzke et al. (2002).

We compared the total number of files, number of pulses per file, and percentage of files surviving the identification filter among the five treatments using a randomized block (by site) analysis of variance. We then compared means using a Tukey test, and species richness using a Median test. For all tests alpha $=$ 0.05.

Results

We surveyed 17 sites in which sampling equipment functioned properly for all five treatments. Mean number of files recorded per night varied by treatment ($F = 4.02$; $P = 0.006$). The mean number of files recorded per night by the BatHat was significantly lower than all other treatments; the units with PVC protection recorded the highest number of files per night (Figure 2A). Mean number of pulses per file varied among treatments ($F = 8.02$; $P < 0.001$) and the BatHat had significantly fewer pulses per file than all other treatments (Figure 2B). Percentage of files that passed through the identification filter were significantly different among treatments ($F = 15.37$; $P < 0.001$), with the BatHat recording calls of significantly lower quality than the other treatments (Figure 2C).

Six bat species were detected: big brown *Eptesicus fuscus*, eastern red *Lasiurus borealis*, northern long-eared *Myotis septentrionalis*, Indiana *M. sodalis*, little brown *M. lucifugus*, and tri-colored *Perimyotis subflavus*. Species richness varied significantly among treatments ($P = 0.003$): the mean number of species was 1.7 for the horizontal orientation, 2.4 for the 45° orientation, 2.4 for the vertical orientation, 2.3 for the PVC weatherproofing, and 1.1 for the BatHat weatherproofing. In general, the pattern of higher detections by the PVC and $45^\circ$and 90° orientations held for each of the species, although northern long-eared bats were only detected by the vertically oriented detectors and Indiana bats were not as readily detected by the detectors with PVC or BatHats (Figure 3).

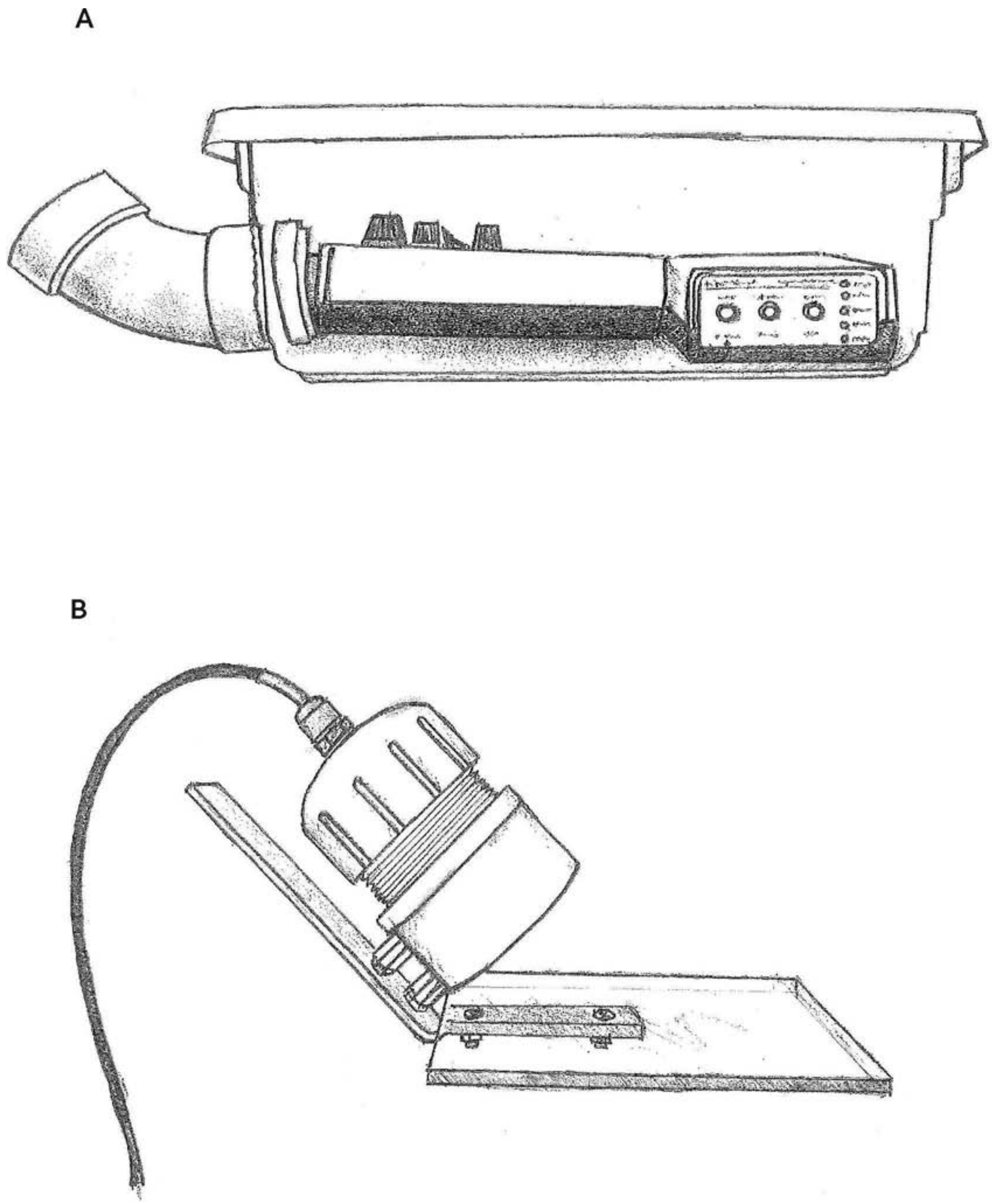

Figure 1. Schematics for the two weatherproofing options tested in this study. (**A**) the PVC weatherproofing option, and (**B**) the BatHat weatherproofing option. Both views are lateral views.

Discussion

Significant differences among the treatment groups suggest that weatherproofing and detector orientation may impact the detection of bat echolocation calls. In particular, these data suggest that studies employing the BatHat system we used may detect lower activity and species richness than are present at a site. If researchers are only interested in relative activity levels among sites, any weatherproofing or orientation may be acceptable as long as detectors are deployed in a similar way among all sites. However, problems may arise if researchers want to conduct species identification or compare their results to studies where other weatherproofing designs or orientations were used. Future studies using passive sampling with the Anabat system should include discussion of the method of deployment and the potential impact on the results.

We measured a variety of parameters to test the effects of orientation and weatherproofing on detector performance. The total number of call sequences or files is often used as a measure of overall activity (e.g., Hayes 1997), while the number of pulses per sequence can provide a measure of the intensity of activity (Gorresen et

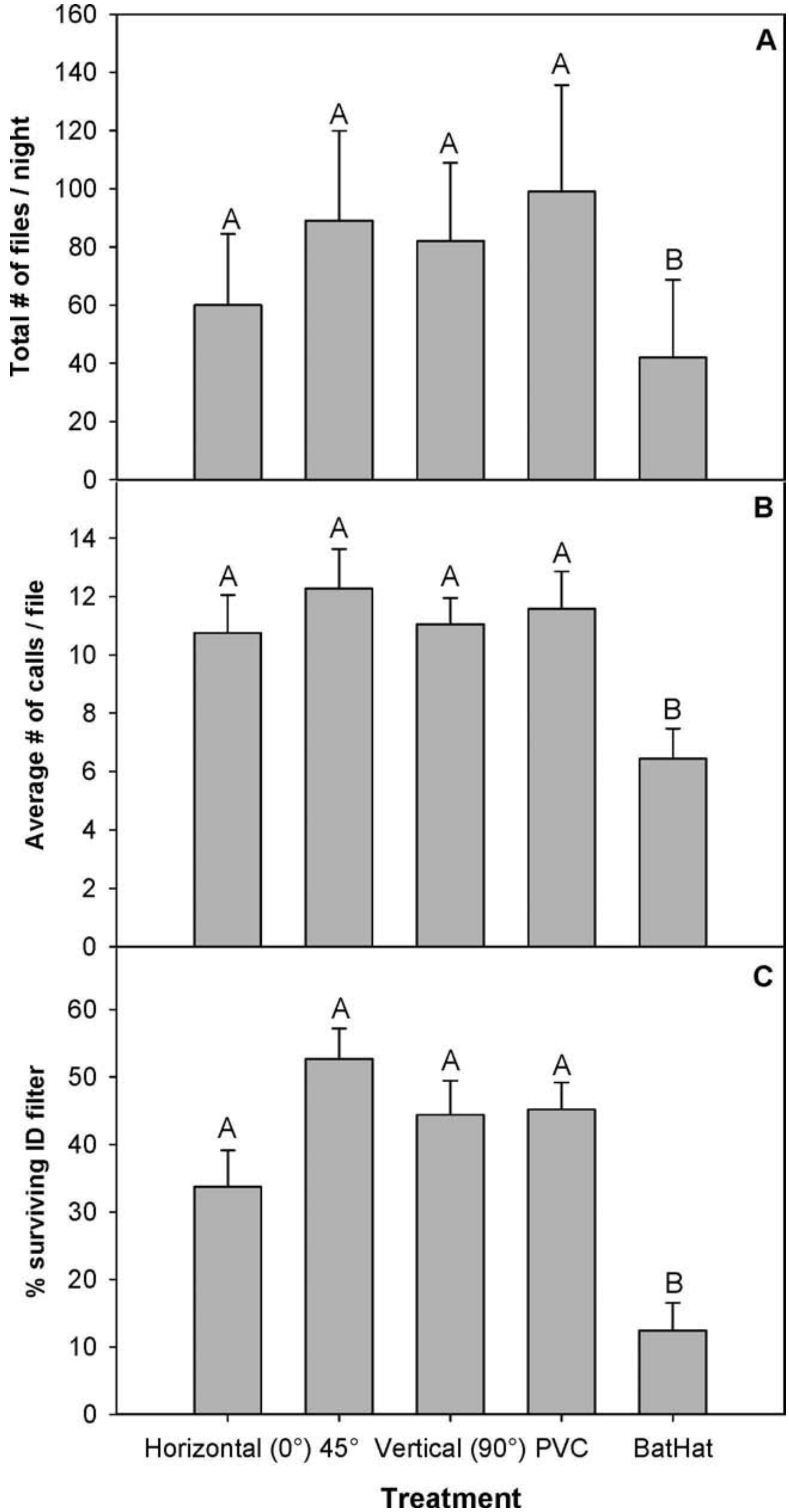

Figure 2. Echolocation sequences and pulses recorded by Anabat II detectors at three orientations and two weatherproofing types in Kentucky, May and June 2008. (**A**) the total number of files, (**B**) average number of pulses per sequence, and (**C**) percent of bat calls surviving identification (ID) filter. Bars with different letters above them were found to be significantly different from each other using the Tukey pair-wise comparisons.

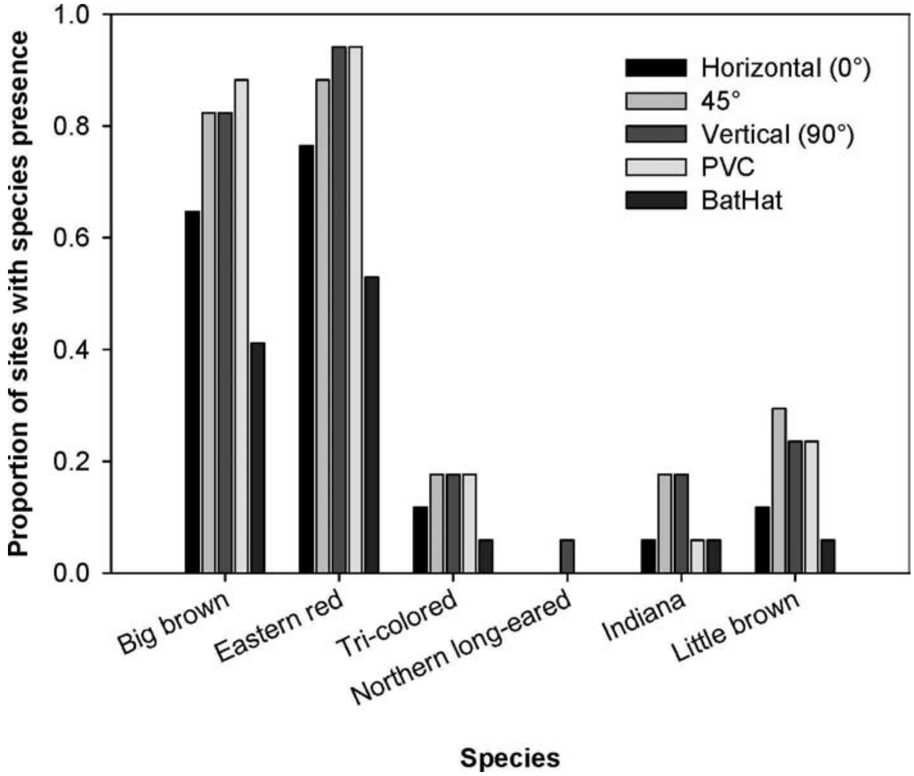

Figure 3. Proportion of sites at which each bat species was detected by Anabats at three orientations and two weatherproofing designs. PVC = polyvinyl chloride tube. Big brown *Eptesicus fuscus*, eastern red *Lasiurus borealis*, tri-colored *Perimyotis subflavus*, northern long-eared *Myotis septentrionalis*, Indiana *M. sodalis*, little brown *M. lucifugus*.

al. 2008), and the percentage of calls surviving the identification filter is a measure of the quality of the recordings. Factors affecting the detection, quality, or length of sequences all have large impacts on the results of studies using Anabat detectors or other acoustic sampling equipment. The consistent pattern of differences across all parameters suggests that the differences among treatments are real.

Weller and Zabel (2002) found no difference between detectors oriented at 30° or 45° if they were on 1.4-m-high stands. However, we found that horizontal deployment tended to record lower (not statistically significant) activity levels (number of files) and species richness than the other orientations. The appropriate orientation may depend on the question of interest. For example, if a researcher is interested in recording bats that forage near the water surface, such as gray bats *M. grisescens*, horizontal deployment can be expected to be better than other orientations.

Six species were detected across the five treatments, but no treatment detected all six species. The PVC, 45°, and vertical (90°) treatments consistently recorded almost twice as many species as the BatHat. Further, the number of species recorded by detectors in the horizontal position tended to be lower than the detectors at 45°and 90°, even though the number of calls recorded by detectors in the horizontal orientation was just slightly below the number of calls recorded by detectors in the vertical (90°) position. This may be due to species use of the habitats or the intensity of the echolocation calls (e.g., low-intensity calls are not detected at as far a distance by the detectors as higher intensity calls). Knowledge of the impacts of weatherproofing and orientation on detector performance allows researchers the opportunity to deploy equipment in such a way as to maximize success or to deploy additional equipment to gain a more accurate representation of species present (Duchamp et al. 2006).

When conducting echolocation surveys for bats, multiple sampling sites may be required. Many detectors are often deployed throughout the project area to record simultaneously. Similarly, studies designed to test the effects of habitat type or management activities on bat habitat use and activity often set detectors simultaneously in each habitat type or treatment to control for the effects of temporal variation on activity (e.g., Loeb and Waldrop 2008). These situations require the use of weatherproofing equipment because detectors are widely scattered across the landscape and sudden storms are possible. Our results suggest that detections obtained from detectors at two common orientations without weatherproofing (45° and 90°) are similar to those from detectors with the PVC weatherproofing, indicating that data can be compared across studies using any of these methods.

This investigation was not meant to test all possible configurations, but was instead focused on the comparison of the most common orientations and weatherproofing options. The impacts of the orientation and weatherproofing options likely vary with local site conditions and the bat community present. For example, Gruver et al. (2009) found that the number of bat passes recorded by the BatHat was greater than the number recorded by a PVC setup in one area but found no differences in the number of passes recorded by the two systems in another area. Results of this study should not necessarily be applied to other modifications of these weatherproofing options, but instead should illustrate the potential impacts of orientation and weatherproofing options on the quality and quantity of data obtained. Knowledge of the impacts or weatherproofing and orientation should assist in appropriate use of data obtained by maximizing the quality of data obtained through studies involving acoustic surveys, thereby improving our knowledge of the impacts of management activities on bats.

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