COMPARISON OF SURVEY TECHNIQUES FOR DOCUMENTING SUMMER BAT COMMUNITIES IN PENNSYLVANIA AND NEW JERSEYA

KAREN E. FRANCL14, R. CRAIG BLAND, JESSICA S. LUCAS2, AND VIRGIL BRACK, JR.3

1Biology Department, Radford University, Radford, VA 24142
2Department of Forestry and Natural Resources, Clemson University, Clemson, SC 29634
3Environmental Solutions and Innovations, Inc., Cincinnati, OH 45233

ABSTRACT

To maximize efficiency in assessing the composition and relative activity of summer bat communities, we quantitatively compared differences in the amount and quality of data collected using the AnaBat echolocation detection system and double- or triple-stacked mist netting efforts. In summer 2009, we surveyed bats at 27 sites in Pennsylvania and New Jersey, monitoring from sunset until 5-h post-sunset over the period of one or two nights. We recorded 5,594 echolocation call sequences in which we identified seven species (Eptesicus fuscus, Lasiurus nocticagans, Lasiurus borealis, Lasiurus cinereus, Myotis lucifugus, M. septentrionalis, and M. sodalis). All of these species except for Myotis sodalis (Indiana bat) also were captured in mist nets (N = 160 individual captured). We found no difference between the total number of echolocation call sequences on the first night versus the average number of calls across both nights, indicating that relative activity of bats could be attained in just one night of AnaBat recordings. However, if the goal is to assess species richness or detection of a particular species, we found that two survey nights were necessary for both acoustic and mist netting techniques. More importantly, AnaBat recordings showed that detection of the endangered Indiana bat is significantly more likely when surveys extend over two nights. Overall, the AnaBat system is more likely to detect more species, assuming species identification techniques are reliable. Mist netting provides vital information about individual health (especially important in light of White-nose Syndrome) and life history traits and can absolutely verify the presence of a target species. Our research can serve as a guide to effectively plan bat surveys for assessing the species richness and relative activity across sites for bat communities.

INTRODUCTION

In light of two major “events” in recent years in the northeastern United States—increased construction of wind turbines (Arnett 2005; Reynolds 2006) and the discovery and spread of White-nose syndrome (WNS; Blehert et al. 2009; Boyles and Willis 2009)—bat communities may be severely impacted at local and regional scales. Current efforts focus on documenting declines in bat communities during their migratory season (for turbines) and in their winter hibernacula (for WNS), but fewer studies address the impacts of either potential threat on summer communities (Francl et al. in press). Long-term monitoring programs are the best ways to document annual trends. However, the choice of surveying techniques may have a marked impact on data collection and interpretation.

Every technique, including mist netting and ultrasonic detection, has strengths and weaknesses. Mist netting allows direct contact with individual bats, so that that species identification, age, gender, body measurements, and health can be assessed. Mist nets also are relatively inexpensive, and a multitude of size choices allow this technique to be employed in many field conditions. However, not all field conditions are appropriate for the use of mist nets, e.g., netting in open-canopy habitats or across large waterbodies are not effective (Murray et al. 1999; Kunz et al. 2009). Additionally, species typically flying above the maximum height of the stacked mist nets may avoid capture in any condition (Menzel et al. 2000).

Researchers may use ultrasonic detectors to counteract such simple bias. This surveying technique, employed passively in this study, continuously records data for days at a time, and is effective in the habitats less suitable for mist nets (Murray et al. 1999). Feeding buzzes also document site-specific feeding activity. However, substantial mist netting efforts are required to catch bats used to develop call libraries, without which ultrasonic detectors provide little useful data (Barclay 1999; Kunz et al. 2009; O'Farrell and Gannon 1999). Furthermore, in light of newly-discovered disease threats to bats like WNS (Blehert et al. 2009), this passive technique cannot document the health of individuals. Finally, the initial cost of the recording device can be quite substantial.

Submitted for publication 9 April 2010; accepted 8 September 2010.

Corresponding author email: Box 6931, Radford, VA 24142; kfrancl@radford.edu
Given the benefits and limitations of these two techniques, researchers and land managers must determine if a single method or a combination of the two is most suitable for answering their questions. Acknowledging limitations in time, personnel, and funding, the choice of technique could be a weighted decision. To aid this selection, our goal was to compare the amount and quality of community and spatial information of relict bat populations on 20 mist nets and passively recording ultrasonic detectors at sites surveyed for two consecutive nights.

Similar techniques comparison studies were completed in Missouri (Murray et al. 1999), Nevada (Keanin and Morri son 1998), and multiple states in the southwestern United States (O’Farrell and Gunnan 1999). However, these studies lack one or more technique we employed—passive, continuous recording techniques (not employed in O’Farrell and Gunnan 1999), sampling two nights in a row (absent in a large and a fairly recently-employed flip for the Indiana bat (absent in all comparative studies; described in methods). Furthermore, because we planned to examine species-specific trends, the previous studies differ in species composition from our surveys in Pennsylvania and New Jersey.

In framing our study, we questioned if 1 or 2 nights provided statistically different estimations of activity patterns (relative bat activity, feeding success; echolocation detectors) only across all species. Species richness also was compared between both techniques and between nights, determining if a second night provided significantly greater richness. We also examined species-specific patterns to assess if one or both methods were necessary to detect a particular regional species or site activity. We hypothesized that 2 nights of surveys would be necessary—or more successful—in assessing all described community trends and in detecting the presence of all regional bats. The last, but not least, our hypothesis would provide justification for time-saving measures, depending on the goals of the project.

RESULTS

During 108 full net-nights and 4 partial net-nights, we captured 160 bats of six species: big brown (Eptesicus fuscus; 20 individuals), little brown (Myotis lucifugus; 42 individuals), 16 individuals, (northern), (S. septentrionalis, 23 individuals, 15 sites), red (16 individuals, 8 sites), hoary (Lasionycteris noctivagans; 3 individuals, 3 sites), and silver-haired (Lasionycteris noctivagans; 2 individuals, 2 sites) bats (Table 1).

Our Anabat surveys detected 5,624 cell phones from seven species—including big brown (1802 cell phone calls [32.4% of all calls], 26 sites), little brown (2265 calls [47.0%], 25 sites), northern (435 calls [7.8%], 24 sites), reds (377 calls [7.0%], 22 sites), hoary (151 calls [2.7%], 13 sites), sil ver-haired (35 calls [0.6%], 5 sites), and Indiana (186 calls [3.3%], 10 sites) bats (Table 1). An additional 55 calls were identified as Myotis spp. (1.0%), and 248 (4.5%) were not identified.

The average number of calls/survey on night 1 (103.9) was not significantly different than the average across both nights (105.2, S = 66.5, p = 0.092). However, the average number of feeding buzzes recorded on night 1 (4,63) was significantly lower than the average of both nights (4,74, S = 220.5, p = 0.037).

Species richness estimates for both methods increased with a second night of data collection. The average number of species detected by Anabat recordings on night 1 (4.0) was significantly lower than species richness accumulated across two nights (AVG = 4.6, S = 39.0, p < 0.001; Table 2).

The detection rate of individual species with Anabat for night versus both nights was not significantly different for 6 of our 7 species (Table 2). However, Myotis sodalis (Indiana bat) was more likely to be detected in night 1 than in night 2 (S = 14.0, p = 0.016; Table 2). For mist netting,

<table>
<thead>
<tr>
<th>Species</th>
<th>Mean Night 1</th>
<th>Mean Night 2</th>
<th>S</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eptesicus fuscus</td>
<td>0.25</td>
<td>0.35</td>
<td>0.10</td>
<td>0.005</td>
</tr>
<tr>
<td>Myotis lucifugus</td>
<td>0.001</td>
<td>0.11</td>
<td>0.30</td>
<td>0.029</td>
</tr>
<tr>
<td>S. septentrionalis</td>
<td>0.78</td>
<td>0.55</td>
<td>0.15</td>
<td>0.250</td>
</tr>
<tr>
<td>M. lucifugus</td>
<td>0.92</td>
<td>0.26</td>
<td>0.50</td>
<td>0.050</td>
</tr>
<tr>
<td>M. septentrionalis</td>
<td>0.54</td>
<td>0.28</td>
<td>0.25</td>
<td>0.250</td>
</tr>
<tr>
<td>M. sodalis</td>
<td>0.15</td>
<td>0.30</td>
<td>0.50</td>
<td>0.001</td>
</tr>
</tbody>
</table>

Table 2. Results of Wilcoxon signed-rank tests comparing differences in detection rate in surveying techniques (mist netting or Anabat echolocation detection) in one night versus two nights at 27 sites in northern Pennsylvania and New Jersey, 2005. Results presented for all species detected, and for average number of species detected per technique. Differences were significant: S显著 indicates significant increases of detection for species or species group. "ND" indicates no differences between means.

Table 1. Number of survey nights by bat species and survey technique documented. Captures (unidentified), echolocation recordings (Anabat), or both techniques for 27 surveys sites (2004) in Pennsylvania and New Jersey, summer 2009.

<table>
<thead>
<tr>
<th>Site</th>
<th>Eptesicus fuscus</th>
<th>Myotis lucifugus</th>
<th>S. septentrionalis</th>
<th>M. lucifugus</th>
<th>M. septentrionalis</th>
<th>M. sodalis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>7</td>
<td>19</td>
<td>27</td>
<td>5</td>
<td>27</td>
</tr>
<tr>
<td>2</td>
<td>7</td>
<td>14</td>
<td>17</td>
<td>22</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>3</td>
<td>7</td>
<td>11</td>
<td>15</td>
<td>19</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>8</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>6</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>6</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>6</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>6</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>9</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>6</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>10</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>6</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>11</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>6</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>12</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>6</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>13</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>6</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>14</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>6</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>15</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>6</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>16</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>6</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>17</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>6</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>18</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>6</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>19</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>6</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>20</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>6</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>21</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>6</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>22</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>6</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>23</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>6</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>24</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>6</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>25</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>6</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>26</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>6</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>27</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>6</td>
<td>1</td>
<td>6</td>
</tr>
</tbody>
</table>
the detection rate of individual species across 2 nights vs. just 1 night per site, found that species richness values did not differ between techniques. However, although our mist netting’s average captures (N = 2.3 species/night) did not markedly differ from Kuenzi and Morrison (2.7 species/night), their Anabat species detection rates (3.2 species/night) was markedly lower than our findings (4.6 species/night). The lower detection rate in their study may be a result of regional differences or Kuenzi and Morrison’s sampling for just 1 night per site and obtaining lower values.

When breaking our analyses down by species, we found that the two techniques differed in their patterns. For mist netting efforts, the most common species (M. lucifugus) required 2 nights of capture. This finding is counter-intuitive. Weller and Lee (2007) examining survey efforts using mist nets, found that the most common species were captured with a very low survey effort. However, their study examined efforts of up to 100 hours at a single site whereas our study was limited to differences in 1 versus 2 consecutive nights. Alternately, using the Anabat, only Indiana bats required 2 nights of surveys. Our 3-day requirement for Anabat data collection is consistent with the U.S. Fish and Wildlife’s standard mist netting protocol in the Indiana bat recovery plan (USFWS 2007). Robbins et al. (2008) evaluated mist netting efforts in areas housing a substantial colony of Indiana bats, and determined that capture success actually declined in a second night of surveying, despite the finding that relative activity of this species did not decline in Anabat analysis.

Based on our mixed findings, we support the recommendation of Robbins et al. (2008): that the best survey method is a combination of echolocation detectors and mist netting. Once detected, mist net efforts could confirm or fail to confirm the presence of this species. Although work efforts are increased (less time-efficient), efficiency is rarely the primary goal in endangered species detection; this approach is critical for the likelihood of capturing this endangered species (USFWS 2007). Indeed, Kentucky is implementing a version of this by requiring both netting and Anabat sampling. If Anabat fails to detect Indiana bats when none are caught in mist nets, an additional mist netting effort of 2 nights is required (USFWS–Kentucky Field Office and KDFWR 2008). Kueha (1998) suggested that when targeting a particular species, mist netting may be an acceptable preliminary survey. This non-handling option may be appealing in light of white-nose syndrome, if handling of potentially infected bats is not helpful.

If the goal of the survey is to document bat health locally, mist netting is the only option. Determining wing damage (Reichert and Kusz 2009) or general health through a measure such as body mass index (Reichert et al. in press) can only be determined with the bat in hand. However, Anabat surveys can prove useful, and have already documented detectable declines in health (e.g., W.M. Ford, USACE, pers. comm.) in areas affected by WNS.

Generally, the goals of a bat survey are not constrained to one of the above; multiple goals can be satisfied in a single round of surveys. If that is the case, then we conclude that the standard practice of 2 nights per site using multiple detection techniques is still the optimal choice in assessing the activity and relative health of this faunal community in Pennsylvania and New Jersey.

ACKNOWLEDGMENTS
We thank the landowners who allowed us to conduct our surveys on their property. We are also grateful for the technicians who assisted in data collection: M. Brennan, D. Mathews, D. Meikle, and B. Meyer.

LITERATURE CITED


BIOLOGY: FRANCI, et al. 55