Bats of the Uwharrie National Forest: Mist-netting (2014 and 2015) and Acoustic Sampling (2013-2015)

Final Project Report for the North Carolina Wildlife Resources Commission

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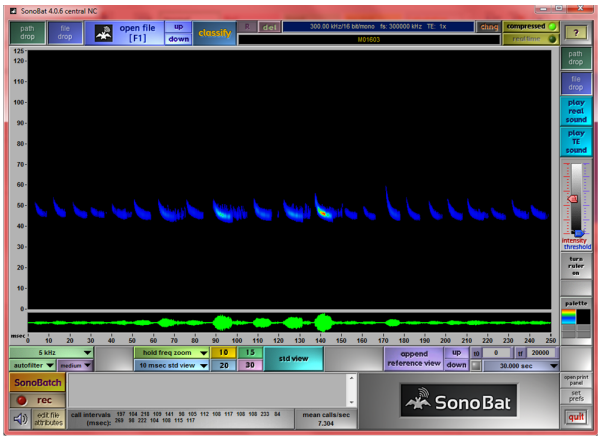

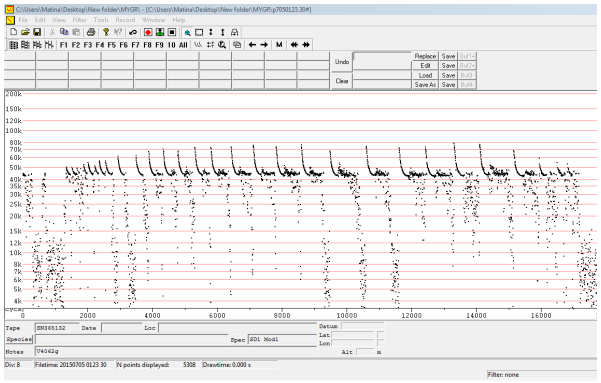

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COVER PHOTOS

Big brown bat (*Eptesicus fuscus*) with transmitter prior to release. Red bat (*Lasiurus borealis*) prior to release. Evening (*Nycticeius humeralis*) roost tree (N4R1). All photos by Kristy King. High quality full spectrum echolocation pass of a tricolored bat (*Perimyotis subflavus)* from an Ophir net site (07/01/2015). Anabat zero-cross recording (P7050123.30#) from a *Myotis* bat from NABat grid 65.

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AUTHOR CONTRIBUTIONS

Matina Kalcounis-Rueppell compiled material for this report from data collected as part of Kristy King's dissertation and from previous project reports. For this report, Matina Kalcounis-Rueppell reanalyzed all full spectrum echolocation pass recordings from net-sites and the Troy Depot and compiled all results. Han Li analyzed all driving transect acoustic data. Matina Kalcounis-Rueppell and Han Li both examined all relevant echolocation pass recordings from driving transects. Han Li wrote initial versions of text related to the driving transects. Matina Kalcounis-Rueppell synthesized all material and wrote the report.

ABSTRACT

The Uwharrie National Forest (UNF) is the largest national forest in the piedmont region of North Carolina, an area that has historically seen a high degree of land conversion. The UNF is an important area for bats and despite this, relatively little systematic work has been done to understand how bats use the UNF. In an effort to understand the distribution of bats and their roost sites in the UNF we intensively sampled bats in the UNF in 2014 and 2015. We used mist netting and 3 approaches to acoustic sampling to determine which species of bats are present, and when, in the UNF. We used radio-telemetry to determine the roost sites of cavity roosting bats captured in the UNF. We swabbed all captured bats and sent a subset of samples to be tested for *Pseudogymnoascus destructans* (*Pd*), the fungus that causes White-nose syndrome. Mist-netting during summer revealed the presence of big brown (*Eptesicus fuscus*), red (*Lasiurus borealis*), evening (*Nycticeius humeralis*), and tricolored (*Perimyotis subflavus*) bats. Acoustic sampling supported mist-netting results and additionally supported the presence of hoary (*Lasiurus cinereus*), silver-haired (*Lasionycteris noctivagans*), and Brazilian free-tailed (*Tadarida brasiliensis*). bats. Our acoustic results from the spring and fall also suggest that the UNF is an important migratory corridor for multiple bat species. We did not catch any *Myotis* species despite intensive netting efforts in interior forest sites. Acoustic evidence is equivocal for the presence of *Myotis* species; two types of intensive full spectrum recordings failed to detect any *Myotis* species whereas driving transects with an Anabat detector revealed limited evidence of gray bats (*Myotis gricescens*) or little brown bats (*M. lucifugus*). We found maternity roost sites of *E. fuscus* and *N. humeralis*. Roost sites of *N. humeralis* were all in trees at relatively high elevation. Roost trees were both live and dead (snags), and all showed some stage of decay with either cracks, cavities, or sloughing bark. Bats did not consistently use roost trees which suggests roosting behavior typical of fission-fusion maternity colonies. Roost sites of *E. fuscus* were both in snags and buildings. We found no evidence for *Pseudogymnoascus destructans (Pd)* or WNS in the form of positive *Pd* swab samples nor in the form of wing damaged. However, our sample sizes were relatively small, especially for *P. subflavus*. The nearness of the UNF to the *Pd* positive Stanley County, warrants careful continued surveillance in the UNF for *Pd*. For a multitude of reasons, acoustic sampling in the UNF is important and should continue. We recommend continuation of acoustic sampling at longer-term stationary sites, along legacy driving transects, and within the NABat grids associated with the UNF.

INTRODUCTION

The Uwharrie National Forest (UNF) is the largest national forest in the piedmont region of North Carolina, an area that includes intense urbanization and has historically seen a high degree of land conversion (Price, Dorcas, Gallant, Klaver, & Willson, 2006). The piedmont region, and the UNF, are home to two state rare species that include hoary (*Lasiurus cinereus*) and silver haired (*Lasionycteris noctivagans*) bats. In addition, the piedmont is the potential home to a state and federal species of concern, the southeastern Myotis (*Myotis austroriparius*), and a federally listed threatened species, the Northern long eared (*Myotis septentrionalis*) bat. Threats to these species include urbanization, mortality from wind farms along migratory corridors throughout their range in the case of *Lasiurus cinereus* and *Lasionycteris noctivagans*, and mortality from White-nose Syndrome in the case of *Myotis septentrionalis* (Arnett & Baerwald, 2013; Blehert et al., 2009; P. Cryan, 2009; Paul. M. Cryan et al., 2014; P.M. Cryan, 2011; P. M. Cryan & Barclay, 2009).

Previous captures in the UNF indicate the presence of red (*Lasiurus borealis*), seminole (*Lasiurus seminolus*), tricolored (*Perimyotis subflavus*), and big brown (*Eptesicus fuscus*) bats (summarized in Pittaway and Kalcounis-Rueppell 2014). Based on results from driving transect analyses (Pittaway & Kalcounis-Rueppell, 2014), relatively little previous work in the UNF, relatively low capture rates of bats at the 2004 SBDN Bat Blitz, and a complete lack of sampling of bats in the UNF during any season other than summer, we began a project in summer 2013 to acoustically sample bats in the UNF year-round.

Because there are relatively low capture rates in the UNF and because of its large area, acoustic sampling is a useful survey tool. Bats produce echolocation pulses for navigation, communication, and feeding (Fenton, 1994). Echolocation pulses produced during the navigation phase have species-specific or group-specific characteristics. Properly recorded and stored echolocation pulses can be analyzed by comparing pulse characteristics for species identification. The identification analysis can be achieved via manual or computational identification (automated) to previously known pulses (O'Farrell, Miller, & Gannon, 1999). Furthermore, the number of pulses from a certain species can represent the activity level of this species. Because of inherent variation in echolocation pulses, it is important to understand the process by which automated identification occurs and assumptions inherent in automated identification from recorded echolocation passes (Barclay, 1999; Clement, Murray, Solick, & Gruver, 2014; Russo & Voigt, 2016)

We surveyed bats in the Uwharrie National Forest (UNF) in the summers of 2014 and 2015 and through the year at a stationary recording station. Our survey involved mist-netting as well as two different types of acoustic monitoring. Our first type of acoustic monitoring was a stationary acoustic recording station set at the Troy Depot of the NCWRC. This recording station was set up in 2013 as part of the MS thesis of John Grider. We continued to monitor the recording station and recording is ongoing to date. Our second type of recording was high quality full spectrum recordings set at mist netting locations by Kristy King in 2014 and 2015. The Troy Depot recordings provide continuous, yearlong information about bats present in the UNF and these data are particular useful for looking at winter activity as well as potential spring and fall migratory activity of particular species; this multi-year sample (2013-2015) was analyzed in detail for both numbers of bats and species of bats through the year, in each of the recording years. The full spectrum recordings at mist-net sites were recordings that would yield high quality recordings of bats in and around our mist-net locations. These recordings are critical because they provide information about any bat species present that we may not have been able to capture in our nets and, because we set nets in the interior of forests, were more likely to record *Myotis* species that are generally interior forest species. Additionally, net site recordings also give us some indication about what type of net effort is required to capture particular species with the UNF. As part of this project we were also asked to analyze a separate set of acoustic recordings. We also analyzed Anabat transects that were conducted in UNF from 2009-2013 and in a separate request 2014-2015. Analysis of the Anabat transect data from 2009-2013 is complete and can be found in Pittaway and Kalcounis-Rueppell (2014).

In addition to understanding the distribution of bats from acoustic recordings and mist-netting, it is critical to understand the basic roost needs of bats, especially during the summer maternity season. Because roosts are more limited for cavity roosting species (i.e., *Myotis species, P. subflavus, N. humeralis, and E. fuscus*) than foliage roosting species (i.e., *Lasiurus* species) we focused our mist netting efforts on cavity roosting species by radio-tracking cavity roosting bats, performing roost counts, monitoring presence at roosts, and measuring roost characteristics. We intended to radio-track *Myotis* species, *Perimyotis subflavus*, *Nycticeius humeralis*, and *Eptesicus fuscus* to identify roosting resources for these species. Lastly, we were interested in monitoring bats for the presence of White Nose Syndrome. Thus, in order to

understand the distribution of bats and roost sites of bats in the Uwharrie National Forest (UNF) we had the following aims:

1. Use mist-netting and acoustic sampling to determine which species of bats are present, and when, in the UNF
2. Use radio-telemetry to determine the roost sites of cavity roosting bats captured in the UNF
3. Sample captured bats for *Pseudogymnoascus destructans* (*Pd*) by swabbing each captured bat individual and sending a subset of samples to be tested at SCWDS.

METHODS

STUDY LOCATIONS AND SITES WITHIN LOCATIONS

We separately describe methods for our mist-netting, net location echolocation recordings, and Troy Depot recordings. At each study location (Figure 1) we either set up a bat detector, mist-nets, or both (Table 1). Within each study location, we might have had multiple net or detector sites and each site has its own coordinate. Study sites within locations refer to the coordinate at which a net was set or a detector was set. All study site coordinates are provided in Results tables, but for the purposes of describing the field methods, we refer only to location displayed in Figure 1.

MIST-NETTING

Using standard mist-netting practices (Kunz & Parsons, 2009), we placed mist-nets in both stream and forest interior sites. We used both single-high and double-high nets depending on what was appropriate for the area. Nets were opened at sunset, approximately 20:30, and left open for approximately 5 hours. Depending on the location, from 1-4 nets were set. On 2 nights in 2014, we left nets open from sunset to sunrise. Once opened, nets were checked every eight to ten minutes and all bats were removed from the nets and placed into individual paper bags. Bags containing bats were weighed using a 60 g hanging scale (Pesola). Bats were removed from the bags and bags were weighed so that this weight could be subtracted from the original weight to determine the weight of the bat. Forearm of bats were measured using calipers. Reichard's wing damage index was determined for each bat we caught (Reichard & Kunz, 2009). Age of the bats was determined to be either juvenile or adult based on ossification of finger joints holding the bat up to a light source and looking at

the individual joints in the bat's forearm (Anthony, 1988). Bat reproductive classes were assigned differently for males and females. Male reproductive classes were scrotal (testes visible) or non-scrotal (testes not visible). Females were classified as: non reproductive (no signs of being pregnant or lactating), pregnant (female has distended belly), lactating (clear, bare nipples), or post lactating (bare nipples still visible but hair growing back). Finally, the species of the bat was determined based on measurements and physical appearance. Once identified, measured, and banded, bats were released at the site of capture. All handling of bats was approved under the UNCG IACUC Protocol #11-02 and under permission of the North Carolina Wildlife Resources Commission. All handling practices followed guidelines for WNS decontamination (Graeter, Weeks, & Cameron, 2013).

MIST-NET LOCATION RECORDINGS

We recorded high quality, full spectrum echolocation passes on 50 nights from 21 mist-net locations during 2014 and 2015. Whenever possible we set up a Pettersson D500x bat detector near our netting sites to record high quality, full spectrum echolocation passes. These recordings were meant to supplement the Troy Depot, long term recording station, and also meant to sample, as much as possible, in habitat that was representative of net sites that were very different from the NCWRC Troy Depot (interior forest sites or forest gaps). The detector was set to record with a microphone that was set to sample away from vegetation. The microphone was elevated on a pole approximately 2-3 meters in height. The microphone was set up after nets were set and taken down before nets were taken down on each sampling night that the Pettersson D500x was set up. The microphone was also set so that the microphone would not hear any noise associated with netting (i.e., it was away from the nets and processing table).

Analysis of recordings from mist-net locations was done with SonoBat 4.0.6 Central NC (DND Designs, Arcata, California; henceforth SonoBat). Settings were as recommended and specifically included: max number of calls to consider per file = 16; sequence decision threshold = 0.90; acceptable call quality = 0.80, acceptable quality to tally passes = 0.20. When an echolocation pass was identified as a *Myotis* species, the pass was examined, by hand to determine if the call was consistent with a *Myotis* species or if the call was more likely to be a fragment of an echolocation pass of another species of bat (for example, a foraging red bat or a red bat with a call characteristic of flying in dense

vegetation). We also examined every call identified as *Corynhorinus rafinesquii*. We used the MLE from SonoBat as recommended with a <0.05 as the general cutoff to screen for confident identifications. The MLE is a maximum likelihood estimator of presence and is a probabilistic estimate of presence based on the number of classified echolocation call passes and the known overlap of classifications. In order to not miss any potential identifications, we also used a very liberal cutoff (MLE<1/species on a given night) as a first pass to look at the data. Because MLE is sensitive to the size of the data set and is best used on a per night, per site, basis, we report our findings on a per night basis.

The species list for the SonoBat 4 NC central regional classifier includes: *Myotis leibii* (MYLE), *M. septentrionalis* (MYSE), *M. lucifugus* (MYLU), *Perimyotis subflavus* (PESU), *Nycticeius humeralis* (NYHU), *Lasiurus borealis* (LABO), *Eptesicus fuscus* (EPFU), *Lasionycteris noctivagans* (LANO), *Corynhorinus rafinesquii* (CORA), *Tadarida brasiliensis* (TABR), and *Lasiurus cinereus* (LACI). For simplicity in reporting results we use the 4 letter acronym for each species in the remainder of this report. The SonoBat 4 NC central regional classifier conservatively includes MYLE and CORA due to the nearness of the piedmont to both the mountains and coastal plain of North Carolina. The SonoBat 4 NC central regional classifier conservatively does not include *M. gricescens* and *M. austroriparius* because addition of these *Myotis* would increase the difficulty in distinguishing amongst *Myotis* species and either of these species would have likely would have likely been identified as another *Myotis* and then could then be looked at in detail.

TROY DEPOT RECORDINGS

A Song Meter SM2+ bat recorder (Wildlife Acoustics, Maynard, MA) was set up at the Troy Depot from 11 June 2013 until 3 November 2015 for this study. Recordings are ongoing at the Troy Depot and will continue while permission to record exists. The microphone on the SM2+ unit was at the height of the roof of buildings and faced centrally into the depot. For recording consistency among detectors, we used the following settings: recording at 48 decibels, high-pass filter set to 1000 Hertz, and sampling rate set to 192,000 Hz. The unit was set to record every night (dusk to dawn). Recordings were stored on memory cards within the unit. Periodically (approximately monthly) units were checked and files were downloaded. Analysis of all sound files recorded at the Troy Depot 2013 was conducted using SonoBat as described above on "Mist-Net Location Recording Methods".

Further, we did not select "SM2 aware" in SonoBat because we wanted to only focus on the best quality recordings (without any SM2-based enhancements).

In addition, we manually examined every sound file recorded at the Troy Depot to count the number of echolocation passes. This was done so that even low quality recordings (that would be rejected by SonoBat) could be counted and so that we could determine at what times during the year bats were active and relate this activity level to the automated (SonoBat derived) activity level. Some nights of the Troy recordings (11 June 2013 – 30 July 2014) have been reported in a separate manuscript (Grider, Homyack, & Kalcounis-Rueppell, 2016 In Revision). Herein, we reanalyzed all the echolocation passes recorded at the Troy Depot, including those from Grider et al (2016 In Revision) because a new version of SonoBat was made available since Grider et al (2016 In Revision). We also manually identified any echolocation passes that were not already reported on in Grider et al (2016 In Revision) – these are all of the recordings since 30 July 2014.

RADIO TELEMETRY

For species that we were interested in radio-tracking, a radio transmitter was attached via standard methods at time of capture if we caught adult females that were within mass ranges appropriate for carrying a transmitter (Kunz & Parsons, 2009). We clipped fur between the scapulae and cleaned the area. A mixture of fur and temporary surgical glue was used as an adhesive for the transmitter to the clipped area. The bat with the attached transmitter was held for a few minutes to ensure that the transmitter was attached and then the bat was released at the site of capture.

The following day (during the day), and for several subsequent days (depending on work load and success in finding roosts), the bat was tracked to roost sites in and around the UNF. Once the roost tree was found, we measured coordinates and left immediately so as not to disturb the bats. We returned to the roost tree the same or the following night to perform a roost watch and count the number of bats emerging. A roost count consisted of counting the number of bats that exit the tree following sunset. The observer remained at the tree until 30 minutes after the last bat was seen exiting. For all roosts, at least one roost count was performed at each roost to pinpoint the roost location and identify the number of bats in the roost. If a bat was tracked to the same roost tree several nights in a row, we performed a roost count and listened for the transmitter signal to leave the tree.

Measurements for roost trees included height, diameter at breast height, canopy cover, and decay stage. We placed each roost tree into 1 of 7 decay stages; decay stage 1 included live trees with intact bark and branches, whereas decay stage 7 included dead trees beginning to decompose with broken tops and no loose bark (Anderson, Maser, & Bull, 1979). Roosts located in 2014 were revisited 4 times during Spring and Summer 2015 to determine if bats were reusing the roosts.

White-Nose Syndrome Surveillance Swabs

We collected swab samples for representative bats that were captured as part of our mist-netting study across the study area. Swabs were sent to the Southeastern Cooperative Wildlife Disease Study (SCWDS) in the College of Veterinary Medicine at the University of Georgia to test for the presence of *Psuedogymnoascus destructans* and determine whether White-nose Syndrome could be diagnosed. Swabs were collected from wing membrane and muzzle using research grade sterile swabs and sterile distilled water. We followed all guidelines for both swab collection and submission in the white-nose syndrome surveillance guidelines for North Carolina (Graeter et al., 2013). Numbers of swab samples sent were also determined through discussions with Dr. Lisa Last at SCWDS.

In 2014 we submitted swabs from 40 LABO, 15 EPFU, and 10 NYHU to SCWDS. In 2015 we submitted swabs from 3 NYHU, 3 EPFU, and 3 PESU to SCWDS. Swab samples were from bats captured at Ophir, Lassiter Mills, East Morris Mountain, High Pine Church, ORV, Coggins Mine, Cali Tract, Bog, Dutch John, Yates, Lovin Hill, and Moccasin Creek (Table 1, Figure 1).

Analysis of Uwharrie National Forest Driving Transects: 2014-2015

In 2014 and 2015, USDA Forest Service Uwharrie Ranger District biologists conducted acoustic mobile transect surveys to record bats species in a standardized manner between June and August. Acoustic mobile transect surveys use Anabat SD2 detectors which are a different recording platform that either the Pettersson D500x or the Wildlife Acoustics SM2+ detectors. Importantly, Anabat detectors do not record full spectrum echolocation information therefore the methods of analysis are different for driving transect data when compared to the mist-net recording stations and the Troy Depot recordings.

The original acoustic data from the driving transects were stored on 3 CF cards accompanied by the original hard copy field data sheets. All acoustic data were stored in data.dat format. We used CF Storage ZCAIM Interface to extract echolocation passes from data.dat files. We used the date, time, and transect information from the hard copy field data sheets to organize call files. We were able to extract echolocation passes from all cards. However, the timestamp of one card from 2014 did not match the field data sheets on the same day (June 25, 2014) and thus we were not able to sort those echolocation files by transects. Therefore, no further analysis was conducted for data collected on June 25, 2014. Additionally, for 2015 data there were many echolocation passes recorded outside of the transect survey time window. These recordings likely were from travel between transects. We analyzed these recordings but could not attribute them to any particular location.

A total of 11 transects within or near the Uwharrie National Forest were surveyed in both years (see Figure 11). The route names were Badin Lake, Coggins Mine, Dusty Level, Dutch John, Lovin Hill, McClean Creek, Moccasin Creek, Mullinix, Tower, and Woodrun. On August 7, 2014, routes McClean Creek and Mullinix were surveyed as one continuous transect. Hence we treated it one additional route (named McClean-Mullinx) in the call identification analysis.

To identify species, we used BCID East 2.7c and EchoClass 3.1 as the Auto ID tools BCID settings were filter setting: S1(OPS) Minimum -9999, Maximum 9999; Dur (ms) Minimum 1, Maximum 20; Minimum Number of Calls Present 5 within (sec) 15. Candidate species selected under the "Species" option were based on the geographic location of Uwharrie National Forest and included: *Myotis austroriparius* (MYAU), *M. septentrionalis* (MYSE), *M. lucifugus* (MYLU), *Perimyotis subflavus* (PESU), *Nycticeius humeralis* (NYHU), *Lasiurus borealis* (LABO), *Eptesicus fuscus* (EPFU), *Lasionycteris noctivagans* (LANO), *and Lasiurus cinereus* (LACI). We also included supplemental BCID runs in which we included two more species of interest that have potential (although remote) for presence in the region and had been included in previous analysis of transects (Pittaway and Kalcounis-Rueppell 2014) these included *Corynhorinus rafinesquii* (CORA) and *Myotis grisescens* (MYGR). EchoClass settings were as recommended with species set 1 as the candidate species list which included the same bats as in the BCID "Species" list with the additional of *Myotis gricescens* (MYGR), *Myotis leibii* (MYLE) and *Myotis sodalis* (MYSO). To ensure the accuracy of automated identifications, we manually examined call files via AnalookW 4.4. We first excluded all files

with noise and low quality echolocation passes (fragmented calls, feeding/social calls, etc.) before running any program.

As with SonoBat 4 Central NC, both BCID and EchoClass generate the Maximum Likelihood Estimates (MLE) for species identification. MLE indicates the probability that a given species identification is incorrectly identified. The lower (closer to 0) the MLE score is, it is less likely that a species is incorrectly identified based on call parameters. In EchoClass, the program differentiates the number of echolocation passes from a given species at a site (transect in this report)/night. Value -1 indicates a specific species was not detected at a site (transect in this report)/night. Value 1 indicates that only one call file of a specific species was recorded at a site (transect in this report)/night. BCID only calculates MLE for species identified.

We used <0.05 as the general cutoff to screen for confident identifications. However, we noticed that EchoClass tends to mis-identify evening bats and assign this species an unusually high MLE. Thus we used a loose cutoff (<1) for this species. If a species' MLE didn't meet the criteria, we would not count it for the total number of echolocation passes in one night for a transect. We also searched for the concordance between BCID and EchoClass (identification agreed by both programs). Combining the concordance and the discriminant probability provided by BCID for each call file, we were able to provide the summary of species presence and total species number for each transect. When confirming species presence, we searched for call files that were agreed on by both programs with a discriminant probability larger than 0.6. Once a species was confirmed as being present along a transect, other echolocation passes identified as the same species from the same transect would not be examined. Due to the special interest in *Myotis* species and *Corynorhinus rafinesquii*, we manually examined all files identified by either BCID or EchoClass as these species.

To incorporate both automated identification results and manual verification results, we report both BCID and EchoClass identification by night/transect. Only echolocation passes from a transect/night with MLE < 0.05 (<1 for NYHU identified by EchoClass) are presented. Due to the uncertainty of *Myotis* species identification, all *Myotis* species echolocation passes that met the criteria were grouped into "*Myotis* spp" in the Results section. Those echolocation passes agreed upon as *Myotis* species were specifically examined by the authors and reported on separately.

Additionally, we reran all files that were reported on in Pittaway and Kalcounis-Rueppell (2014) because we were interested in whether updated versions of BCID and EchoClass would provide different results than were presented in 2014. We provide a short report on that reanalysis.

RESULTS

All locations in this study are shown in Figure 1 and Table 1, except for the driving transect locations which are shown in Figure 11 (as a reproduction from Pittaway and Kalcounis-Rueppell 2014). Capture results from mist-netting are shown in Tables 2 and 3, and Figures 2 and 3. Mist-net location recording results are shown in Table 4 and Figure 4. Troy Depot recording results are shown in Table 5 and Figures 5 through 8, with Figure 8 being a comparison between the mist-net location recordings and the Troy Depot. Roost results from radio-telemetry are shown in Tables 6 and 7 with roost locations described in Figure 9 (with several additional maps provided). A sampling of photos of roost trees from the UNF are shown in Figure 10. Driving transect results from 2014-2015 are shown in Tables 8 through 10.

MIST-NET RESULTS

Over the two years of this study, we surveyed using mist-nests at 29 locations over 83 nights. In 2014, we surveyed 20 locations over 63 nights and in 2015, we surveyed 15 sites over 40 nights. The only site we visited in both years was East Morris Mountain (3 nights in 2014 and 1 night in 2015). At least one bat was captured at all sites except for the 24/27 Stream site.

At each location, 1-4 nets (average of 2.3 nets in both years) were set. The average number of hours that nets were open in 2014 was 4.74 (range 2.08-9 hours) and in 2015 was 4.80 (2.76-6 hours). The total number of net hours was 1125 (691 net hours in 2014 and 434 net hours in 2015) and the total number of hours spent netting was 490.65.

Bats were captured 274 times. In total, we captured 43 big brown (*Eptesicus fuscus*, EPFU), 178 red (*Lasiurus borealis*, LABO), 37 evening (*Nycticeius humeralis*, NYHU), and 5 tricolored (*Perimyotis subflavus*, PESU) bats. All bats were released at the site of capture. Of all of our captured bats, 17 escaped or were let go before being banded and 11 were recaptured once, usually on the same night as first capture (Table 2). Thus, we banded 246 bats in this

study. We banded the 246 bats with unique numbers that fell between NCKR0001-NCKR0162 and NCKR0183-NCKR0192 in 2014 and between NCKR0204-NCKR0243 and NCKR0501-NCKR0528, and also included NCKR301 (Table 2). Of the 274 captures, Reichard's wing score averaged 0.05 (248 scores were 0; 13 scores were 1; 13 bats were unable to be scored before they were released).

With few exceptions, we caught more red bats than any other species, followed by big brown bats and evening bats, respectively (Figure 2). A majority of the bats were caught at Dutch John, Ophir, and Uwharrie trail (Figure 2). However, because not all locations were sampled with the same number of nights, we standardized captures by sampling night effort (Figure 3). Captures standardized by number of sampling nights reveal that Dutch John and Uwharrie Trail were locations with the best capture success followed by Birkhead Wilderness, Moccasin Creek, North Polly Branch, and Ophir (Figure 2). The highest diversity of captures (4 species: PESU, NYHU, LABO, EPFU) was at Ophir and East Morris Mountain (Figure 2). Other diverse sites (with all species except for PESU) were Buck Mountain, Cali Tract, Dutch John, Lovin Hill, North Poly Branch, ORV, and Uwharrie Trail.

We captured tricolored bats at two locations, East Morris Mountain and Ophir (Figure 2). Of the 5 tricolored bats sampled, we could determine sex and age for 4 of them (one escaped). All 4 tricolored bats caught were juvenile males (Table 2, Table 3).

We caught adult males and females and juvenile males and females of LABO, EPFU, and NYHU (Table 2, Table 3). All juveniles were captured in July, August, or September (Table 2, Table 3). We stopped catching pregnant LABO on 7 July 2014 (we did not catch any pregnant LABO in 2015), pregnant EPFU on 21 July 2014 (we did not catch any pregnant EPFU in 2015), and pregnant NYHU on 17 June 2014 (we did not catch any pregnant NYHU in 2015) (Table 2). The earliest date that we caught juveniles was 4 July 2014. We started catching juvenile LABO on 4 July 2014 and 9 July 2015. We started catching juvenile EPFU on 10 July 2014 and 7 July 2015. We started catching juvenile NYHU on 11 July 2014 and 10 July 2015.

MIST-NET LOCATION RECORDINGS

In 2014 recordings were made at 9 different mist-net locations on 29 nights from 26 June 2014 to 6 Sept 2014 (Table 4). In 2015 recordings were made at 12 different mist-net

locations on 21 nights from 3 May 2015 to 4 Aug 2015. Mist-net location recording sites are listed in Table 1 and mapped on Figure 1.

We analyzed 2003 echolocation passes (Table 4). Of those 2003 echolocation passes, 2 were identified as MYLU, however closer examination of the two echolocation passes (M00058 recorded on 29 June 2014 at Lovin Hill Stream & M00124 recorded on 13 July 2014 at East Morris Mountain) revealed them to be more consistent with LABO echolocation. All other echolocation passes, were identified as LABO, PESU, EPFU, TABR, NYHU, LACI, and LANO (Table 4) with average MLE estimates across nights (where the MLE was <1) suggesting the likelihood of their presence in the order listed (Figure 4). However, only LABO (16 nights), EPFU (4 nights), and PESU (3 nights) had significant MLE estimates lower than 0.05 (Table 4).

TROY DEPOT RECORDINGS

From 11 June 2013 until 3 November 2015 (874 days) equipment functioned for 589 nights which represents approximately 67% of all nights. The 589 days can be divided nights that fall into all 4 seasons as follows: winter = 111 nights, spring = 146 nights, summer = 169 nights, and fall = 163 nights. Our SonoBat analysis of all 589 nights of recording revealed 68083 echolocation passes. We also manually counted passes within each night for all nights subsequent to 30 July 2014 and compared our manual counts to our auto ID counts. For the 279 nights where we compared auto ID to manual ID counts, there was a significant positive relationship between the two count methods (ANOVA: $F_{1,277} = 196.15$, $p < 0.001$, $R^2 = 0.41$). We manually counted 61978 echolocation passes across 279 nights compared to 15689 echolocation passes counted by SonoBat. The equation representing the relationship of manual to auto ID counts is manual counts/night = 130.21 + 1.63 (auto counts/night). This equation is useful for converting reported Auto ID levels to actual levels of activity.

Based on the 68303 echolocation passes from SonoBat over the 589 nights, highest average nightly levels of activity were in summer, followed by spring and fall (Table 5). There were very few nights with any detection of *Myotis* bats (< 1% for all *Myotis* species) or CORA (<2%). For all other species except for NYHU there was some detection on over a quarter of all recording nights in either spring, summer or both spring and summer (Figure 5). Note that we carefully examined all *Myotis* and CORA files reflected in Figure 5: both the single

MYLE and MYLU files were more likely LABO and 3 of the 4 CORA files poor recordings that were more likely LABO or EPFU files. One CORA file (20140728_231658.wav), however, was a relatively clear recording of what might be CORA file. This did not result in a high MLE value for CORA however, because this was a single echolocation pass (both within that night and among the 589 nights).

Numbers of nights recorded with presence indicated by MLE values <1, where we focused only on those species where a proportion of greater than 2% nights of species present, reveals activity from PESU, NYHU, LABO, EPFU, LANO, TABR, and LACI (Figure 6). The majority of activity is in the spring, summer, and fall, with NYHU, LANO, and LACI showing relatively high spring activity compared to summer and fall (Figure 6). Highest summer activity is seen with PESU, LABO, and EPFU. However, using a strict value of MLE <0.05, spring presence is indicated for PESU, LABO, LANO, TABR, and LACI; summer presence for PESU, LABO, EPFU, LANO, TABR, and LACI.; and fall presence for PESU, LABO, EPFU, LANO, and TABR (Figure 7). We were not able to confirm winter presence for any species based on SonoBat analyses (Figure 7). Average MLE values for each species that have a high number (<25%) of nights with presence indication from the recordings at the Troy Depot are generally concordant with average MLE values from high quality recordings at mist-netting site (Figure 8). The lowest average MLE values (indicating likelihood of presence) for both recording types are for LABO and PESU (Figure 8).

Roost Sites via Radio Telemetry

Because we captured no *Myotis* bats, we placed transmitters on seven female EPFU and four NYHU bats during Summer 2014 (Table 6). We were unable to locate 4 of the 7 EPFU with transmitters. We spent approximately 15 hours per bat trying to locate each of the missing bats, which involved both day and night searches. For the bats that were able to locate, we tracked each bat until either their transmitter fell off or the battery died. Transmitters lasted approximately 7 days. We were able to identify 14 roost trees in the UNF (Table 7 and Figure 9). Roost trees included both large and small living trees and snags (characteristics in Table 7 and photos in Figure 10). The majority of trees were located at elevations higher than where the individual bats were caught foraging. Many of the living trees were identified as chestnut oaks (*Quercus prinus*). The trees were near paths, ORV trails,

or streams (Figure 9). Bats emerged from either holes in the trunk or limbs or from underneath loose bark. Tree roost counts ranged from 2 to 134 individuals emerging. We also identified 3 privately-owned, manmade structures that were used as roosts. NYHU 1 and NYHU 3 appeared to prefer small living trees or small snags. NYHU 2 and NYHU 4 appeared to prefer large living oaks or large snags. The roost trees used by NYHU 2 were located along an ORV trail. EPFU 1, EPFU 5, and EPFU 6 all preferred roosting in manmade structures which included an attic, a carport, and a large, metal decorative star on the outside of a house. EPFU 6 did roost in large trees (pine and oak), occasionally.

During Summer 2015, we placed a transmitter on one female EPFU but were unable to locate her roost. We performed roost watches at roost trees identified in Summer 2014 once in April, May, June, and July 2015. No bats were seen emerging from the roost trees in 2015. However, the house roost identified in Badin, NC remained active.

Based on tree roost counts in 2014, NYHU reused roosting trees both on consecutive and non-consecutive nights. For example, a N1R1 (Figure 10) had bats in it on 3 nights over 10 days, and none of the nights were consecutive (roost emergence counts on these 3 nights varied from 16-20 bats).

White-Nose Syndrome Surveillance Swabs

All 76 swab samples came back negative for the presence of *Psuedogymnoascus destructans*. All reports on the swab samples have been submitted separately to the NCWRC.

Analysis of Uwharrie NF Driving Transects from 2014-2015

In 2014, 1188 recording files were extracted and matched to transects. BCID yielded 346 identifications that met MLE criteria (Table 8A). EchoClass yielded 290 identifications that met MLE criteria (Table 9A). In 2015, 1647 recording files were extracted but only 880 recordings could be matched to transects. BCID yielded 370 identifications that met MLE criteria (Table 8B). EchoClass yielded 294 identifications that met MLE criteria (Table 9B). However, nearly half of the 2015 identifications occurred for recordings that could not be matched to a transect (160 based on BCID results, 129 based on EchoClass results).

According to BCID results (Table 8A), the most common species in 2014 was LABO (35.3%), followed by NYHU (25.7%), PESU (18.5%), and EPFU (15.9%). In 2015

(Table 8B) the pattern changed slightly with NYHU (32.4%) as the most common species, followed by LABO (28.6%), PESU (26.5%), and EPFU (7.8%).

The transects with the highest number of bat passes were: Lovin Hill, Flint Hill, and Moccasin Creek. In contrast, Woodrun and Coggins Mine had low a number of bat passes. In general, transects with a high number of identified passes tended to have higher species diversity.

In both years there was concordance between both programs that identified a small number of *Myotis* species echolocation passes (Table 10). Through manual verification, we were able to validate some of these echolocation passes (Table 10). There is no consistent pattern of which transects tended to have *Myotis* species echolocation passes.

Originally BCID identified a few echolocation passes as CORA. But a manual check revealed that those were mis-identified as they lacked the unique characteristics of *Corynorhinus rafinesquii* (Loeb & Britzke, 2010).

Our reanalysis of the data from 2009, 2010, and 2013 presented in Pittaway and Kalcounis-Rueppell (2014) lead to similar conclusions as were previously reported. Of the 2 files that were previously agreed upon in 2014 as MYGR, one (2009: 9041048.01#) was no longer agreed upon by both programs and the other (2010: 9142048.19#) was agreed upon by both programs as MYGR. An additional 8 files were agreed upon as MYGR from 2009 (2), 2010 (1), and 2013 (5).

DISCUSSION

WHICH SPECIES OF BATS ARE PRESENT IN THE UWHARRIE NATIONAL FOREST?

Our results from multiple lines of evidence that include mist-net captures and 3 very different approaches to acoustic sampling (stationary Wildlife Acoustics SM2+ dector at the Troy Depot, stationary Pettersson D500x detector at mist-net sites, and Anabat detectors on driving transects) confirm that the tricolored (*Perimyotis subflavus*; PESU), evening (*Nycticeius humeralis*; NYHU), red (*Lasiurus borealis*; LABO), big brown, (*Eptesicus fuscus*; EPFU), silver-haired (*Lasionycteris noctivagans*; LANO), Brazilian free-tailed (*Tadarida brasiliensis*; TABR), and hoary (*Lasiurus cinereus*; LACI) bats are all present in the Uwharrie National Forest. Additionally, a single Seminole bat (*Lasiurus seminolus*; LASE) was captured in 2004

confirming the presence of Seminole bats (see Pittaway and Kalcounis-Rueppell 2014). It is very likely that some of our LABO recordings were from Seminole bats; these two species are closely related and have echolocation characters that are similar enough to preclude confidence in acoustic identification between the two species and this is why LASE was not considered in the SonoBat species list. Although we did not capture LANO, TABR, or LACI, there was clear support from the Troy Depot and the driving transect recordings in the case of LANO and LACI and the Troy Depot recordings in the case of TABR. All three of these species are difficult to capture because they have morphologies that are adapted to high, open habitat flight and so the likelihood of catching them is reduced to times when they fly low, most likely to drink (Norberg, 1994). Despite the difficulty in capture, the presence of LANO and TABR are confirmed through mist-netting and roost searches from nearby Greensboro (Kalcounis-Rueppell, unpublished data) which also supports the acoustic results from the UNF. Of note, although we frequently caught NYHU, there was not strong evidence of NYHU from either the mist-net recordings or the Troy Depot recordings suggesting that this species is hard to sample acoustically, at least in the UNF with full spectrum recordings. Thus, these 8 species: LABO, EPFU, NYHU, PESU, LANO, LACI, LASE, TABR, are present in the UNF. These species are ones we expected to catch and/or record in the UNF based on previous work (Pittaway and Kalcounis-Rueppell 2014).

In contrast to multiple lines of evidence supporting the presence of LABO, EPFU, NYHU, PESU, LANO, LACI, LASE, TABR, the evidence is equivocal for *Myotis* species. Despite intense mist-netting effort in habitat typical of *Myotis* bats (interior forests and interior forest corridors) we never caught a *Myotis* bat, and despite over 50 nights of high quality, full spectrum echolocation recording at mist-net sites, we never recorded a *Myotis* bat. Additionally, over 2 years and 589 nights of recording at the Troy Depot, we never recorded a *Myotis* bat. On the other hand, the mobile transect surveys do show some support for the presence of MYLU (Table 10) and MYGR (Pittaway and Kalcounis-Rueppell 2014; this study). Of relevance to the question of the presence of MYLU and MYGR (and other *Myotis* species such as MYSE) are preliminary results from the North American Bat (NABat) monitoring protocol. In 2015 (June and July), we followed the North American Bat Monitoring Program (NABat) protocols and conducted mobile transect surveys throughout the state of North Carolina (Li, Caldwell, and Kalcounis-Rueppell, unpublished). Two of the surveyed areas (Grid 20 and Grid 65) have some overlap with the UNF. Grid 20 is near

Biscoe and Grid 65 is near the intersection of NC Highways 27 and 109. A mobile transect was run (June 2015) on Grid 20 and there was no evidence of *Myotis* from that transect. However, stationary point surveys (through the night) were conducted on both grids in early July and there was a total of 368 *Myotis* IDs from either BCID and EchoClass. On Grid 65, there was concordance between EchoClass and BCID on 8 of these files [1 MYGR on Yate's Trail in UNF, 1 MYSE at the Bog (see Table 1), and 6 MYLU from a combination of the Bog and near Hwy 27 near the Troy Depot]. We have closely examined all of these 8 files and the only one that appears to be a good, representative, echolocation pass from a *Myotis* bat is the call identified as MYGR (P7050123.30; see photo on cover page of report). However, this call is also consistent with a MYLU (Susan Loeb, Pers. Comm.). Future manual identification of the 368 files may yield reveal more *Myotis* identifications. Thus, there is no acoustic evidence for MYSE, but there is limited acoustic evidence for MYGR or MYLU. A capture of MYLU in the Pee Dee NWR (Richmond Co.; Katherine Caldwell, Pers. Comm.) in summer 2016 is exciting and supports the identification of *Myotis* calls.

The discordance between *Myotis* results from mist-netting and the different recording platforms are likely due to the following. First, if *Myotis* are present they are likely present only in low numbers – if they were present in high numbers we would have more evidence of them both in terms of captures and acoustic recordings. Low numbers of *Myotis* may preclude capture with mist-nets. Low numbers would also explain the lack of evidence in our Troy Depot recordings because the Troy Depot is relatively open and not typical for *Myotis* habitat. Low numbers would also explain why we did not record them at mist-net sites because even though recorded on 50 nights, our net sites are only a small area within the UNF on any given night so there could be relatively low detection probability at net sites both in terms of capture and recording. If this is the case, it may be that the best method for sampling *Myotis* is driving transects that cover a relatively large area within a short amount of time. Additionally, it may be that roads in the UNF are important flight corridors (Kalcounis-Rueppell et al., 2013) for *Myotis*.

If *Myotis* are using roads as corridors in the UNF, which is likely because roads are narrow, rural, and have a well defined canopy, detection probability may be higher along driving transects than at stationary sites set up for relatively short periods of time. If this is the case, there are several ways of increasing sampling of *Myotis* for more unequivocal evidence of their presence. First, it might be worthwhile to set up long-term stationary

recording stations along the driving transects where *Myotis* bats have been recorded. It is important to note that the driving transects where possible *Myotis* bats were recorded were located relatively far way from each other within the UNF and varied among years. Based on driving transect and activity/abundance results, suggested locations would be Lovin Hill, Flint Hill, Dutch John, Yates Trail, and other mist-net locations with high capture numbers (see Figure 3). Second, it might be worthwhile to set up both Anabat and full spectrum recording stations because many of the characteristics used to discriminate amongst *Myotis* species are based on amplitude which is not recorded with zero-cross detectors such as Anabat. In other words, there will be more discrimination ability if *Myotis* echolocation passes are recorded with high quality full spectrum platforms like the Pettersson D500x. It is curious that the only evidence for *Myotis* bats in this study come from Anabat recordings and one explanation may be that Anabat recordings from other non-*Myotis* species are more likely to be identified as *Myotis* bats due to the lack of other information (like amplitude) in the recording. Many fragments of echolocation passes of other species (especially while foraging) look like *Myotis* echolocation passes and without full spectrum recordings of many echolocation passes it will be difficult to determine actual *Myotis* echolocation passes from other species' foraging calls (or fragments). Third, it might be worthwhile to add full spectrum recording to driving transects (for reasons outlined above). Fourth, it might be worthwhile to drive transects earlier in the season. Although not previously discussed, transects seem to be driven in late July through August and it would be informative to have samples from earlier in the summer because it is not clear if the limited *Myotis* evidence is only showing up in the late summer because that is when they are in the UNF or if this is a sampling bias due to the timing of the transects.

Regardless of future plans to survey *Myotis*, any future driving transects could be easily improved with spatial information. Analyses of driving transect data from 2009 through 2015 was a challenge because many echolocation passes were collected somewhere other than a designated transect. A few of these undesignated echolocation passes showed characteristics of *Myotis* species. Considering that the current driving survey protocol involves sampling multiple transects on a single night, travel between transects is unavoidable. Thus, we strongly suggest including a GPS unit with the current Anabat detector system. In this way, echolocation passes collected between transects can be potentially traced back to a location to generate more information of the bat community.

Furthermore, a GPS unit will also allow standardization of the transect survey effort for more robust analyses and interpretation.

Lastly, of interest with respect to species presence, is the single CORA call identified from the Troy Depot. It is curious that this single file was recorded over the relatively long time frame of the study. It will be important to continue to look for CORA echolocation passes from the Troy Depot recordings and from the mobile transect surveys (including those of NABat).

THE IMPORTANCE OF THE UWHARRIE NATIONAL FOREST FOR MIGRANTS?

As noted in a previous study (Grider et al 2016 In Review) there is high spring activity of migratory species that include LACI and LANO. Both of these species are migratory bats and based on the data presented here (see Figures 6 and 7), they are in the UNF in higher numbers in the spring than at any other time of the year. Grider et al 2016, based, in part on these data presented herein suggest that the piedmont (and specifically the UNF) is an important migratory corridor for both LACI and LANO. Our acoustic data additionally support the UNF as being important for NYHU activity in the spring. Interestingly the same peak activity is not seen in the fall suggesting that these two bat species either migrate towards coastal North Carolina in fall or do not use the piedmont (or the UNF) for a southward migratory corridor (Grider et al 2016 In Review). Relatively high spring and fall activity for PESU, LABO, and TABR suggest the use of the UNF in both spring and fall for migrants. As with the conclusions of Grider et al (2016 In Review), our data suggest relatively low winter activity of bats in the UNF.

TREE ROOST SITES IN THE UWHARRIE NATIONAL FOREST.

Our original intent was to determine natural roosting sites for any *Myotis* species captured in the UNF. Unfortunately, we did not capture any *Myotis* species and we did not capture any PESU adults. The juveniles we captured were not suitable for carrying transmitters (Kunz & Parsons, 2009). Thus, we did not gain any insight into roost sites of *Myotis* species or PESU. However, we were able to track both NYHU and EPFU to roost sites and the information gained is important, especially regarding natural tree roost sites for bats in the UNF.

First, our results confirm the flexibility in roost use of EPFU, both from the type of building and occasional snag used as roosts by this species (Agosta, 2002). We also had difficulty in tracking this species (signals were difficult to find within the UNF) likely due to the long distances travelled from net sites to roost sites. Taken together, this suggest that roost sites, especially in buildings, are available to EPFU in and around the UNF.

The roost trees in the UNF that we did find were primarily from NYHU. Importantly, the characteristics of the roost trees we found share important characteristics of bat tree roosts both in the southeastern US, North Carolina, and internationally (Fabianek, Simard, & Desrochers, 2015; Kalcounis-Rueppell, Psyllakis, & Brigham, 2005; Naďo & Kaňuch, 2015). NYHU in the UNF selected tree roosts that were tall, in relatively open forest gaps, in later decay stages that included sloughing bark and cavities that originated form cracks and broken limbs as well as from primary cavity excavating birds. Additionally, these trees were at relatively high elevations compared to sites of capture (mean roost elevation 217 m vs mean net site elevation 160 m). Height and elevation, as well as roost tree characteristics, are important for both bat navigation to and from roost trees as well as for reproductive physiology (Fabianek et al., 2015; Kalcounis-Rueppell et al., 2005; Naďo & Kaňuch, 2015). Trees provide important roost habitat especially during the summer maternity season and our exit counts suggest that these trees were used as maternity colonies.

Additionally, the pattern of reuse is common among maternity colonies of bats. Females use a suite of roost trees as opposed to a single roost tree during the maternity season (Metheny, Kalcounis- Rueppell, Willis, Kolar, & Brigham, 2008) and roost are reused both within and between years (Willis, Kolar, Karst, Kalcounis-Rueppell, & Brigham, 2003). Even though we did not see bats using the same trees in 2015 as 2014 it is likely that they are important resources on the landscape for bats and should be retained whenever possible.

The results from the roost survey suggest that there should be an effort to retain any snags or live large trees at higher elevations that are beyond decay stages that include sloughing bark and cavities. Pictures of roost trees are included (Figure 10) to give a sense of what these roost trees look like in the UNF. Having said this, our results can only speak to the importance of the type of tree roosts we found for NYHU (large, higher elevation within UNF, early or late stages of decay indicated by sloughing bark and cavities). Several species of bats, including *Myotis* species, and especially MYSE, can use live relatively small

trees for roosting (Lacki, Cox, & Dickinson, 2009) and other tree types have potential to be used as roost sites as well within UNF.

EVIDENCE OF *PSUEDOGYMNOASCUS DESTRUCTANS* OR WHITE-NOSE SYNDROME IN THE UWHARRIE NATIONAL FOREST?

Based on two lines of evidence we did not find *Psuedogymnoascus destructans* (*Pd*) or White-nose syndrome (WNS) in our study. First, we were careful to check and document a Reichard's score (Reichard & Kunz, 2009) all the wings of bats that were captured for any evidence of WNS on wing membranes and we found no evidence of membrane trauma from examination of live bats that we caught in nets. Second, we swabbed 74 bats and all results came back negative from SCWDS.

Of the species we swabbed, the two that are affected by WNS are EPFU and PESU (Blehert et al., 2009) and we were particularly interested in *Pd* or WNS evidence in either of these species. All captured bats of both species had Reichard's scores of zero and all swabbed bats were negative for *Pd*. However, we were only able to submit swabs for 3 PESU captures (all juvenile bats from Ophir) so it may be that we did not have a high enough sample to detect *Pd* if it was indeed present (ie, our PESU results are false negatives). Our 18 EPFU swabs were from various locations in the UNF and the number of samples was relatively large and still did not show any evidence of *Pd* or WNS. Although LABO is not affected by WNS, is known to be *Pd* positive (Bernard, Foster, Willcox, Parise, & McCracken, 2015). We submitted 40 LABO samples from locations across the UNF and none were *Pd* positive.

These results suggest that bats in the UNF are not positive for *Pd* or affected by WNS. However, a May 2015 swab from either substrate surrounding roosting PESU, or from a roosting PESU, in Stanley County was *Pd* positive, despite being negative in 2014 and 2016 (Brooke Massa, Pers. Comm.). The nearness of this location to the UNF and to sites where we caught PESU (approximately 25km away) suggests that the probability of *Pd* presence in the UNF is high and all available measures to protect all bats in the UNF from *Pd* and WNS should be taken. The positive sample of *Pd* near the UNF is also a compelling reason to continue both the driving transects and the long term acoustic monitoring of bats, through the year, at the Troy Depot.

RECOMMENDATIONS

1. Continue long term stationary recording at the Troy Depot.
2. Consider setting up a few long term stationary recording sites, with full spectrum detectors, in areas with *Myotis* activity from legacy driving transects.
3. Continue legacy driving transects that began in 2009 with the following additions: a) integrate GPS to the driving transects, b) drive earlier in the summer, c) consider expanding to the spring and fall, and d) consider adding a full spectrum detector.
4. Where possible, retain all high elevation trees that have characteristics similar to those roost trees described herein. Considerations are elevation, openness of forest canopy, DBH, height of tree, and decay class (sloughing bark, cracks, cavities, bracket fungi).
5. Continue to monitor for *Pd* and WNS. All precautions to prevent the spread of *Pd* in and around the UNF should be taken.
6. Continue to support the NABat monitoring protocol as it relates to Grids 20 and 65 (Grids associated with the UNF).

FUTURE WORK WITH NOTE ON SCOPE OF WORK AND PERSONNEL

This project supported the work of two graduate students, Mr. John Grider and Ms. Kristy King. John Grider used data from the Troy Depot as one of two piedmont comparison sites for the study of year round activity on the North Carolina coastal plain. Mr. Grider graduated with an MS in Biology Degree, and is currently doing a PhD at the University of Georgia. Ms. King was supported for the first two summers of her PhD data presented herein will be incorporated into her dissertation. As part of her dissertation on the effects of urbanization on piedmont bats, Ms. King is also examining contaminants in bats using fur collected as part of this project. Analysis of fur samples will be future work along with comparisons of UNF data, presented herein, to other urban and rural sites. We had initially intended to sample insects and collect fecal pellets as part of King's dissertation but decided early on that it was much more important, given the difficulty in capturing bats in the UNF, to focus on setting up a full spectrum Pettersson bat detector at mist net locations to have both high quality acoustic and capture data mist-net locations, throughout the UNF. We also opted to not hold bats for any longer than necessary and thus collected fur, but did not hold bats to wait for the production of fecal samples.

PRODUCTS

PUBLICATIONS

Grider, JF, Homyack, JA and Kalcounis-Rueppell, MC. 2016 (Revision under review). High winter activity of peripheral bat populations has conservation implications for species affected by white-nose syndrome and wind energy facilities. PLoS ONE.

REPORTS

Pittaway, L and Kalcounis-Rueppell, MC. 2014. Uwharrie National Forest Bat Transect Data Analysis 2009, 2010, 2012. Project Report for the North Carolina Wildlife Resources Commission.

King, K. and Kalcounis-Rueppell, MC. 2014. Distribution and Habitat Preferences of Priority Bat Species in the North Carolina Piedmont. Interim Report for the North Carolina Wildlife Resources Commission (29 August 2014).

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THESIS

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PRESENTATIONS AT SCIENTIFIC CONFERENCES

Grider, JG, Homyack, JA, and MC Kalcounis-Rueppell. 2014. Year Round Activity of Peripheral Bat Populations in the North Carolina Coastal Plain. North American Society for Bat Research (NASBR). Albany, NY

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Grider, JG, Homyack, JA, and MC Kalcounis-Rueppell. 2013. Year Round Activity of Peripheral Bat Populations in the North Carolina Coastal Plain. 16th International Bat Research Conference (IBRC). San Jose, Costa Rica

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OUTREACH

This project has been incorporated into our outreach program "Bats and Mice in Your Backyard". The outreach program has been delivered to multiple groups locally and within the state of North Carolina over the period of the project. In 2014 and 2015 the program was delivered to approximately 700 people in the piedmont region of North Carolina at 14 different events that reached children, students from K-12 and at Universities, famers, and senior citizens.

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TABLES

TABLE 1. LOCATIONS IN OUR STUDY IN THE UWHARRIE NATIONAL FOREST and surrounding area in 2014 and 2015. At each location we either set up mist-nets, a Pettersson D500x bat detector, or both mist-nets and a bat detector. Locations are plotted on Figure 1 and labeled by the number in the Number Code column.

Location	Year	Data Type	Easting	Northing	Number Code on Fig 1	Elvation (meters)
Baden	2015	Both	35.480194	-80.062146	0	159.11
Birkhead Wilderness	2014	Both	35.61611667	-79.94416667	1	124.97
Bog	2014	Both	35.31911667	-79.96973333	2	195.68
Cali Tract	2014	Net	35.46948333	-79.98968333	3	140.21
Coggins Mine	2014	Net	35.50275	-80.02256667	4	156.97
Dutch John	2014	Both	35.4062	-80.0516	5	117.35
East Morris Mnt	2014 & 2015	Both	35.449971	-79.969385	6	202.08
Buck Mnt	2015	Both	35.407321	-79.997675	7	241.40
Flint Hill	2015	Both	35.478579	-79.925875	8	222.81
Hicks	2015	Both	35.302724	-79.886198	9	121.31
High Pine Church	2015	Net	35.605048	-79.876834	10	235.31
Howell Tract	2015	Both	34.98923333	-79.8641	11	61.57
Lassiter Mills	2015	Both	35.54013333	-79.96565	12	186.54
Lovin Hill	2014	Both	35.24006667	-79.81983333	13	99.06
Moccasin Creek	2014	Both	35.411733	-80.088717	14	134.42
MOMO SP	2015	Both	35.3735	-80.09315	15	157.89
North Polly Branch	2014	Both	35.257483	-79.817467	16	189.89
Ophir	2015	Both	35.480285	-79.95749	17	138.38
ORV	2014	Net	35.43501667	-80.02	18	134.72
Pee Dee NWR	2014	Both	35.063695	-80.086229	19	61.88
Horse Trough Mnt	2014	Net	35.33021667	-80.03261667	20	167.03
South Polly Branch	2014	Both	35.244517	-79.846733	21	168.86
Tower Handicap	2015	Both	35.449201	-79.961725	22	205.13
Tower Road	2015	Both	35.463132	-79.955481	23	212.75
Uwharrie River	2015	Both	35.386474	-80.041791	24	87.48
Uwharrie Trail	2014	Both	35.406317	-79.975083	25	189.28
Woodrum	2014	Net	35.30971667	-80.03395	26	180.75
Yates	2014	Net	35.3569	-79.98986667	27	233.78
Stream 24/27	2014	Net	35.32098333	-79.94936667	28	147.83
Depot	2014 & 2015	Detector	35.31598861	-79.97624472	29	181.36

TABLE 2. BATS CAPTURED IN THE UWHARRIE NATIONAL Forest and surrounding area in 2014 and 2015. Species acronyms: *Myotis lebii* (MYLE), *M. septentrionalis* (MYSE), *M. lucifugus* (MYLU), *Perimyotis subflavus* (PESU), *Nycticeius humeralis* (NYHU), *Lasiurus borealis* (LABO), *Eptesicus fuscus* (EPFU), *Lasionycteris noctivagans* (LANO), *Corynhorinus rafinesquii* (CORA), *Tadarida brasiliensis* (TABR), *and Lasiurus cinereus* (LACI). Sex: F=female, M=male. Age: A=adult, J=juvenile. Repro: NR=non reproductive, P=pregnant, L=lactating, PL=post-lactating, NS=non-scrotal, S=scrotal.

Date	Location	Species	Band #	Sex	Age	Repro	Easting	Northing
16-May-14	Coggins Mine	LABO	n/a	F	A	NR	35.503317	-80.023483
16-May-14	Coggins Mine	LABO	NCKR0001	F	A	NR	35.503317	-80.023483
16-May-14	Coggins Mine	LABO	NCKR0002	F	A	NR	35.503317	-80.023483
16-May-14	Coggins Mine	LABO	NCKR0004	F	A	NR	35.503317	-80.023483
16-May-14	Coggins Mine	LABO	NCKR0003	F	A	P	35.503317	-80.023483
17-May-14	Coggins Mine	LABO	NCKR0005	F	A	NR	35.503317	-80.023483
17-May-14	Coggins Mine	LABO	NCKR0006	F	A	P	35.503317	-80.023483
19-May-14	Coggins Mine	LABO	NCKR0007	M	A	NS	35.502750	-80.022567
19-May-14	Coggins Mine	LABO	NCKR0008	M	A	NS	35.502750	-80.022567
21-May-14	ORV	LABO	NCKR0009	M	A	NS	35.435017	-80.020000
21-May-14	ORV	EPFU	NCKR0011	M	A	NS	35.435017	-80.020000
21-May-14	ORV	LABO	NCKR0012	M	A	NS	35.435017	-80.020000
21-May-14	ORV	EPFU	NCKR0010	M	A	S	35.435017	-80.020000
23-May-14	ORV	EPFU	NCKR0013	F	A	P	35.435017	-80.020000
23-May-14	ORV	NYHU	NCKR0014	M	A	S	35.435017	-80.020000
24-May-14	ORV	LABO	NCKR0015	M	A	NS	35.434800	-80.020333
24-May-14	ORV	LABO	NCKR0016	F	A	P	35.434800	-80.020333
26-May-14	Cali Tract	LABO	NCKR0017	M	A	NS	35.469483	-79.989683
26-May-14	Cali Tract	NYHU	NCKR0018	M	A	S	35.469483	-79.989683
26-May-14	Cali Tract	NYHU	NCKR0019	M	A	S	35.469483	-79.989683
27-May-14	Cali Tract	LABO	NCKR0020	M	A	NS	35.469483	-79.989683
27-May-14	Cali Tract	LABO	NCKR0022	M	A	NS	35.469483	-79.989683
27-May-14	Cali Tract	LABO	NCKR0021	M	A	NS	35.469483	-79.989683
27-May-14	Cali Tract	LABO	NCKR0020	M	A	NS	35.469483	-79.989683
28-May-14	Cali Tract	LABO	NCKR0023	M	A	NS	35.469233	-79.997650
28-May-14	Cali Tract	LABO	NCKR0024	M	A	NS	35.469233	-79.997650
28-May-14	Cali Tract	LABO	NCKR0025	F	A	P	35.469233	-79.997650
28-May-14	Cali Tract	LABO	NCKR0026	M	A	S	35.469233	-79.997650
29-May-14	Cali Tract	LABO	NCKR0027	M	A	NS	35.469233	-79.997650
29-May-14	Cali Tract	EPFU	NCKR0028	F	A	P	35.469233	-79.997650
9-Jun-14	Horse Trough Mnt	LABO	NCKR0029	M	A	NS	35.309717	-80.033950
9-Jun-14	Horse Trough Mnt	LABO	NCKR0031	M	A	NS	35.309717	-80.033950
9-Jun-14	Horse Trough Mnt	LABO	NCKR0030	M	A	NS	35.309717	-80.033950
9-Jun-14	Horse Trough Mnt	LABO	NCKR0032	F	A	P	35.309717	-80.033950
10-Jun-14	Horse Trough Mnt	NYHU	NCKR0033	M	A	S	35.309717	-80.033950
12-Jun-14	Woodrum	LABO	NCKR0035	M	A	NS	35.330217	-80.032617
12-Jun-14	Woodrum	LABO	NCKR0034	F	A	P	35.330217	-80.032617
15-Jun-14	Dutch John	EPFU	NCKR0044	M	A	NS	35.406200	-80.051600
15-Jun-14	Dutch John	EPFU	NCKR0049	M	A	NS	35.406200	-80.051600

15-Jun-14	Dutch John	NYHU	NCKR0038	F	A	P	35.406200	-80.051600
15-Jun-14	Dutch John	LABO	NCKR0037	F	A	P	35.406200	-80.051600
15-Jun-14	Dutch John	NYHU	NCKR0040	F	A	P	35.406200	-80.051600
15-Jun-14	Dutch John	LABO	NCKR0041	F	A	P	35.406200	-80.051600
15-Jun-14	Dutch John	NYHU	NCKR0045	F	A	P	35.406200	-80.051600
15-Jun-14	Dutch John	NYHU	NCKR0046	F	A	P	35.406200	-80.051600
15-Jun-14	Dutch John	NYHU	NCKR0047	F	A	P	35.406200	-80.051600
15-Jun-14	Dutch John	NYHU	NCKR0048	F	A	P	35.406200	-80.051600
15-Jun-14	Dutch John	NYHU	NCKR0036	M	A	S	35.406200	-80.051600
15-Jun-14	Dutch John	NYHU	NCKR0039	M	A	S	35.406200	-80.051600
15-Jun-14	Dutch John	NYHU	NCKR0042	M	A	S	35.406200	-80.051600
15-Jun-14	Dutch John	NYHU	NCKR0043	M	A	S	35.406200	-80.051600
16-Jun-14	Dutch John	LABO	NCKR0041	F	A	L	35.406200	-80.051600
16-Jun-14	Dutch John	NYHU	n/a	M	A	NS	35.406200	-80.051600
16-Jun-14	Dutch John	LABO	n/a	F	A	P	35.406200	-80.051600
16-Jun-14	Dutch John	NYHU	n/a	F	A	P	35.406200	-80.051600
16-Jun-14	Dutch John	NYHU	n/a	F	A	P	35.406200	-80.051600
16-Jun-14	Dutch John	NYHU	n/a	F	A	P	35.406200	-80.051600
16-Jun-14	Dutch John	LABO	n/a	F	A	P	35.406200	-80.051600
17-Jun-14	Dutch John	LABO	NCKR0051	F	A	L	35.406200	-80.051600
17-Jun-14	Dutch John	LABO	NCKR0052	F	A	L	35.406200	-80.051600
17-Jun-14	Dutch John	NYHU	NCKR0050	M	A	NS	35.406200	-80.051600
17-Jun-14	Dutch John	NYHU	n/a	F	A	P	35.406200	-80.051600
17-Jun-14	Dutch John	NYHU	NCKR0053	F	A	P	35.406200	-80.051600
18-Jun-14	Dutch John	LABO	n/a	F		n/a	35.406200	-80.051600
18-Jun-14	Dutch John	LABO	NCKR0054	M	A	NS	35.406200	-80.051600
18-Jun-14	Dutch John	NYHU	NCKR0055	M	A	S	35.406200	-80.051600
22-Jun-14	Yates Place	EPFU	NCKR0056	F	A	L	35.356900	-79.989867
23-Jun-14	Yates Place	EPFU	NCKR0057	M	A	NS	35.356900	-79.989867
25-Jun-14	Bog	LABO	NCKR0058	F	A	L	35.319117	-79.969750
28-Jun-14	Lovin Hill	LABO	NCKR0059	F	A	L	35.239700	-79.819700
28-Jun-14	Lovin Hill	NYHU	NCKR0060	F	A	L	35.239533	-79.819483
28-Jun-14	Lovin Hill	LABO	NCKR0061	F	A	L	35.240067	-79.819833
29-Jun-14	Lovin Hill	LABO	NCKR0062	F	A	L	35.240067	-79.819833
29-Jun-14	Lovin Hill	LABO	NCKR0064	F	A	L	35.239700	-79.819700
29-Jun-14	Lovin Hill	NYHU	NCKR0063	M	A	NS	35.239533	-79.819483
29-Jun-14	Lovin Hill	LABO	NCKR0065	M	A	NS	35.239533	-79.819483
30-Jun-14	Lovin Hill	EPFU	NCKR0066	M	A	NS	35.239533	-79.819483
1-Jul-14	Lovin Hill	EPFU	NCKR0067	M	A	NS	35.234017	-79.819283
2-Jul-14	Lovin Hill	LABO	NCKR0068	F	A	L	35.234017	-79.819283

4-Jul-14	Moccasin Creek	LABO	NCKR0069	F	A	L	35.411733	-80.088717
4-Jul-14	Moccasin Creek	LABO	NCKR0071	F	A	L	35.411733	-80.088717
4-Jul-14	Moccasin Creek	LABO	NCKR0075	F	A	L	35.411733	-80.088717
4-Jul-14	Moccasin Creek	LABO	NCKR0076	F	A	L	35.411733	-80.088717
4-Jul-14	Moccasin Creek	LABO	NCKR0072	F	J	NR	35.411733	-80.088717
4-Jul-14	Moccasin Creek	EPFU	NCKR0073	M	A	NS	35.413617	-80.086917
4-Jul-14	Moccasin Creek	LABO	NCKR0070	M	A	S	35.411733	-80.088717
4-Jul-14	Moccasin Creek	EPFU	NCKR0074	M	A	S	35.411733	-80.088717
5-Jul-14	Moccasin Creek	LABO	NCKR0078	F	A	L	35.411733	-80.088717
5-Jul-14	Moccasin Creek	LABO	NCKR0080	M	J	NS	35.411733	-80.088717
5-Jul-14	Moccasin Creek	EPFU	NCKR0081	M	A	NS	35.411733	-80.088717
5-Jul-14	Moccasin Creek	LABO	NCKR0082	M	A	NS	35.411733	-80.088717
5-Jul-14	Moccasin Creek	EPFU	NCKR0077	F	A	P	35.411733	-80.088717
5-Jul-14	Moccasin Creek	LABO	NCKR0079	F	A	P	35.411733	-80.088717
6-Jul-14	Moccasin Creek	EPFU	NCKR0083	M	A	NS	35.409250	-80.089333
6-Jul-14	Moccasin Creek	EPFU	NCKR0084	M	A	NS	35.409250	-80.089333
6-Jul-14	Moccasin Creek	LABO	NCKR0086	F	A	PL	35.409250	-80.089333
6-Jul-14	Moccasin Creek	LABO	NCKR0085	M	A	S	35.409250	-80.089333
7-Jul-14	Moccasin Creek	LABO	NCKR0075	F	A	L	35.409250	-80.089333
7-Jul-14	Moccasin Creek	LABO	NCKR0069	F	A	P	35.409250	-80.089333
10-Jul-14	Uwharrie Trail	EPFU	NCKR0088	M	J	NS	35.402950	-79.975650
10-Jul-14	Uwharrie Trail	LABO	NCKR0087	F	A	PL	35.404667	-79.974900
10-Jul-14	Uwharrie Trail	EPFU	NCKR0089	M	A	S	35.402950	-79.975650
10-Jul-14	Uwharrie Trail	LABO	NCKR0090	M	A	S	35.402950	-79.975650
10-Jul-14	Uwharrie Trail	LABO	NCKR0091	M	A	S	35.402950	-79.975650
11-Jul-14	Uwharrie Trail	LABO	NCKR0093	F	J	NR	35.402950	-79.975650
11-Jul-14	Uwharrie Trail	NYHU	NCKR0094	F	J	NR	35.402950	-79.975650
11-Jul-14	Uwharrie Trail	LABO	NCKR0092	M	J	NS	35.402950	-79.975650
11-Jul-14	Uwharrie Trail	LABO	NCKR0096	F	A	PL	35.404667	-79.974900
11-Jul-14	Uwharrie Trail	LABO	NCKR0095	M	J	S	35.402950	-79.975650
12-Jul-14	Uwharrie Trail	LABO	NCKR0103	F	J	NR	35.406317	-79.975083
12-Jul-14	Uwharrie Trail	LABO	NCKR0097	M	J	NS	35.406733	-79.975467
12-Jul-14	Uwharrie Trail	NYHU	NCKR0098	M	A	NS	35.406317	-79.975083
12-Jul-14	Uwharrie Trail	LABO	NCKR0099	M	J	NS	35.406317	-79.975083
12-Jul-14	Uwharrie Trail	EPFU	NCKR0100	M	J	NS	35.406317	-79.975083
12-Jul-14	Uwharrie Trail	LABO	NCKR0101	F	A	PL	35.406317	-79.975083
12-Jul-14	Uwharrie Trail	LABO	NCKR0102	M	A	S	35.406317	-79.975083
13-Jul-14	Uwharrie Trail	LABO	NCKR0104	F	J	NR	35.406317	-79.975083
13-Jul-14	Uwharrie Trail	LABO	NCKR0105	F	J	NR	35.406317	-79.975083
13-Jul-14	Uwharrie Trail	EPFU	NCKR0108	F	J	NR	35.406317	-79.975083

13-Jul-14	Uwharrie Trail	EPFU	NCKR0107	M	J	NS	35.406317	-79.975083
13-Jul-14	Uwharrie Trail	EPFU	NCKR0106	F	A	PL	35.406317	-79.975083
13-Jul-14	Uwharrie Trail	EPFU	NCKR0109	F	A	PL	35.406317	-79.975083
13-Jul-14	Uwharrie Trail	LABO	NCKR0110	M	J	S	35.406317	-79.975083
14-Jul-14	East Morris Mnt	LABO	NCKR0112	F	J	NR	35.449967	-79.969317
14-Jul-14	East Morris Mnt	PESU	NCKR0113	M	J	NS	35.451150	-79.970083
14-Jul-14	East Morris Mnt	NYHU	NCKR0111	M	A	S	35.449967	-79.969317
16-Jul-14	East Morris Mnt	LABO	NCKR0114	F	J	NR	35.444917	-79.969533
16-Jul-14	East Morris Mnt	LABO	NCKR0115	M	J	NS	35.445400	-79.969667
16-Jul-14	East Morris Mnt	EPFU	NCKR0118	M	J	NS	35.444917	-79.969533
16-Jul-14	East Morris Mnt	NYHU	NCKR0116	M	J	S	35.444917	-79.969533
16-Jul-14	East Morris Mnt	NYHU	NCKR0117	M	J	S	35.444917	-79.969533
17-Jul-14	East Morris Mnt	LABO	NCKR0120	M	J	NR	35.444917	-79.969533
17-Jul-14	East Morris Mnt	LABO	NCKR0115	M	J	NR	35.444917	-79.969533
17-Jul-14	East Morris Mnt	NYHU	NCKR0119	M	A	S	35.444917	-79.969533
19-Jul-14	South Polly Branch	EPFU	NCKR0122	F	A	L	35.243950	-79.846700
19-Jul-14	South Polly Branch	LABO	NCKR0124	F	J	NR	35.244517	-79.846733
19-Jul-14	South Polly Branch	LABO	NCKR0121	M	J	NS	35.244517	-79.846733
19-Jul-14	South Polly Branch	EPFU	NCKR0123	M	A	NS	35.244517	-79.846733
19-Jul-14	South Polly Branch	EPFU	NCKR0125	F	A	PL	35.244517	-79.846733
19-Jul-14	South Polly Branch	LABO	NCKR0126	F	A	PL	35.244517	-79.846733
20-Jul-14	South Polly Branch	EPFU	NCKR0127	M	J	NS	35.244517	-79.846733
21-Jul-14	South Polly Branch	EPFU	NCKR0129	F	A	P	35.244517	-79.846733
21-Jul-14	South Polly Branch	EPFU	NCKR0128	M	A	S	35.244517	-79.846733
22-Jul-14	South Polly Branch	LABO	NCKR0130	F	J	NR	35.244067	-79.840633
22-Jul-14	South Polly Branch	LABO	NCKR0131	F	J	NR	35.244067	-79.840633
23-Jul-14	North Polly Branch	LABO	NCKR0133	F	A	L	35.257367	-79.818200
23-Jul-14	North Polly Branch	LABO	NCKR0139	F	A	L	35.257367	-79.818200
23-Jul-14	North Polly Branch	LABO	NCKR0138	F	A	NR	35.257483	-79.817467
23-Jul-14	North Polly Branch	LABO	NCKR0132	M	J	NS	35.257483	-79.817467
23-Jul-14	North Polly Branch	LABO	NCKR0136	M	J	NS	35.257483	-79.817467
23-Jul-14	North Polly Branch	NYHU	NCKR0137	M	A	S	35.257367	-79.818200
24-Jul-14	North Polly Branch	LABO	NCKR0140	F	J	NR	35.257483	-79.817467
24-Jul-14	North Polly Branch	LABO	NCKR0141	F	J	NR	35.257367	-79.818200
24-Jul-14	North Polly Branch	LABO	NCKR0144	F	J	NR	35.257483	-79.817467
24-Jul-14	North Polly Branch	EPFU	NCKR0142	F	A	PL	35.257367	-79.818200
24-Jul-14	North Polly Branch	EPFU	NCKR0143	F	A	PL	35.257367	-79.818200
24-Jul-14	North Polly Branch	LABO	NCKR0145	F	A	PL	35.257367	-79.818200
25-Jul-14	North Polly Branch	LABO	NCKR0141	F	J	NR	n/a	n/a
25-Jul-14	North Polly Branch	LABO	NCKR0147	F	A	PL	n/a	n/a

25-Jul-14	North Polly Branch	LABO	NCKR0146	M	A	S	n/a	n/a
25-Jul-14	North Polly Branch	LABO	NCKR0148	M	A	S	n/a	n/a
26-Jul-14	North Polly Branch	LABO	NCKR0149	F	J	NR	n/a	n/a
26-Jul-14	North Polly Branch	LABO	NCKR0150	F	J	NR	n/a	n/a
26-Jul-14	North Polly Branch	LABO	NCKR0151	M	J	S	n/a	n/a
28-Jul-14	Birkhead Wilderness	LABO	NCKR0153	F	J	NR	35.616117	-79.944167
28-Jul-14	Birkhead Wilderness	LABO	NCKR0157	F	J	NR	35.616717	-79.944917
28-Jul-14	Birkhead Wilderness	NYHU	NCKR0152	M	J	S	35.616117	-79.944167
28-Jul-14	Birkhead Wilderness	LABO	NCKR0154	M	J	S	35.616117	-79.944167
28-Jul-14	Birkhead Wilderness	LABO	NCKR0155	M	A	S	35.616117	-79.944167
28-Jul-14	Birkhead Wilderness	LABO	NCKR0156	M	J	S	35.616717	-79.944917
28-Jul-14	Birkhead Wilderness	LABO	NCKR0158	M	A	S	35.616117	-79.944167
29-Jul-14	Birkhead Wilderness	LABO	NCKR0153	F		n/a	35.616117	-79.944167
29-Jul-14	Birkhead Wilderness	LABO	NCKR0159	M	J	S	35.616717	-79.944917
29-Jul-14	Birkhead Wilderness	LABO	NCKR0160	M	J	S	35.616117	-79.944167
30-Jul-14	Birkhead Wilderness	LABO	NCKR0161	F	A	PL	35.616067	-79.944383
30-Jul-14	Birkhead Wilderness	LABO	NCKR0162	F	A	PL	35.616067	-79.944383
30-Jul-14	Birkhead Wilderness	LABO	NCKR0160	M	J	S	35.616067	-79.944383
6-Aug-14	Dutch John	LABO	NCKR0185	M	J	NR	35.406200	-80.051600
6-Aug-14	Dutch John	LABO	NCKR0187	F	J	NR	35.406200	-80.051600
6-Aug-14	Dutch John	EPFU	NCKR0189	F	J	NR	35.406200	-80.051600
6-Aug-14	Dutch John	LABO	NCKR0186	F	A	PL	35.406200	-80.051600
6-Aug-14	Dutch John	LABO	NCKR0183	M	J	S	35.406200	-80.051600
6-Aug-14	Dutch John	LABO	NCKR0184	M	J	S	35.406200	-80.051600
6-Aug-14	Dutch John	LABO	NCKR0188	M	J	S	35.406200	-80.051600
6-Aug-14	Dutch John	EPFU	NCKR0190	M	A	S	35.406200	-80.051600
8-Aug-14	Dutch John	LABO	NCKR0192	F	A	NR	35.406200	-80.051600
8-Aug-14	Dutch John	LABO	NCKR0191	M	J	S	35.406200	-80.051600
21-Aug-14	Pee Dee NWR	LABO	NCKR0193	M	J	S	n/a	n/a
21-Aug-14	Pee Dee NWR	LABO	NCKR0194	M	A	S	n/a	n/a
21-Aug-14	Pee Dee NWR	LABO	NCKR0195	M	A	S	n/a	n/a
29-Aug-14	Pee Dee NWR	LABO	NCKR0197	F	A	NR	n/a	n/a
29-Aug-14	Pee Dee NWR	LABO	NCKR0196	M	A	S	n/a	n/a
30-Aug-14	Pee Dee NWR	LABO	NCKR0198	F	J	NR	n/a	n/a
5-Sep-14	Pee Dee NWR	LABO	n/a	n/a	n/a	n/a	n/a	n/a
3-May-15	East Morris Mnt	NYHU	NCKR0301	M	n/a	S	35.449971	-79.969385
17-May-15	Uwharrie River	LABO	n/a	n/a	n/a	n/a	35.386474	-80.041791
28-Jun-15	Hicks	LABO	NCKR0204	F	A	L	35.303064	-79.884960
28-Jun-15	Hicks	LABO	n/a	na	n/a	n/a	35.302724	-79.886198
1-Jul-15	High Pine Church	EPFU	NCKR0205	F	A	L	35.605048	-79.876834

7-Jul-15	Lassiter Mills	EPFU	NCKR0207	F	J	NR	35.540133	-79.965650
7-Jul-15	Lassiter Mills	EPFU	NCKR0206	M	A	S	35.539450	-79.966867
9-Jul-15	Ophir	LABO	NCKR0210	F	A	L	35.479969	-79.958308
9-Jul-15	Ophir	LABO	NCKR0214	F	A	L	35.749480	-79.957102
9-Jul-15	Ophir	LABO	NCKR0208	F	J	NR	35.480285	-79.957490
9-Jul-15	Ophir	LABO	NCKR0211	F	J	NR	35.479969	-79.958308
9-Jul-15	Ophir	LABO	NCKR0213	M	J	NR	35.479969	-79.958308
9-Jul-15	Ophir	LABO	NCKR0215	M	J	NR	35.749480	-79.957102
9-Jul-15	Ophir	PESU	NCKR0216	M	J	NR	35.479969	-79.958308
9-Jul-15	Ophir	LABO	NCKR0217	F	J	NR	35.749480	-79.957102
9-Jul-15	Ophir	LABO	NCKR0218	M	J	NR	35.479969	-79.958308
9-Jul-15	Ophir	LABO	n/a	M	J	NR	35.480285	-79.957490
9-Jul-15	Ophir	LABO	NCKR0247	F	J	NR	35.480285	-79.957490
9-Jul-15	Ophir	LABO	NCKR0209	M	A	S	35.479969	-79.958308
9-Jul-15	Ophir	LABO	NCKR0212	M	A	S	35.479969	-79.958308
9-Jul-15	Ophir	LABO	NCKR0219	M	A	S	35.749480	-79.957102
9-Jul-15	Ophir	LABO	NCKR0220	M	A	S	35.749480	-79.957102
10-Jul-15	Ophir	LABO	NCKR0221	F	J	NR	35.479969	-79.958308
10-Jul-15	Ophir	LABO	NCKR0222	M	J	NR	35.479969	-79.958308
10-Jul-15	Ophir	LABO	NCKR0224	F	J	NR	35.479969	-79.958308
10-Jul-15	Ophir	LABO	NCKR0225	M	J	NR	35.479969	-79.958308
10-Jul-15	Ophir	LABO	NCKR0246	M	J	NR	35.479969	-79.958308
10-Jul-15	Ophir	LABO	NCKR0226	F	J	NR	35.479969	-79.958308
10-Jul-15	Ophir	NYHU	NCKR0227	M	J	NR	35.479969	-79.958308
10-Jul-15	Ophir	PESU	NCKR0228	M	J	NR	35.479969	-79.958308
10-Jul-15	Ophir	LABO	NCKR0218	F	J	NR	35.480285	-79.957490
10-Jul-15	Ophir	LABO	NCKR0229	M	J	NR	35.479969	-79.958308
10-Jul-15	Ophir	LABO	NCKR0230	M	J	NR	35.749480	-79.957102
10-Jul-15	Ophir	LABO	NCKR0231	F	J	NR	35.479969	-79.958308
10-Jul-15	Ophir	NYHU	NCKR0223	M	A	S	35.480285	-79.957490
11-Jul-15	Ophir	PESU	n/a	na	n/a	n/a	35.749480	-79.957102
11-Jul-15	Ophir	PESU	NCKR0232	M	J	NR	35.479969	-79.958308
11-Jul-15	Ophir	LABO	NCKR0233	M	J	NR	35.479969	-79.958308
11-Jul-15	Ophir	LABO	NCKR0235	F	J	NR	35.479969	-79.958308
11-Jul-15	Ophir	LABO	NCKR0211	F	J	NR	35.479969	-79.958308
11-Jul-15	Ophir	LABO	NCKR0236	F	J	NR	35.479969	-79.958308
11-Jul-15	Ophir	LABO	NCKR0239	F	J	NR	35.479969	-79.958308
11-Jul-15	Ophir	LABO	NCKR0243	M	J	NR	35.749480	-79.957102
11-Jul-15	Ophir	EPFU	NCKR0242	F	A	PL	35.749480	-79.957102
11-Jul-15	Ophir	LABO	NCKR0234	M	A	S	35.480285	-79.957490

11-Jul-15	Ophir	NYHU	NCKR0237	M	A	S	35.749480	-79.957102
11-Jul-15	Ophir	LABO	NCKR0240	NM	A	S	35.480285	-79.957490
11-Jul-15	Ophir	LABO	NCKR0241	M	A	S	35.480285	-79.957490
22-Jul-15	MOMO SP	LABO	n/a	na	n/a	n/a	35.377679	-80.088110
22-Jul-15	MOMO SP	EPFU	NCKR0501	F	A	PL	35.377277	-80.090041
26-Jul-15	Tower Road	LABO	NCKR0502	F	J	n/a	35.463132	-79.955481
26-Jul-15	Tower Road	LABO	NCKR0503	M	J	n/a	35.463132	-79.955481
29-Jul-15	MOMO SP	EPFU	n/a	na	n/a	n/a	35.373167	-80.093783
29-Jul-15	MOMO SP	EPFU	NCKR0505	M	J	NR	35.373167	-80.093783
29-Jul-15	MOMO SP	LABO	NCKR0507	M	J	NR	35.373500	-80.093150
29-Jul-15	MOMO SP	LABO	NCKR0504	M	J	S	35.373500	-80.093150
29-Jul-15	MOMO SP	EPFU	NCKR0506	M	A	S	35.373500	-80.093150
30-Jul-15	Tower Handicap	LABO	NCKR0508	M	J	S	35.449201	-79.961725
3-Aug-15	Buck Mnt	LABO	n/a	na	n/a	n/a	35.406571	-79.998719
3-Aug-15	Buck Mnt	LABO	NCKR0509	M	J	NR	35.406571	-79.998719
3-Aug-15	Buck Mnt	LABO	NCKR0510	F	J	NR	35.406571	-79.998719
3-Aug-15	Buck Mnt	LABO	NCKR0512	F	J	NR	35.407321	-79.997675
3-Aug-15	Buck Mnt	EPFU	NCKR0511	M	A	S	35.407321	-79.997675
3-Aug-15	Buck Mnt	NYHU	NCKR0513	M	A	S	35.407321	-79.997675
4-Aug-15	Buck Mnt	LABO	NCKR0514	M	J	NR	35.407321	-79.997675
4-Aug-15	Buck Mnt	LABO	NCKR0515	F	J	NR	35.407321	-79.997675
5-Aug-15	Buck Mnt	LABO	NCKR0510	F	A	NR	35.407321	-79.997675
26-Aug-15	Ophir	LABO	NCKR0516	M	J	S	35.480285	-79.957490
26-Aug-15	Ophir	LABO	NCKR0517	M	J	S	35.480285	-79.957490
26-Aug-15	Ophir	LABO	NCKR0518	M	J	S	35.480285	-79.957490
26-Aug-15	Ophir	LABO	NCKR0519	M	A	S	35.480285	-79.957490
26-Aug-15	Ophir	LABO	NCKR0520	M	J	S	35.749480	-79.957102
27-Aug-15	Ophir	LABO	NCKR0521	M	A	S	35.749480	-79.957102
28-Aug-15	Ophir	LABO	NCKR0522	M	A	S	35.479969	-79.958308
29-Aug-15	Ophir	LABO	NCKR0523	F	J	NR	35.480285	-79.957490
30-Aug-15	Ophir	LABO	NCKR0524	F	A	NR	35.480285	-79.957490
31-Aug-15	Ophir	LABO	NCKR0525	M	J	S	35.479969	-79.958308
1-Sep-15	Ophir	LABO	NCKR0526	F	A	NR	35.749480	-79.957102
2-Sep-15	Ophir	LABO	NCKR0527	M	J	S	35.480285	-79.957490
3-Sep-15	Ophir	LABO	NCKR0528	M	J	S	35.749480	-79.957102

TABLE 3. NUMBER OF BATS IN EACH SEX AND AGE CLASS. Number of bats captured in the Uwharrie National Forest and surrounding area in 2014 and 2015 in each sex and age class. Species acronyms: *Perimyotis subflavus* (PESU), *Nycticeius humeralis* (NYHU), *Lasiurus borealis* (LABO), *Eptesicus fuscus* (EPFU). Captures include 11 recaptures and do not include bats we were not able to age or sex if they escaped before determination. Years are pooled.

	Adult Female	Adult Male	Juvenile Female	Juvenile Male
LABO				
May	9	14		
June	15	6		
July	23	17	32	33
Aug	5	6	6	13
Sept	1			2
EPFU				
May	2	2		
June	1	4		
July	11	11	2	6
Aug		2	1	
NYHU				
May		3		
June	12	9		
July		6	1	4
Aug		1		
PESU				
July				4

TABLE 4. SITE, NAME, DATE, AND COORDINATES OF ACOUSTIC RECORDING LOCATIONS AT NET SITES IN 2014 AND 2015. Recordings were made with a Pettersson D500 detector and analyzed with SonoBat 4.0.6 Central North Carolina. Numbers are maximum likelihood estimates of presence each night with presence being indicated by 0 and absence by 1. All sites were in the Uwharrie National Forest except those labeled MOMO which were from Morrow Mountain State Park and Pee Dee which were from the Pee Dee National Wildlife Refuge. Passes are the number of passes examined and IDed by Sonobat 4.0.6 Central North Carolina. Species acronyms: *Myotis lebii* (MYLE), *M. septentrionalis* (MYSE), *M. lucifugus* (MYLU), *Perimyotis subflavus* (PESU), *Nycticeius humeralis* (NYHU), *Lasiurus borealis* (LABO), *Eptesicus fuscus* (EPFU), *Lasionycteris noctivagans* (LANO), *Corynhorinus rafinesquii* (CORA), *Tadarida brasiliensis* (TABR), *and Lasiurus cinereus* (LACI). MLE in italics represent files that were checked by the the first author and deemed to not belong to MYLU. Nights with MLE values <0.05 are highlighted.

Partial File Name	Location Name	Date	Northing	Easting	Passes	Myle	Myse	Mylu	Pesu	Nyhu	Labo	Epfu	Lano	Cora	Tabr	Laci
Bog	Bog	26-Jun-14	35.319115	-79.969742	110	1	1	1	0.63	1	0	0	1	1	0.46	1
LovinHillStream	Lovin Hill	29-Jun-14	35.240067	-79.819833	86	1	1	*0.81*	1	0.82	0	0	0.82	1	1	1
LovinHillSideRoad	Lovin Hill	30-Jun-14	35.238392	-79.820575	94	1	1	1	0.81	0.82	0	0	1	1	1	1
LovinHillSideRoad	Lovin Hill	1-Jul-14	35.238392	-79.820575	27	1	1	1	1	0.83	0.22	1	1	1	0.82	1
LovinHillSideRoad	Lovin Hill	2-Jul-14	35.238392	-79.820575	28	1	1	1	1	0.82	0.02	1	1	1	1	1
MocassinCreekRd	Mocassin Creek	4-Jul-14	35.411733	-80.088717	0	1	1	1	1	1	1	1	1	1	1	1
MocassinCreekRd	Mocassin Creek	5-Jul-14	35.411733	-80.088717	102	1	1	1	1	1	0.39	1	1	1	1	0.82
MocassinCreekRd	Mocassin Creek	6-Jul-14	35.411733	-80.088717	44	1	1	1	0.63	1	0.28	1	1	1	1	1
MocassinCreekRd	Mocassin Creek	7-Jul-14	35.411733	-80.088717	11	1	1	1	1	1	0.53	1	1	1	1	1
UwharrieTrail	Uwharrie Trail	10-Jul-14	35.406317	-79.975083	30	1	1	1	1	1	0.02	0.39	1	1	1	1
UwharrieTrail	Uwharrie Trail	11-Jul-14	35.406317	-79.975083	2	1	1	1	1	1	1	1	1	1	1	1
UwharrieTrail	Uwharrie Trail	12-Jul-14	35.406317	-79.975083	86	1	1	1	1	1	0	0.73	1	1	0.82	1
EastMorrisMtn	East Morris Mnt	13-Jul-14	35.451150	-79.970083	57	1	1	*0.81*	1	1	0	0.03	1	1	1	1
EastMorrisMtn	East Morris Mnt	16-Jul-14	35.451150	-79.970083	41	1	1	1	1	0.82	0.31	1	1	1	0.82	1
EastMorrisMtn	East Morris Mnt	17-Jul-14	35.451150	-79.970083	73	1	1	1	1	0.72	0	1	1	1	1	1
South	South Polly Branch	19-Jul-14	35.244517	-79.846733	15	1	1	1	1	1	0.39	1	1	1	1	1
South	South Polly Branch	20-Jul-14	35.244517	-79.846733	17	1	1	1	1	1	0.39	1	1	1	1	1
NorthSouth	North Polly Branch	23-Jul-14	35.257483	-79.817467	26	1	1	1	1	1	0.08	1	1	1	1	0.82
NorthSouth	North Polly Branch	24-Jul-14	35.257483	-79.817467	62	1	1	1	1	1	0	0.15	1	1	1	1
Wilderness	Birkhead Wilderness	28-Jul-14	35.616117	-79.944167	80	1	1	1	1	1	0.73	1	1	1	0.82	1
Wilderness	Birkhead Wilderness	29-Jul-14	35.616117	-79.944167	35	1	1	1	1	1	0.15	0.73	1	1	1	1
Wilderness	Birkhead Wilderness	30-Jul-14	35.616117	-79.944167	80	1	1	1	1	1	0.04	0.41	0.82	1	1	1
DutchJohn	Dutch John	6-Aug-14	35.406200	-80.051600	56	1	1	1	0.24	1	0	0.53	1	1	1	1
PeeDeeOffice	Pee Dee NWR	21-Aug-14	35.061042	-80.093156	0	1	1	1	1	1	1	1	1	1	1	1
PeeDeeOffice	Pee Dee NWR	22-Aug-14	35.061042	-80.093156	27	1	1	1	1	1	0.73	1	1	1	0.73	1
PeeDeePonds	Pee Dee NWR	29-Aug-14	35.085892	-80.096280	57	1	1	1	1	1	0.53	1	1	1	0.82	0.82

PeeDeeStream	Pee Dee NWR	30-Aug-14	35.093412	-80.047160	3	1	1	1	1	1	0.73	1	1	1	1	1
PeeDeeWetland	Pee Dee NWR	5-Sep-14	35.063695	-80.086229	51	1	1	1	1	1	0.73	0.73	1	1	1	0.82
PeeDeeWetland	Pee Dee NWR	6-Sep-14	35.063695	-80.086229	3	1	1	1	0.39	1	1	1	1	1	1	1
EastMorrisMtn	East Morris Mnt	3-May-15	35.451150	-79.970083	27	1	1	1	1	0.16	0.76	1	1	1	1	1
20150518_unf	Uwharrie River	18-May-15	35.386474	-80.041791	47	1	1	1	0.25	0.64	0.57	0.73	1	1	0.54	1
EastMorrisMtn	East Morris Mnt	8-Jun-15	35.451150	-79.970083	8	1	1	1	1	1	0.73	0.73	1	1	1	1
EastMorrisMtn	East Morris Mnt	9-Jun-15	35.451150	-79.970083	14	1	1	1	1	1	0.73	1	1	1	1	1
howelltract	Howell Tract	13-Jun-15	34.989236	-79.864098	2	1	1	1	1	1	1	1	1	1	1	1
Hicks Road	Hicks	28-Jun-15	35.302635	-79.885727	143	1	1	1	0.43	0.46	0	0.08	1	1	1	0.82
Hicks Road	Hicks	29-Jun-15	35.302635	-79.885727	77	1	1	1	0.42	0.64	0	0.73	1	1	0.15	1
LassiterMills	Lassiter Mills	6-Jul-15	35.540133	-79.965650	6	1	1	1	1	1	1	1	1	1	1	1
LassiterMills	Lassiter Mills	7-Jul-15	35.540133	-79.965650	8	1	1	1	1	1	0.53	1	1	1	1	1
OphirPoison	Ophir	9-Jul-15	35.480285	-79.957490	80	1	1	1	0.04	0.82	0	0.53	1	1	1	0.82
OphirPoison	Ophir	10-Jul-15	35.480285	-79.957490	64	1	1	1	0	0.82	0.01	0.53	1	1	1	1
OphirPoison	Ophir	11-Jul-15	35.480285	-79.957490	40	1	1	1	0.02	1	0.09	0.73	1	1	0.82	0.82
FlintHill	Flint Hill	15-Jul-15	35.478579	-79.925875	11	1	1	1	1	1	0.73	1	1	1	1	0.82
RecAreaBadin	Baden	18-Jul-15	35.480194	-80.062146	26	1	1	1	1	0.82	0.06	0.73	1	1	1	1
RecAreaBadin	Baden	19-Jul-15	35.480194	-80.062146	33	1	1	1	0.81	0.88	0.07	0.73	1	1	1	1
TowerRoad	Tower Road	26-Jul-15	35.463132	-79.955481	8	1	1	1	1	1	0.73	1	1	1	1	0.73
MOMO_MtnTop	MOMO SP	27-Jul-15	35.351725	-80.093524	39	1	1	1	1	1	0.21	1	1	1	1	0.82
MOMO_BilesRd	MOMO SP	29-Jul-15	35.373167	-80.093783	32	1	1	1	0.24	1	0	1	1	1	1	1
TowerRdHandicap	Tower Handicap	30-Jul-15	35.463132	-79.955481	16	1	1	1	1	1	0.08	1	1	1	1	1
FireTowerBuckMtn	Buck Mnt	3-Aug-15	35.407321	-79.997675	6	1	1	1	0.63	0.79	1	1	1	1	1	1
towernetting	Buck Mnt	4-Aug-15	35.407321	-79.997675	13	1	1	1	0.63	1	0.73	1	1	1	1	1

TABLE 5. AVERAGE NIGHTLY ACTIVITY BY SEASON FROM TROY DEPOT FROM 2013 - 2015. Recordings were made with a Wildlife Acoustics SM2+ detector and analyzed with SonoBat 4.0.6 Central North Carolina. Years are pooled.

Season	Average Number of Passes/Night	St Dev Passes per Night	Number of Nights
Fall	54.95	148.39	163
Spring	124.49	185.83	146
Summer	241.04	266.82	169
Winter	1.95	5.05	111

TABLE 6. SUMMARY OF TRANSMITTERS ATTACHED TO BATS AND ROOST TREES FOUND, BY SITE, IN THE UWHARRIE NATIONAL FOREST 2014. The following table includes the number of transmitters attached to each species and the number of transmitters either lost or the number and type of roosts identified.

	Number of Transmitters Put on Bats	Number of Bats with Transmitters never Found	Number of Roost (trees)	Number of Roost (structures)
East Morris Mtn.				
Cali Tract				
Entrance to ORV				
Dutch John Rd	2 NYHU	0	6	
Moccassin Rd	1 EPFU	0		1
Lovin Hill Rd	1 NYHU	0	1	
Highway 6726	1 EPFU	0		1
Northern part of South	2 EPFU	1 EPFU	2	1
Yates Place				
Uwharrie Trail	1 NYHU, 3 EPFU	3 EPFU	5	0
Wood Run				
Bog				
Coggins Mine				
Thornburg TH				
TOTALS	11	4	14	3

TABLE 7. LOCATION AND CHARACTERISTICS OF ROOST TREES (SEE FIGURE 9). Coordinates for each identified roost for each individual bat in the Uwharrie National Forest. The first letter (E or N) represents the species (*Eptesicus fuscus*; big brown bat or *Nycticeius humeralis),* the second number represents a unique individual, "R" stands for roost, and the fourth letter represents a unique roost. Decay stage was measured according to Thomas et al. 1979 1where 1 represents living and 7 represents most decayed standing tree.

Roost ID	Northing	Easting	Elevation (m)	Roost type	DBH (m)	Height (m)	Decay Stage
N1R1	35° 24.216'	80° 03.498'	231.65	Snag	0.95	12.5	5
N1R2	35° 24.232'	80° 03.469'	234.39	Unknown	0.4	3.51	2
N2R1	35° 24.145'	80° 02.621'	226.47	*Quercus prinus*	1.7	10.97	2
N2R2	35° 24.180'	80° 02.446'	251.16	Snag	2.2	11.13	4
N2R3	35° 24.051'	80° 02.393'	254.51	*Quercus prinus*	2.4	14.17	2
N2R4	35° 24.133'	80° 02.422'	246.58	Snag	2.1	11.28	4
N3R1	35° 14.145'	79° 48.994'	129.54	*Quercus* sp. (not *prinus*)	1.55	21.18	1
N4R1	35° 24.750'	79° 58.550'	210.01	Snag	0.5	7.16	5
N4R2	35° 24.781'	79° 58.548'	214.88	Snag	0.42	8.99	5
N4R3	35° 24.899'	79° 58.465'	157.98	Snag	0.3	8.38	7
N4R4	35° 24.716'	79° 58.506'	245.36	Snag	0.3	4.57	7
N4R5	35° 24.803'	79° 58.530'	203	Snag	0.64	9.75	4
E1R1	35° 24.276'	80° 06.523'	167.94	Attic of townhouse			
E5R1	35°15.207'	79°51.080'	n/a	Metal star over porch			
E6R1	35°15.892'	79°51.020'	148.74	Metal roofed carport			
E6R2	35°15.571'	79°50.505'	157.89	Snag	1	7.6	7
E6R3	35°15.461'	79°50.559'	160.63	Snag	2.5	19.96	4

[1] Thomas JW, RG Anderson, C Maser, E Bull. Snags. Pages 60-77 in Thomas JW ed Wildlife Habitats in Managed Forests-The Blue Mountains of Oregon and Washington. USDA Forest Service Agricultural Handbook 553, 512 pages.

TABLE 8. DRIVING TRANSECT BCID RESULTS SORTED BY TRANSECT AND DATE IN A) 2014 AND B) 2015.

Data were collected during 2014 and 2015 using Anabat detectors. The location of each transect can be found in Figure 11.

A)

Transect	Date	EPFU	LABO	LACI	LANO	NYHU	PESU	Myotis spp.	Total
Badin Lake	20140724	2	0	0	0	1	1	0	4
Badin Lake	20140814	1	3	0	0	3	0	0	7
Badin Lake	20140822	1	0	0	0	1	1	0	3
Coggins Mine	20140724	0	2	0	0	0	0	0	2
Coggins Mine	20140814	0	3	0	0	0	0	1	4
Coggins Mine	20140822	0	0	0	0	1	1	0	2
Dusty Level	20140722	5	2	0	0	0	2	0	9
Dusty Level	20140729	0	4	0	0	2	2	0	8
Dusty Level	20140806	8	5	0	0	0	3	0	16
Dutch John	20140814	1	6	0	1	0	3	1	12
Dutch John	20140819	1	0	0	0	0	1	0	2
Dutch John	20140822	0	0	0	0	2	3	0	5
Flint Hill	20140725	1	2	0	0	2	2	0	7
Flint Hill	20140806	0	10	0	0	6	0	1	17
Flint Hill	20140822	0	6	0	0	0	3	1	10
Lovin Hill	20140722	1	14	1	0	9	10	0	35
Lovin Hill	20140729	2	19	0	0	15	9	1	46
Lovin Hill	20140806	3	4	0	3	2	0	1	13
McClean-Mullinix	20140807	0	9	0	0	12	0	0	21
McClean Creek	20140724	0	0	0	0	4	1	0	5
McClean Creek	20140814	0	2	0	0	0	1	0	3
Moccasin Creek	20140724	11	0	0	0	7	6	0	24
Moccasin Creek	20140807	5	4	0	0	5	0	0	14
Moccasin Creek	20140819	3	8	0	0	4	6	0	21
Mullinix	20140724	0	0	0	0	0	0	0	0
Mullinix	20140814	1	3	0	0	2	0	0	6
Tower	20140725	2	4	0	1	3	3	1	14
Tower	20140806	5	10	0	0	4	4	0	23
Tower	20140814	0	2	0	0	4	1	1	8
Woodrun	20140722	0	0	0	0	0	0	1	1
Woodrun	20140729	1	0	0	0	0	1	1	3
Woodrun	20140806	1	0	0	0	0	0	0	1
Total	n/a	55	122	1	5	89	64	10	346

B)

Transect	Date	EPFU	LABO	LACI	LANO	NYHU	PESU	Myotis spp.	Total
Badin Lake	20150710	0	0	0	0	0	0	0	0
Badin Lake	20150805	0	0	0	0	0	0	0	0
Badin Lake	20150817	1	0	0	0	0	0	0	1
Badin Lake	20150827	0	1	0	0	0	1	1	3
Coggins Mine	20150710	1	1	0	0	0	0	0	2
Coggins Mine	20150805	0	0	0	0	0	0	0	0
Coggins Mine	20150817	0	0	0	0	0	0	0	0
Dusty Level	20150708	0	1	0	1	0	0	0	2
Dusty Level	20150721	1	0	0	0	1	0	0	2
Dusty Level	20150729	0	0	0	0	0	0	0	0
Dutch John	20150710	0	0	0	0	0	0	0	0
Dutch John	20150817	0	9	0	0	7	6	0	22
Dutch John	20150827	0	0	0	0	0	0	0	0
Flint Hill	20150709	0	15	0	0	12	7	0	34
Flint Hill	20150722	0	7	0	0	5	3	0	15
Flint Hill	20150805	0	0	0	0	0	0	0	0
Lovin Hill	20150708	0	14	0	0	16	2	0	32
Lovin Hill	20150721	0	11	0	0	14	10	2	37
Lovin Hill	20150729	0	3	0	0	3	3	0	9
McClean Creek	20150722	0	2	0	1	0	1	1	5
McClean Creek	20150805	0	0	0	0	0	0	0	0
McClean Creek	20150817	0	0	0	0	0	0	0	0
Moccasin Creek	20150710	0	3	0	0	5	3	0	11
Moccasin Creek	20150817	0	0	0	0	2	1	0	3
Moccasin Creek	20150827	0	3	0	0	2	9	1	15
Mullinix	20150709	1	1	0	0	0	1	1	4
Mullinix	20150722	0	0	0	0	0	0	0	0
Mullinix	20150805	2	0	0	0	0	0	0	2
Tower	20150709	0	0	0	0	0	1	0	1
Tower	20150722	0	4	0	0	2	0	1	7
Tower	20150729	1	0	0	0	0	0	0	1
Woodrun	20150708	0	0	0	0	0	0	0	0
Woodrun	20150721	0	0	0	0	0	0	0	0
Woodrun	20150729	2	0	0	0	0	0	0	2
Not-a-transect	20150708	6	0	0	0	7	6	0	19
Not-a-transect	20150709	5	0	0	0	7	5	0	17
Not-a-transect	20150710	0	0	0	0	1	3	0	4
Not-a-transect	20150721	4	6	0	2	10	3	0	25
Not-a-transect	20150722	0	3	0	1	3	2	2	11
Not-a-transect	20150729	3	4	0	0	7	4	1	19
Not-a-transect	20150805	0	12	0	0	13	7	0	32
Not-a-transect	20150817	2	4	0	0	3	11	1	21
Not-a-transect	20150827	0	2	0	0	0	9	1	12
Total	n/a	29	106	0	5	120	98	12	370

TABLE 9. DRIVING TRANSECT ECHOCLASS RESULTS SORTED BY TRANSECT AND DATE IN A) 2014 AND B) 2015.

Data were collected during 2014 and 2015 using Anabat detectors. The location of each transect can be found in Figure 11.

A)

Transect	Date	EPFU	LANO	LABO	LACI	NYHU	PESU	Myotis spp.	Total
Badin Lake	20140724	2	0	4	0	0	0	1	7
Badin Lake	20140814	0	0	6	0	0	0	1	7
Badin Lake	20140822	0	0	3	0	0	0	0	3
Coggins Mine	20140724	0	0	3	0	0	0	0	3
Coggins Mine	20140814	0	0	3	0	0	0	1	4
Coggins Mine	20140822	0	0	2	0	0	0	0	2
Dusty Level	20140722	4	0	5	0	0	0	0	9
Dusty Level	20140729	0	0	6	0	0	0	0	6
Dusty Level	20140806	5	0	9	0	0	2	0	16
Dutch John	20140814	0	0	7	0	0	0	1	8
Dutch John	20140819	0	0	3	0	0	0	0	3
Dutch John	20140822	0	0	4	0	0	0	0	4
Flint Hill	20140725	0	0	5	0	0	0	0	5
Flint Hill	20140806	0	0	14	0	3	0	1	18
Flint Hill	20140822	0	0	10	0	2	0	1	13
Lovin Hill	20140722	0	0	24	0	0	0	0	24
Lovin Hill	20140729	3	0	28	0	5	3	0	39
Lovin Hill	20140806	3	0	7	0	2	0	0	12
McClean-Mullinix	20140807	0	0	19	0	0	0	0	19
McClean Creek	20140724	0	0	0	0	0	0	0	0
McClean Creek	20140814	0	0	3	0	0	0	0	3
Moccasin Creek	20140724	3	0	13	0	0	2	2	20
Moccasin Creek	20140807	3	0	9	0	2	0	0	14
Moccasin Creek	20140819	0	0	12	0	0	0	0	12
Mullinix	20140724	0	0	0	0	0	0	0	0
Mullinix	20140814	0	0	5	0	0	0	0	5
Tower	20140725	3	0	5	0	0	2	0	10
Tower	20140806	4	0	15	0	2	0	0	21
Tower	20140814	0	0	3	0	0	0	0	3
Woodrun	20140722	0	0	0	0	0	0	0	0
Woodrun	20140729	0	0	0	0	0	0	0	0
Woodrun	20140806	0	0	0	0	0	0	0	0
Total	n/a	30	0	227	0	16	9	8	290

B)

Transect	Date	EPFU	LANO	LABO	LACI	NYHU	PESU	Myotis spp.	Total
Badin Lake	20150710	0	0	0	0	0	0	0	0
Badin Lake	20150805	0	0	0	0	0	0	0	0
Badin Lake	20150817	0	0	0	0	0	0	0	0
Badin Lake	20150827	0	0	2	0	0	0	1	3
Coggins Mine	20150710	0	0	0	0	0	0	1	1
Coggins Mine	20150805	0	0	0	0	0	0	0	0
Coggins Mine	20150817	0	0	0	0	0	0	0	0
Dusty Level	20150708	0	0	0	0	0	0	0	0
Dusty Level	20150721	0	0	0	0	0	0	0	0
Dusty Level	20150729	0	0	0	0	0	0	0	0
Dutch John	20150710	0	0	0	0	0	0	0	0
Dutch John	20150817	0	0	17	0	0	0	0	17
Dutch John	20150827	0	0	2	0	0	0	0	2
Flint Hill	20150709	0	0	24	0	0	0	0	24
Flint Hill	20150722	0	0	13	0	0	2	0	15
Flint Hill	20150805	0	0	2	0	0	0	0	2
Lovin Hill	20150708	0	0	27	0	0	2	0	29
Lovin Hill	20150721	0	0	25	0	0	0	1	26
Lovin Hill	20150729	0	0	4	0	0	2	0	6
McClean Creek	20150722	0	0	3	0	0	0	0	3
McClean Creek	20150805	0	0	0	0	0	0	0	0
McClean Creek	20150817	0	0	0	0	0	0	0	0
Moccasin Creek	20150710	0	0	11	0	0	0	0	11
Moccasin Creek	20150817	0	0	8	0	0	0	0	8
Moccasin Creek	20150827	0	0	5	0	0	2	0	7
Mullinix	20150709	0	0	2	0	0	0	1	3
Mullinix	20150722	0	0	0	0	0	0	0	0
Mullinix	20150805	0	0	0	0	0	0	0	0
Tower	20150709	0	0	0	0	0	0	0	0
Tower	20150722	0	0	6	0	0	0	0	6
Tower	20150729	0	0	2	0	0	0	0	2
Woodrun	20150708	0	0	0	0	0	0	0	0
Woodrun	20150721	0	0	0	0	0	0	0	0
Woodrun	20150729	0	0	0	0	0	0	0	0
Not-a-transect	20150708	5	0	11	0	0	4	0	20
Not-a-transect	20150709	3	0	12	0	0	0	0	15
Not-a-transect	20150710	0	0	5	0	0	0	0	5
Not-a-transect	20150721	2	0	13	0	3	4	0	22
Not-a-transect	20150722	0	0	10	0	0	0	0	10
Not-a-transect	20150729	0	0	13	0	0	0	0	13
Not-a-transect	20150805	0	0	23	0	0	0	0	23
Not-a-transect	20150817	0	0	7	0	0	0	1	8
Not-a-transect	20150827	0	0	7	0	0	4	2	13
Total	n/a	10	0	254	0	3	20	7	294

TABLE 10. MYOTIS FILE IDENTIFICATIONS AGREED ON BY BOTH BCID AND ECHOCLASS IN 2014 AND 2015.

Data were collected during 2014 and 2015 using Anabat detectors. The location of each transect can be found in Figure 11. Files listed are those files identified by both BCID and EchoClass as *Myotis* species. Call notes are summaries of opinions on the echolocation passes from both authors of the report.

Call file name	Year	Species ID	Transect name	Notes
O8062111.33	2014	MYGR	Flint Hill	Short fragment
O8142245.25	2014	MYGR	Coggins Mine	Short fragment - low frequency
O7252147.49	2014	MYLU	Tower Rd	Long good quality call
O7292202.52	2014	MYLU	Woodrun	Poor quality call
O8222055.18	2014	MYLU	Flint Hill	Poor quality call
P8272302.36	2015	MYGR	Badin Lake	Short fragment - low frequency
P8172152.58	2015	MYSE	No transect information	Short fragment
P7092254.40	2015	MYLU	Mullinix	Poor quality call
P7212142.28	2015	MYLU	Lovin Hill	Long call
P7212149.00	2015	MYLU	Lovin Hill	Good quality call
P7222352.50	2015	MYLU	No transect	Long call
P7292350.26	2015	MYLU	No transect	Short fragment

FIGURES

FIGURE 1. MIST NET (AND TROY DEPOT) LOCATIONS. Study locations in the Uwharrie National Forest and surrounding areas in 2014 and 2015. Locations are plotted as the representative site within location (either the center of multiple sites or one of two sites). Names of locations and data types collected at each location are found in Table 1.

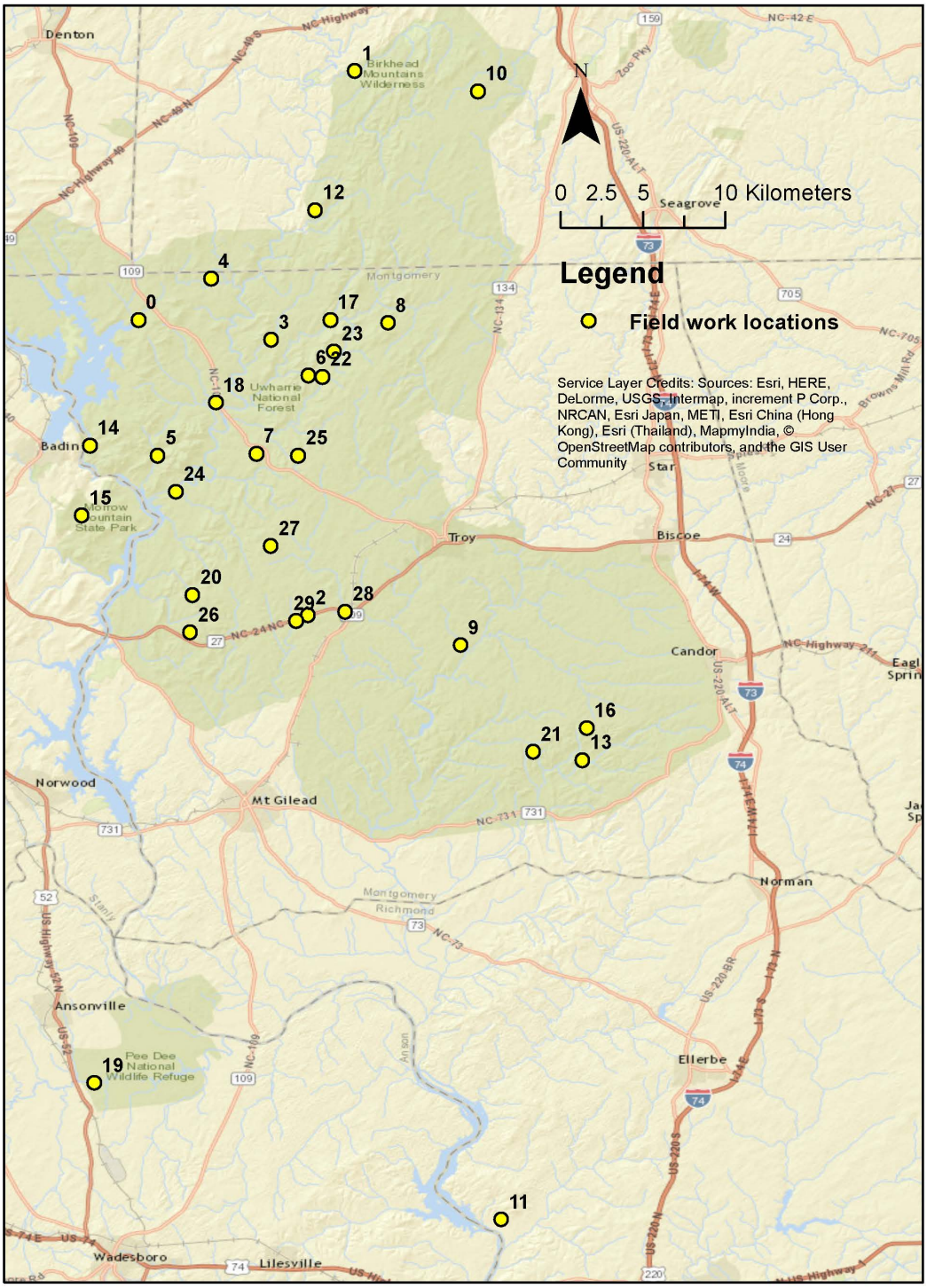


FIGURE 2. TOTAL NUMBER OF BATS OF EACH SPECIES CAPTURED AT MIST-NET LOCATIONS. Total number of bats captured in mist netting surveys by site in the Uwharrie National Forest and Surrounding areas in 2014 and 2015. Locations are ordered alphabetically. Species acronyms: *Perimyotis subflavus* (PESU), *Nycticeius humeralis* (NYHU), *Lasiurus borealis* (LABO), *Eptesicus fuscus* (EPFU).

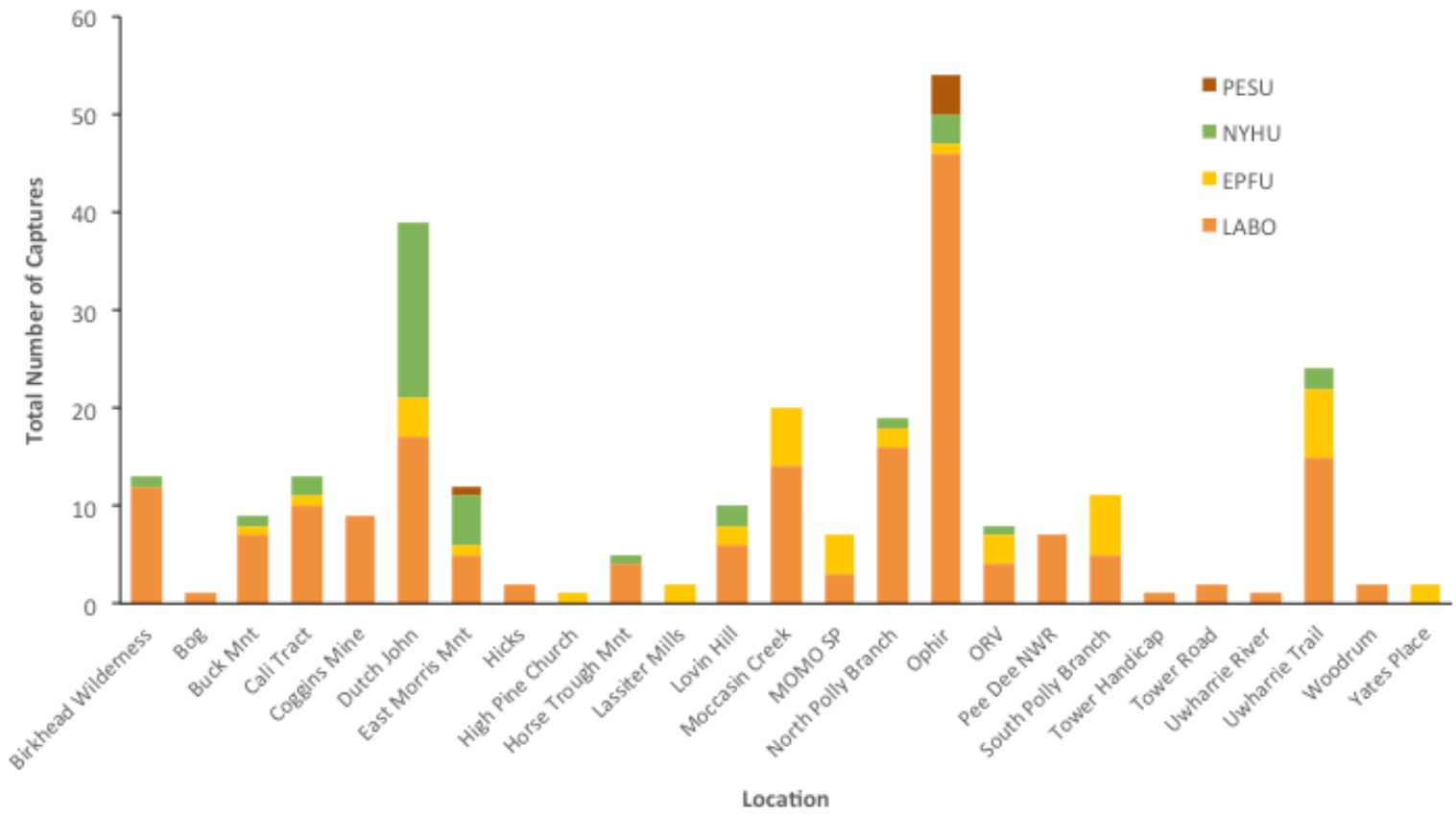


FIGURE 3. STANDARDIZED BAT CAPTURES AT MIST NET LOCATIONS. Total number of bats captured in mist netting surveys by site in the Uwharrie National Forest and Surrounding areas in 2014 and 2015 divided by the number of nights spent at each location.

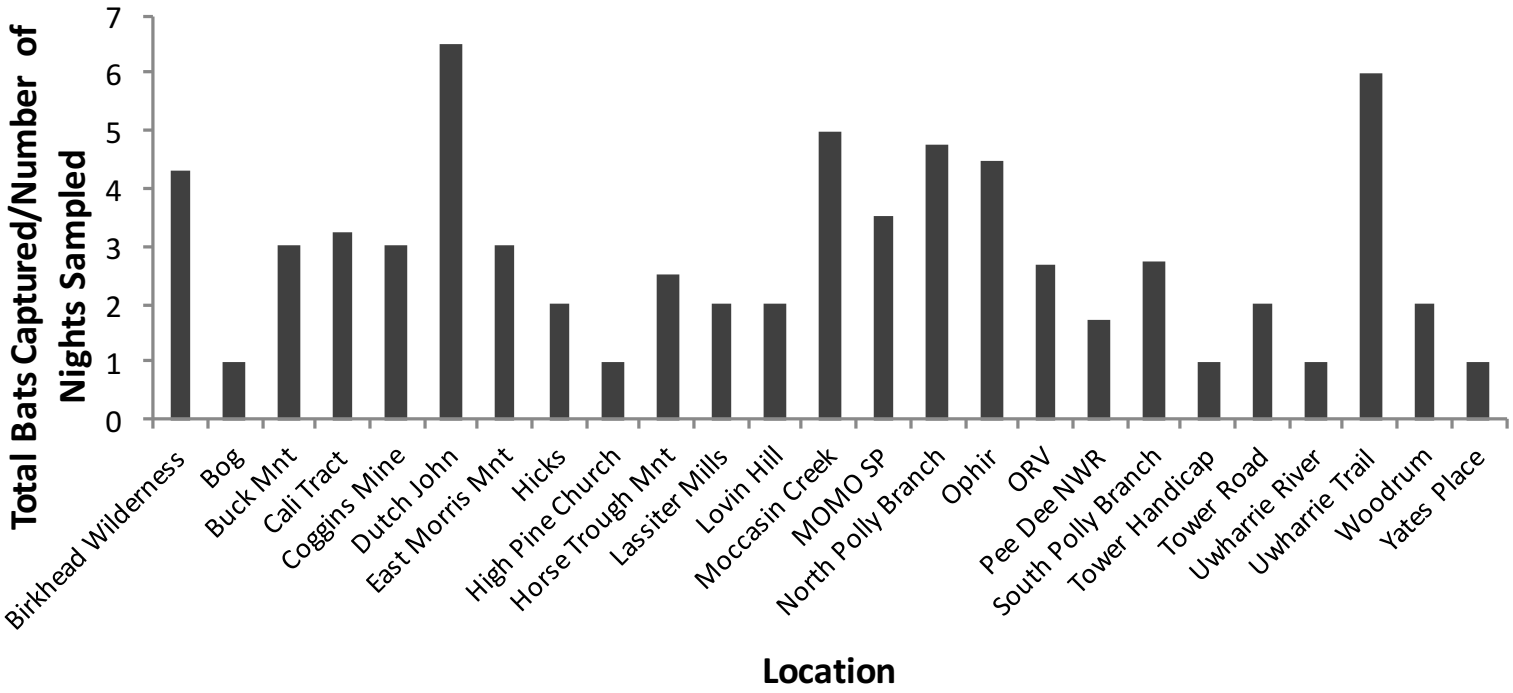


FIGURE 4. AVERAGE MLE VALUES OF IDENTIFIED BAT ECHOLOCATION PASSES AT MIST NET LOCATIONS. Average MLE across nights with MLE <1 from all high quality recordings at mist-net locations in the Uwharrie National Forest and surrounding areas in 2014 and 2015. Recordings were made on 50 nights from 14 locations in each year. MLE estimates of presence are indicated by nearness to zero. Two files identified as MYLU checked by the the first author and deemed to not belong to MYLU are not included. Species acronyms: *Perimyotis subflavus* (PESU), *Nycticeius humeralis* (NYHU), *Lasiurus borealis* (LABO), *Eptesicus fuscus* (EPFU), *Lasionycteris noctivagans* (LANO), *Tadarida brasiliensis* (TABR), and *Lasiurus cinereus* (LACI).

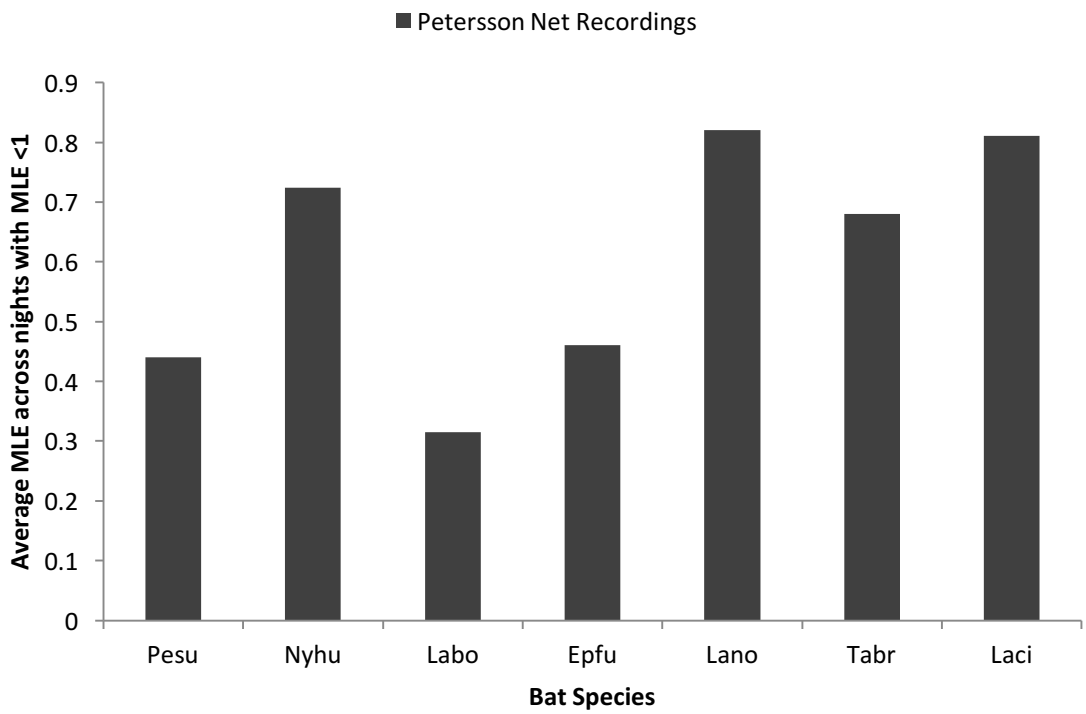


FIGURE 5. PROPORTION OF NIGHTS IN EACH SEASON WITH MLE VALUES FOR SPECIES OF <1. Recordings were made with and SM2+ detector at the NCWRC Troy Depot from 11 June 2013 to 3 Nov 2015. Number of nights per season are: Winter = 111, Spring = 146, Summer = 169, Fall = 163). Species acronyms: *Myotis lebii* (MYLE), *Myotis septenrtionalis* (MYSE), *Myotis lucifugus* (MYLU), *Corynorhinus rafinesquii* (CORA), *Perimyotis subflavus* (PESU), *Nycticeius humeralis* (NYHU), *Lasiurus borealis* (LABO), *Eptesicus fuscus* (EPFU), *Lasionycteris noctivagans* (LANO), *Tadarida brasiliensis* (TABR), and *Lasiurus cinereus* (LACI).

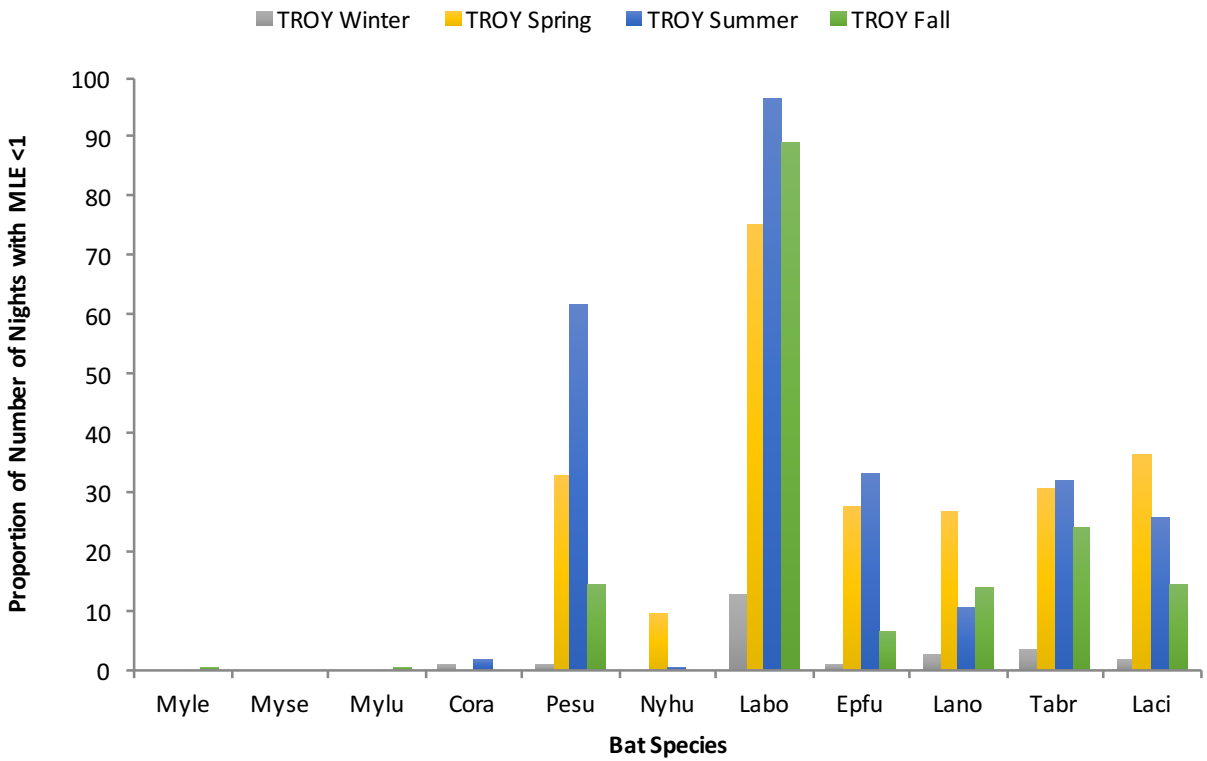


FIGURE 6. NUMBER OF TOTAL NIGHTS IN EACH SEASON WITH MLE VALUES FOR SPECIES OF <1. Recordings were made with and SM2+ detector at the NCWRC Troy Depot from 11 June 2013 to 3 Nov 2015. Species acronyms: *Perimyotis subflavus* (PESU), *Nycticeius humeralis* (NYHU), *Lasiurus borealis* (LABO), *Eptesicus fuscus* (EPFU), *Lasionycteris noctivagans* (LANO), *Tadarida brasiliensis* (TABR), and *Lasiurus cinereus* (LACI). We are not including species for which the proportion of nights with MLE<1 was lower than 2% (see Fig 5).

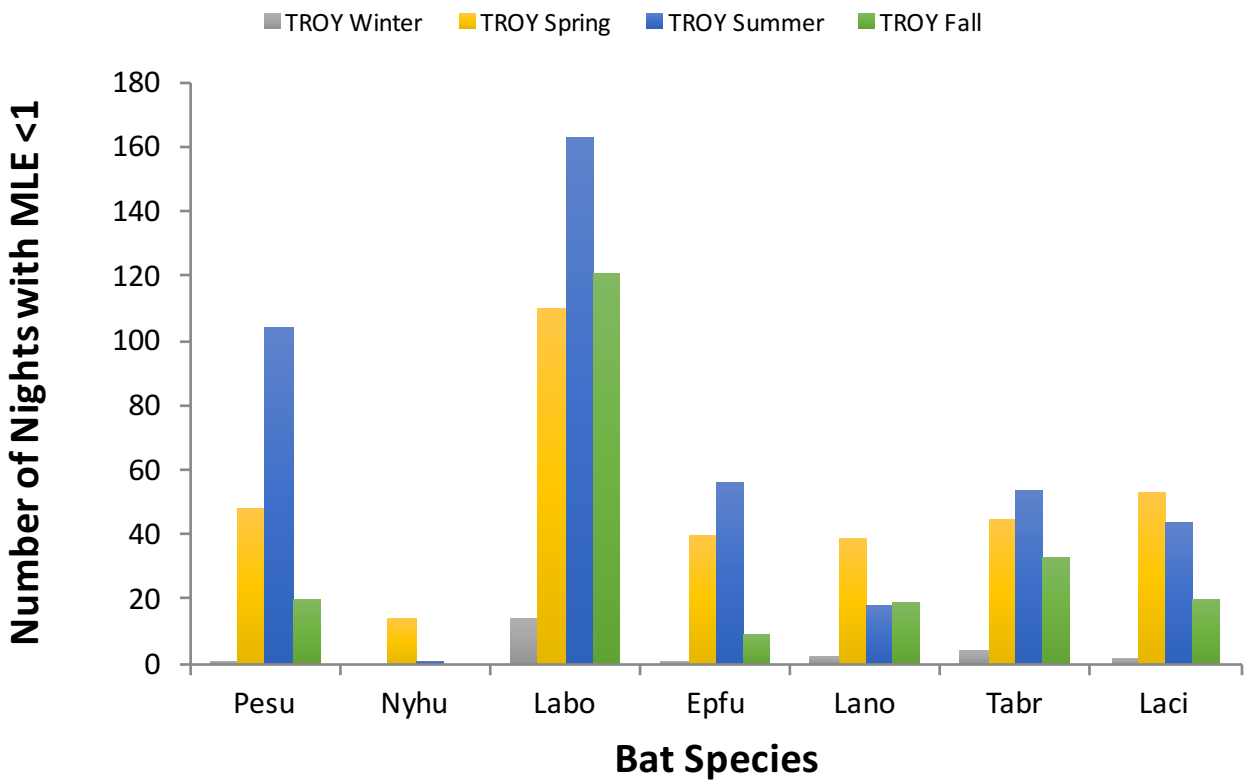


FIGURE 7. NUMBER OF TOTAL NIGHTS IN EACH SEASON WITH MLE VALUES FOR SPECIES OF <0.05. Recordings were made with and SM2+ detector at the NCWRC Troy Depot from 11 June 2013 to 3 Nov 2015. Species acronyms: *Perimyotis subflavus* (PESU), *Nycticeius humeralis* (NYHU), *Lasiurus borealis* (LABO), *Eptesicus fuscus* (EPFU), *Lasionycteris noctivagans* (LANO), *Tadarida brasiliensis* (TABR), and *Lasiurus cinereus* (LACI).

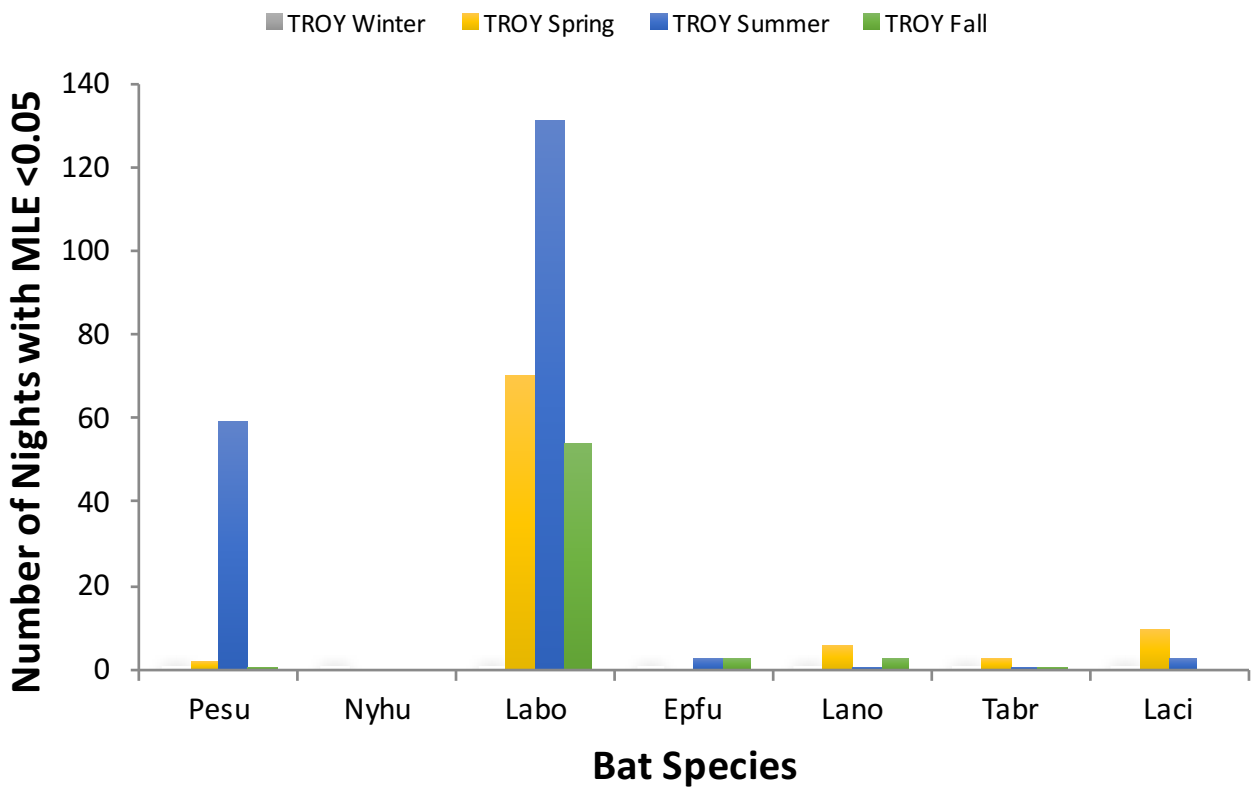


FIGURE 8. AVERAGE MLE VALUES OF IDENTIFIED BAT ECHOLOCATION PASSES AT MIST NET LOCATIONS AND THE TROY DEPOT. Average MLE across nights with MLE <1 from all high quality recordings at mist-net locations in the Uwharrie National Forest and surrounding areas in 2014 and 2015. MLE estimates of presence are indicated by nearness to zero. Species acronyms: *Perimyotis subflavus* (PESU), *Nycticeius humeralis* (NYHU), *Lasiurus borealis* (LABO), *Eptesicus fuscus* (EPFU), *Lasionycteris noctivagans* (LANO), *Tadarida brasiliensis* (TABR), and *Lasiurus cinereus* (LACI).

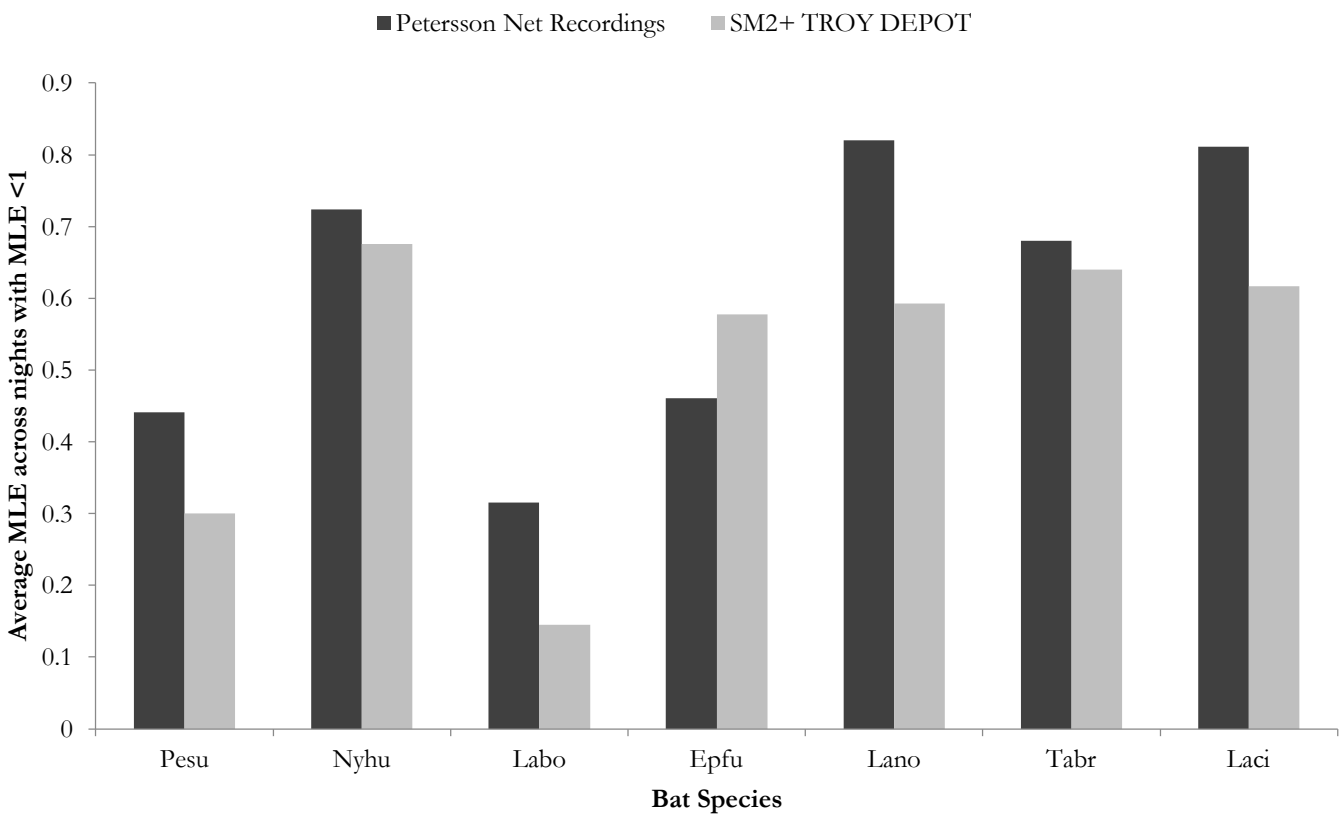
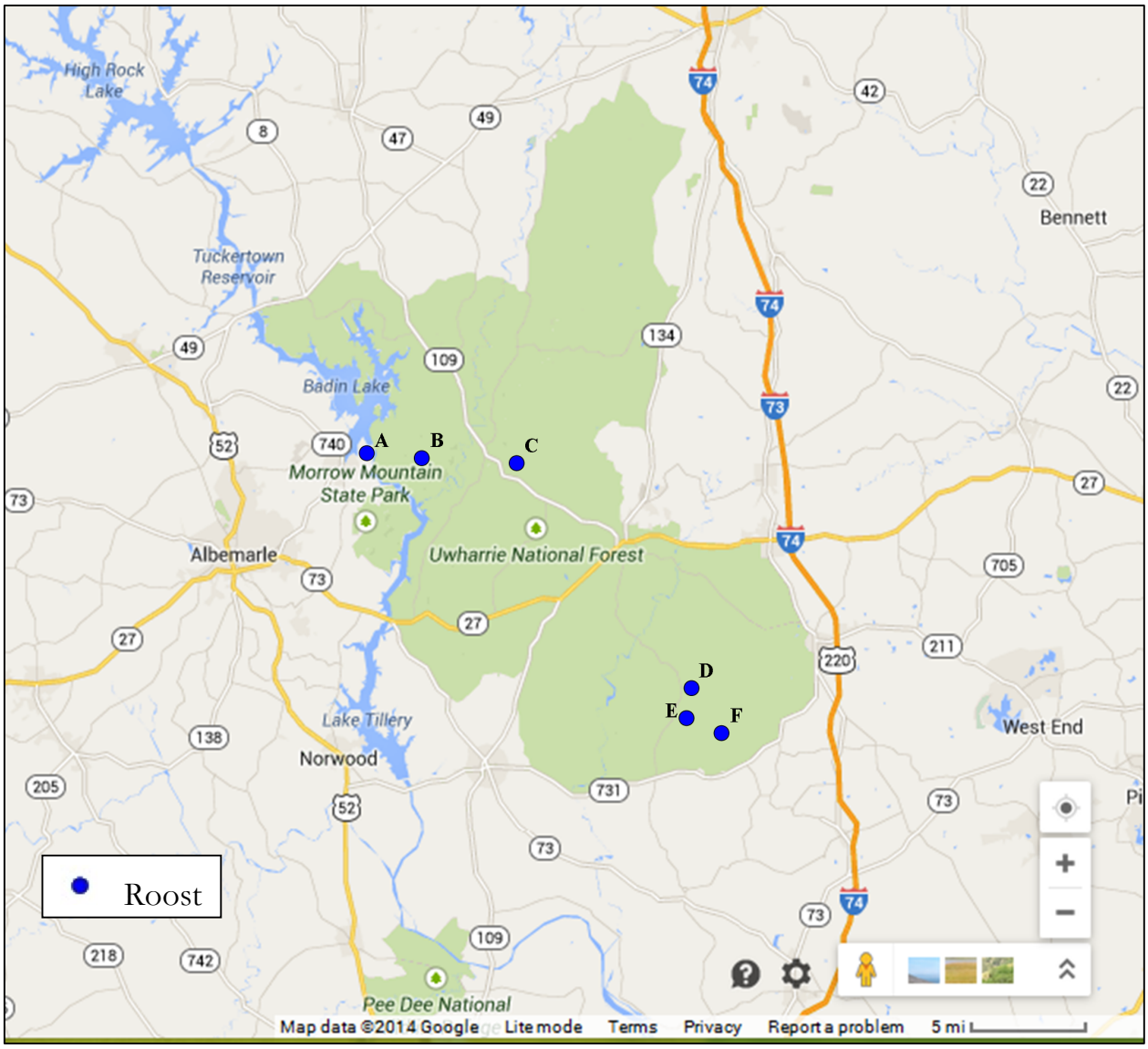


FIGURE 9. LOCATION OF BAT ROOST TREES IN THE UWHARRIE NATIONAL FOREST. Created using Google Maps ©2014, by Kristy King. Each blue circle represents a roosting area (a cluster of roost trees in the same area). Each area is expanded in the Google Earth images that follow. Depending on location, roosts include either *Nycticeius humeralis* or *Eptesicus fuscus* and the net sites where bats were caught is indicated. The first letter (E or N) represents the species, the second number represents a unique individual, "R" stands for roost, and the fourth letter represents a unique roost.

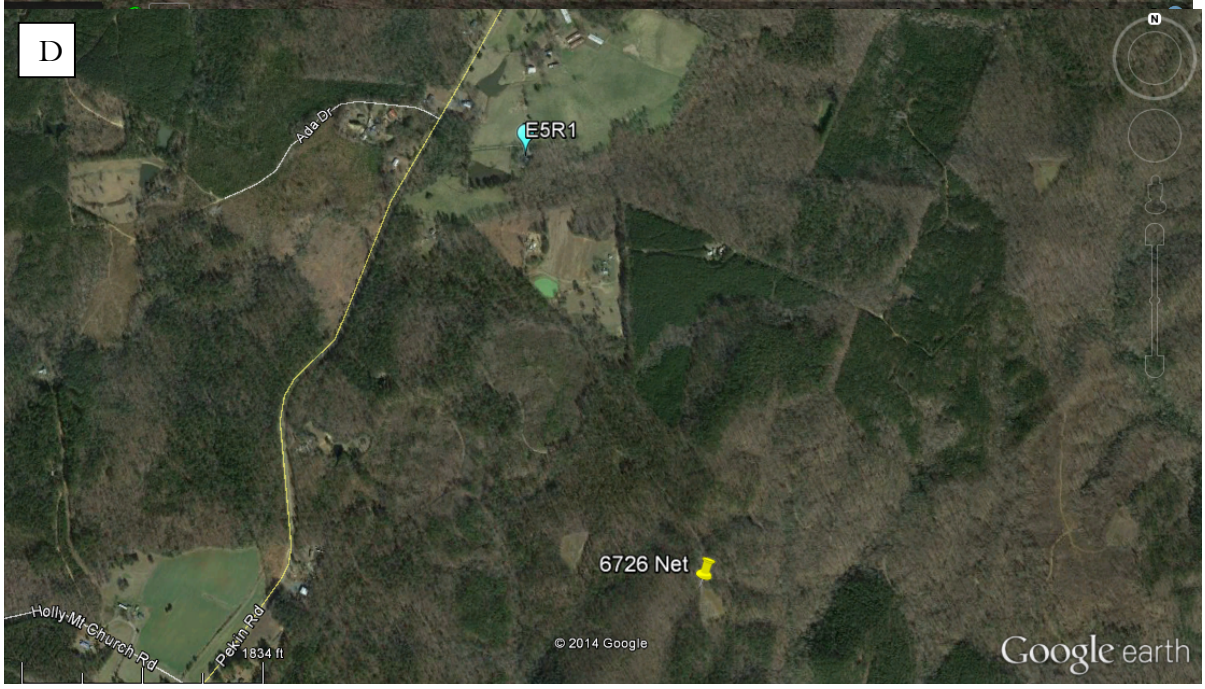


A
Moccasin Rd Net
E1R1
Poplar St
Elm St
Cedar St
Boyden St
Maple St
Spruce St
Falls Rd
Moccasin Creek Rd
740
1683 ft
© 2014 Google
Google earth
B
Dutch John Rd Net
N1R2
N1R1
N2R2
N2R4
N2R1
N2R3
Dutch John Rd
1504 ft
© 2014 Google
Google earth

C

Uwharrie Trail Rd Net
N4R1
N4R4
N4R2
N4R5
N4R3
737 ft
© 2014 Google
Google earth

D


Ada Dr
E5R1
6726 Net
Holly Mt Church Rd
Pekin Rd
1834 ft
© 2014 Google
Google earth

E

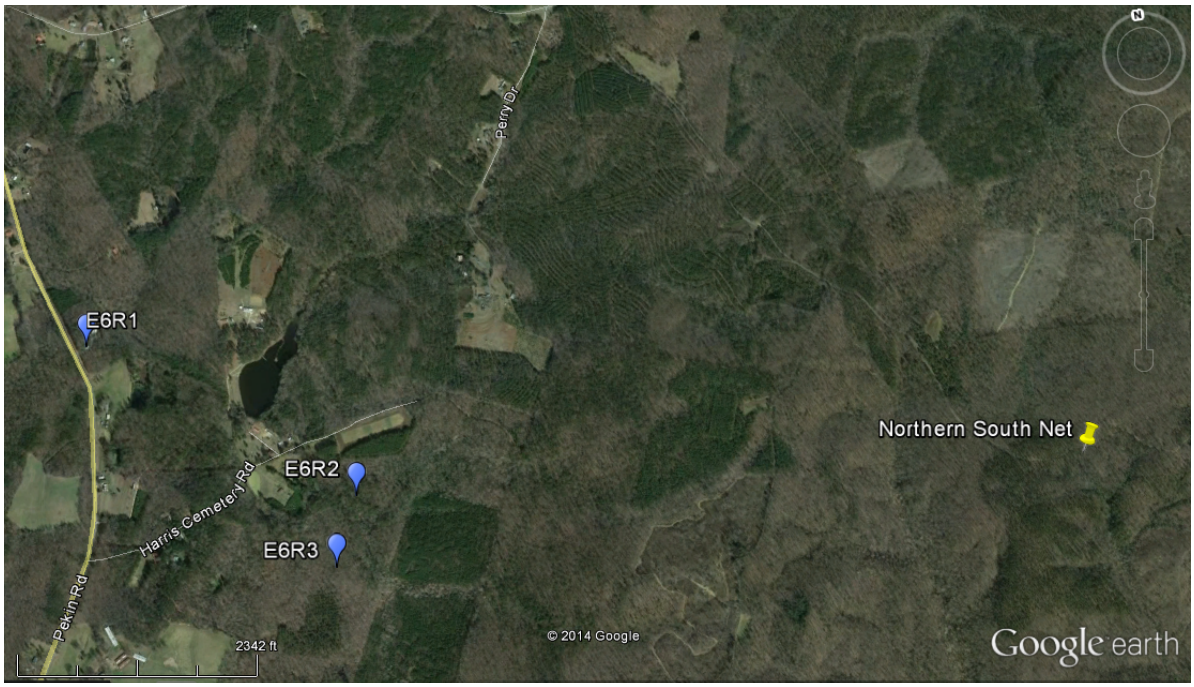

E6R1
E6R2
E6R3
Northern South Net
Perry Dr
Harris Cemetery Rd
Pekin Rd
2342 ft
© 2014 Google
Google earth

FIGURE 10. PHOTOGRAPHS OF EXAMPLE EVENING BAT (*NYCTICEIUS HUMARILS)* ROOST TREES IN THE UWHARRIE NATIONAL FOREST. In order from left to right (see Table 7 for details): N1R1, N1R2, N2R1, N2R4, N3R1. Note that N2R1 and N3R1 are live while the others are snags. All photos by K. King.

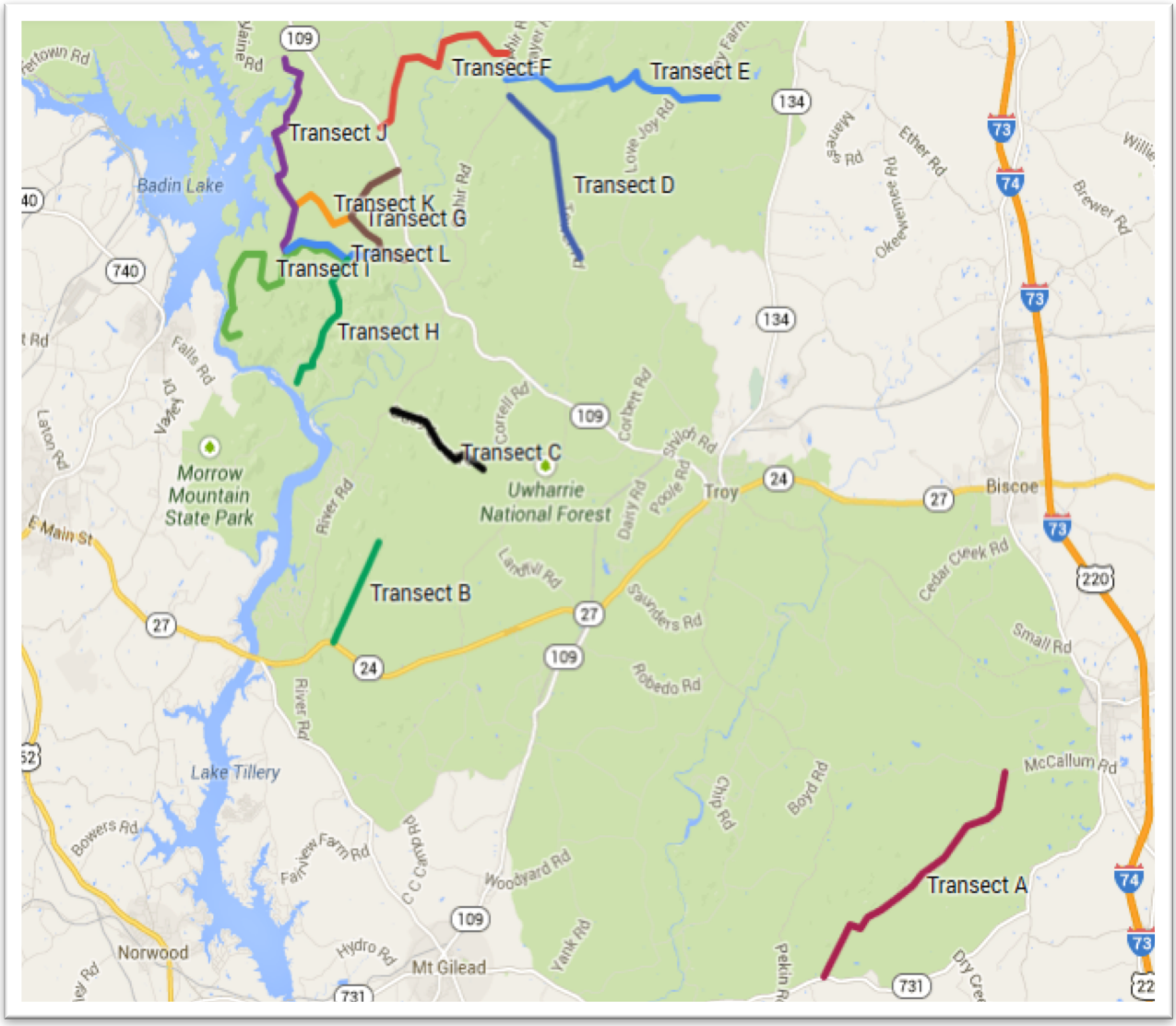



FIGURE 11. LOCATION OF DRIVING TRANSECTS IN THE UWHARRIE NATIONAL FOREST. [Reproduced from Figure 2 in Pittaway and Kalcounis-Rueppell 2014]. Created using Google Maps ©2014, by Lee H. Pittaway. All routes drawn in this figure were drawn on 02/19/2014 from hand drawn records written by Kacy Cook NCWRC. Each line is identified with an alphabetic location marker determined by transect datasheets and the original paper map that was provided. Recordings took place during each year: 2009, 2010, 2011, 2012, and 2013. A=Lovin Hill, B=Woodrun, C=Dusty Level, D=Tower Road, E=Flint Hill, F=Coggins Mine Rd., G=Mullinix, H=Mocassin-Dutch John, I=Mocassin-Deep Water, J=Badin Road, K=Mullinix to McLean, L=Moccasin Creek.