Analysis of echolocation calls to measure bat species populations of Massachusetts

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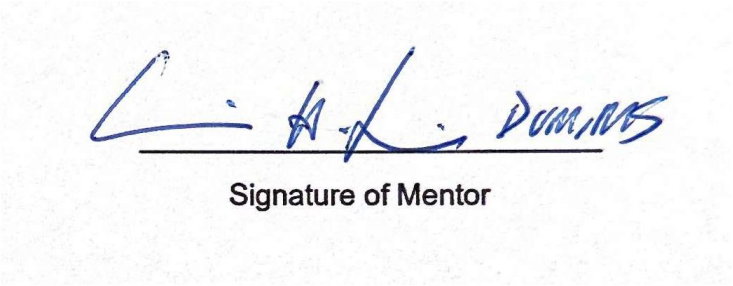

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Abstract

White-nose syndrome and wind turbines have caused major population declines of insectivorous bat species of North America. Conservational efforts are made to preserve the remaining bat populations. Among these conservational efforts is monitoring population trends. NaBat is a national conservational monitoring program that has set up standard protocols to measure U.S. bat population trends. This program organizes North American into grids cells. In this study, we implement the protocols outlined in NaBat to measure population density and abundance of bat species within the Carlisle, MA and Westford, MA grids. Driving surveys and stationary monitors were performed according to NaBat standards to measure abundance and density, respectively. Non- migratory species (Big and Little Brown bats) measured lower in abundance than migratory species (Silver-haired and Hoary) on driving surveys. Westford grids measured higher in species diversity overall than Carlisle grids on stationary monitors. Differences in diversity and abundance between stationary and driving surveys highlight the importance of multifaceted monitoring in capturing complete population statuses. Recovery efforts are dependent on continuous monitoring of population status and trends. Next steps with this study are to upload our data to the NaBat database to contribute to their conversational efforts and to continue annual monitoring of population trends. More work needs to be done to help conserve declining bat populations.

1. Introduction

Insectivorous bats play an important role in our ecosystem and play a role in regulating populations of nocturnal insects. However, White-nose syndrome and wind energy have threatened populations of bat species. White nose is a fungal disease caused by *Pseudogymnoascus destructans* that affects hibernating insectivorous bats in caves and mines. The fungus grows on their skin, effecting their hydration and essential fat reserves, leading to starvation and death. Millions of bats have succumbed to this fungus, greatly affecting population density and abundance. There is no current cure for White nose, so conservational efforts are focused on supporting populations through typical conservation measures of protecting habitat. Additionally, wind turbines have caused the deaths of thousands of bats in North America. While the reasons to why bats are attracted to wind turbines is still unknown, their effects are seen in populations trends. (1,7,8)

Conservational efforts have played an essential role in the management and protection of declining bat species. An important aspect of conservation is through continuous monitoring of population trends. Population abundance and density can be measured through acoustic monitoring of bat's ultrasonic echolocation calls. In this study we examine population trends of Massachusetts bat species.

There are 9 species of bats that live in Massachusetts. Non-migratory bat species of Massachusetts include the Big Brown, Little Brown, Tri-Colored, Northern Long-Eared, Indiana,

Eastern-small footed bats. These bats roost in trees and buildings during the summer months and hibernate in caves and mines during the winter months. Of these 6 species, only the Big Brown is not considered endangered. Migratory species of Massachusetts include the Silver-haired, Hoary, and Eastern Red bats. During the summer months they roost in trees in Massachusetts and migrate to warmer climates during the winter months. (2, 4)

NaBat is a national conservational monitoring program that has set up standard protocols to measure U.S. bat population trends. Species diversity (via stationary monitors) and abundance (via driving surveys) can be measured through acoustic monitoring of bat's ultrasonic echolocation calls. The objective of our experiment is to measure abundance and diversity of native Massachusetts bat species using NaBat protocols. (5,6)

2. Methods and Materials

2.1 Study Areas

Our study was located in the towns of Carlisle and Westford Massachusetts and surveys were performed during the month of June 2023. We selected two routes for our driving surveys ranging from 17.5 miles for the Carlisle survey and 20.1 for the Westford survey in length (Figure 1 and Figure 2).

2.2 Stationary monitors

Figure 1

Location of the Carlisle, MA stationary monitor and route sampled during June 2023 using variations on the NaBat bat survey protocol

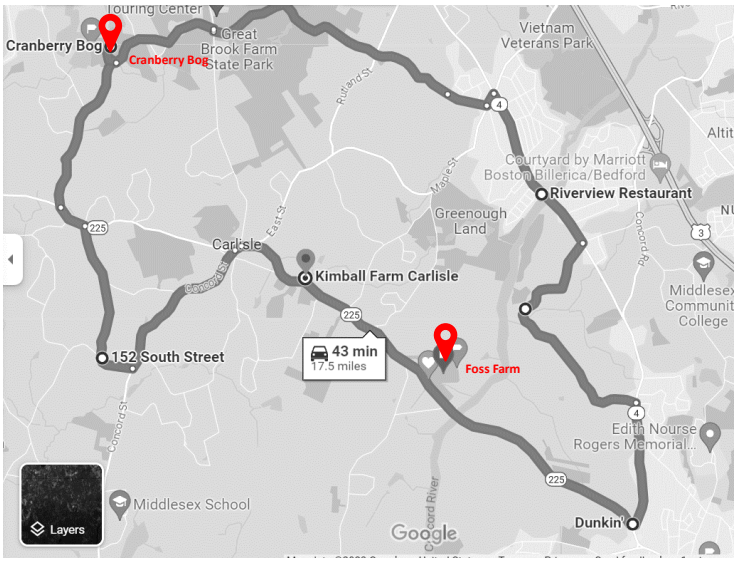
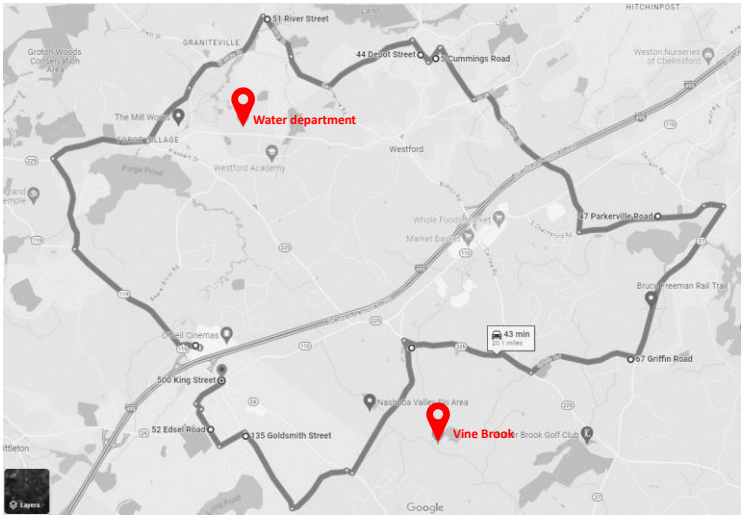


Figure 2

Location of the Westford, MA stationary monitors and route sampled during June 2023 using variations on the NaBat bat survey protocol.



Microphones were connected to a Wildlife Acoustics Song Meter SM4BAT FS bioacoustics recorder and attached to a pole measuring about 4 meters high. Microphones were set to record from sunset to sunrise for 2 weeks at each location during the month of June 2023. Recording equipment was stabilized with metal stakes and rope to anchor into the ground. The stationary monitoring system can be seen in Figure 3.

Figure 3

Stationary monitor set-up

Stationary monitors deployed to detect species diversity in two separate grids: Carlisle, MA and Westford, MA. Each grid was separated into 2 locations being the Cranberry bog Conservation and Foss Farm for the Carlisle grid and the Water Department well field and Vine Brook trail for the Westford grid.

Recordings were stored on SD cards inserted into the Wildlife Acoustics recorders and were uploaded to a secure cloud storage system once per week during the 2-week recording interval for each location.

2.3 Driving surveys

Driving surveys were conducted on clear nights with no rain and low windspeed between 11 June and 29 June 2023 once a week for 2 weeks simultaneously in Carlisle and Westford MA. Driving routes were done on two-laned roads that were mostly paved and a speed of 20mph was maintained throughout the collection period. Echolocation calls were recorded in real time using the Echo Meter Touch 2 Module and Car Bracket mounted outside onto the roof of a vehicle. The module was connected to a smartphone with the Echo Meter Touch Bat Detector mobile application. Driving began when the Echo Meter application was set to “Record,” and stopped as soon as the application was set to “Stop Recoding.” Surveys began approximately 20 minutes before sunset and ran for approximately 1 hour.

2.4 Data analysis

Recordings collected from the stationary monitors were analyzed using NaBat Kaleidoscope Pro software system to inspect the quality of the call recording and identify the species of each call.

Recordings collected from the driving surveys were automatically analyzed in real time with the Echo Meter Touch Bat Detector mobile application and was later manually verified to assess quality of the call.

3. Results

3.1 Stationary monitors

Total calls per species and species diversity results recorded by stationary monitors at each of the two locations from the Carlisle and Westford grids are shown in Tables 1-4 and Figures 4-7, respectively. It can be seen that there was a higher recorded species diversity in both locations of the Westford grid compared to locations of the Carlisle grids.

Table 1: Total calls by species recorded by stationary monitor at the Cranberry bog conservation in Carlisle, MA grid from 6/8/2023 to 6/11/2023

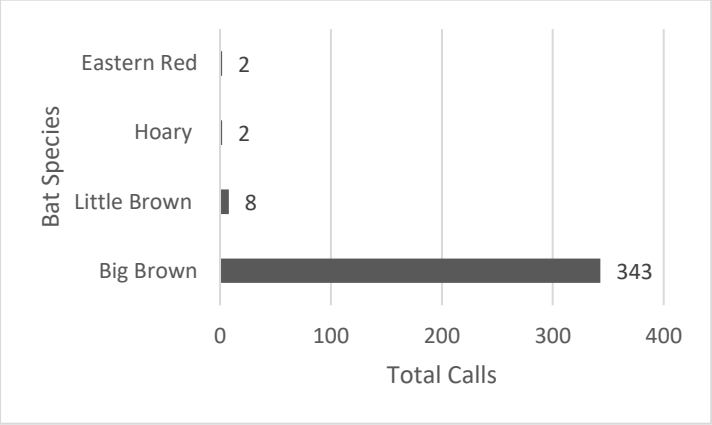


Figure 4: Proportion of calls by species from stationary monitor at Cranberry bog conservation in Carlisle, MA grid from 6/8/2023 to 6/11/2023

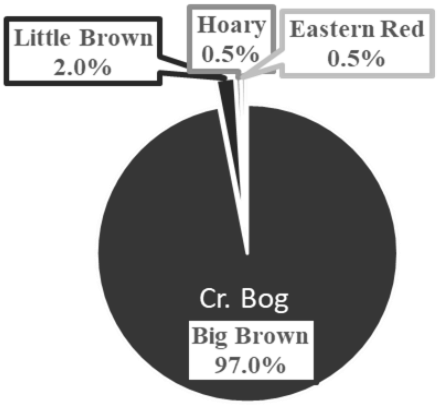


Table 2: Total calls by species recorded by stationary monitor at Foss Farm in Carlisle, MA grid from 6/8/2023 to 6/11/2023.

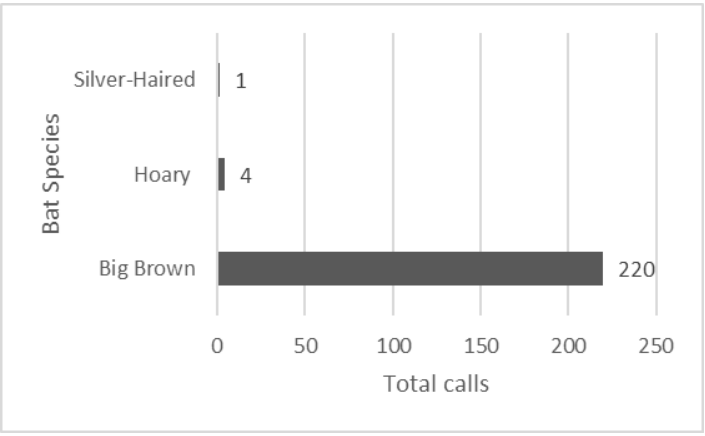


Figure 5: Proportion of calls by species from stationary monitor at Foss Farm in Carlisle, MA grid from 6/8/2023 to 6/11/2023.

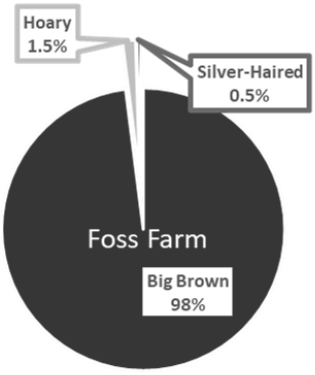


Table 3: Total calls by species recorded by stationary monitor at the Vine Brook trail in Westford, MA grid from 6/21/2023 to 6/24/2023

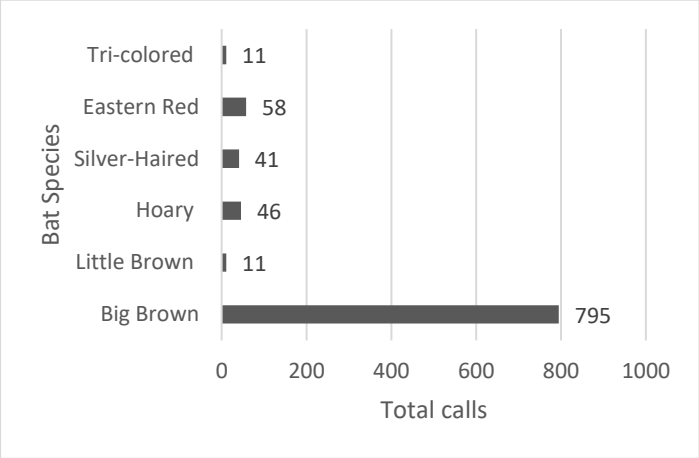


Figure 6: Proportion of calls by species from stationary monitor at the Vine Brook trail in Westford, MA grid from 6/21/2023 to 6/24/2023

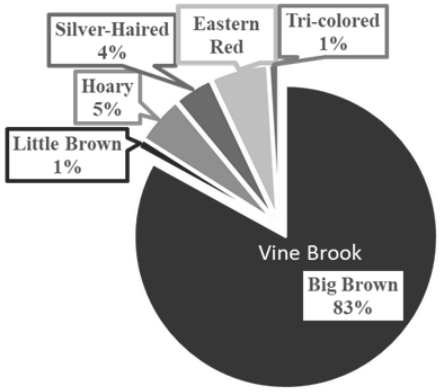


Table 4: Total calls by species recorded by stationary monitor at the water department well field in Westford, MA grid from 6/21/2023 to 6/24/2023

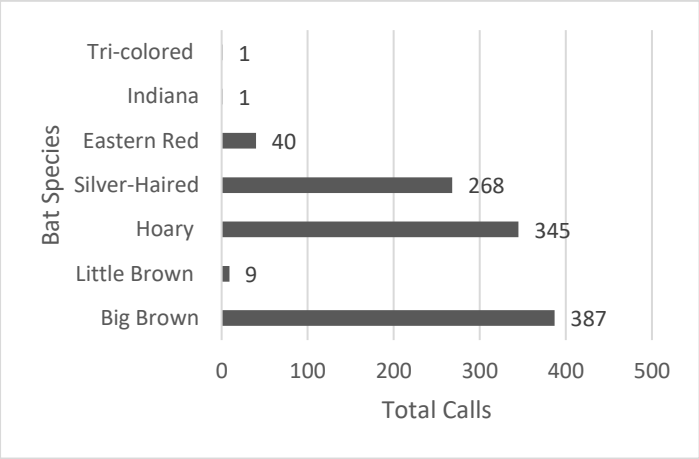
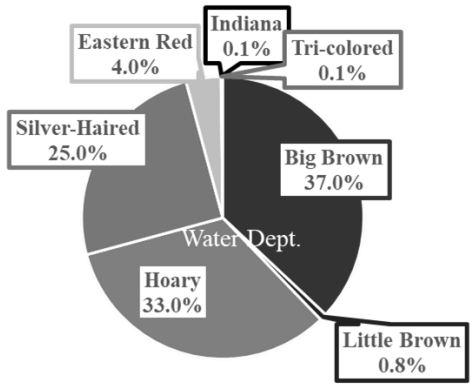


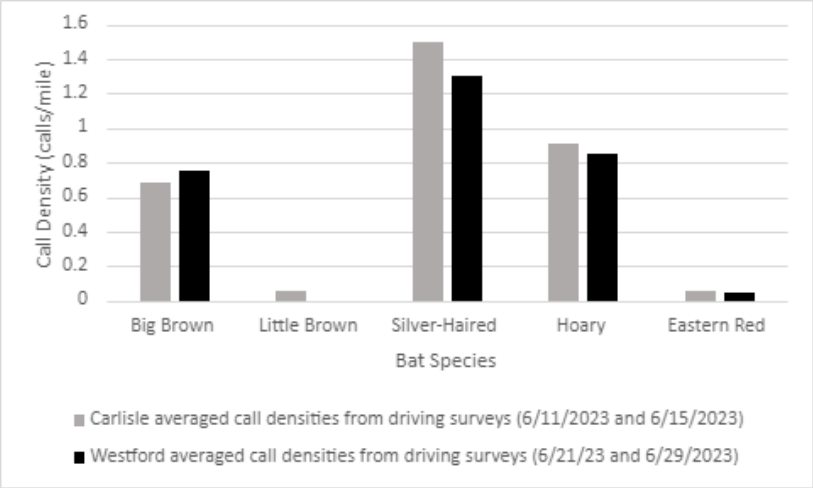
Figure 7: Proportion of calls by species from stationary monitor at the water department well field in Westford, MA grid from 6/21/2023 to 6/24/2023



3.2 Driving survey

Two driving surveys were conducted on each of the Carlisle and Westford routes. Call density was calculated for each of the two driving surveys by dividing the total number of calls detected for each species by the total mileage of each route. For each species, the calculated call density from the two surveys were averaged. This was done for both the Carlisle and Westford routes. The comparison between these averages is shown in Table 5. Abundance recorded of the migratory species Silver-haired and Hoary was higher than the non-migratory species Big and Little brown bats.

Table 5: Averaged call density between Carlisle and Westford, MA driving surveys



4. Discussion

Driving surveys in total recorded 5 species whereas stationary monitors collected more. This is because stationary monitors were set out for longer periods of time in a single location. We did set out the stationary monitors for longer periods of time than presented in this report and we got bat species that were not captured in this four-day period. This shows us that the longer you monitor the more likely you are to measure rare species. Additionally, the highest proportion of calls from the driving surveys were identified as the migratory species Silver-Haired and Hoary, whereas with the stationary monitors most of the calls were identified as the non-migratory Big Brown. This could be due to the effects of White Nose on non-migratory species populations. However, confounding variables for this finding could be population differences in the locations we performed our driving surveys and time of day they were performed at compared to other possible locations/times. Westford grids measured higher in species diversity overall than Carlisle grids on stationary monitors. This could be due to differences in the natural habitats, human density, proximity to major roads, or insect density that could make one area more habitable than others. (3) For our Westford locations, the Water Department and Vine Brook trails had a forested wetland habitat. Conversely, for our Carlisle locations, the Cranberry bog and Foss Farm had a field/forest edge habitat. Differences in these habitat types could have effects on habitability and insect density, which could influence the bat populations.

Differences in diversity and abundance between the stationary and driving surveys highlight the importance of multifaceted monitoring in capturing complete population statuses. Recovery efforts are dependent on continuous monitoring of population status and trends.

Next steps with this study are to upload our data to the NaBat database to contribute to their conversational efforts and to continue annual monitoring of population trends. More work needs to be done to help conserve declining bat populations. As an insectivorous animal, they play an important role in the balance of our ecosystem. Future studies should include longer survey times and wider distribution surveyed areas.

6. Conflicts of Interest

None declared.

7. Acknowledgements

We thank Tufts Cummings School of Veterinary Medicine and the Wildlife Clinic for their support.

8. References

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