Acoustic identification of Chiroptera species in eastern Suffolk County and Brookhaven National Laboratory using full spectrum call analysis.

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Abstract

First discovered in Albany, New York in 2006, white-nose syndrome (WNS) has decimated bat populations throughout North America. WNS is caused by the cold-loving fungus *Pseudogymnoascus destructans*, which is native to Europe. Nine species of Chiroptera are known within New York State, 6 of which winter in caves. It is believed that *P. destructans* arouses these bats from torpor at inappropriate times, leading to a depletion of their fat-stores and causing death by starvation.

Acoustic surveys were conducted in eastern Long Island in coordination with Brookhaven National Laboratory (BNL) and the New York State Department of Environmental Conservation (NYSDEC) in order to note trends among bat populations as a result of WNS. Ultrasonic bat calls were recorded along 4 different routes using a car-mounted microphone and the unique frequency of "search phase" calls used to identify the species of bat. Of the 6 species recorded, most prevalent were 2 species, the big brown bat (*Eptesicus fuscus*) and the eastern red bat (*Lasiurus borealis*), composing 83% of calls recorded. The data collected were compared with 2 previous years of collected data and indicated a substantial decrease in *E. fuscus* and increase in *L. borealis.*

Acoustic surveys were also conducted within BNL in order to determine differences between the solar farm and a recently burned forest when compared to a control site. This research is helping to get a better idea of population trends and niche changes as WNS spreads across America.

Introduction

Chiroptera is the second most numerous order of mammals, composed of nearly 1,300 species commonly referred to as bats. Chiropterans are the only mammals capable of true flight and may travel distances of up to 50 km a night to forage, consuming nearly 50% of their body weight in insects per night.[I] As one of the few nocturnal predators of

flying insects, they provide pest-control services valued as high as 53 billion dollars that save crops and help to control the spread of insect-borne diseases.[II]

In 2006, a psychrophilic fungus commonly referred to as white-nose syndrome, recently reclassified from *Geomyces destructans* to *Pseudogymnoascus destructans*, was found within hibernacula in upstate New York.[III,IV] Since that time, WNS has spread throughout the United States and killed over 5.7 million bats.[V] *P. destructans* is thought to be a novel pathogen from Europe and is only associated with the mortality of North American bats. Injections of both the American and European strains of *P. destructans* to *Myotis lucifugus* resulted in WNS infection, leading to hyper-arousal and eventually mortality.[VI] WNS infects the wing, ear, tail and muzzle tissue of hibernating cave bats, destroying tissue and increasing arousal from torpor to once every 10-20 days to as often as every 3-4 days.[VII] This quickly depletes the fat stores of these animals and can force them to forage during the winter months when the cold and low availability of insects become lethal.[VIII]

Forty-seven species of Microchiropterans are found in the United States, 9 of which are found within New York State.[IX] Of these, 3 species are tree bats which over-winter in hollow trees or migrate south.[X] The tree bats, *Lasiurus borealis* (eastern red bat), *Lasiurus cinereus* (hoary bat) and *Lasionycteris noctivagans* (silver-haired bat) generally have more than one offspring per year and are less susceptible to WNS due to their roosting habits.[XI] These 3 species migrate south for the winter, with *L. borealis* roosting solitarily, using its furred tail membrane for insulation. *L. cinereus* may travel further south, often avoiding hibernation entirely and foraging within the tropics, while *L.*

noctivagans hibernates in small clusters within the southern United States in rock crevices and trees.[XII]

Cave bats are easily distinguished from tree bats due to the lack of fur on their tail membranes and their tendency to spend the winter hibernating in caves.[XIII] Of the 6 species of cave bats found in New York, 5 have been drastically reduced in number due to WNS. Populations of *Myotis lucifugus* (little brown bat), *Perimyotis subflavus* (tri-colored bat) and *Myotis septentrionalis* (northern long-eared myotis) have all declined by over 90%. *Myotis sodalis* (Indiana bat) numbers have decreased by 71% and *Myotis leibii* by 13%.[XIV] *Eptesicus fuscus* (big brown bat) is typically found in small numbers but is rarely sighted with WNS.[XV] Since these species typically only bear 1 offspring per year, these populations are in dire shape without immediate conservation initiatives.[XVI]

Of the 5 initially infected hibernacula, 3 have shown increases in *M. lucifigus* numbers but it is unclear if this growth is due to integration of new bats to the area or reproductive success of the colonies.[XVII]

The purpose of this study was to continue ongoing population surveys within eastern Long Island in order to note any population trends among Chiropteran species as a result of WNS. We hypothesized that a continued decline in cave bat species would lead to an increase in tree species as more resources, such as habitat and obtainable food, became available. This study also provided a preliminary look at bat species present at BNL and examined habitat usage of these species.

Materials and Methods

These procedures were adapted from: Bat Survey Training. (Herzog, Carl. 2010)

Route Selection

Four routes in eastern Suffolk County were plotted using DeLorme 2012©. Each route was approximately 15-25 miles in length. Routes were selected to avoid high speed areas and congestion when possible. Three of the routes pass primarily through the Pine Barrens Region while the Sound Ave. route is located further east to get an idea of bat populations near farmland. The North Street route travels along the Peconic River and Carman-Rocky Point route passes through the Carmans River watershed (Appendix 2).

Three mobile routes and 3 stationary locations were also plotted within BNL in order to cover areas of the Long Island Solar Farm and a recently burned forest to compare to a control (Appendix 3). One additional stationary survey was conducted in Manorville, NY at a private residence containing 3 bat houses and bordering the burned area from the 2012 Crescent Bow fire.[XVIII]

Survey Conditions and Setup

Mobile surveys for the NYDEC were conducted from June 5th through July 1st and surveys on-site on BNL property were conducted July 17th until July 23rd. Mobile surveys were conducted beginning 30 minutes after sunset and stationary surveys ran from 20:00-21:30 EST. Weather data was collected prior to recording and surveys were conducted if sustained winds were less than 15 mph and temperature was greater than 55º F with no rain. Weather data was also collected immediately after recording was complete.

Mobile surveys within Suffolk County were conducted at a speed of 18-20 mph while surveys at BNL were reduced to speeds between 10-15 mph due to road conditions. Hazard lights were used to indicate the slow speed of the vehicle and we pulled off to the shoulder to let cars pass. The number of cars that passed in this manner were recorded to help determine whether or not the route should be repeated next season.

Calls were recorded using an acoustic monitoring device mounted by magnet to the vehicle's roof. The program Spect'R III© was used to record full-spectrum bat calls with a tuner that allowed for conversion of ultrasonic frequencies to audible levels and a sonographic analyzer used to visualize the call.[XIX] The coordinates traveled and their associated times were logged using Delorme 2012© in conjunction with a GPS unit attached to the roof of the vehicle. Each NYDEC route was run 4-5 times and BNL surveys were conducted once.

Identification

Calls were analyzed using the program Scan'R© which visually the displayed frequency (kHz), slope (Sc) and shape of each pulse over time (ms). With the aid of a flowchart designed by Carl Herzog, calls were manually deciphered based on characteristic frequency (Fc) and Sc. In order to identify species using this method, the search phase call was used, defined by a minimum of 5 evenly-spaced pulses occurring approximately every 100 ms. Calls inadequate in length or uneven in spacing were classified as unknown Chiropteran species. Due to the difficulty in differentiating *E. fuscus* and *L. noctivagans* by Fc, all calls fitting the criteria for these species were lumped into one category and referred to as "*E. fuscus*" in the results.

Results

Overall trends

A total of 500 positive Chiropteran calls were recorded over the course of this study. Of these calls, 12.02% were attributed to unidentified species (10.70% at BNL, 12.82% Suffolk County).

Changes in Suffolk County

The mobile surveys for the NYDEC showed a decrease in *E. fuscus* calls (-19.76%) and an increase in *L. borealis* (10.44%) since 2012.[XX] *E. fuscus* was the most commonly encountered species representing 56.09% of positive calls. Also encountered were *L. borealis* (26.92%), *M.lucifugus* (2.56%), *P. subflavus* (1.28%) and *L. cinereus* (0.32%).

BNL & Manorville

E. fuscus was also the most commonly encountered species within BNL (51.60%) followed by *L. borealis* (32.45%). Also recorded were *P. subflavus* (2.13%), *M. leibii* (1.06%) and *L. cinereus* (2.13%). Unidentified bats composed 10.63% of the calls recorded.

Discussion

The results of this study indicate a decline in the number of *E. fuscus* calls recorded over the last two years (Figure 2). Correlating with this is the prevalence of *L. borealis* compared to previous years, having increased by nearly 10%. It is important to note that the number of unidentified bat calls has also increased but not significantly enough to have had an impact on these trends. *M. lucifigus* was the only other *Myotis* species encountered during the NYDEC surveys, showing a 2.24% increase since

2011.[XXI] Continuing studies are needed to determine if populations are in fact growing and whether or not these changes are associated with migration or reproductive success in native bats.[XXII]

Bat surveys at BNL showed the most concentrated number of calls within and immediately adjacent to the burned forest. Of the 5 species recorded on-site, 4 were recorded in the wildfire area, including 2 individuals of *M. leibii.* This result suggests that burned forest may contain more usable habitat than unburned forest, potentially due to the low canopy density, increased sun exposure and high availability of roosts from standing dead trees.[XXIII] The presence of *M. leibii*, an elusive species, suggests that this area may provide summer roosts to many species.

A stationary survey in close proximity to the Long Island Solar Farm (Meadow Marsh) yielded twice as many bat calls when compared to a control (Weaver Pond). This pond is technically outside of the fenced-off solar arrays, which are inaccessible at night. A comparison of these results to an internal solar farm survey site would be beneficial to identify bat usage of solar farm areas.

More acoustic surveying should be conducted on-site at BNL in order to provide an adequate comparison of these unique areas. Since acoustic surveys, particularly static surveys, introduce some bias regarding populations, mist-netting should also be employed in appropriate areas to estimate population density.

In future surveys measuring abundance, care should be taken to learn the map routes before conducting surveys. Surveying at BNL in particular was challenging due to the number of unmapped roads traveled. Surveys in Suffolk County often resulted in incorrect directions from Delorme 2012© so a partner is needed to interpret directions

unless the driver is completely comfortable with the area. Data points from false turns were often picked up and were included in the results despite the deviance from the route.

Acknowledgements

I would first and foremost like to thank my mentor, Kathy Schwager, for her guidance and insight with this project. I would also like to thank Tim Green and Jennifer Higbie for sharing their experience and lending support. Thanks to Carl Herzog and Kathleen O'Connor for resources and aid in identifying bat calls. Many thanks to my fellow interns who helped with data collection, especially Molly Foley. Finally, I would like to thank the Office of Educational Programs and the Department of Energy for making this experience possible.

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Appendix 1

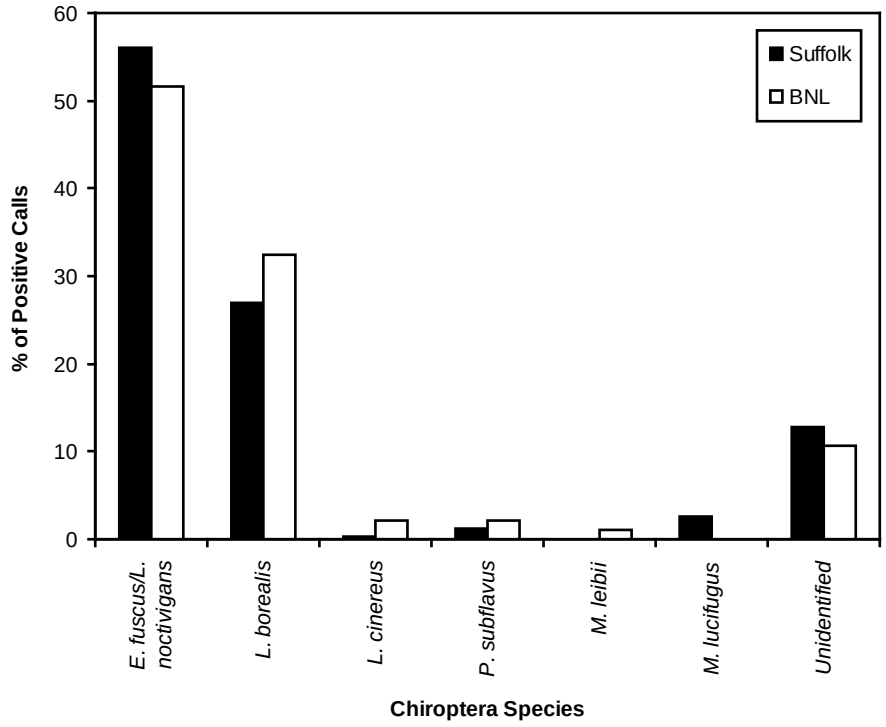

Figure 1. Chiropteran species identified in eastern Suffolk County and Brookhaven National Laboratory.

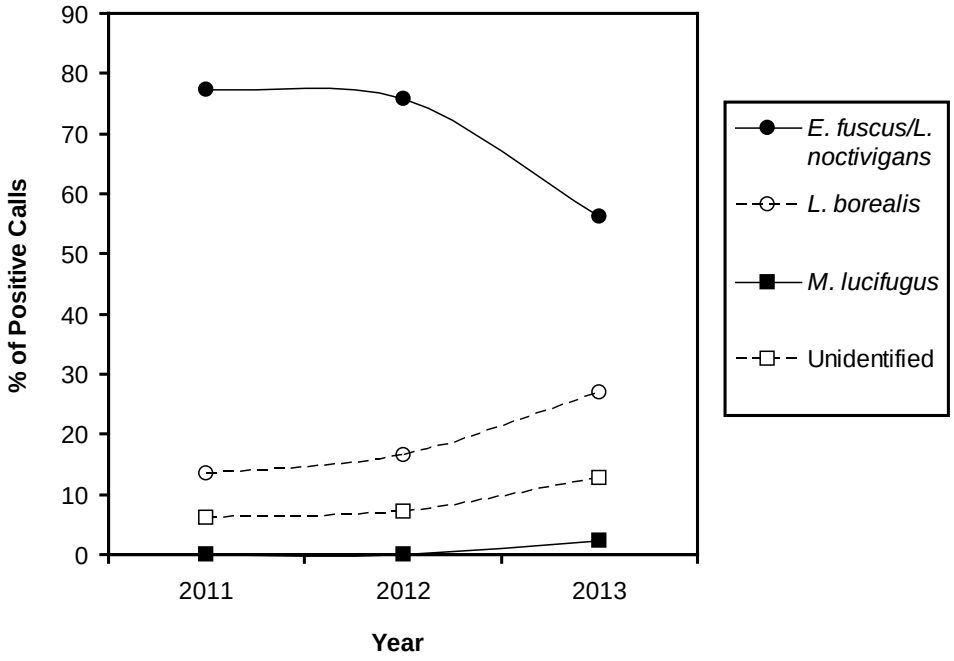

Figure 2. Population changes in prominent Chiropteran species within eastern Suffolk County.

Appendix 2.

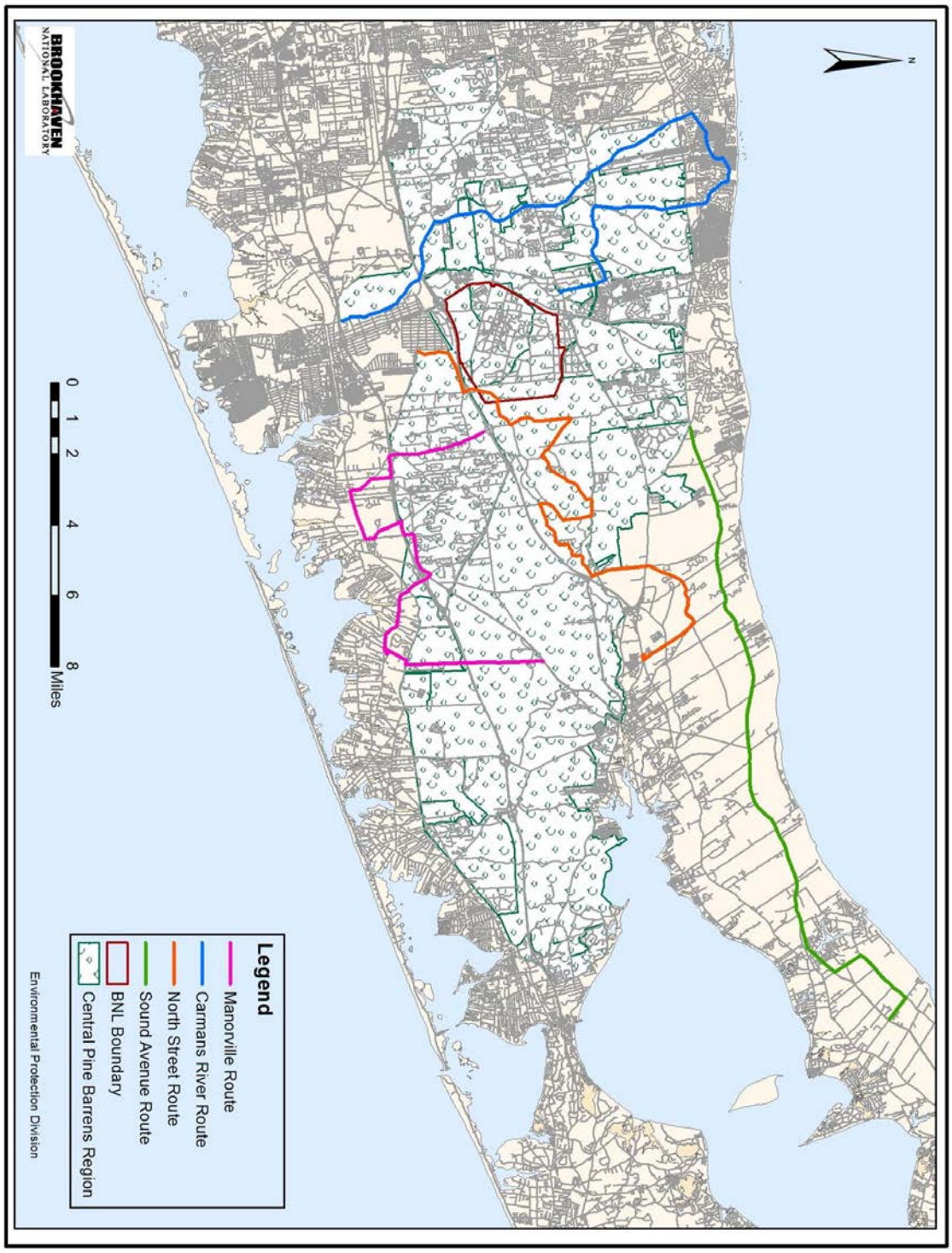

Figure 3. Mobile survey routes through eastern Suffolk County, New York.

Appendix 3.

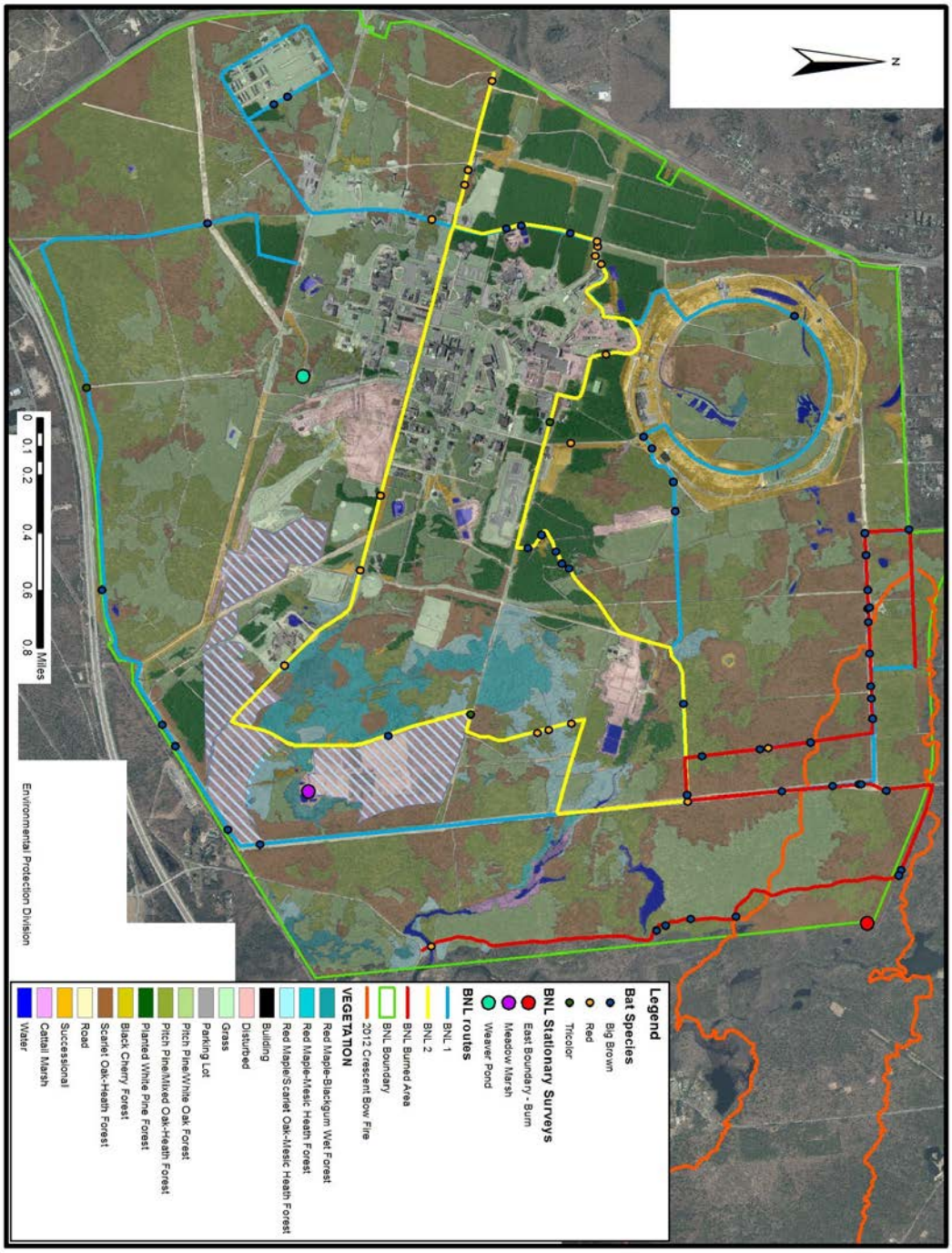

Figure 4. Mobile survey routes with associated Chiropteran species recorded and stationary survey points within Brookhaven National Laboratory.

Notes

[I] Harvey, Michael J., J. Scott Altenbach, and Troy L. Best. *Bats of the United States and Canada*. Baltimore: Johns Hopkins UP, 2011. Print.

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[VI] Warnecke, Lisa, et al. "Inoculation of bats with European Geomyces destructans supports the novel pathogen hypothesis for the origin of white-nose syndrome." *Proceedings of the National Academy of Sciences* 109.18 (2012): 6999-7003.

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[XIV] 2012 Winter Bat Survey Results." *NYS Dept. of Environmental Conservation*. NYS Department of Environmental Conservation, 19 Apr. 2012. Web. 30 July 2013.

[XV] "White-nose Syndrome." *U.S. Fish & Wildlife Service*. U.S. Fish & Wildlife Service, Apr. 2009. Web. 30 July 2013. <http://www.fws.gov/northeast/pdf/white-nosefaqs.pdf>.

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[XXIII] Boyles, Justin G., and Doug P. Aubrey. "Managing forests with prescribed fire: implications for a cavity-dwelling bat species." *Forest Ecology and Management* 222.1 (2006): 108-115.

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