Determining Species Occurrence and Vegetation Preference of Foraging Chiroptera:
An Acoustic Survey Using Driving Transects and Geographic Information Systems

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ABSTRACT

Static acoustic surveys have traditionally been used to determine species presence, community composition, and habitat preference amongst foraging bats. Driving transects supplemented with GIS technology may allow researchers to more effectively monitor bat communities and note annual trends related to species occurrences and vegetation preferences. Acoustic surveys were implemented each year from 2011 to 2014 along designated driving transects throughout Suffolk County, NY. Bat echolocation calls were recorded and analyzed using binary acoustics software for individual species identification. Identified calls were then mapped using a 76.2 meter buffer around each point in order to determine vegetation-type preferences. A total of seven out of nine Chiropteran species were found, in which *Myotis* spp. occurrence decreased by 1.3%, *Eptesicus fuscus/ Lasionycteris noctivagans* decreased by 25.6%, and *Lasiurus borealis* increased by 25.6%. Average percent cover of vegetation types suggested greater preference within areas of pitch pine forest (38.6%), oak forest (24.8%), and oak/pitch pine forest (17.7%). The methods used in this survey may ultimately reduce the time and costs associated with acoustic and vegetation surveys. Data suggest the importance of continual monitoring efforts of bat communities and the need for additional research efforts on vegetation preferences of foraging bats.

INTRODUCTION

Bat populations across eastern North America have undergone devastating declines due to the harmful effects of white-nose syndrome (WNS) (2). Not only have bats been found to be important bioindicators in relation to habitat loss and climate change (7), but have also provided economic relief at an estimated $22.9 billion per year within agricultural industries by contributing as pest managers (3). Such values support the need for increased monitoring efforts and understanding of bat ecology. Acoustic surveys have proven to be effective in gathering inventories of bat communities (10) and the use of Geographic information systems (GIS) in reference to landscape structure, specifically regarding relationships amongst small mammal communities, has increased in recent years (6,11). The following survey uses acoustic driving transects and GIS to determine species occurrences and vegetation preferences amongst bat communities of Long Island. Predictions include a decrease in *Myotis* spp. occurrences from 2011 - 2014 and greater vegetation preference in wooded areas.
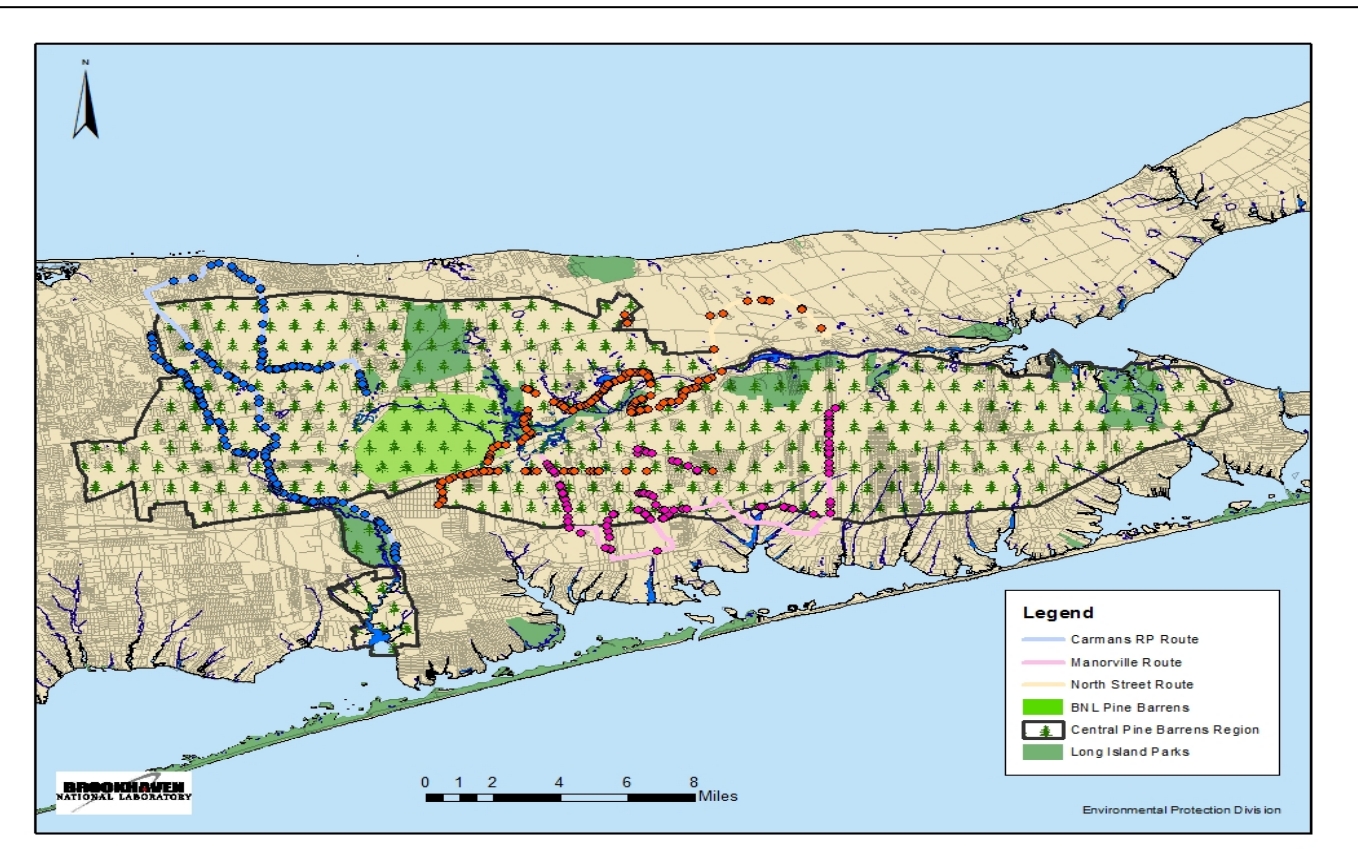
Figure 1: Map of bat acoustic routes and identified calls within Suffolk County, NY, 2011-2014.

MATERIALS AND METHODS

Driving Transects
- Three routes were created within Suffolk County, NY (Figure 1).
- Route length: 32– 40 km ea.
- Areas of interest: Central Pine Barrens Region and water sources

Survey Protocol
- Survey duration: approx. one month ea., June to early July (2011 - 2014), surveys began 30 min after sunset
- Climate conditions: temperatures >12.8 °C , 0% chance of rain, and wind speeds of <24 kph
- Safety: Each route was safely driven at 32 kph

Acoustics Equipment
- Bat detector and global positioning system (GPS): placed on top of vehicle to record bat echolocation calls and GPS log data
- DeLorme Street Atlas © (DeLorme, Yarmouth, ME) - GPS software used to create and implement routes
- SPECT'R III © (Binary Acoustics Technology LLC., Tucson, AZ): binary acoustics software used for audio recording and translation of calls

Species Identification
- SCAN'R © (Binary Acoustics Technology LLC., Tucson, AZ): binary acoustics software used for filtering and individual call analysis (Figure 2)
  - Calls filtered via ≥ 5 chirps
  - Characteristic frequency (Fc) and characteristic slope (Sc) call parameters (kHz) used for individual species identification

Geographic Information Systems (GIS)
- ArcGIS 10.1 © (Esri, Redlands, CA): GIS software used to map identified calls and determine vegetation preference
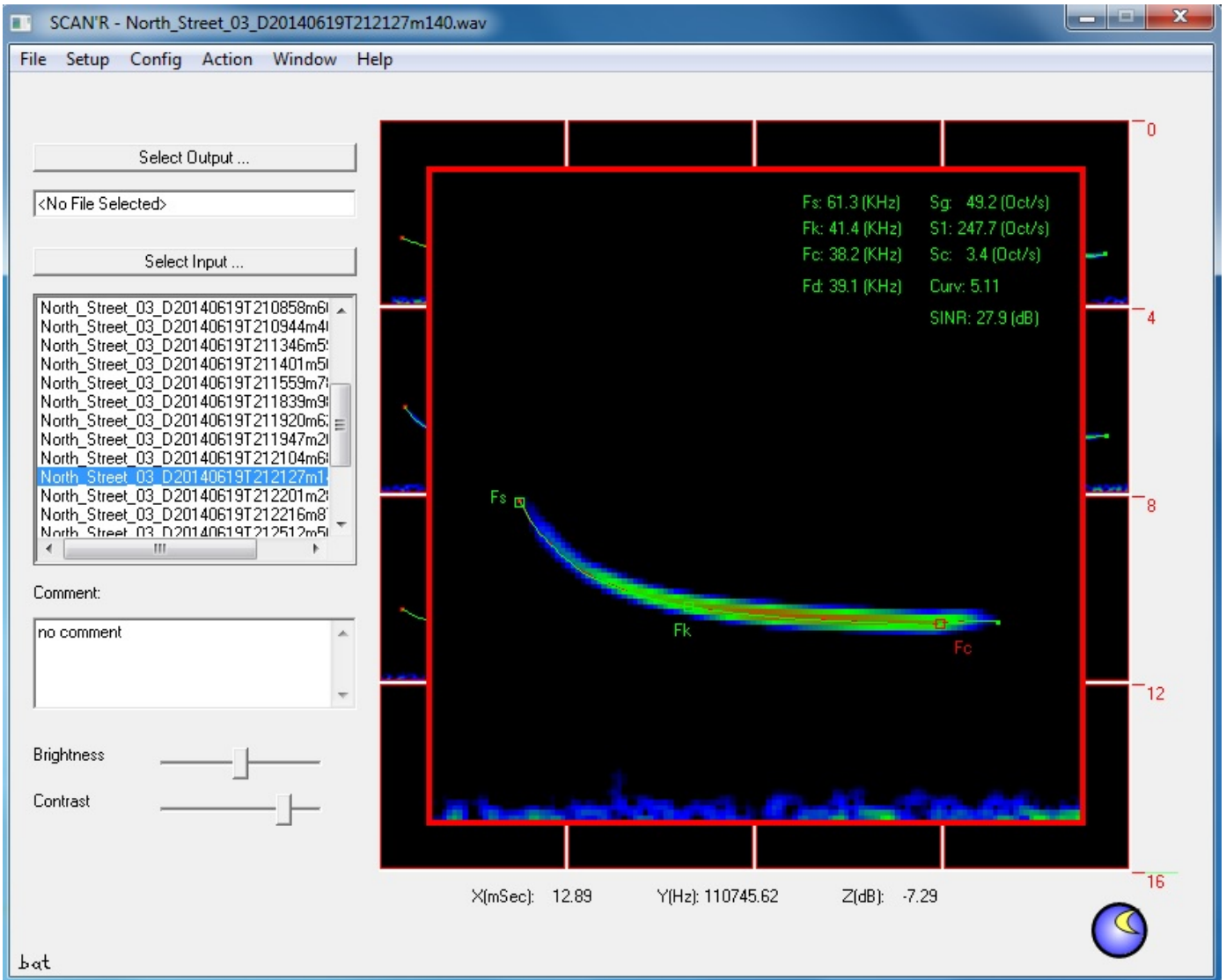 - 76.2 m buffer placed around ea. identified call (Figure 4)

Figure 2: Eastern Red Bat (*Lasiurus borealis*) sonogram identified using SCAN'R © spectral analysis software.

RESULTS

- Big brown bat (*Eptesicus fuscus*), silver haired bat (*Lasionycteris noctivagans*), Eastern red bat (*Lasiurus borealis*), hoary bat (*L. cinereus*), little brown bat (*Myotis lucifugus*), Eastern small footed bat (*M. leibii*), and tricolored bat (*Pipistrellus subflavus*).

- No Northern long-eared bat (*M. septentrionalis*) presence was detected and Indiana bat (*M. sodalis*) occurrence was too insignificant to document.

- Average percent occurrence was greatest amongst *E. fuscus/ L. noctivagans* (70.2%) and *L. borealis* (26.7%) (Figure 3).

- *Myotis* spp. occurrence decreased by 1.3%, *E. fuscus/ L. noctivagans* decreased by 25.6%, and L. borealis increased by 25.6% (Figure 3).

- Average percent cover of vegetation types suggested greater preference within areas of pitch pine forest (38.6%), oak forest (24.8%), oak/pitch pine forest (17.7%), grass lawn (4.5%), agriculture (3.7%), and grassland (3.1%) (Table 1).

- Difference in percent cover revealed a decrease in preference toward pitch pine forest (-10.9%) and grassland (-5.7%) vegetation types and an increase in oak/pitch pine forest (+7.2%), oak forest (+3.0%), grass lawn (+2.1), and agriculture (+0.3%) (Table 1).
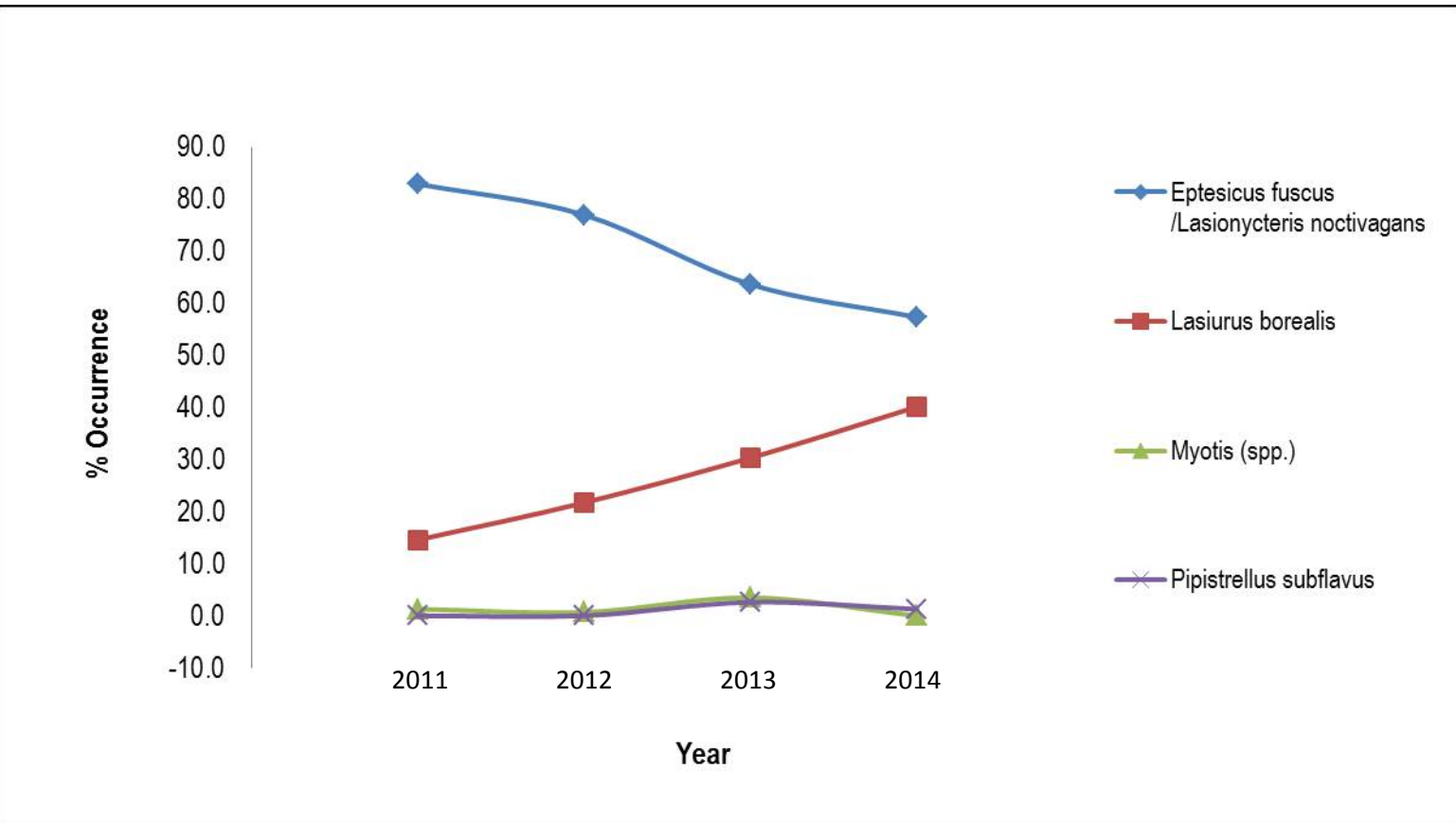
Figure 3: Percent change in species occurrence from 2011-2014.

Table 1: Percent cover of each vegetation type found along acoustic routes from 2011-2014.

Vegetation Type	% Cover			
	2011	2012	2013	2014
Pitch Pine Forest	43.74	43.44	34.52	32.83
Oak Forest	23.94	22.20	25.99	26.98
Oak/ Pitch Pine Forest	12.73	18.12	19.99	19.92
Grass Lawn	3.28	4.17	5.06	5.39
Agriculture	3.43	3.92	3.71	3.74
Grassland	7.60	1.30	1.48	1.94
Pitch Pine / Oak Forest	0.42	3.39	2.72	2.64
Scrub Oak Shrubland	1.03	0.96	2.52	0.70
Freshwater Wetland	0.99	1.23	1.20	0.90
Successional Oak Forest	-	-	0.44	3.47
Sand / Sparse Vegetation	1.45	0.43	1.09	0.37
Water	0.21	0.65	0.42	0.87
Forested Wetland	0.42	0.14	0.50	0.04
Successional Pitch Pine / Oak Forest	0.41	0.02	0.17	0.09
Plantation	0.26	0.00	0.02	0.00
Tree Oak Scrub Oak Woodland	-	-	0.11	0.02
Pitch Pine Grass Savanna	0.02	-	0.01	0.08
Tree Oak Grass Savanna	0.04	0.00	0.00	0.02
Successional Pitch Pine Forest	0.03	-	0.02	-
Pitch Pine Tree Oak Scrub Oak Woodland	-	0.02	0.02	-
Pitch Pine Scrub Oak Woodland	-	-	0.01	-
Tree Oak Heath Woodland	-	0.00	0.00	0.00
Pitch Pine Heath Woodland	0.00	0.00		0.00
Dwarf Pine Plains 2	-	-	0.00	-

*- " Indicates vegetation type was not found

DISCUSSION AND CONCLUSIONS

- Predictions of a continual decline in *Myotis* spp. occurrence was confirmed. Such declines may have resulted from self-induced spread of WNS via dense clustering in caves during winter hibernaculum, a physiological response to inhibit evaporative water loss, thus making *Myotis* spp. more susceptible to the fungus (5).

- Increased *L. borealis* occurrences may have been attributed to their long-distance migratory behavior (8) and use of trees as primary roosting sites (9). Whereas, *E. fuscus*, a sedentary species (1) traveling less than 50 km from winter to summer roosting sites (8), rely heavily on caves for winter hibernation sites, thus explaining decreased occurrences. Moreover, *L. borealis* may be occupying newly available niches left by species infected with WNS.

- Additional research efforts are needed to determine preferences of pitch pine and oak forest types. However, changes in vegetation preference from pitch pine to oak forests may have been directly correlated to increased *L. borealis* occurrences due to their preference of oaks as primary roosting sites (9).
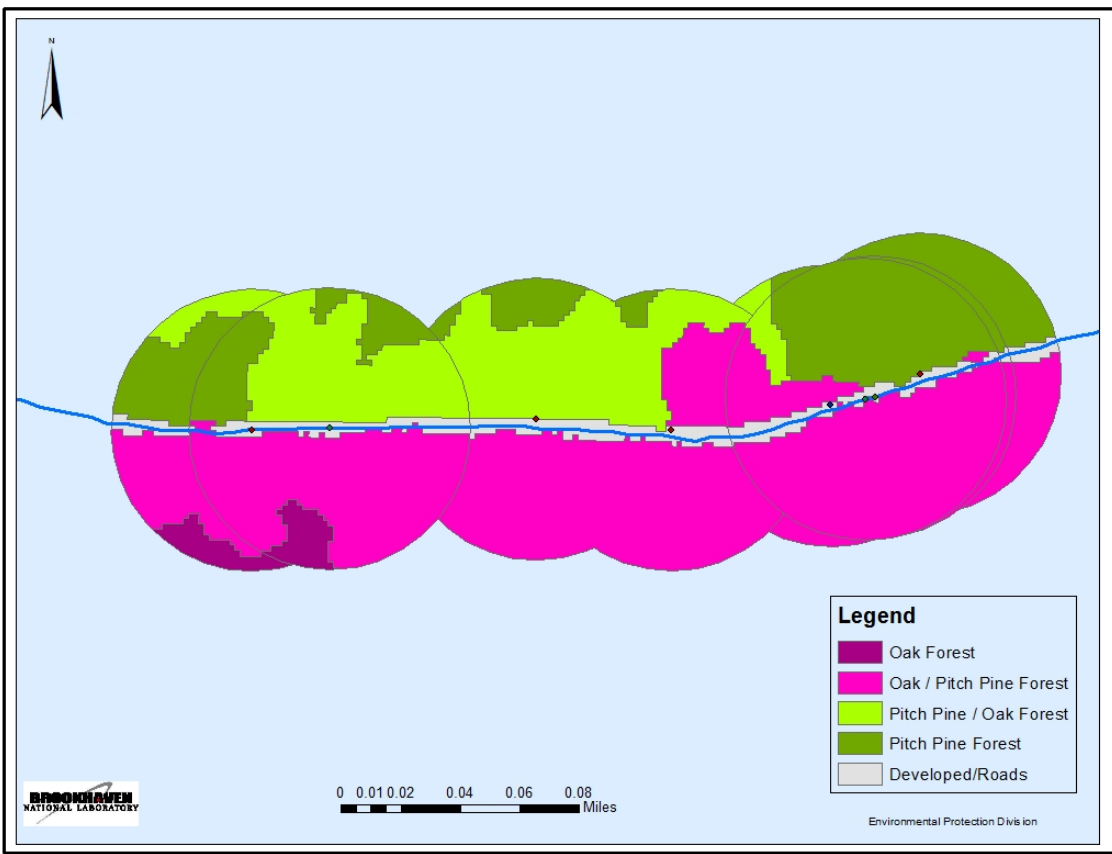
Figure 4: Example of buffers surrounding identified calls and corresponding vegetation-types, Suffolk County, NY, 2011-2014.

ACKNOWLEDGMENTS

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