Relationship analysis between Order Chiroptera and burned forest areas

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Abstract
Fires can be beneficial to forest health, especially in the Central Pine Barrens Region of Long Island which is a fire dependent ecosystem, but fire can be detrimental to some fauna living in the forest. The northern long-eared bat (*Myotis septentrionalis)* is a species which has been federally listed as threatened; some research has pointed to the fact that fires might be beneficial to the *M. septentrionalis* population in the long term by creating snags in which the species can roost. In the immediate short term, fires can burn parts of the bats which are not protected by fur, or smoke inhalation can harm adults and non-volant young. The purpose of this research was to determine if there is any difference between bat species utilizing burned and unburned forests at Brookhaven National Laboratory (BNL), with particular focus placed on the presence or absence of *M. septentrionalis*. Static acoustic surveys were conducted by placing detectors in burned and unburned forest locations to determine what species were using each forest type, and the bat calls were identified using Sonobat® and SCAN'R® (automated snapshot characterization and analysis software). 87% of the total collected calls were in the northeastern portion, or areas which had experienced fire in the past 10 years, although more research is needed to identify any significant correlation. This knowledge can help BNL determine where are possible roost areas are. This is beneficial for the planning of prescribed fires, so that during the pupping season additional preparation of the burn units will be conducted to minimize the impacts on the roosts.

1. Introduction

There have been multiple studies showing the possible benefits of prescribed fires on the presence of bat species (Lacki *et al*., 2009; Cox *et al*., 2015). The northern long-eared bat (*Myotis septentrionalis)* was once a common bat species in the region, but its population sizes have been decreasing drastically due to white nose syndrome (*Pseudogymnoascus destructans*) (WNS), a fungal disease which has been decreasing bat populations globally (USFWS, 2013). *M. septentrionalis* has recently been federally listed as threatened. Understanding the habitats in which these species live and their responses to habitat modification are key to the conservation of the populations (Cox *et al*., 2015). Prescribed fire, or fires in general, have the ability to create roost sites for many different species of bats, assisting their population. Fire can affect the ecosystem by killing trees, creating snags, or weakening trees to allow insects or diseases to take over. It has the ability to alter forest composition, and the habitats of the species living there (Cox *et al*., 2015; Johnson *et al*., 2011; Lacki *et al*., 2009; Perry, 2012). In addition to creating roost trees, fires can also increase the amount of light penetration. This then increases the temperatures in roost trees, and can facilitate in raising pups (Dodd & Lacki, 2015).

While fire can possibly benefit species of bats, it also has the ability to decrease bat population sizes. During the day some species of bats enter torpor, a strategy which helps the individual save energy by lowering body temperature and slowing bodily functions (Dodd & Lacki, 2015). If the temperature is less than 4 degrees Celsius the night before, the bats may not be able to awake from their torpor in time, and be killed by the fire. Bats which roost closer to the ground may suffer from burns on parts of their bodies which are not covered by fur, such as their ears and wings. Other individuals may be harmed by smoke inhalation, or mothers during pupping season may not be able to get their non-volant pups out of the fire to safety (Perry, 2012). Snags provide important roosts for bats (Kunz & Fenton, 2005), and fire may destroy ones which had been previously used as roosts for the bats (Lacki *et al*., 2009).

The purpose of this study was to compare the frequency of bat calls in forests which had previously been burned by a fire to those which had not had a fire before. This was to see if fire did in fact affect bat foraging frequency in an area. The methods did not allow for determining the size of the population or how many individuals were in an area, but rather the species located in the area and how often they flew by the detector's location. The information gives an idea of how often the site is used by the different species.

2. Materials and Methods

2.1. Study Site

This study was conducted at Brookhaven National Laboratory (BNL) in Upton, New York, from June through August, 2016. BNL is located in the Central Pine Barrens Region of

Long Island, which is a fire dependent ecosystem. On the project site, two general types of stands were classified, those which had experienced fire within the last 10 years, and those which had not. In 2006 and 2011 low intensity prescribed burns were conducted in the northeastern portion (Northeast Unit) of the study site, and in 2012 a moderate-high intensity wildfire burned through some of the prescribed burn units. The tree species composition in the burned sites (in the Northeast Unit of the Laboratory) consists mostly of scarlet and black oak (*Quercus coccinea* and *Q. velutina*) and pitch pine (*Pinus rigida)*, while the species composition in the non-burned sites was mostly mixed oak and scattered *P. rigida*. The sites in the southern portion (South Unit) consisted of closed canopy pitch pine-mixed oak forest with little understory and high basal area. The two forest stands were broken up into smaller study sites of approximately 20 acres (Figure 1).

2.2. Static Surveys

Bat calls were mainly collected by using static surveys. These surveys were completed using Song Meter SM2BAT+® detectors. The Song Meters were deployed in approximately the middle of each plot. The detector was tied onto the trunk of a tree and had two Wildlife Acoustics® SMX-US ultrasonic microphones attached, approximately 2 meters away from the detectors. The microphones were attached to PVC poles and stood approximately 3.66 meters off the ground, at bat flying height. Microphones faced opposite directions in order to maximize the range and amount of calls collected. The Song Meters were recording from a half hour after sunset until sunrise, cycling between 10 minutes of recording followed by 10 minutes of not recording (Cox *et al*., 2015). The detectors each remained in the plot for a minimum of one week. If rain was in the forecast, then plastic bags were put over the microphones in order to protect them from the rain so that they were not damaged.

2.3. Mobile Surveys

In addition to the static surveys, mobile surveys were conducted. An AR 125 Ultrasonic Receiver® by Binary Acoustic Technology® was placed on the top of a vehicle and connected to a laptop computer. Spectral Tuning and Recording Software *(*SPECT'R III®) was used to record the calls collected by the receiver, and DeLorme Street Atlas USA 2012 Plus® was used to collect the GPS locations of the vehicle at the time of the calls. Surveys were conducted between 2100 and 2230, after the bats have left their day roost to forage for the night. During the survey, the speed of the vehicle was maintained between 5 and 10 miles per hour. There were a total of three survey routes, each of which was done three times. The species location was then mapped on Google Earth™ to determine the habitat type in which they are foraging.

2.4. Call Analysis

Every few days, call data was downloaded from the detectors. The .wav sound files were then run through Snapshot Characterization and Analysis Routine (SCAN'R®), and files with less than 5 chirps were 'failed,' or set aside to look at later. Calls which passed were identified as to which species made them based upon the minimum frequency of the call, the shape of the call, and the slope of the call in octaves per second (Sc). The call classification was then compared to a program which automatically classifies the calls as to which species made them by using an algorithm which is based on thousands of species calls located in the software's reference library, SonoBat®. Calls which failed the SCAN'R® scan were then run through SonoBat®, because that program can sometimes identify bat species based on less than 5 chirps. Species identified as the big brown bat (*Eptesicus fuscus*) or the silver-haired bat (*Lasionycteris noctivagans*) through SonoBat® and SCAN'R® were grouped together for the results.

3. Results

A total of 552 calls were positively identified to species. Of those calls, 95% were located in the Northeast Unit of the study site (Figure 4), and the majority of the calls from different species came from the Northeast Unit (Figures 6, 7, 9, 10). *M. septentrionalis* was located in the Northeast Unit 83% of the time, but represented only 1% of the collected calls (Figures 1, 8). The majority of the calls (86%) came from the *E. fuscus*/*L. noctivagans* characterized group (Figure 1). The mobile surveys yielded 144 positively identified calls. Of those calls, 43% were collected in the Northeast Unit (*Q. coccinea/Q. velutina*/*P. rigida*), and 42% were collected in the South Unit (*Quercus spp*. and scattered *P. rigida*). The remaining 15% of the calls were located near the solar farm and other areas with mostly open landcover (Figure 3). 79% of the mobile survey calls were made by *E. fuscus*/*L. noctivagans*, and none were made by *M. septentrionalis*. When both mobile and static surveys are taken into consideration (696 calls), 87% of the calls came from the Northeast Unit of the study site (Figure 5).

4. Discussion

Fire affects species of bats differently, although the bat's natural history determines the impact of the fire (Perry, 2012). One of the reasons why bats may utilize forests which have recently experienced a burn is because insect activity has been found to increase after prescribed fires (Lacki *et al*. 2009). For this study, *E. fuscus* and *L. noctivagans* were characterized together to minimize classification errors due to their similar call structure and frequency (Cox *et al*., 2015; Yates & Muzika, 2006). While these species were characterized together, the majority of them identified were *E. fuscus*. Very few, if any, bats located in this area are *L. noctivagans*. In addition to WNS, the lack of calls by *M. septentrionalis* might be due to the fact that they require continuous forest cover (Yates & Muzika, 2006). While Yates and Muzika (2006) stated that there is no apparent negative correlation between *M. septentrionalis* and fragmentation, they also stated that there is an inverse relationship between the presence of the species and the presence of edge habitat. Every detector was 152.4 - 241.4 meters from a road, so that could partially explain the lack of *M. septentrionalis* detected.

As the study continued, fewer calls were detected. This could be due to the second half of the study being done in an area that had not burned in the past 10 years, therefore it may not provide suitable habitat. Alternatively, it could be due to timing. Pupping season occurs from June to August (Singleton, 2012), and female bats may forage differently while taking care of their young because of different energy requirements of the pups (Yates & Muzika, 2006). Yates and Muzika (2006) found a decrease in the number of calls in their study during July 7-20 when the juvenile bats started to fly. During this study, there was a decrease in calls during that time as well, however, at the last location surveyed between July 25 and August 3 more calls were collected than during the other two static surveys in the South Unit. This location was also near a pond with standing water, which may make the area more attractive to bats (Cox *et al*., 2015; Yates & Muzika, 2006). None of the static survey sites in the Northeast Unit had a nearby water source, but more calls were recorded there than it the South Unit which was near water.

In this study, basal area was not a factor that was measured. Forests in the Northeast Unit had less canopy cover and more light reaching the forest floor where the South Unit had a more mature, closed canopy. Cox *et al*. (2015) found that bat activity was generally higher in areas with lower overstory basal area. This could be because species like *Lasiurus borealis* (eastern red bat), *E. fuscus*, *L. noctivagans*, and *L. cinereus* (hoary bat) tend to fly in areas where there is less clutter. The more open area caused by fire thinning can create more favorable roost sites for bats as well (Perry, 2012). Maternity roosts are especially likely to be located in areas with less canopy basal area to increase the solar exposure and warmth to the roost for the pups (Johnson *et al.*, 2011; Perry, 2012). In the study area snags were also created by insects killing some of the trees.

A way to test if it was the location or the time of the year which reduced the number of calls would be by having detectors in the Northeast Unit and the South Unit at the same time in a future study. This study lasted for only three months and locations change over time, so further studies will need to be done to test these results (Cox *et al.*, 2015).

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Figure 1. Map of the different sites

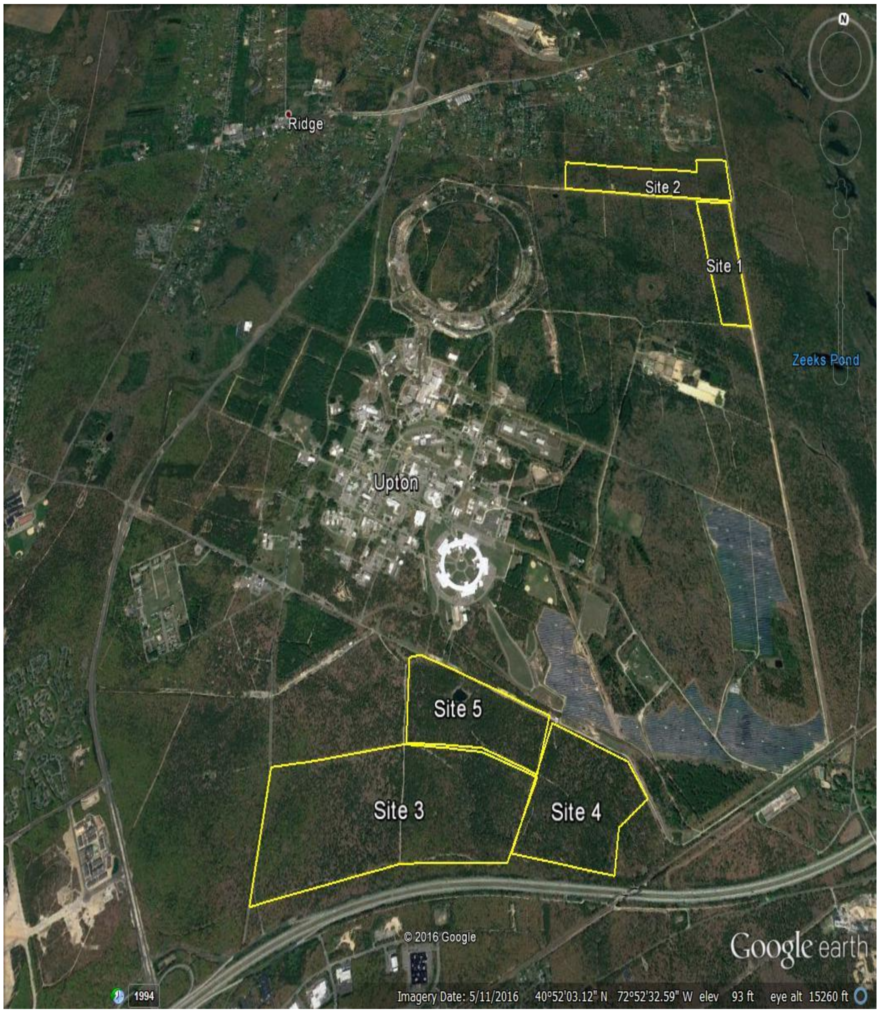


Figure 2. Total percents of bat species located during the study:
Epfu= Big brown bat, Lano = Silver haired bat, Labo= Red bat, Laci= Hoary bat, Pesu= Tri-colored bat, Mylu= Little brown bat, Myse= Northern long eared bat, Myle= Small-footed bat

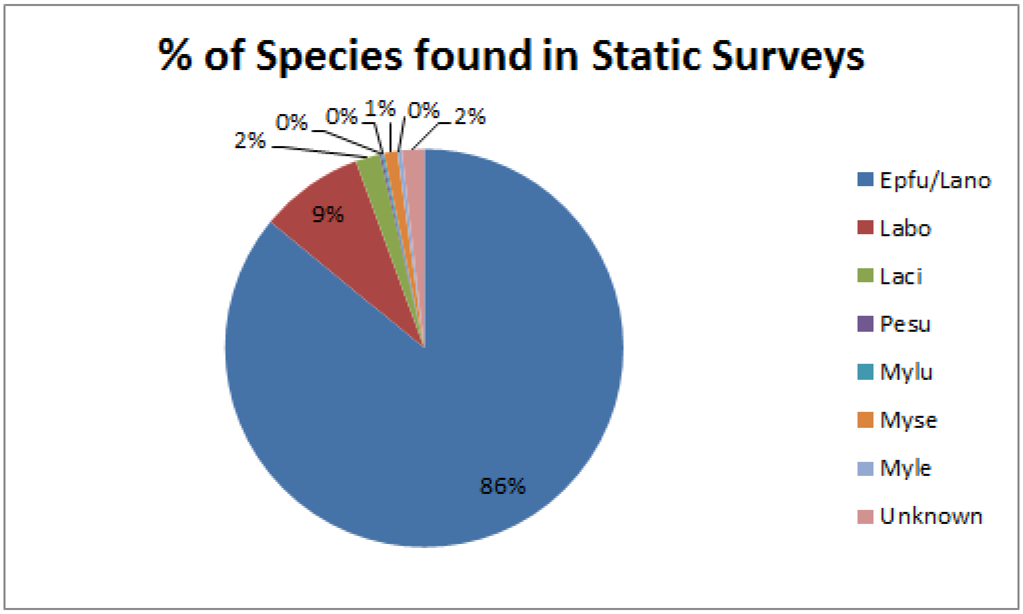


Figure 3. Percent bat species located in each stand during mobile surveys.

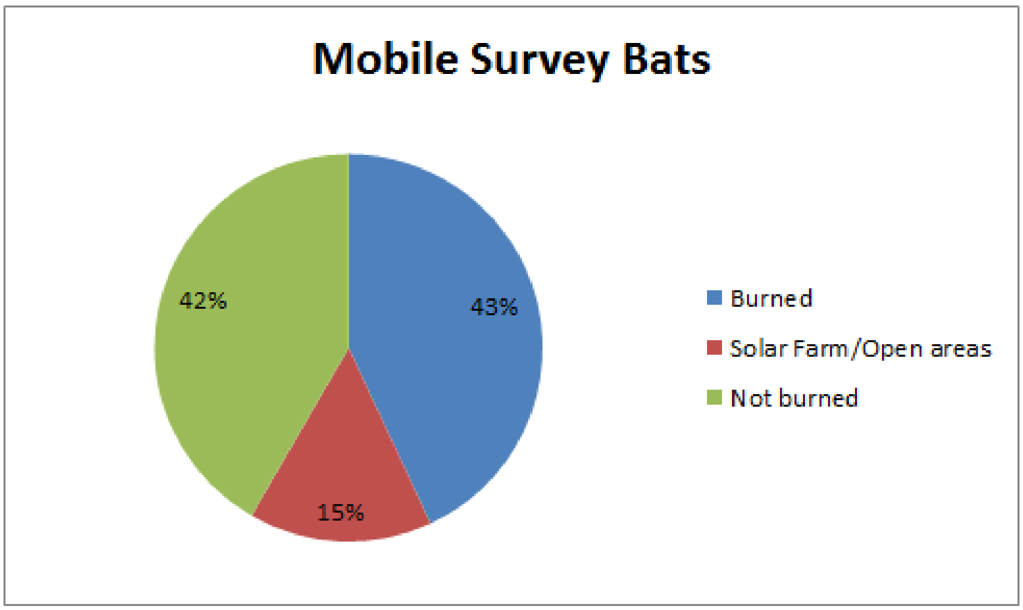


Figure 4. Percent bat species located in each stand during static surveys.

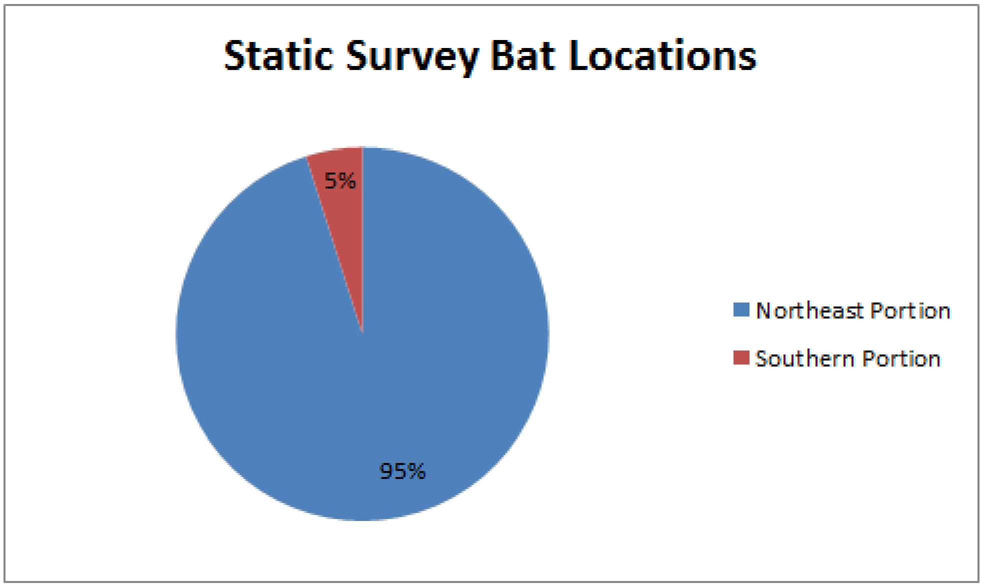


Figure 5. Percent bat species located in each stand during static and mobile surveys.

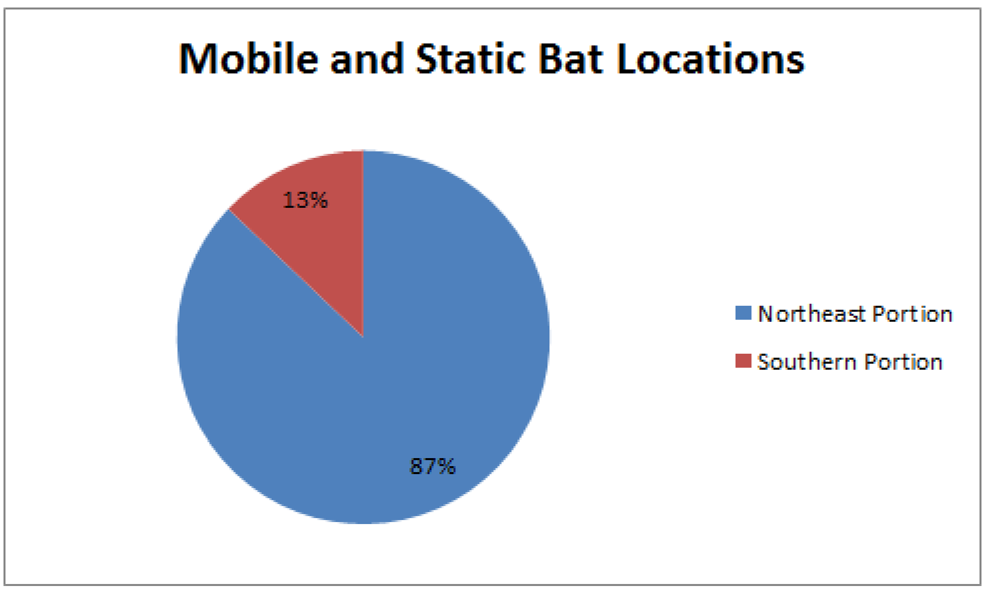


Figure 6. Percent of *E. fuscus* and *L. noctivagans* located in each stand of the study site

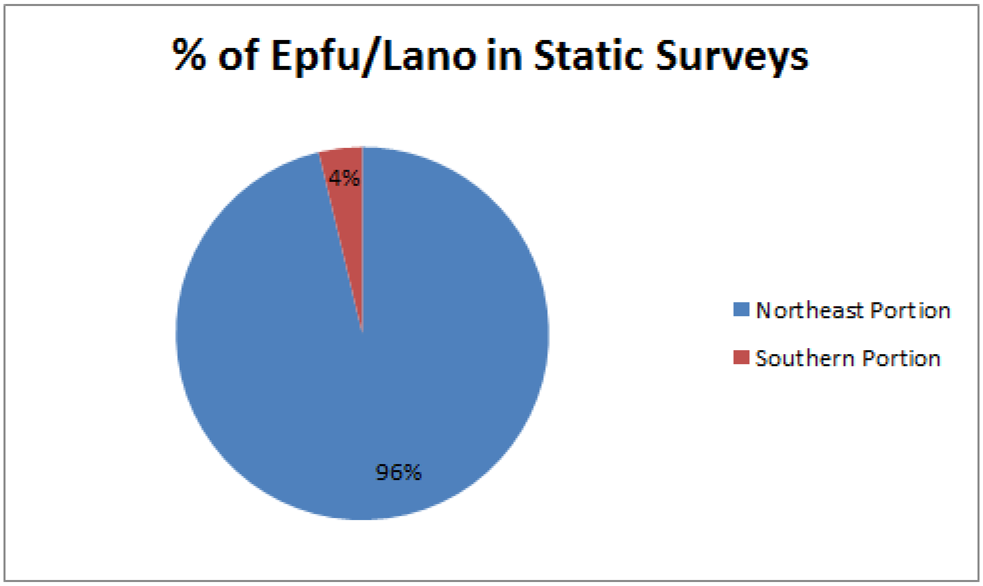


Figure 7. Percent of *L. cinereus* located in each stand of the study site

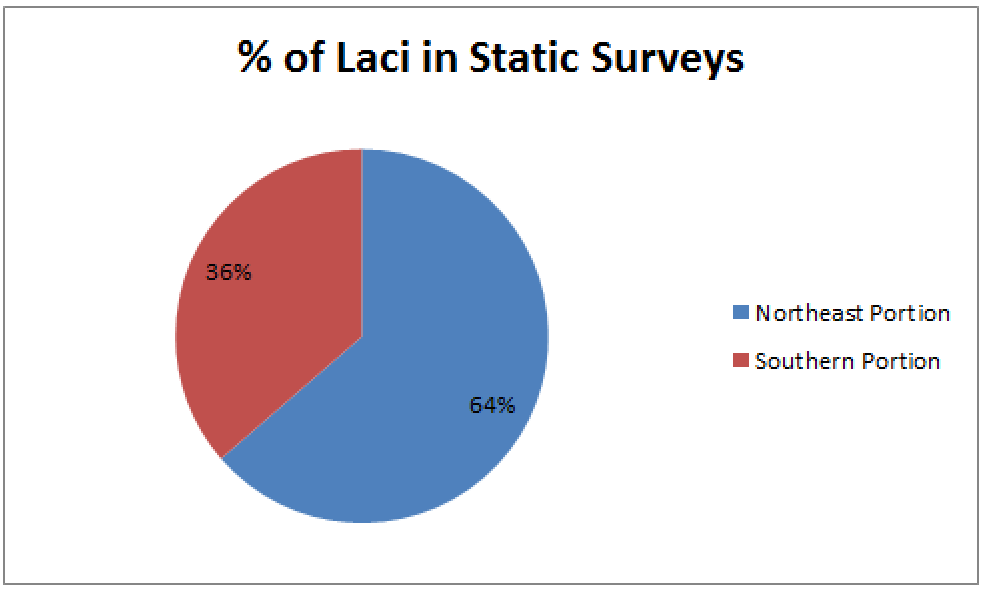


Figure 8. Percent of *M. septentrionalis* located in each stand of the study site

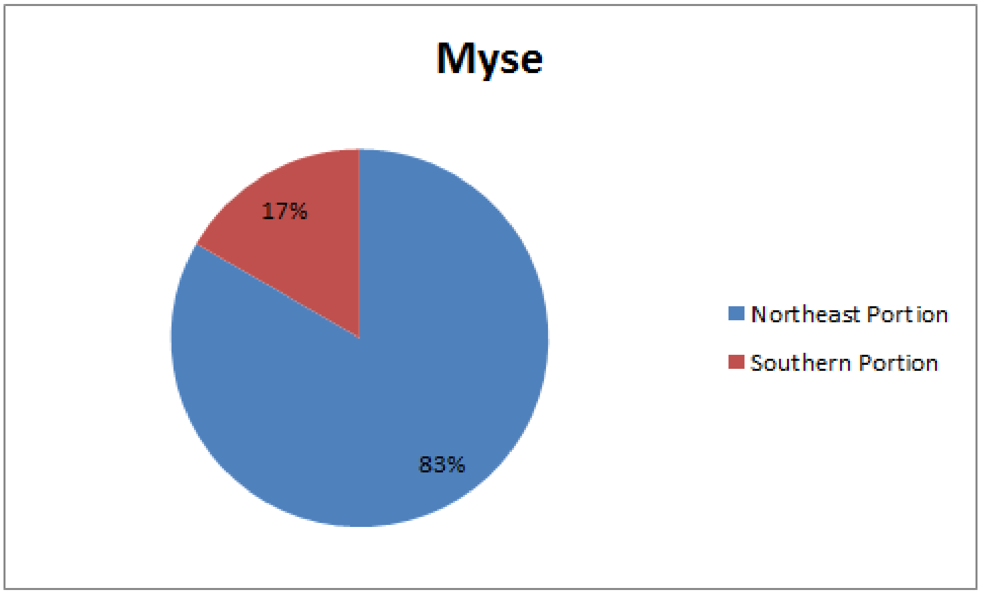


Figure 9. Percent of *Myotis leibii* (small-footed myotis) located in each stand of the study site

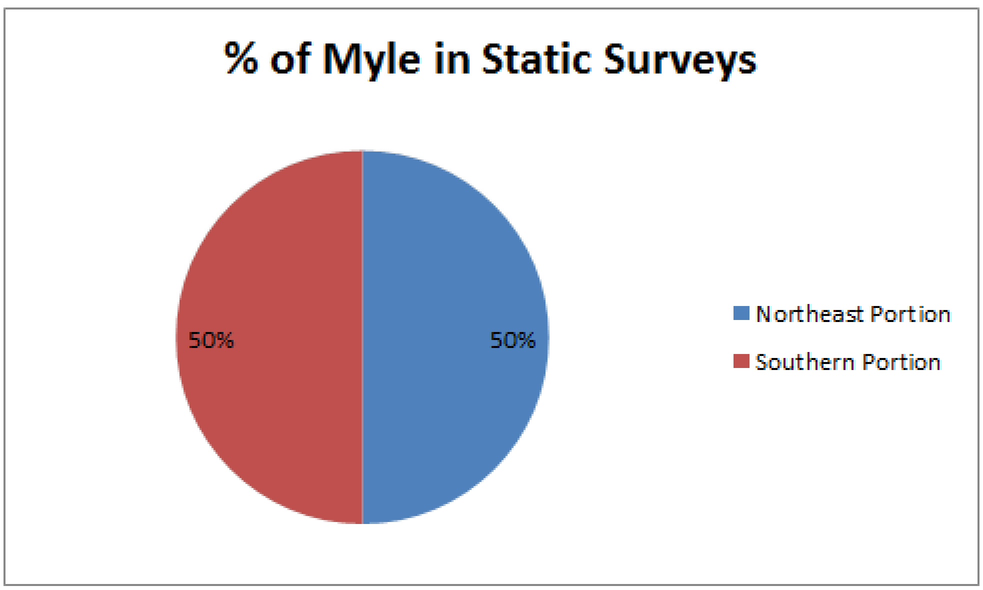
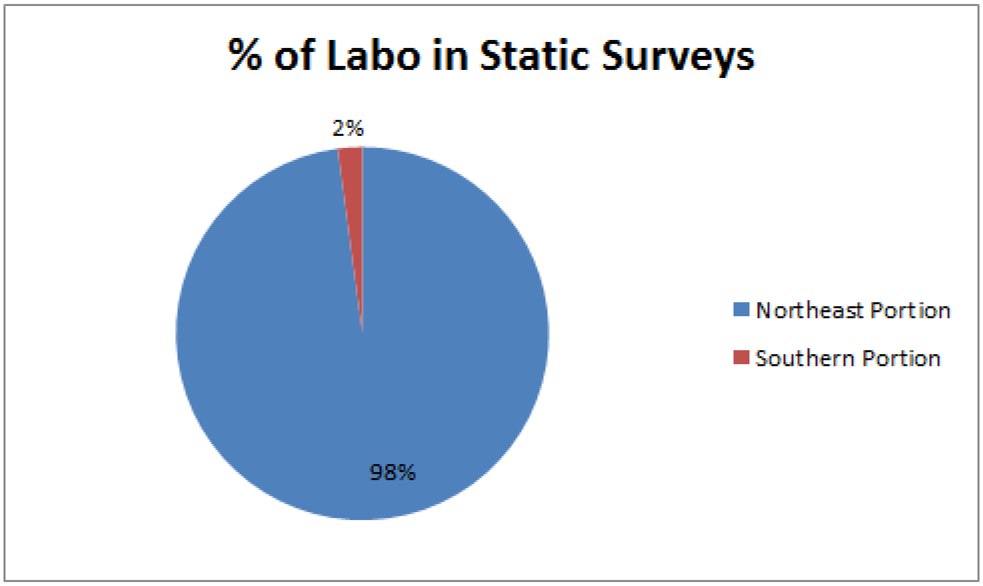


Figure 10. Percent of *L. borealis* located in each stand of the study site



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