Habitat Utilization of Bats at Pierce Cedar Creek

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Introduction

Pierce Cedar Creek Institute has not conducted a full research project on bats prior to the development of URGE. In addition to gaining more insight about the habitat utilization of bats on the property, this project will also provide a species inventory for bats at PCCI, potentially including the endangered Indiana bat (*Myotis sodalis*). PCCI contains a variety of streams and open water systems on its 661 acres, which make for an ideal habitat for bats. Bats are often seen at the institute, but due to their elusive nature and nocturnal habits they are rarely the focus of examination. This study will shed light on their behavior, habitat use and their species diversity at Pierce Cedar Creek Institute.

There are eight bat species known in Michigan, including the little brown bat (*Myotis lucifugus),* the big brown bat *(Eptesicus focus),* the Eastern red bad *(Lasiurus borealis),* the hoary bat (*Lasiurus cinereus),* the silver haired bat (*Lasionycteris noctivagans),* the Indiana bat (*Myotis solidalis),* the evening bat (*Nycticeius humeralis),* and the Northern long eared bat (*Myotis septentrionalis).Myotis lucifugus* is the most widely distributed bat species in North America (Michigan DNRE**).** During the summer, *Myotis lucifugus* sexually segregate with females forming maternity colonies to raise pups and males roosting with other males or alone (Swystun et al. 2007). Bats have been shown to be faithful to a day roosting "area", of approximately 2 hectares (Nixon et al. 2009). While *Myotis lucifugus* prefers natural roost sites, the Big Brown bat (*Eptesicus fuscus)* prefers man-made roosting structures. The difference in behavior is believed to result from the varying density of insects near the roost along with the permanence of structure (Brigham 1991).

Bats prefer to roost during the day in mature tree stands, which are in the early stages of decline (Swystun et al. 2007, Jung et al. 2004). Male bats seem to be more flexible in regards to where they roost during the day and will roost in less desirable areas, such as recently thinned and open forests. In fact, *Eptesicus fuscus* males were 84% more likely to roost in tree stands that had recently undergone partial harvesting than stands that were untouched (Perry et al. 2008). Other evidence has shown that some bats seem to be very specific about the microhabitat surrounding their day roost, and the flexibility of a bat species in regard to the roost plays a major factor in their overall abundance and distribution (Lacki et al. 2009). Female Long-Eared bats (*Myotis septentrionalis)* were found to be 24 times more likely to be roosting in a shade tolerant deciduous tree than a coniferous tree, while male bats were found to roost almost exclusively in coniferous trees (Broders et al. 2004).

Insectivorous microbats forage most readily near broadleaved woodlands and near water, and they tend to avoid arable or sparsely vegetated lands (Walsh et al. 1996). Bats also tend not to discriminate and will readily use man made water sources such as ponds and drainage ditches for drinking and foraging just as readily as they will use a natural source (Vindigni et al. 2009). The smaller the bat is the more likely that they will forage in areas containing foliage. Similarly, the larger the bat, the higher the preference to forage in clear cut or open areas (Patraquin et al. 2003). Patraquin et al. concluded that minimal harvesting of forest had little to no effect on long term habitat utilization by bat species. There does not appear to be a great difference in bat or insect abundance at a forest edge unless the forest happens to border a grassland (Verboom et al. 1999).

Previous studies have not found a significant difference in insect abundance at a man made water source and insect abundance at a natural source (Vindigni et al. 2009). Water seems to be the biggest contributing microhabitat factor to bat abundance (Campbell 2009). This is believed to be due the density of insect life that gathers over the surface of water and the ease of access to a drinking source (Schumacher et al. 2009). Some evidence has suggested that as long as water is nearby, other microhabitat factors do not seem to have an effect on the day roost preference of bats (O'Keefe et al. 2009.)

The primary goal of our project is to determine which habitats the bat species at Pierce Cedar Creek are utilizing for foraging. We predict that, 1. bat species will not have preferences in their habitat selection for foraging, 2. insect abundance and diversity will not vary between the foraging habitats used by bats. A secondary goal of our project will be to assess the species of bats present at Pierce Cedar Creek Institute.

Methods

To begin we selected five different habitats on the Pierce Cedar Creek property that we felt had the best characteristics to be suitable as foraging habitat for bats. We selected Brewster Lake, Hyla Pond, a section of Pierce Cedar Creek, a section of swamp, and an open field near a forest edge.

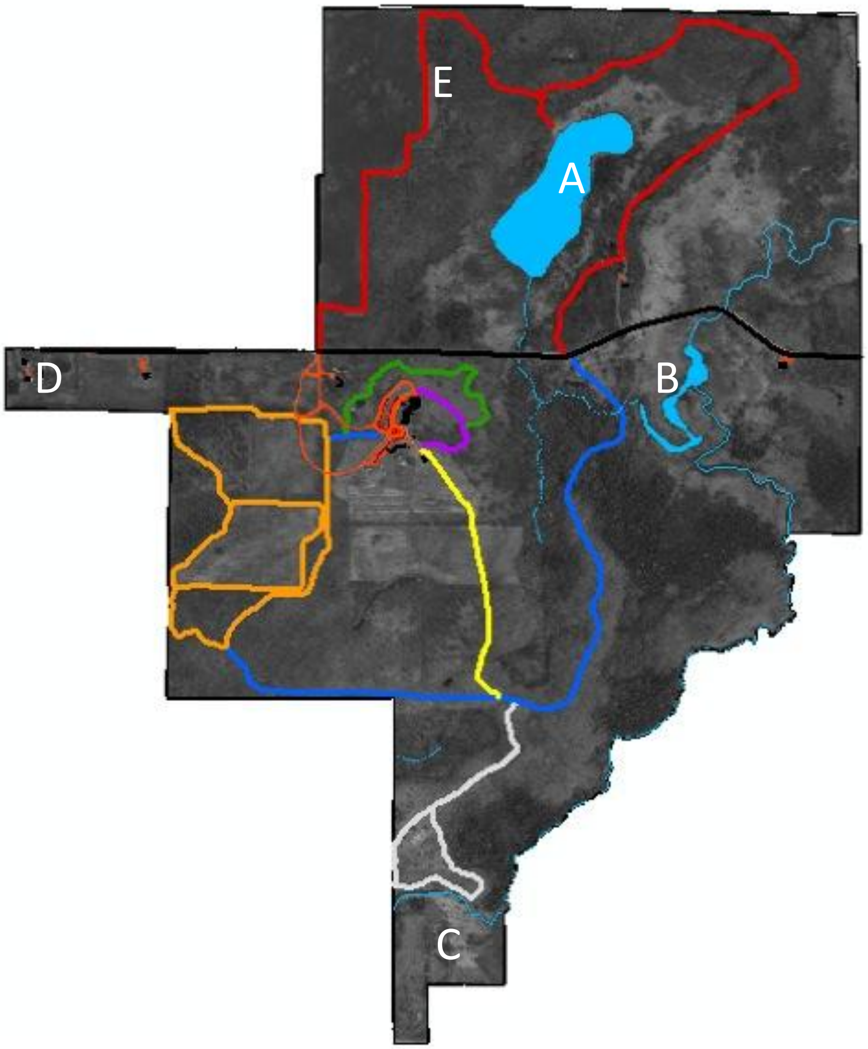

Figure 1. Sampling locations for foraging activity and insect diversity including property trails

A- Brewster Lake B- Swamp C- Pierce Cedar Creek

D- Hyla Pond E-Open Field

Each night we chose one location to sample. Sampling occurred beginning June 1st and lasted through August 5th. We did not sample on nights that it rained or nights with a 40% or greater chance of rain. We rotated through locations alphabetically. Using a Pettersson Ultrasound Detector D 240x (Pettersson Elektronik AB, Dag Hammarskjolds v. 34AS-751 83 UPPSALA Sweden) set in the time expansion mode and connected to Zoom Digital recording device (Samson Technologies Corp. 45 Gilpin Ave, Suite 100 Hauppauge, NY11788) or directly connected to our NetBook (Toshiba American Information Systems, Inc. Computer Systems Division 9740 Irvine Blvd, P.O. Box 19724 Irvine, CA 92713), we would record bat calls beginning approximately 10 minutes before sundown. The Pettersson Ultrasound Detector and Zoom recorder were mounted on a tripod that stood approximately 0.6 m off of the ground. Occasionally, we would stay with the recorder and record calls directly to our portable NetBook. Other times, we would leave the Ultrasound Detector set up and collect it and the Zoom recorder in the morning. A plastic bag was placed around them to protect the devices from the elements.

Recordings were uploaded to our NetBook and analyzed using SonoBat 2.9.5 (SonoBat, 315 Park Ave, Arcata, CA 95521) by comparing the recorded calls to a reference library of bat calls. Based on high/low frequency, duration, upper/lower slope, basic geometry, and similarity to reference calls, we identified bat species. Calls that SonoBat was unable to distinguish due to disturbances (i.e. background noise interference, illegible) were disregarded.

During the last 4 weeks of our experiment, we began insect diversity and abundance sampling. Each of the habitats where we sampled for foraging activity were also sampled for insects using a light trap. Three samples of insects per habitat were collected. Two small glass bottles were filled with ethyl acetate and placed in the bottom of the trap. The trap was powered using a 12 V battery, which was recharged after each use. The trap was collected each morning. The insects were sorted and classified down to Order then counted. We stored them in paper lunch bags and they were frozen for preservation.

Results

Four bat species were identified on the PCCI property; Big Brown Bat (*Eptesicus fucus)*, Silver Haired Bat (*Lasionycteris noctivagans),* Hoary Bat (*Lasiurus cinereus),* and the Eastern Red Bat (*Lasiurus borealis).* Looking at five different locations on Pierce Cedar Creek Property, the only difference we found between species and habitat was the presence and absence of the Eastern Red Bat (*Lasiurus borealis*) (Table 1).

Table 1. Species Present at Different Habitats at PCCI.

	Brewster Lake	Hyla Pond	Pierce Cedar Creek	Swamp	Meadow
Eptesicus fucus	+	+	+	+	+
Lasionycteris noctivagans	+	+	+	+	+
Lasiurus cinereus	+	+	+	+	+
Lasiurus borealis	-	+	-	+	-

The distribution of bats was not independent of habitat (X^2=31.98; d.f.=12; p=0.001). The distribution of Silver Haired bats and Eastern Red bats did not differ between habitats (X^2=7.79; d.f.=4; p=0.09). The distribution of Silver Haired bats and Hoary bats did differ between habitats (X^2=12.3; d.f.-4; p=0.015). The distribution of Silver Haired bats and Big Brown Bats did differ between habitats (X^2=12.06; d.f.=4; p=0.017). The distribution of Eastern Red bats to Hoary bats did differ between habitats (X^2=16.47; d.f.=4; p=0.02). The distribution of Eastern Red bats to Big Brown bats did not differ between habitats (X^2=7.32; d.f.=4; p=0.12). The distribution of Hoary bats to Big Brown bats did differ between habitats (X^2=18.3; d.f.=4; p=0.001).

The distribution of insects was not independent of habitat (X^2=582.16; d.f.=16: p=<<0.01). All piece wise comparisons of insects across habitats revealed p values less than 0.05. The distribution of beetles and moths did differ between habitats (X^2=28.8; d.f.=4; p=<<0.01); The distribution of beetles and flies did differ between habitats (X^2=198.32; d.f.=4; p=0); The distribution of beetles and leafhoppers did differ beween habitats (X^2=72; d.f.=4; p=0); The distribution of beetles and mosquitos did differ between habitats (X^2=16.7; d.f.=4; p=<<0.01); The distribution of flies and moths did differ between habitats (X^2=356.1; d.f.=4; p=0); The distribution of flies and leafhoppers did differ between habitats(X^2=161.9; d.f.=4; p=0); The distribution of flies and mosquitoes did differ between habitats (X^2=35.9; d.f.=4; p=<<0.01); The distribution of moths and leafhoppers did differ between habitats (X^2=53.8; d.f.=4; p=0); The distribution of moths and mosquitoes did differ between habitats (X^2=27.7; d.f.=4; p=<<0.01); The distribution of leafhoppers and mosquitoes did differ between habitats (X^2=55.2; d.f.=4; p=0).

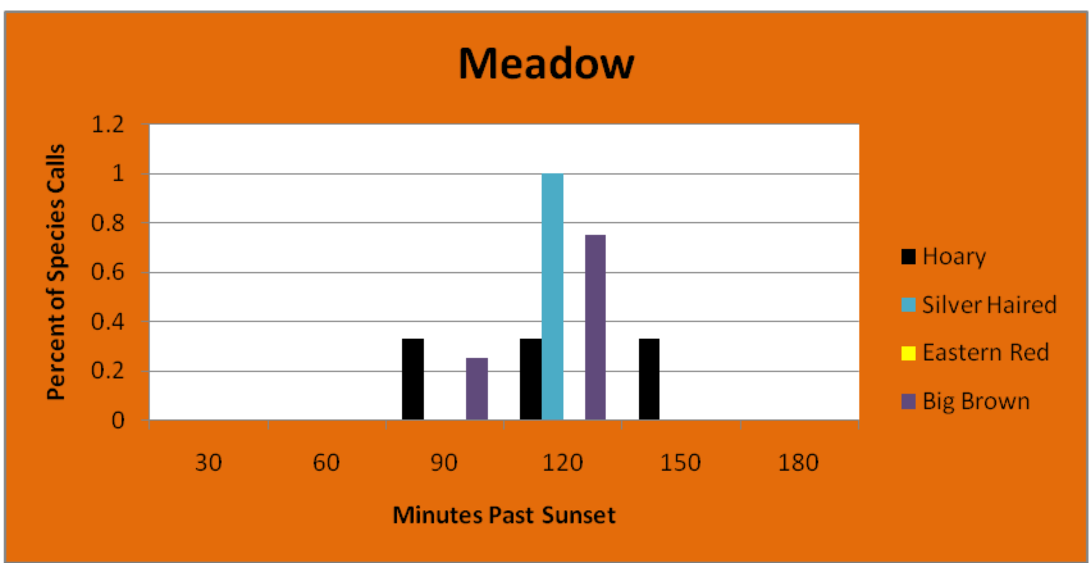

Figure 2. Percent of species calls after sunset at meadow

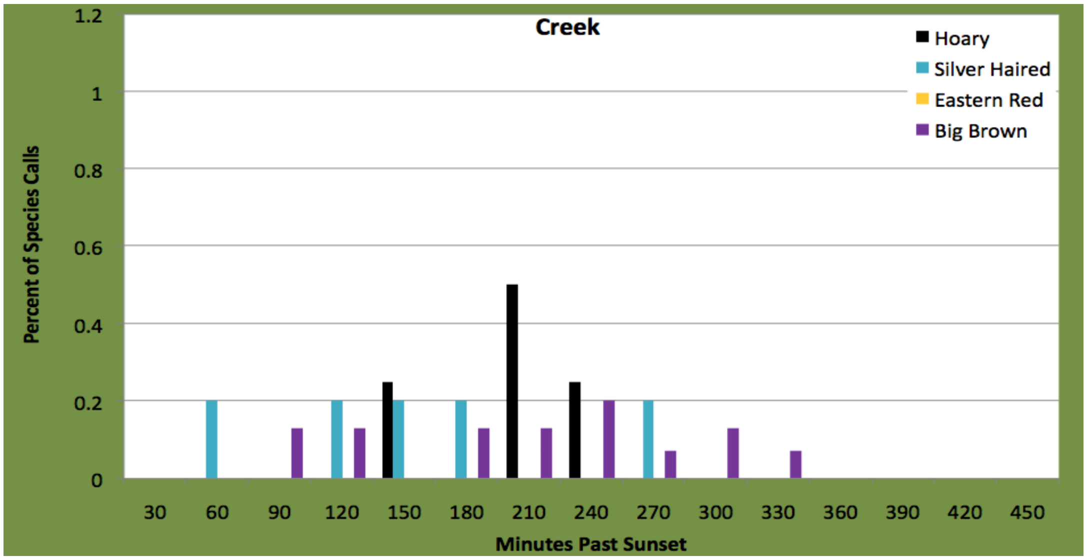

Figure 3. Percent of species calls after sunset at creek

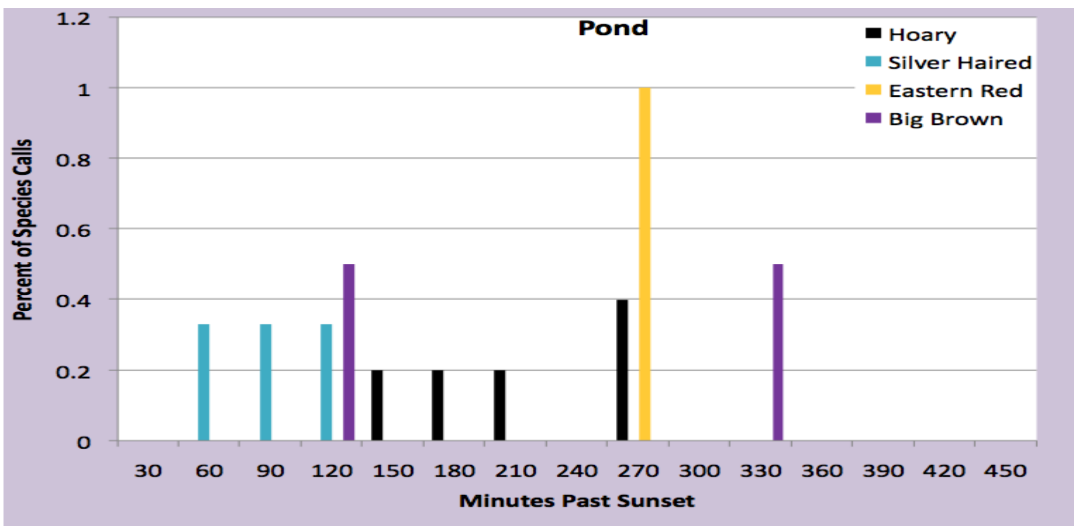

Figure 4. Percent of species calls after sunset at pond.

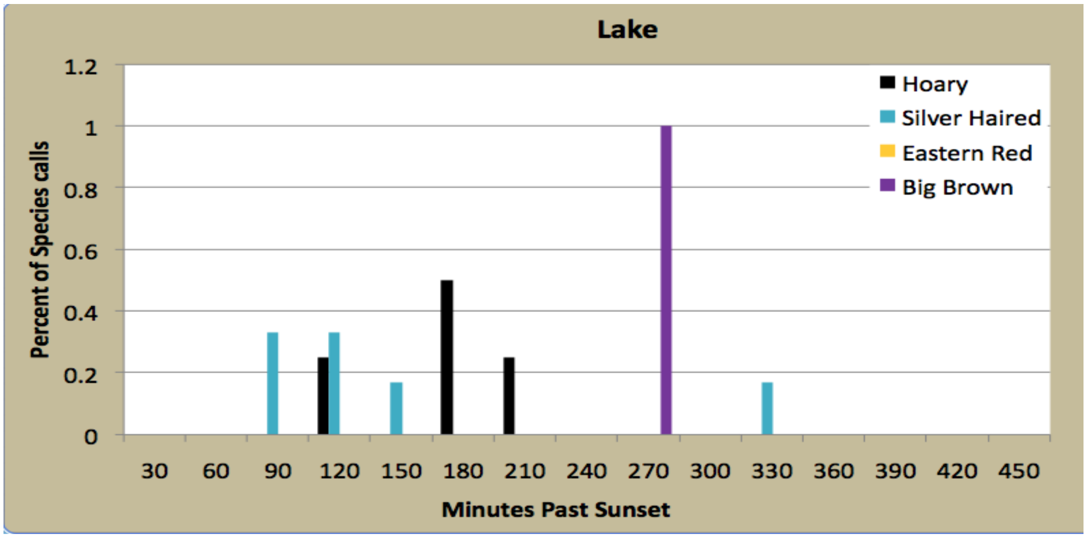

Figure 5. Percent of species calls after sunset at lake.

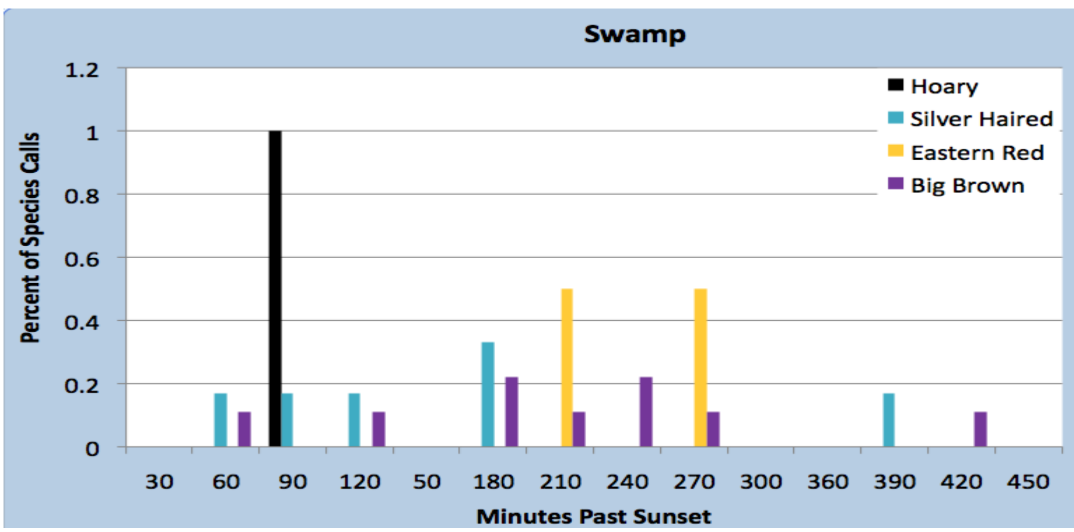

Figure 6. Percent of species calls after sunset at lake.

When combined, we found Silver Haired bats emerging at the same time as Big Brown bats, as well as peaking in activity at the same time. Eastern Red bats emerged between 210 and 270 minutes past sunset while the Hoary bat ended early in the night (Figure 7).

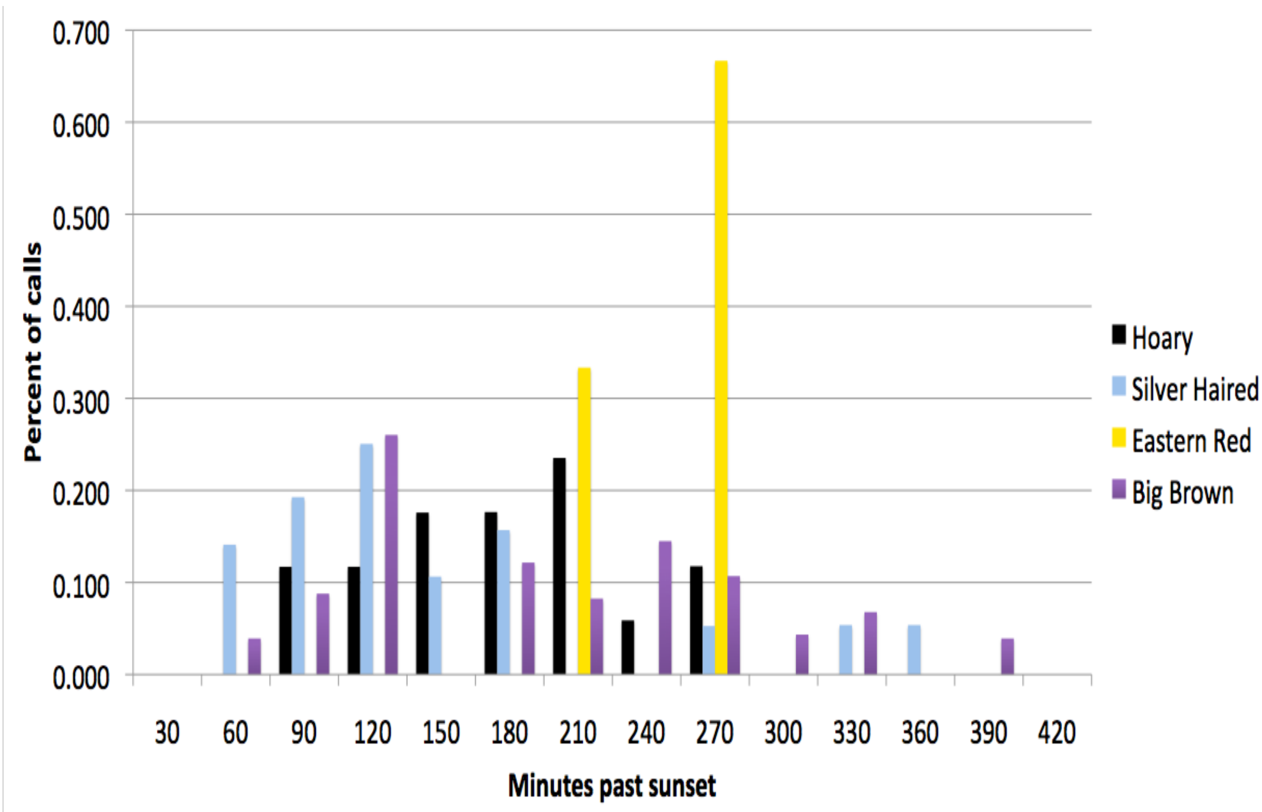

Figure 7. Percentage of species calls after sunset over PCCI property summer 2010.

When the insect data was analyzed statistically, we found that every habitat had a p-value less than 0.05, therefore they were all significantly different from each other. Although since the water habitats had no difference between species, there was no correlation between Insects and the habitats bat species chose (figures 8 and 9).

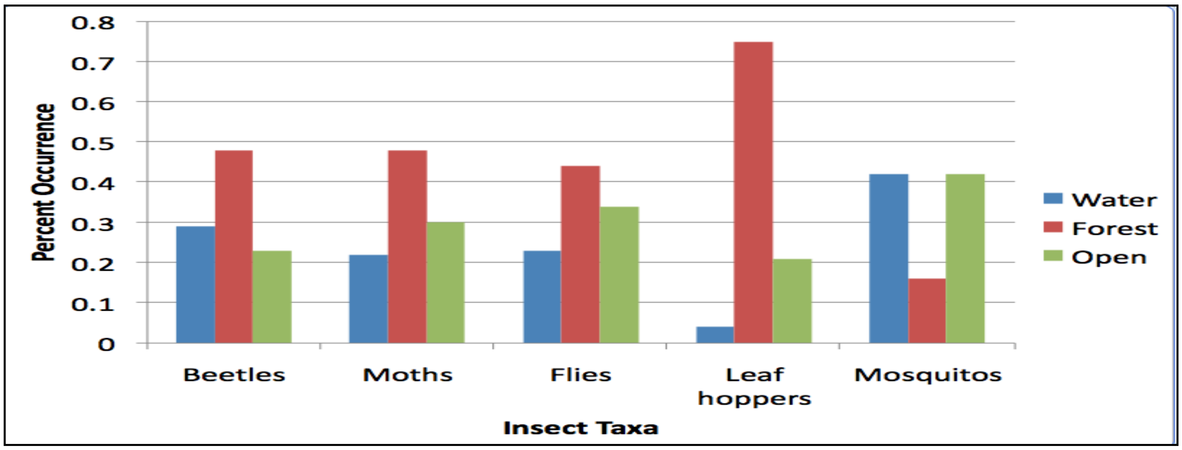

Figure 8. Percent occurrance of insects at water, forest, and open habitats.

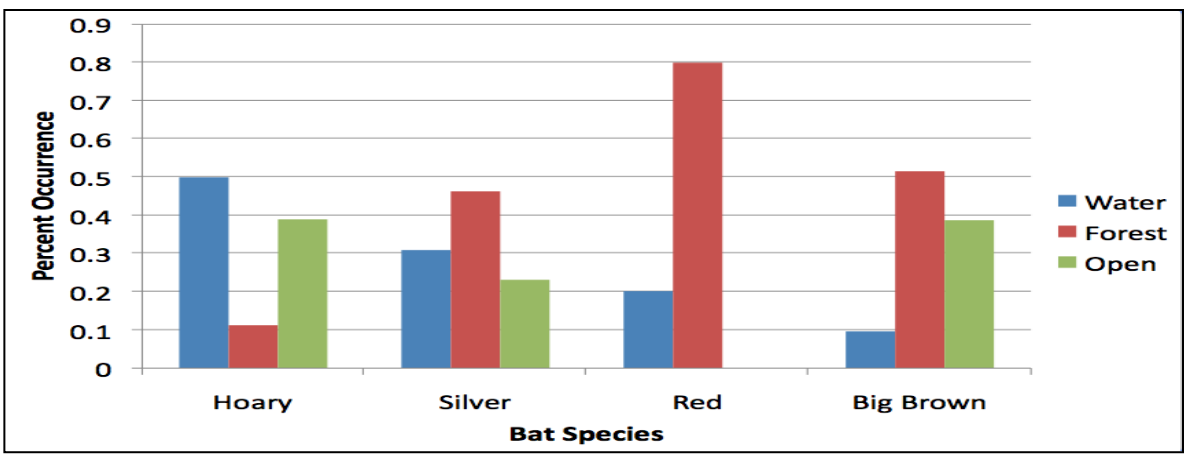

Figure 9. Percent occurrence of bat species at water, forest, and open habitats.

Discussion

Our first objective was to provide PCCI with a species inventory. Originally, we suspected to find mostly little brown bats (*Myotis lucifugus*) because they are one of the most common in the Great Lakes region, but to our surprise we found none. We did however successfully find four other species, The Big Brown Bat (*Eptesicus fucus*), Hoary Bat (*Lasiurus cinereus*), Eastern Red Bat (*Lasiurus borealis*), and the Silver Haired Bat (*Lasionycteris noctivagans*).

We also found that there was only a difference in species habitat selection on PCCI property for the Eastern Red Bat (*Lasiurus borealis*). The Hoary (*Lasiurus cinereus*), Big Brown (*Eptesicus fucus*), and Silver Haired Bat (*Lasionycteris noctivagans*) were found in all five habitats we observed, while the Eastern Red Bat (*Lasiurus borealis*) was only found at Hyla Pond and the swamp off of Blue Trail. This indicates that Eastern Red Bats (*Lasiurus borealis*) prefer foliaged wetland areas, while the other three species were less selective with their foraging sites. Eastern Red bats have the strongest affinity for foliaged wetlands because they prefer to forage in areas that contain a high number of aquatic invertabrates , while Big Brown Bats are more general by foraging and roosting in multiple habitats (Lookingbill et al. 2010). The statistical tests we conducted for this had minor problems because of the amount of zeros in our data.

Another goal of this study was to determine if different species are active at different times in the night. When looking at the data as a whole we noticed that there was not a large temporal difference between bat species, in fact the Big Brown Bat (*Eptesicus fucus*) and Silver Haired Bat (*Lasionycteris noctivagans*) were active at the same time and even peaked in the same hour. However, we discovered that when spatially portioned by habitat the majority of Silver Haired Bats (*Lasionycteris noctivagans*) forage within the first few hours after sunset, whereas Hoary (*Lasiurus cinereus*) and Big Browns (*Eptesicus fucus*) tend to come out later. Species behave this way in order to avoid foraging competition with each other. In communities where there is species coexistence, temporal partitioning allows for different species to obtain proper access to space and food which enhances local richness (Castro-Arellano et al. 2010). In addition, we noted that in the open field location, foraging was entirely in the early evening, suggesting that bats migrate to a different area throughout the night. Bats avoid open areas at certain time intervals when there is high lunar illumination, because it subjects them to increased risk of predators (Presley et al. 2009).

Lastly, we found no correlation between insect diversity and the habitats bat species chose to utilize. This gives evidence that bats are less concerned about a specific diet, and are more focused on the characteristics of their foraging surroundings. Bats tend to forage in vegetation immediately surrounding their roost sites, and are primarily concentrated in riparian habitats (Fellers, Pierson 2002).

In conclusion, Pierce Cedar Creek should not drastically change any portion of their property. The diverse habitats allow bats to partition PCCI both temporally and spatially, which permits a healthy amount of bat species to reside on the property. Any large changes could result in the disturbance in the roosting and foraging habits of multiple bat species at PCCI.

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