Determining proper bat activity survey methods for the monitoring of the effect of *Pseudogymnoascus destructans* in Michigan bat populations

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Abstract

Pseudogymnoascus destructans, a fungal infection of European origin, was introduced to Michigan in the spring of 2014. The fungus is believed to wake hibernating bats more often than normal, which can be a problem because coming out of torpor decreases fat stores and makes it hard for bats to survive the winter months. It is important to determine an effective way to survey bat activity and obtain a baseline measurement of bat activity before *P. destructans* affects Michigan bat populations. Our study aims to find a way to monitor bat activity in order to give us an idea of how *P. destructans* might affect bat colonies.

We monitored bat activity along two routes at the University of Michigan Biological Station (45.56 N, 84.67 W) for 7 weeks and compared it with wind speed, time after sunset, temperature, lunar phase, barometric pressure, humidity, and date. Our measurement of bat activity was strongly positively associated with time after sunset (Least-Squares Regression Slope=-0.02, F=16.674, $p<0.001$) and temperature (Least-Squares Regression Slope=2.08, F=4.851, p=0.034). We also found a decreasing relationship, although not statistically significant, between bat activity and date (Least-Squares Regression Slope=-0.502, F=2.511, p=0.122). Our results showed that an effective way to monitor bat activity is by monitoring activity on warmer nights closer to sunset. This allows studies to control for the variables that impact bat activity and focus on the effect of *P. destructans.*

Introduction

In recent years bat populations on the eastern seaboard and throughout the Midwest United States have greatly decreased due to the fungal infection *Pseudogymnoascus destructans* (formerly *Geomyces destructans*), commonly known as White-nose Syndrome (WNS), which grows on the skin of hibernating bats (Lorch, 2011). Afflicted bats wake frequently from hibernation due to irritation from the fungus. It is normal for bats to wake up occasionally, but when bats come out their hibernating state they burn off their stores of fat; if they wake too often they do not have sufficient energy stores to make it through the winter, and they often die.

Pseudogymnoascus destructans is of European origin and arrived on the eastern seaboard of North America in the winter of 2006-2007. It has since spread west and was officially confirmed in Michigan hibernacula in April of 2014 (USGS, 2014). *Pseudogymnoascus destructans* has particularly affected hibernating colonies of little brown bats (*Myotis lucifugus*) because of their high metabolism and small size. They also hibernate in large groups, allowing for increased transmission of the fungus during the winter months. In some caves, mortality rates have been as high as 90% of the hibernating population (Cryan, 2010).

Myotis lucifugus is a common species throughout North America and Michigan, but its numbers have been rapidly declining. With the recent introduction of *P. destructans* in Michigan it is important to determine baseline levels for activity of bats to see if the levels change in future years, as *P. destructans* is transmitted among bat populations in Michigan. We also used the opportunity to research bat activity in response to weather and temperature changes throughout seven weeks of the summer. Our goal was to use this information to improve the timing and methodology of future activity surveys.

Methods

We observed bat activity on the University of Michigan Biological Station (UMBS) campus (45.56 N, 84.67 W) in Cheboygan County in the northern lower peninsula of Michigan. The study took place over seven weeks from June 26 to

August 2, 2014. The UMBS campus is residential and located on the shore of Douglas Lake. Nightly, we walked two predetermined 0.4 mile routes and used an Anabat bat detector to record the activity of *M. lucifugus*. Though there could be other bats living in this area (Kurta, 1995), *M. lucifugus* is known to be the most common and we did not attempt to distinguish between *Myotis* species, assuming each call we heard was *M. lucifugus*.

Aspen and pine trees dominated both routes (http://sitemaker.umich.edu/umbs/files/cover.gif; Figure 1). The route traversed by Route 1 was slightly higher than Route 2 and heavily wooded. Route 2 was more residential and along the lakeshore. Both routes started and ended at the same established bat colonies. At the beginning of the study, we observed bat activity around the roosts in five-minute intervals to identify peak time of emergence, which we concluded to be approximately 45 minutes after sunset. We walked each route nightly at peak activity time. Observers walked each 0.4 mi route in 10 to 15 minutes.

While walking the routes, we held the Anabat bat detector at chest height, pointed forward and slightly angled upward. We set the detector volume to 7, division ratio to 8, and sensitivity to 9. We used data on wind speed, temperature, barometric pressure, and humidity recorded by the UMBS buoy (http://uglos.mtu.edu/station_page.php?station=UMBIO). If we used a flashlight, we placed a red filter over the light so as not to disturb bat activity. We measured activity by adding one point to the click counter once every time we heard a series of three or more uninterrupted clicks. We marked the end of the series of clicks if the clicking stopped for a second or more. At the end of each route we noted how many series of clicks we recorded and then reset the click counter to zero. For the second half of the study period we reversed the order in which we ran the routes on alternate nights in order to avoid differences in bat activity due to time after sunset.

Results

We found no significant difference between the two routes (Mann Whitney U Test, N=62, MWU Value=428, p=0.459; Adams 1976). Data from the two routes were combined in all further analyses. Bat activity appeared not to be related to wind speed, barometric pressure, humidity, or lunar phase (Figures 2-5). Activity appeared to decline with date (Figure 6), but the relationship was not statistically significant (Least-Squares Regression Slope=-0.502, F=2.511, p=0.122).
Bats were significantly more active on warmer nights than colder nights (Least-Squares Regression Slope=2.08, F=4.851, p=0.034; Figure 7). Activity recorded was also higher when the survey began closer to sunset rather than later in the night (Least-Squares Regression Slope=-0.02, F=16.674, p<0.001; Figure 8).

Discussion

Our findings suggest that time after sunset and temperature both affected measurements of the activity level of *M. lucifugus* whereas humidity, barometric pressure, wind speed, and lunar phase did not. We can use these data to help us determine an effective method for monitoring the effect of WNS through bat activity in future years. Because bats seem to be more active soon after sunset, activity monitoring should be done closer to sunset than later in the night. Bats likely come out around sunset for an early round of foraging and then come out again later after digesting food, as their major foraging period is closer to two to three hours after sunset (Kurta, 1995). The trend of activity earlier on may be because they travel farther away to forage as the night goes on and they are no longer near the routes we chose. On nights where the temperature is lower, bat activity declines, possibly because fewer insects are available on colder nights. The decreasing trend with date may be due to a change in prey abundance or size as the season progresses, but we did not research insect blooms so the reason for this trend is unclear. It may be useful to pay attention to insect activity in future bat activity research.

These data are important in analyzing future activity surveys of *M. lucifugus* and other bat species. Our results suggest that future bat surveys can get better data by recording activity closer to sunset and on warmer nights. Our data also showed that barometric pressure, lunar phase, humidity, and wind speeds do not have an effect on the activity of bats and are therefore not as important to monitor in future studies. Studies should also be performed around the same range of dates in order to control for the apparent decreasing trend in activity that we found.

Knowing which variables affect bat activity helps us determine which variables to control for. This allows future surveys to better monitor changes in activity due to *P. destructans* rather than other factors. It should be noted that our method of survey is only capable of showing relative activity, and not quantitative population counts. However, by researching relative bat activity, we can indirectly get an idea of the size of the population. With the introduction of White Nose Syndrome into Michigan, it will be even more important to know how healthy our bat populations are in the coming years.

Figures

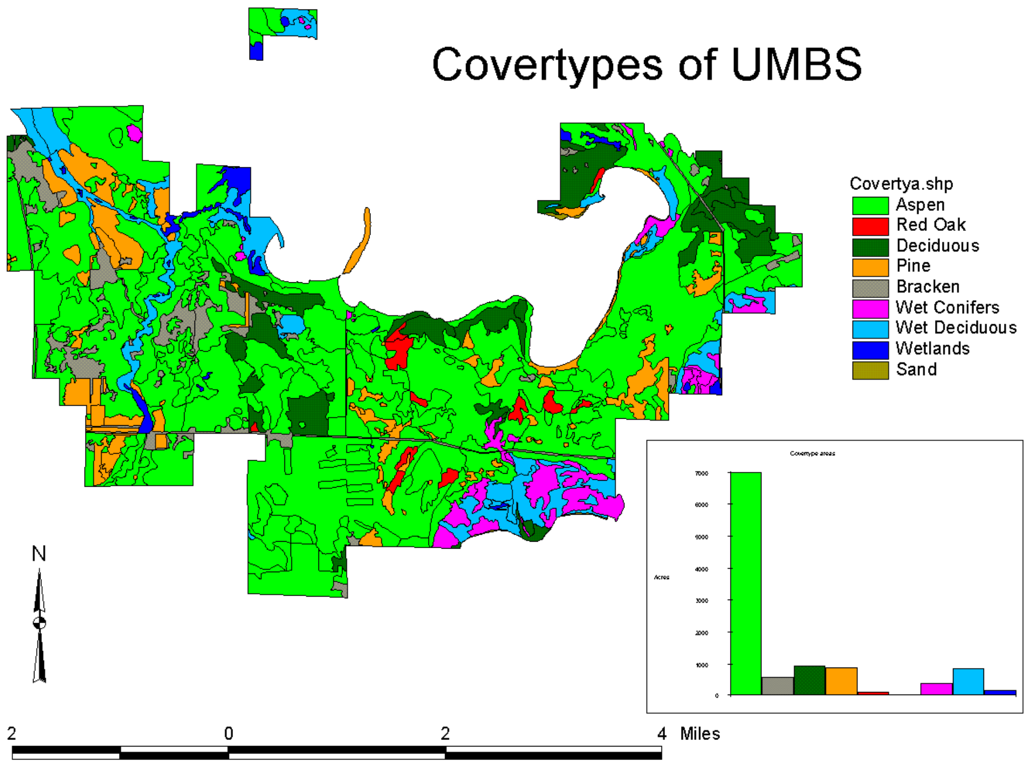

Figure 1: Covertype map of UMBS property. Mainly dominated by aspen with bracken, pines, and deciduous trees present as well.

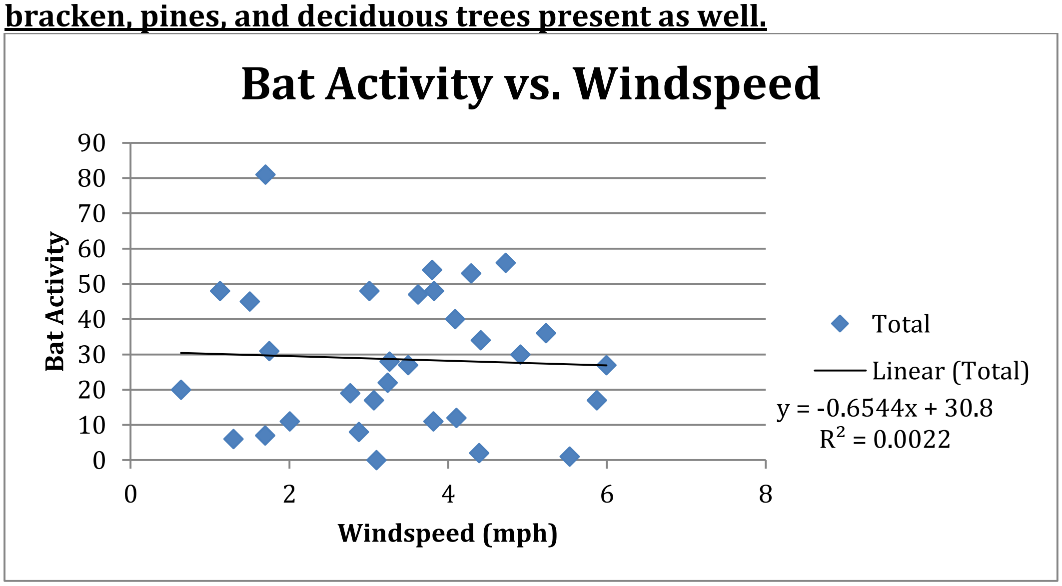

Figure 2: Comparison of bat activity with wind speed. There is no obvious correlation between the two.

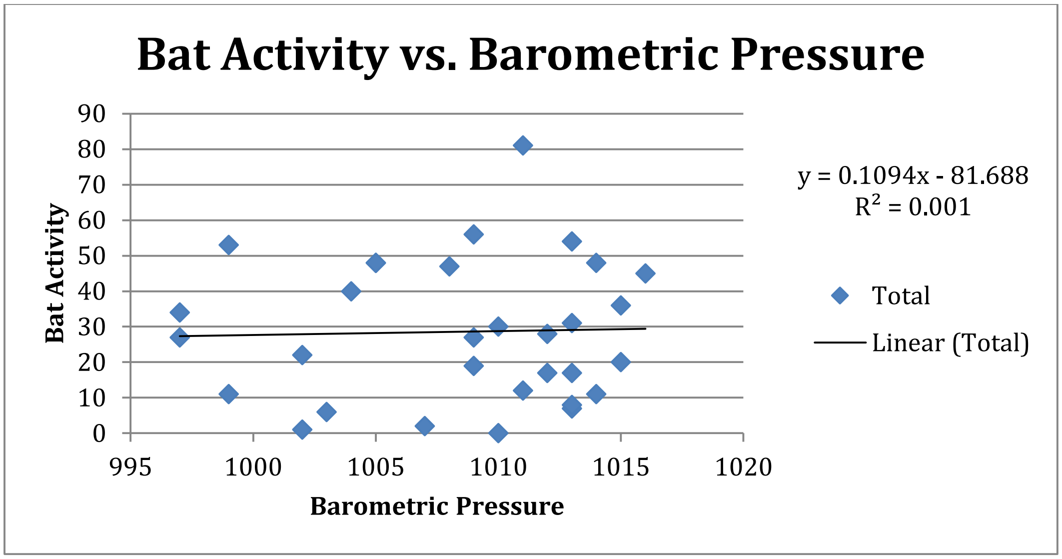

Figure 3: Bat activity compared to Barometric Pressure. No statistically significant relationship.

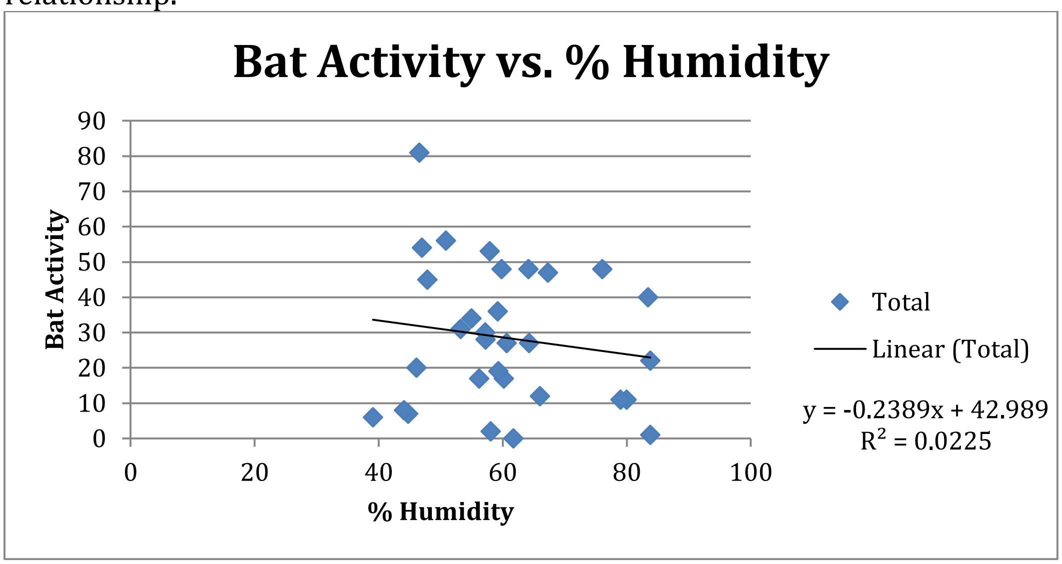

Figure 4: Bat activity compared to % Humidity. There is no statistically significant relationship between the two.

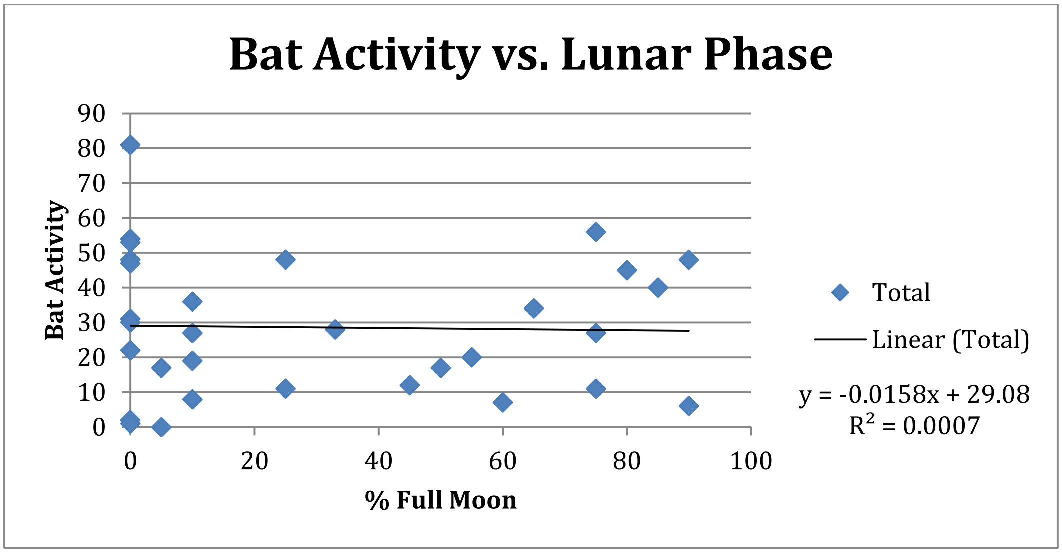

Figure 5: Relationship between Bat Activity and Lunar Phase is nearly non-existent. R^2 value is almost 0.

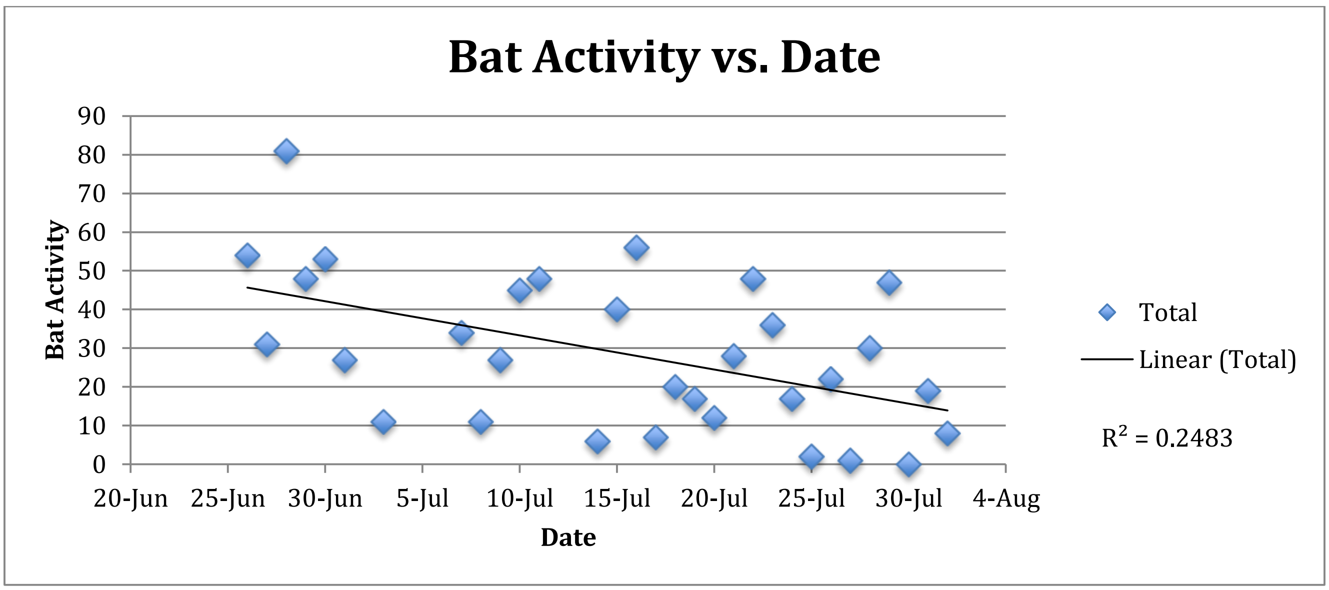

Figure 6: An apparent decline in activity with date. This is not statistically significant, but there does appear to be a pattern.

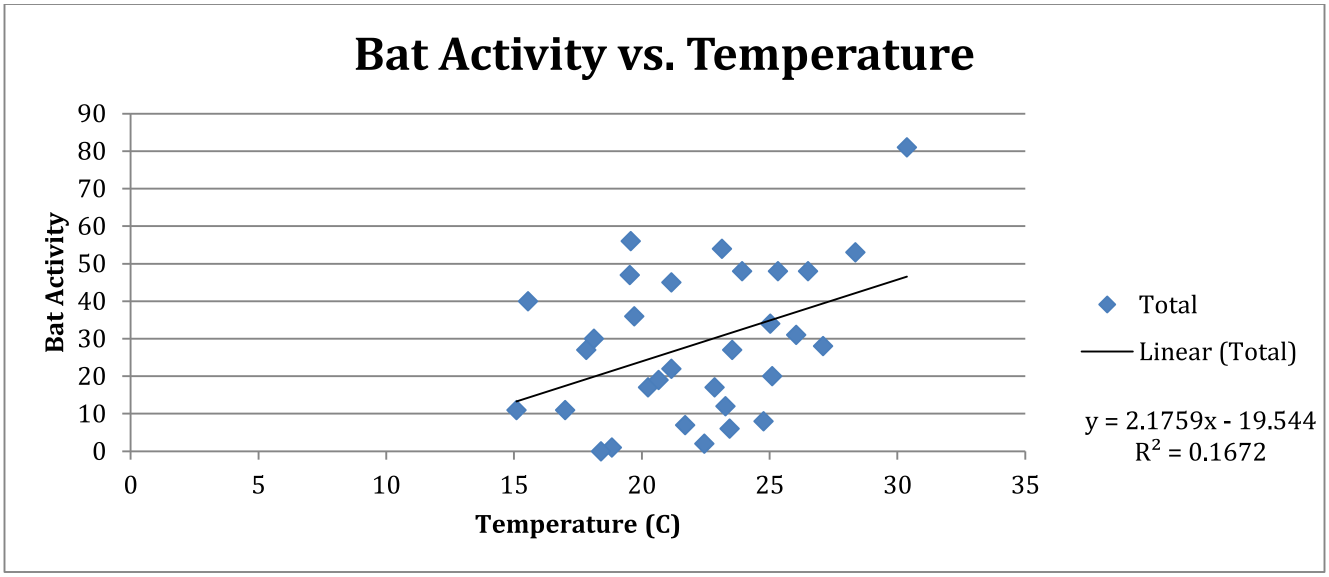

Figure 7: The relationship between temperature and bat activity is statistically significant. There is an obvious positive trend as temperature increases.

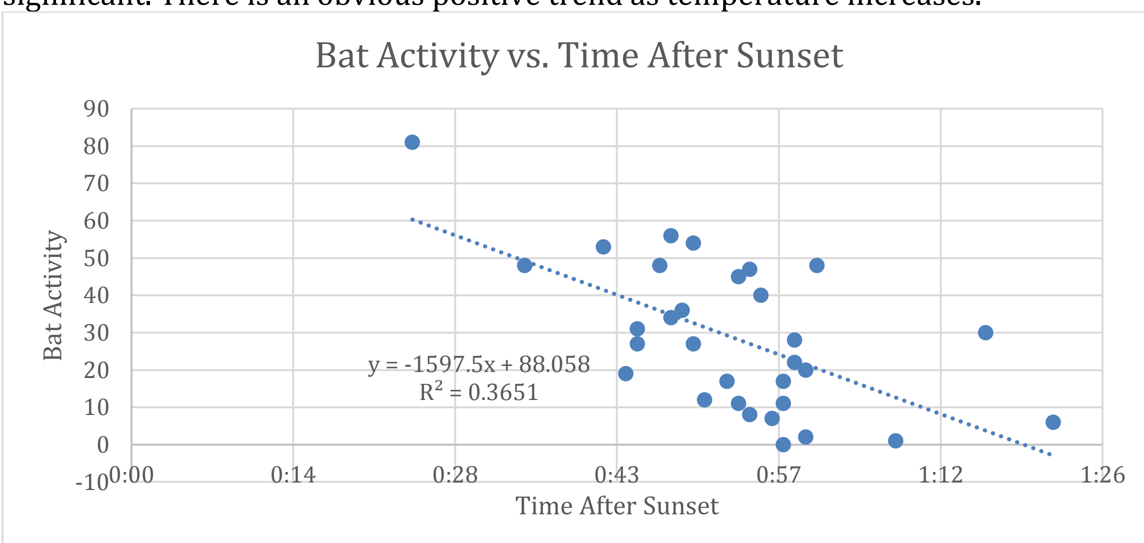

Figure 8: Obvious downward trend as time after sunset increases. There is a statistically significant relationship between bat activity and the amount of time that has passed after the sun has set.

<u>Acknowledgements</u>

I want to thank the 2014 EEB 453 class for helping with data collection and management. Also thank you to Dr. Phil Myers and Kayla Paulson, the professor and teaching assistant for the course for providing important feedback and helping design and carrying out the research we did. I would also like to thank my family members, who have always been there to help me if I need it.

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