Bat-Tacular! Investigating the Effects of Urban And Environmental Features on Bat Populations

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INTRODUCTION

Bats (Chiroptera) have many of the identified characteristics that make a certain taxa viable to become a bioindicator, a species whose status tells us about the health of the ecosystem. Because they are one of the most abundant groups of mammals and present in various geographical locations, bats are easy to sample using acoustic monitoring and active monitoring. Additionally, insectivorous and frugivorous bats play many roles in their ecosystem including maintaining the numbers of nocturnal insect species, pollinating certain plant species, and serving as a food source for predators.[1] Research has shown that bats are sensitive to both environmental and anthropogenic changes.[2] Although many recognize the potential of bats as an indicator species for various ecosystems, few studies have explored the feasibility of bats as a bioindicator species capable of indicating the urbanization effect. The goal of this study was to see if correlations existed between bat activity and urban and environmental factors including artificial light, canopy cover, noise level, and insect—especially moth—richness. In our study, both active and passive monitoring were used to collect data on bat activity and diversity on the seven species found in the zoo: Eastern Red bat (*Lasiurus borealis*), Big brown bat (*Eptesicus fuscus*), Hoary Bat (*Lasiurus cinereus*), Silver Haired Bat (*Lasionycteris noctivagans*), Little Brown Bat (*Myotis lucifugus*), Tri-Colored Bat (*Perimyotis subflavus*), and the newly recorded Northern long-eared myotis (*Myotis septentrionalis*).[3] Data on insect abundance and diversity were collected by surveying insects caught through black light traps.

Fig 1. A chart of all bats found in the zoo.

METHODS

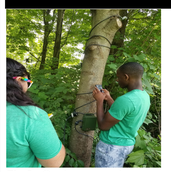

Fig 2. Our team securing an ultrasonic recorder to a tree.

Passive Bat Monitoring

Our project utilized the SM4BAT ultrasonic recorder(Wildlife Acoustics) in eight different sites around the zoo. We fastened the recorder onto a suitable tree and then connected an ultrasonic microphone which we usually hung over a branch. Over a period of 3-6 nights, the recorder captured the ultrasonic bat calls from civil twilight to civil sunrise onto an SD card.

Blacklight Insect Trap

We chose three locations in the bronx zoo to set up our light traps. The insects were attracted to a blacklight powered by a car battery and secured to the top of the bucket by a metal vane. In order to trap and drown the insects, we filled the buckets with a soap water solution. We had to wait for adequate weather before putting the buckets in the location, so they would not overflow with rainwater. Once we had the insects in the bucket, we filtered them out onto a tray and allowed them to air dry for a few hours. Then, once the organisms were dry we counted the total abundance of insects, total richness, and moth richness.

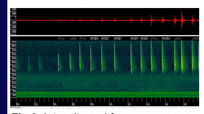

Fig 3. Intensity and frequency range of one of the bat calls after running it through Kaleidoscope.

Bat Call Analysis

In order to analyze the data collected from the bat monitors, we used the Kaleidoscope ultrasonic analysis software(Wildlife Acoustics) which automatically identifies different species of bats by their calls. We were then able to quantify the amount of bat pulses made and filter by the time and date in order to further organize and analyze the data.

Fig 4. A completed blacklight trap

Active Monitoring

In order to actively monitor bat activity, we went on night hikes around the Bronx zoo around sunset. Using the Echometer(Wildlife Acoustics) app and its corresponding ultrasonic module, we were able to hear bat calls in real time, which are normally undetectable by the human ear. This app had a feature that identified the species of bat as well. Although no data were collected, this information helped aid our visual observations: flight patterns, hair color, size, territory range, and other visual information we could pick up.

Fig 5. The portable recording unit used during the active survey.

RESEARCH QUESTIONS

1. Question: What effect does artificial lighting have on bat activity?
Hypothesis: There will be more bat activity in the area with artificial light sources.
2. Question: What effect does canopy cover have on bat activity?
Hypothesis: There will be more bat activity in areas with less canopy cover.
3. Question: What effect does the proximity to the urban edge have on bat activity?
Hypothesis: There will be more bat activity in sites closer to the interior of the zoo.
4. Question: Is there a relationship between bat activity and insect abundance?
Hypothesis: There will be more bat activity at sites with greater insect abundance.
5. Question: How does bat activity vary throughout the night?
Hypothesis: Bat activity would stay at a constant level throughout the night.

RESULTS

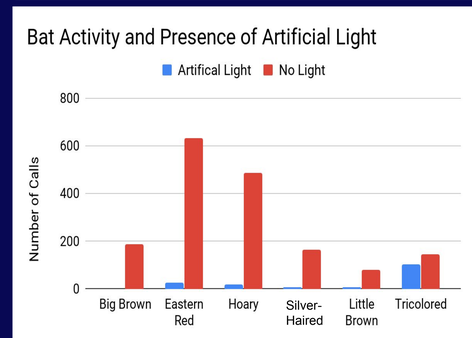

Fig 6. A Comparison of bat activity and diversity between TRUE Trailer and Congo Site.

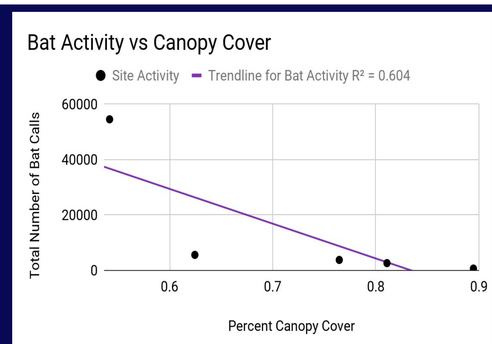

Fig 7. Relationship between bat activity and percent canopy cover within a 50 meter radius of monitor placement at 5 different sites.

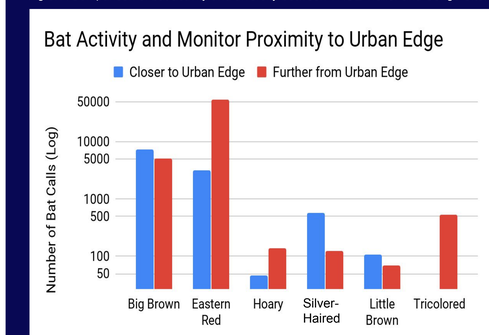

Fig 8. A Comparison of bat activity and diversity between Site 5 and Site 6.

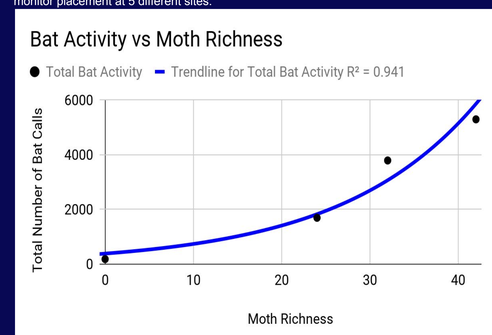

Fig 9. Relationship between bat activity and moth richness at 4 different sites.

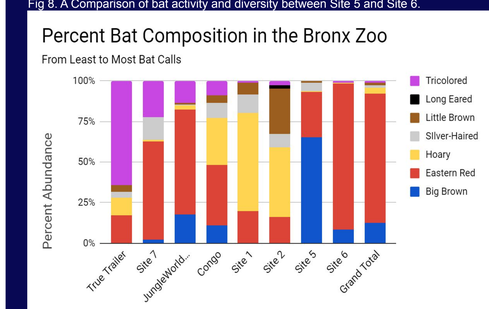

Fig 10. Breakdown of what species were present in which quantities at different zoo sites.

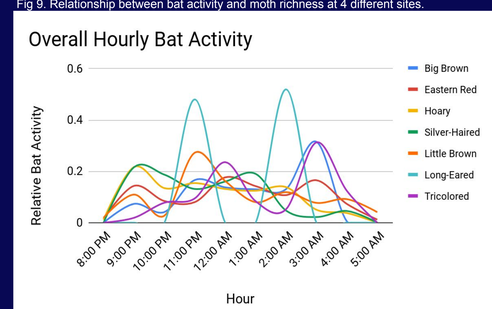

Fig 11. Proportional total bat activity per hour for all species.

DISCUSSION/CONCLUSION

Artificial Light

Knowing that many moths and insects are attracted to light, our hypothesis stated that we will see more bat calls at the site with artificial light sources because they will be able to easily hunt prey gathering there (Figure 6). After comparing bat activity at the Congo Site and the TRUE Trailer, there was an abundance of more calls in the Congo Site which had no light sources at night, thus these data ***do not support our hypothesis (Q1)***. The greater evenness found in Tricolored Bats can be explained by their specialization in light hunting.[4] Further research can be done by placing a black light trap at sites with artificial light to see if there is a correlation with moth richness and bat activity.

Canopy Cover

Despite the greater amount of bats found at the green roof, the data show that there is more bat activity at sites with a smaller percentage of canopy cover and little to no anthropogenic features nearby such as artificial lights or active roads (Figure 7). These findings ***support the Canopy Permeability Hypothesis (Q2)*** that dictates that bat activity increases as canopy cover decreases.[5] Furthermore, most bats would avoid hunting in dense low canopy cover as it makes it more challenging to find their prey using echolocation.

Fig 12. A map of the used sites in the Bronx zoo

Proximity to Urban Edge

We compared two areas within the Bronx zoo which both had 0% canopy cover as the common characteristic. Overall, the data show that bats were more active in an area closer to the interior of the zoo, despite being a man-made structure, than an area closer to the edge of the zoo (Figure 8). These findings ***support our hypothesis (Q3)***. The anthropogenic noise coming from outside of the zoo can negatively affect some bat species' activity, but further research must be done in order to determine if some bats are more adaptable and why some bat species prefered the area closer to the edge of the zoo.[6]

Insect Abundance

The data showed little to no correlation between bat activity and insect abundance or diversity, thus ***not supporting our original hypothesis*** **(Q4)**. However, there was a direct correlation between moth richness and bat activity (Figure 9). Considering that moths are bat's main food source, it makes sense that there was more overall bat activity at sites where we saw a greater diversity of moth species.

Fig 13. displays our collection of pinned moth species.

Nightly Activity and Composition

We expected that all six bat species' activity would stay at a constant level throughout the night. However, the data shows that around 8PM to 9PM, the activity levels spike for the more abundant species (Figure 10). The less abundant species appear to have a delayed appearance, only spiking in activity around 11PM to 12AM. With the exception of the silver-haired bat, all species' activity spike at around 2AM to 3AM before waning as we approach sunrise. As a result, this data ***does not support the hypothesis*** **(Q5)**. Night time bat activity is concentrated right after sunset before the nightly temperature decreases to its minimum which supports studies linking bat activity with temperature.[7] It is clear in Figure 11 that the Eastern Red Bat is the most abundant species overall with Big Brown Bat coming in second. Despite the Eastern Red's overall presence, other species of bats have dominance in different sites around the zoo, suggesting that there are habitat characteristic preferences among all the species.

Conclusion

Our data support previous studies emphasizing bat sensitivity to habitat characteristics and show that bats can be feasibly used as a bioindicator of urbanization. Due to their sensitivity to artificial light, canopy cover, moth diversity, noise levels, and temperature, and the devastating appearance of the White-Nose Fungus, we expect to see changes among bat species populations.

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