Acoustic Monitoring in an Urban Landscape: Parks versus Residential Areas

Angie Price
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Abstract

The importance of bat conservation is at an all-time high historically. With increasing urbanization and habitat destruction, bats face more concerns than ever before. The viability of urban habitat in sustaining bat populations is an urgent concern. This study sought to research the abundance and diversity of bat species within an urban city, as well as whether or not the presence of parks might have an effect on both diversity and abundance. Results were mixed, with a number of external factors such as weather and inaccessibility interfering with data collection attempts. An action component was created of leading a bat tour to educate and encourage local interest in bats, as well as provide conservation possibilities and alternatives.

Introduction

Bats are widely noted as a keystone animal group; with over 1,300 species, they comprise around one-fourth of mammal species worldwide, and they are often regarded as foundational drivers and important contributors in ecosystems (Stahlschmidt & Brühl, 2012; Bat Conservation International, 2017). Urban development generally detracts from species abundance and diversity both among bats in ecosystems; this is due to everything from direct habitat destruction to anthropogenic developments that negatively impact animal species, such as light and sound pollution (Kurta & Teramino, 1992; Avila-Flores & Fenton, 2005).

Green spaces within urban landscapes can operate as stopgaps and serve as oases in some cases for maintaining pockets of ecosystems and their inhabitants (Oprea, Mendes, Vieira, & Ditchfield, 2009; Esbérard, Luz, Costa, & Bergallo, 2014; Arias-Aguilar, Chacon-Madrigal, & Rodriguez-Herrera, 2015; MacGregor-Fors, Escobar, Rueda-Hernández, Avendaño-Reyes, Baena, Bandala, & ... Utrera-Barrillas, 2016). There are a variety of urban landscape types available for bats to use (open spaces, residential, vegetative cover, park areas); actual bat utilization of particular spaces can reflect the differences in long-term viability for bat survival in an area. Although results can vary, certain landscape types in urban locations have been shown to be more beneficial for certain bat species, particularly areas with more vegetative cover (Dixon, 2012).

Acoustic monitoring has grown in recent years as a non-invasive method for detecting bat species (Rodhouse, T. J., Vierling, K. T., & Irvine; Stahlschmidt & Brühl, 2012; Fenton, Keeley, & Tyburec, 2017). Using a bat detector, researchers can often record data of species that cannot be detected via other methods; this may include species that are unlikely or less likely to be encountered in physical capture methods (mist-netting and harp-trapping); this might include particularly high-flying bat species or those in more difficult-to-access habitats. Acoustic monitoring can also potentially capture data for more instances of bats in a wider area expanse with less equipment and manpower, depending on the setup. While it may not be the best and only tool for all situations, acoustic monitoring is a very important tool that bat researchers can utilize to create a more accurate and representative picture of bat populations in urban environments.

Bats specifically in the southeast do not have extensive published literature on acoustic monitoring readily available. One of the positive attributes of studying bats in the southeastern

United States is a longer study period that in some colder northern areas when bats may be hibernating or migrated. Bernard and McCracken (2017) completed studies on bats in the southeastern United States and specifically bats in Tennessee found that bat species in this region were active in foraging throughout winter, regardless of temperature, down to -13 degrees Celsius (~8.6 degrees Fahrenheit). Temperatures recorded during this study in Memphis ranged from around 11 to 27 degrees Celsius (52 to 80 degrees Fahrenheit). This study sought to sample the bat species diversity and abundance in an urban area with little to no data available already, as well as look at whether trends might be visible in bat utilization of park areas versus more developed urban, commercial, and residential areas.

Methods

Study Area

This study was conducted in the Memphis metropolitan area, also called the Memphis combined statistical area. This consists of ten intersecting Tennessee-Mississippi-Arkansas counties in an area known colloquially as the Mid-South (City Population, 2016). This area has a population of over 1.3 million people and an area of over 12,900 square kilometers (City Population, 2016). (I would say this is definitely urban) There are over 100 city-run parks in Memphis alone, with numerous others in the surrounding areas. Like any sizeable urbanized area, there is also a variety of landscape coverage and development throughout the city. Parks in the Memphis area were visited, as well as control sites. Each control site was measured to be at least half a mile from any official parks, and included both urban and residential/suburban areas. This method of measurement was loosely adapted from an amalgamation of several different acoustic monitoring studies (Avila-Flores, & Fenton, 2005; Loeb, Post, & Hall, 2008; Arias-Aguilar, Chacon-Madrigal, & Rodriguez-Herrera, 2015).

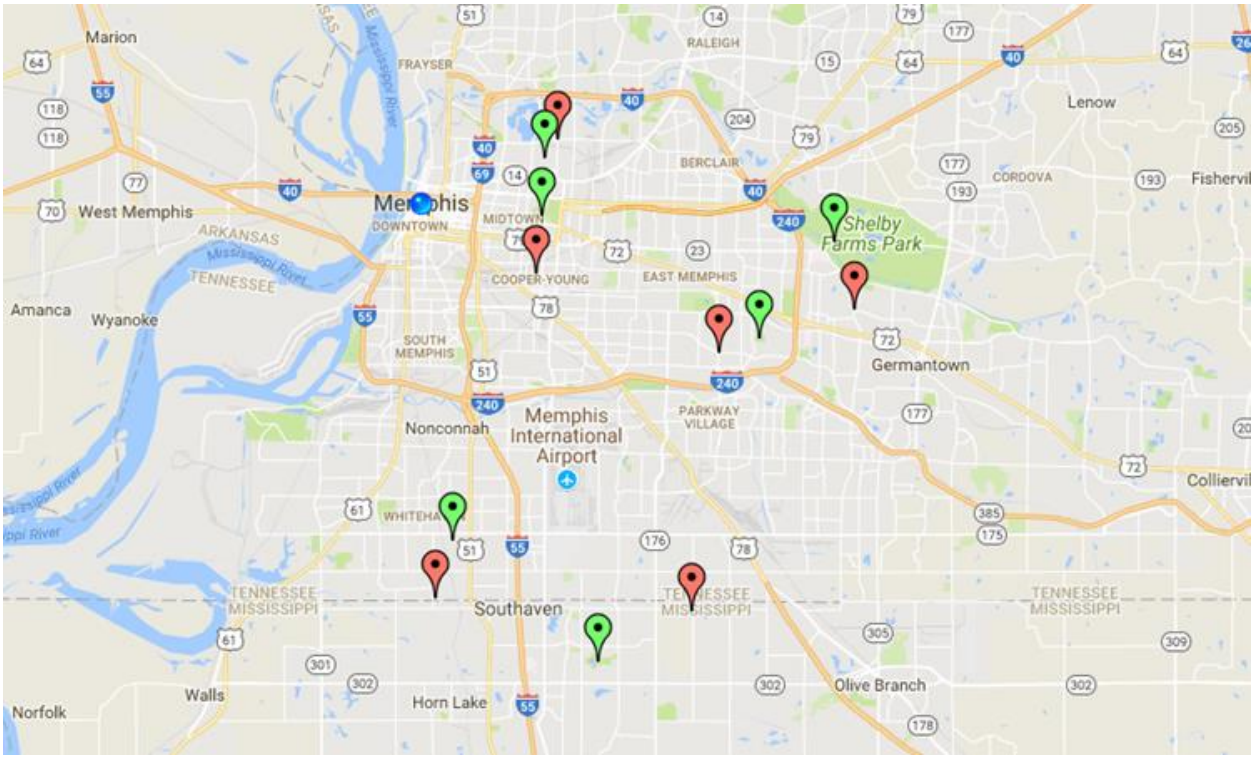

Fig. A. Map of Acoustic recordings (Parks in green, residential/non-park areas in red)
(https://www.zeemaps.com/map?group=2748066&location=Memphis%2C%20Tn&add=1#)

Equipment and Techniques

Parks were designated as either "large" (over 25 acres in area) or "small" (25 acres or less in area), alphabetized within their categories, and assigned numbers. The numbers were then run through a random number generator to decide which parks would be chosen for the study. Only parks in Memphis and Southaven were listed, in consideration of accessibility. Control sites were chosen to be at least half a mile from park sites, in either adjacent residential/suburban areas or developed/urban areas, not to be adjoining any other park areas.

The bat detector used for this study was a Echo Meter Touch 2 Bat Detector for iOS. This detector attaches to an iPhone or iPad and operates with a free app to provide bat recordings which can provide information about bat populations. The information recorded can be paired with statistical analysis, can be shared and saved in a variety of forms, and has been used already in citizen science initiatives for raising awareness and collecting information about bats (Bloomberg TV, 2017).

Fig. B. The Echo Meter Touch 2 bat detector, which plugs into an iPhone or iPad

In regards to species detection, the Echo Meter suggests the top one or two possibilities for bat species when calls are recorded (See figures C-D). Some species, such as *Myotis*, are notoriously difficult to differentiate, even for professionals. Results were checked against professional standards for acoustic calls, although even among those, there is overlap in range and variation on definitive numbers for calls (Humboldt State University Bat Lab, 2011).

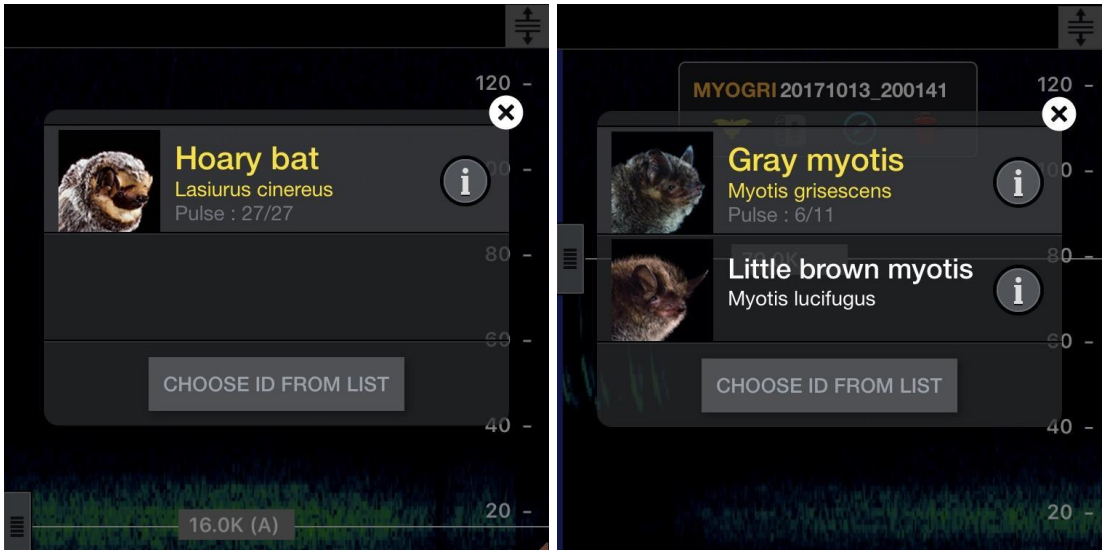

Fig. C and D. Screenshots: single species suggestion; top two species suggestions

Recordings were made starting at sunset each day and lasted for two hours afterwards. Recordings were made from October 1 - November 7, 2017, on twelve different nights, six parks areas and six non-park/control areas). Acoustic monitoring can be conducted in several different ways, usually either mobile or stationary; literature does not provide a united consensus on which method is the most accurate, with different researchers using different methods (Dixon 2012; Skalak, Brigham, & Sherwin, 2012; Esbérard, C. E. L., Luz, J. L., Costa, L. M., & Bergallo). For this particular study, with the hopes of gathering a larger sample of species, the choice was made to complete mobile acoustic monitoring walks throughout the parks, and graduated mobile walks and slow drives through the non-park areas to achieve highest possible diversity in recordings. Environmental and atmospheric conditions at the time of recording start were documented, such as temperature, precipitation, weather conditions, and moon phase. Notes were also taken on ambient lighting and sound conditions (Tables 1-2).

Results

Bat species calls were recorded at all sites, although there were variations in both the abundance and diversity of individuals depending on the site. Unanticipated difficulties arose at some sites; for instance, at the Shelby Farms site, the first night researchers were rained out and did not record a single call; the second attempt at Shelby Farms, there was a night-lit skateboarding show occurring in a nearby area, resulting in likely highly skewed findings. The night that recordings were made at Overton Park, an outdoor concert was being held in an arena contained within the park, introducing light and sound elements not always present.

Unfortunately, weather and accessibility issues had significant effects on a number of attempts at other sites as well.

Table 1. Parks Conditions

Date	Area	Temp	Skies	Prec	Hum	Moon	Light notes	Sound notes
10/1	Overton Park	80°F	Mostly cloudy	0.00	52%	Waxing gibbous	Lights from nearby arena concert	Loud music on speakers from concert
10/12	Shelby Farms Park	67°F	Mostly clear	0.00	67%	Waning gibbous	Lights from nearby skateboard event	Very loud noise from nearby busy traffic
10/13	Sea Isle Park	79°F	Clear	0.00	42%	Third Quarter	Fairly dark throughout, a few residential lights	Noise in some park edges from residential traffic
10/21	Central Park	76°F	Mostly cloudy	0.00	60%	New moon	Some residential lighting on edges	Fairly quiet, some residential traffic
10/22	David Carnes Park	68°F	Mostly cloudy	0.00	86%	New moon	Residential lighting	Some residential traffic
11/1	University Park	66°F	Mostly cloudy	0.00	79%	Waxing gibbous	Residential lighting	Some residential traffic

Table 2. Residential/Non-Park Areas Conditions

Date	Area	Temp	Skies	Precip	Hum	Moon	Light notes	Sound notes
10/26	Sea Isle Residential	78°F	Partly cloudy	0.00	76%	Waning gibbous	Regular residential streetlights	Moderate residential traffic noise
10/16	Central Park Residential	61°F	Partly cloudy	0.04	78%	Waning crescent	Regular residential streetlights	Some residential traffic noise

10/25	Overton Residential	60°F	Clear	0.00	44%	Waxing crescent	More and brighter lights than many other res. areas	More traffic noise, near several busy streets
10/10	Shelby Farms Res.	75°F	Clear	0.00	31%	Waxing crescent	Lots of bright lights	Significant traffic noise
11/5	David Carnes Res.	75°F	Mostly cloudy	0.00	76%	Waxing gibbous	Residential lighting, more subdued light	Some residential traffic noise
11/7	University Park Res.	52°F	Mostly clear	0.00	89%	Waning gibbous	Residential light, more subdued light	Some residential traffic noise

Park sizes were as follows: Shelby Farms Park - 4,500 acres; Overton Park - 342 acres; Central Park - 121 acres; Sea Isle Park - 12.5 acres; David Carnes Park - 9 acres; University Park - 10 acres. Overall, there was a larger number of bat species and more individuals recorded in large parks as opposed to small parks and residential areas, and definitively more bats recorded in park areas versus residential/non-park areas.

There were seven species of bats detected in this study - *Lasiurus borealis* (Eastern Red bat), *Lasiurus cinereus* (Hoary bat), *Lasiurus noctivigans* (Silver-haired bat), *Myotis grisescens* (Gray bat), *Myotis lucifigans* (Little brown bat), *Nycticebus humeralis* (Evening bat), and *Perymyotis subflavus* (Tri-colored bat). The species diversity of bats appeared to follow trends over areas. For example, the Sea Isle residential area had the highest record of species diversity in any residential/non-park area; this held true with its closest park, Sea Isle Park, having the highest species diversity recorded, despite the fact that it was far from the largest park in the study. Shelby Farms Park was by far the largest park sampled; unfortunately, however, much of the park remained inaccessible (due to locked gates) and the parts that were accessible were adjacent to a lighted skateboarding show at night, which definitely skewed the results.

Samples of echolocation calls can be seen in Figures E-F.

Table 3. Bat Species in Parks

	Shelby Farms	Overton Park	Central Park	Sea Isle Park	David Carnes Park	University Park
LASBOR	10	58	9	9	4	6
LASCIN	17		7	4		
LASNOC			7	1		
MYOGRI		2	5	1		
MYOLUC				2		
NYCHUM		42	2	1	5	4
PERSUB		13	5	1	1	
Totals	27	115	55	29	10	10

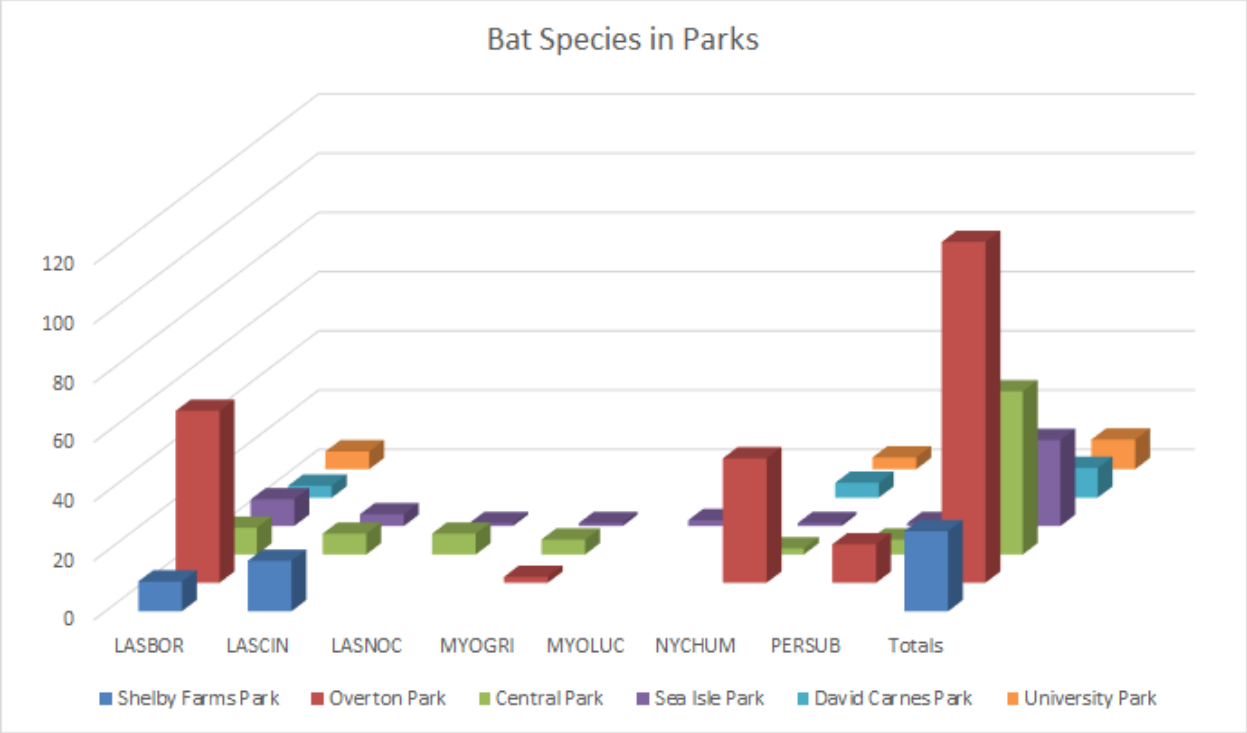

Table 4. Bat Species in Residential Areas

	Shelby Farms	Overton Park	Central Park	Sea Isle Park	David Carnes Park	University Park
LASBOR	1		2	2		2
LASCIN	4	4	4	5	2	2
LASNOC		1				
MYOGRI				2		
MYOLUC						
NYCHUM	1	2	2	1	2	

PERSUB			1	1		
Totals	6	7	9	11	4	4

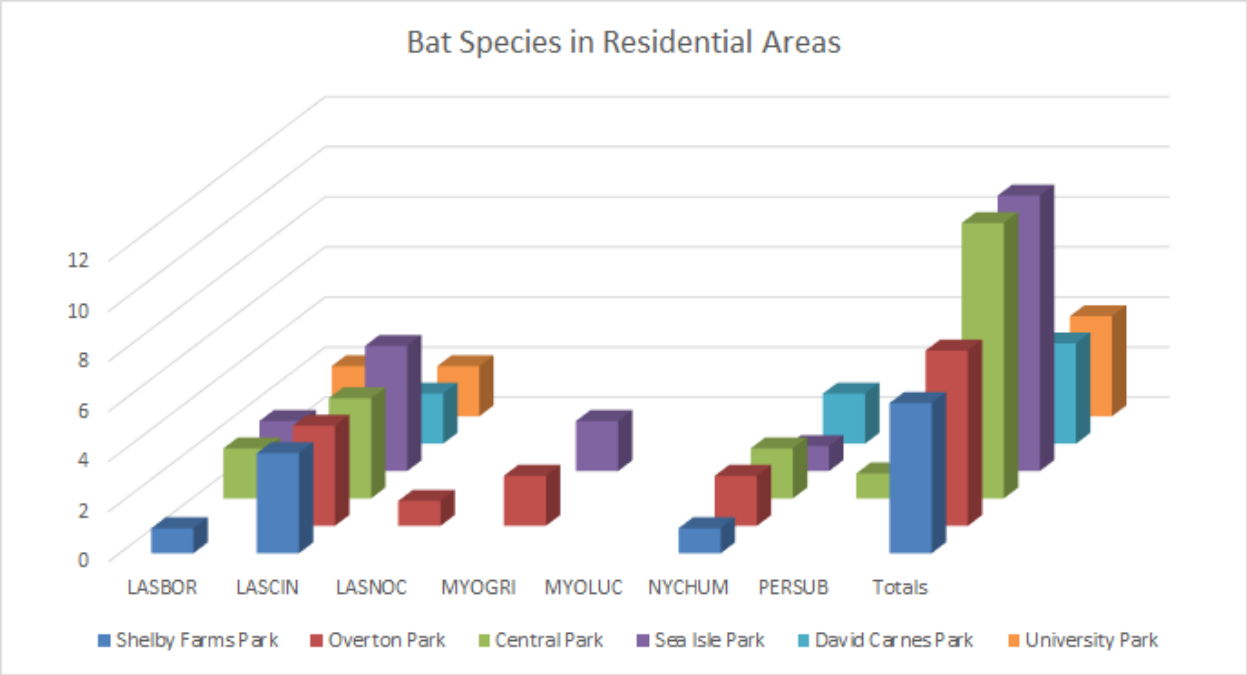

Fig. E and F. Screenshots of echolocation calls from *Myotis grisescens* and *Lasiurus borealis*

Discussion

The results of this study only provided a very small snapshot of the bat abundance and biodiversity that can be found in the greater Memphis area; they are not meant to be comprehensive. Only a limited number of data samples could be taken, due to limited supplies, research volunteers, and time, as well as obstacles in the form of weather and physical inaccessibility issues. The results are not definitive by any means, either; for example, as mentioned *Myotis* species often have overlap in their spectrographic analysis, and therefore it is possible that any number of *Myotis* species could be present (Humboldt State University Bat Lab, 2011). A larger range of nights and a longer-term study would have allowed for more accurate data overall. In one study, Skalak, Brigham, and Sherwin (2012) found that generally fewer nights of acoustic sampling were needed to detect common species of bats, but for more rare ones, a much larger sample was needed (45 nights or more in a single location). In the Memphis study, this level and amount of sampling was not feasible. Therefore, the data

accumulated from it has to be taken with a bit of a grain of salt. It is providing a small glimpse of some short-term trends. To make more confident extrapolations, a longer-term and larger-scale study would have to be carried out; it is possible that volunteers could be recruited for this project.

While urbanization is an increasingly imminent threat for numerous species and entire ecosystems, there are still ways to preserve at least some small sections of biodiversity in situ. Parks and public lands set aside for conservation can provide some of the largest possible impacts; however, the quality of the parks matters as much as the existence of the parks themselves. One study found that fragmentation of the parks themselves is actually more detrimental to bat species than urbanization near parks (Johnson, Gates, & Ford, 2008). The parks in my study included both more and less developed sections. The larger ones tended to have more abundance in species. Some of the residential areas yielded fewer recorded species than originally anticipated. Additional studies could provide a more accurate reflection of the state of the bat species in Memphis. Additional awareness for bat plights can be raised through activities such as night hikes with bat detectors, and with detectors growing increasingly more affordable and easy to use, such as with the Echo Meter, citizen science and participation is becoming more common and accessible than ever.

Action Component

The action component of the project has been planned but not yet completed. An initial date was scheduled in November, but schedule complications led to postponement. A community bat tour has been created; a loose script was finalized, and some respondents have already signed up for a second tentative date. The respondents will be led on a night walk in an area of known high species diversity and abundance to ensure a positive encounter. The tour will utilize the bat detector and iPhone setup, and will aim to discuss both the findings of this paper as well as other actions that local community members can take to positively impact bat conservation locally and globally. Respondents will be allowed to hold and use the detector themselves, perhaps even plug it into their owns phones, and told about the free app that can be used along with the detector. Some small educational materials for the tour have already been purchased from Bat Conservation International (small pamphlets, bat tattoos, etc.); these will be distributed after the tour. The tour guide will be myself, a former bat keeper and occasional field researcher, and there will also be photographs available to pass around with both native and non-native bats, as

well as both wild and captive bat situations. A glossary of acoustic monitoring terms will also be available to educate further on terminology (USFWS, 2016). The Memphis Zoo will be incorporated into the chat as well, as they have the second-largest nocturnal animal exhibit in the U.S., including bat exhibits featuring five different species of bats. Other nocturnal animal spottings may be addressed as they occur. A question-and-answer segment will also be included as a part of the tour.

Conclusions

The findings of species diversity variance across the city was somewhat unexpected. What precisely makes each area supportive of higher or lower diversity is a matter that would require further study. Vegetation composition, residential vegetation coverage, nearby water sources, ambient light and sound contributions, and more can all have an effect on the viability of an area for bat foraging and roosting habitat. Part of data collection included taking notes on these factors, but the exact combination that provides the best habitat for bats has not definitively been determined.

My initial inquiry looked at the influence of large versus small parks and park areas in general on bat populations in an urban environment. Parks advocacy in Memphis is fairly disjointed and uneven when it comes to where action and attention get focused. My attempts to solicit volunteer researchers for trips were met with lukewarm results at best. Most people have other commitments and getting them to commit to something on a weeknight especially seemed to be very difficult; this is only anecdotal experience, so I am not sure if this is specific to myself and the people in my life or the area in which I live. The action component is an attempt to create an interesting and interactive event that would gather more people and more interest, as well as educate people about bats and parks and their value in the roles that they serve. I was able to garner interest for the bat tour, and hope that with the creation of events such as this one and others like it, education and advocacy on bat conservation can be improved locally over time.

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