BAT ACTIVITY IN MADISON SQUARE PARK
YEAR-ROUND ACOUSTIC RECORDING

Prepared for:

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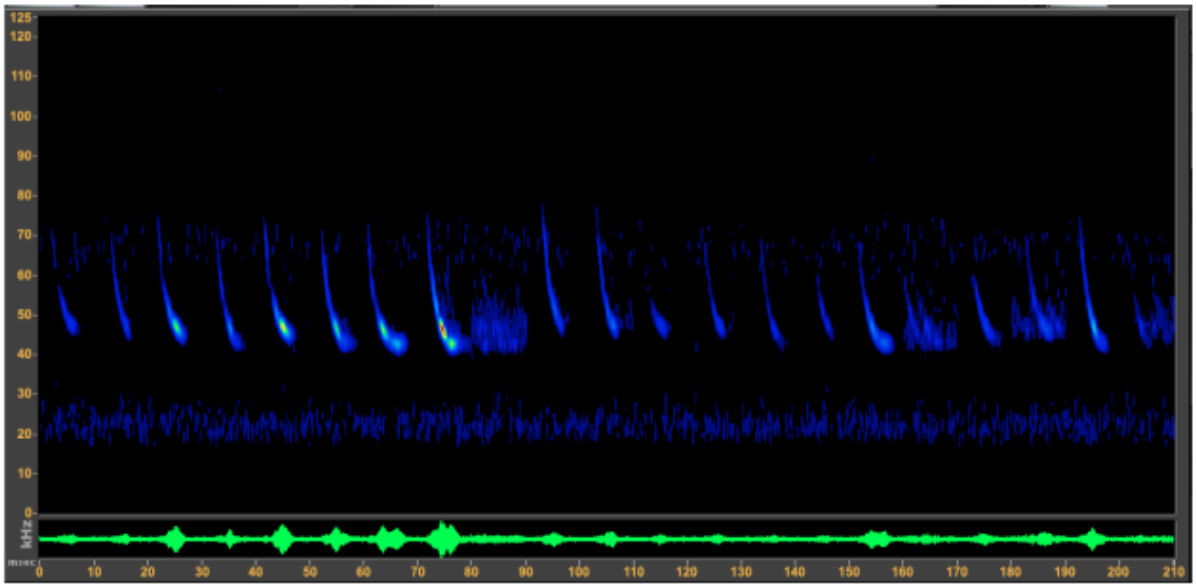
KEY FINDINGS

- We recorded bats using a passive acoustic recorded on 220 days from January 2022 to January 2023.
- We recorded 10,936 bat passes.
- Four bat species were recorded in Madison Square Park: Eastern Red Bat, Silver-haired Bat, Big Brown Bat and Hoary Bat.
- Eastern Red Bat was the most commonly recorded species.
- Bats were present in the park in every month from March through November.
- Bat activity peaked during the summer months, particularly at the end of June.



An Eastern Red bat recorded on April 10, 2022.

INTRODUCTION

Madison Square Park is a 6.2-acre public park located in the borough of Manhattan, New York City and managed by Madison Square Park Conservancy. In addition to being a respite for over 60,000 visitors daily, the Park's landscape is also home to a variety of wild native and non-native plants and animals. Despite its location in the center of one of the most densely populated cities on the planet, Madison Square Park has the potential to provide a valuable refuge for native wildlife. In modern urban ecology studies, the population density of NYC if often referred to as not just "urban" but "superurban" due its high population density relative to other sites (DeCandia et al. 2019). Research on wildlife in green spaces in NYC is critical for understanding the effects of living in a superurban environment on wildlife.

Madison Square Park Conservancy has done an excellent job of using citizen science surveys like BioBlitzes and the City Nature Challenge, and crowd-sourced wildlife apps like iNaturalist and eBird to document the wildlife in the park. For example, using eBird, 113 species of resident and migratory birds have been reported in the park. In iNaturalist, community members have reported 88 species of native plants, 110 different arthropod species, and 507 observations of 38 vertebrate species.

A taxonomic group often overlooked in these types of surveys are bats (Chiroptera). Due to their cryptic nocturnal behavior and the difficulty of visually identifying them in flight, bat observations by the public are few and far between. Often bats are only observed by the public when they become injured and can result in unwanted human-wildlife interactions. Within the Madison Square Park vertebrate observations on iNaturalist, just three are of bats. A grounded Silver-haired Bat was reported on November 23, 2018. A grounded Eastern Red Bat was reported on September 30, 2019. A second Eastern Red Bat was reported on November 11, 2020, flying during the day, landing on a tree and then being eaten by a hawk. Both Eastern Red Bat reports in iNaturalist were made by Conservancy staff

The purpose of this study was to fill knowledge gaps about bats in Madison Square Park by collecting data on bat activity and species presence in during the full annual cycle using non-invasive acoustic sampling. Recording bat echolocation calls can give insight into the species present and behavior. These data can be used for educational opportunities and to inform ecological management— suggestions are provided at the end of this report. These data can also provide a baseline dataset on bat activity; future bat surveys can be undertaken to examine the effects of habitat management, climate change, and development on the bat community in Madison Square Park.

METHODS

We recorded bats from January 10, 2022 to January 31, 2023 using a stationary Wildlife Acoustics SM4BAT full spectrum ultrasonic acoustic recorder (ARU) with a SMM-U2 microphone on a five meter cable elevated above the ground. Raising the microphone helps reduce echolocation bounce off hard surfaces like pavement but it is impossible to avoid entirely in an urban setting. The recorder was located at the northeast end of the park (Fig.1). Initially the detector was attached to the lamp post central in Figure 2, but due to concerns about high frequency noise from the light, it was moved to the taller light post a few meters further east of the original (on the left in Figure 2).

Bat echolocation calls were recorded daily from sunrise to sunset using a 256 kHz sample rate, 3.0 second trigger window, and 12 dB gain. After some troubleshooting in January and February, I increased the trigger level from 12 dB to 18 dB due to the amount of noise files being recorded each night (see Quarter One Report for details).

Bat echolocation calls were recorded to SD cards as WAV files. Madison Square Park staff changed batteries at an optimal target interval of every two weeks, though data retrieval varied depending on staff availability. Data was transferred to the consultant via Google Drive. Recordings are initially scrubbed using Sonobat 4.4.5 Batch Scrubber to automatically remove most background noise. Remaining files are then manually checked for bat passes before analysis. I then use Sonobat 4.4.5 to identify bats to the species level and then manually confirm software auto-identifications. A bat "pass" is considered a series of calls separated by no more than 1 second. Bat activity was calculated using an index of passes/day.

Figure 1. Location of bat recording unit in Madison Square Park

Figure 2. Bat ARU attached to lamp post on site at Madison Square Park

RESULTS

We recorded bats on 220 days between January 10, 2022, to January 31, 2023 (a day was included if the recorder functioned on that date from sunset to 11:59 pm, 12:00am to sunrise, or both). Recording days were not distributed evenly across months or seasons (Figure 3). No recording took place in December. We recorded 10,936 bat passes. Bats were present March through April, and no bats were recorded in December, January, or February.

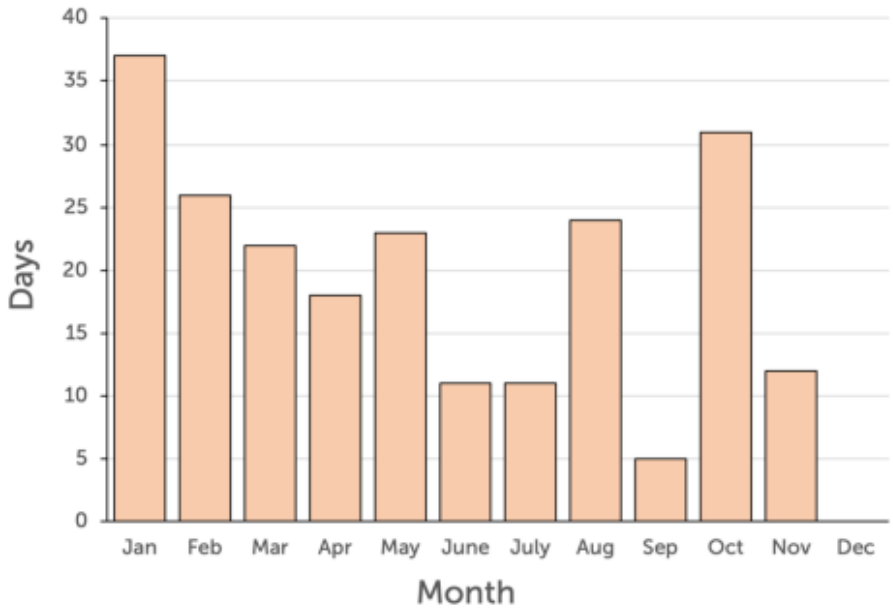


Figure 3. Number of recording days per month between January 10, 2022, to January 31, 2023

SPECIES PRESENCE & RELATIVE ACTIVITY

Of the 10, 936 passes recorded, 8,449 (77%) were able to be identified to the species level and confirmed. We recorded four species of bat in Madison Square Park: Eastern Red Bat (Lasiurus borealis), Silver-haired Bat (Lasionycteris noctivagans), Hoary Bat (Lasiurus cinereus (or synonymously Aeorestes cinereus)), and Big Brown Bat (Eptesicus fuscus). 96% of all passes were from Eastern Red Bat (8,108 passes), 2.1% from Big Brown Bat (175), 1.5% from Silver-haired Bat (130), and .4% from Hoary Bat (36) (Fig. 4). Two other species were identified by the autoclassifier but did not pass manual checks and did not have a maximum likelihood estimate high enough to be considered present (maximum likelihood estimate is the probability of species presence based on the number of calls recorded, the relative number of calls to the total, and the chance that the species is misclassified as other species present.) These were Little Brown Bat (Myotis lucifugus) and Tricolored Bat (Perimyotis subflavus) (Table 1)

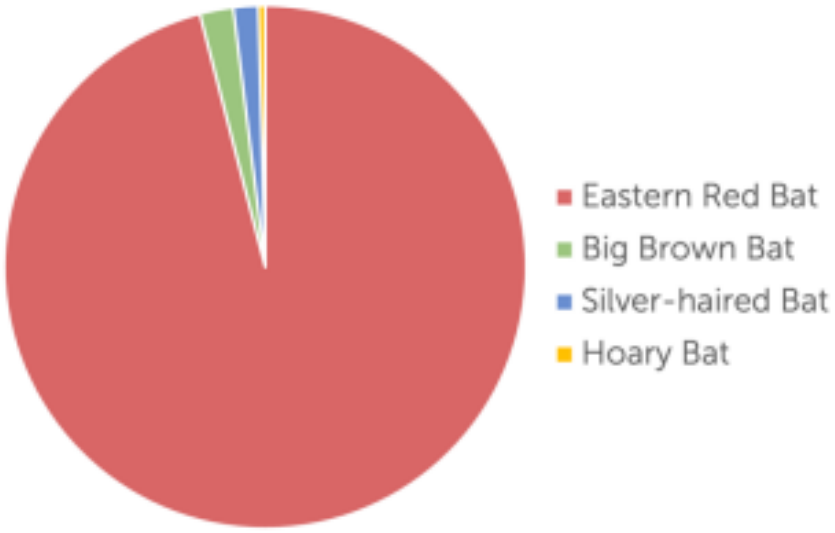


Figure 4. Proportion of total passes for four species of bat confirmed present in Madison Square Park.

Table 1. Sonobat calculated estimates of species presence based on all recordings. 1 = likely present, 0= likely not present.

Species	Likelihood estimate
Eastern Red Bat	1
Silver-haired Bat	1
Hoary Bat	1
Big Brown Bat	1
Tri-colored Bat	.04
Little Brown Bat	0

Species presence and activity was not uniform throughout the year. Silver-haired bat was recorded in all nine months during which bats were present, while Big Brown Bat was present during just three months (June July and October) (Table 2). Early in the year Silver-haired Bats made up the greatest proportion of all recorded passes, while Eastern Red Bats were the largest proportion from May to November. Big Brown bats were mostly active in July and August, and Hoary Bat was recorded most in September relative to the other months (Fig. 5.)

Table 2. Species presence by month

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Eastern Red Bat				X	X	X	X	X	X	X	X	
Big Brown Bat						X	X			X		
Silver-haired Bat			X	X	X	X	X	X	X	X	X	
Hoary Bat							X	X	X	X		

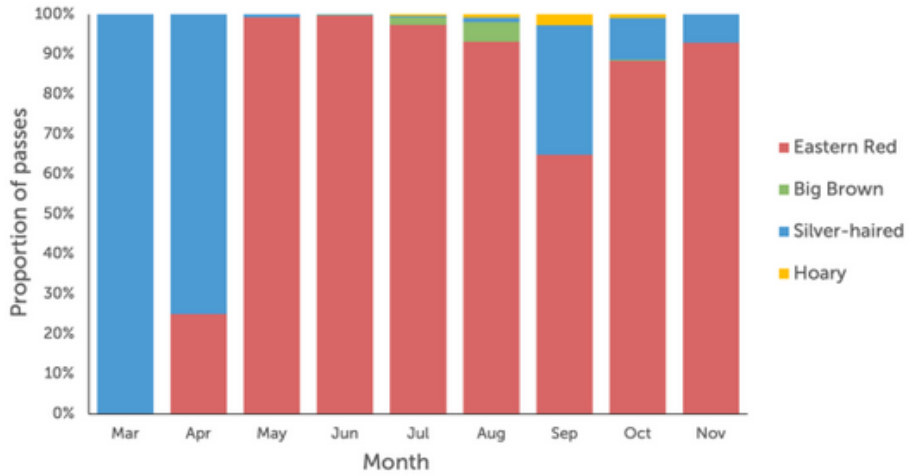


Figure 5. Relative proportion of passes recorded from each bat species by month.

BAT ACTIVITY

Bat activity ranged from zero to 739 passes per day, with a mean of 50 passes/day. The date with the most activity was June 21. Large amounts of activity also took place on August 13 (640 passes), August 17 (533), June 30 (529) and June 8 (488).

Bat activity by hour must be considered in the context of changing sunset times over the course of the year but can still be valuable information. 22% of all passes were recorded between 9pm and 10pm, and 19% of passes between 8pm and 9pm. Overall 63% of activity was recorded between 8pm and midnight. 32% of activity occurred between 12am and 5am. Only 4% was recorded between 5pm and 8pm, and 2% between 5am and 7am (Figure 6).

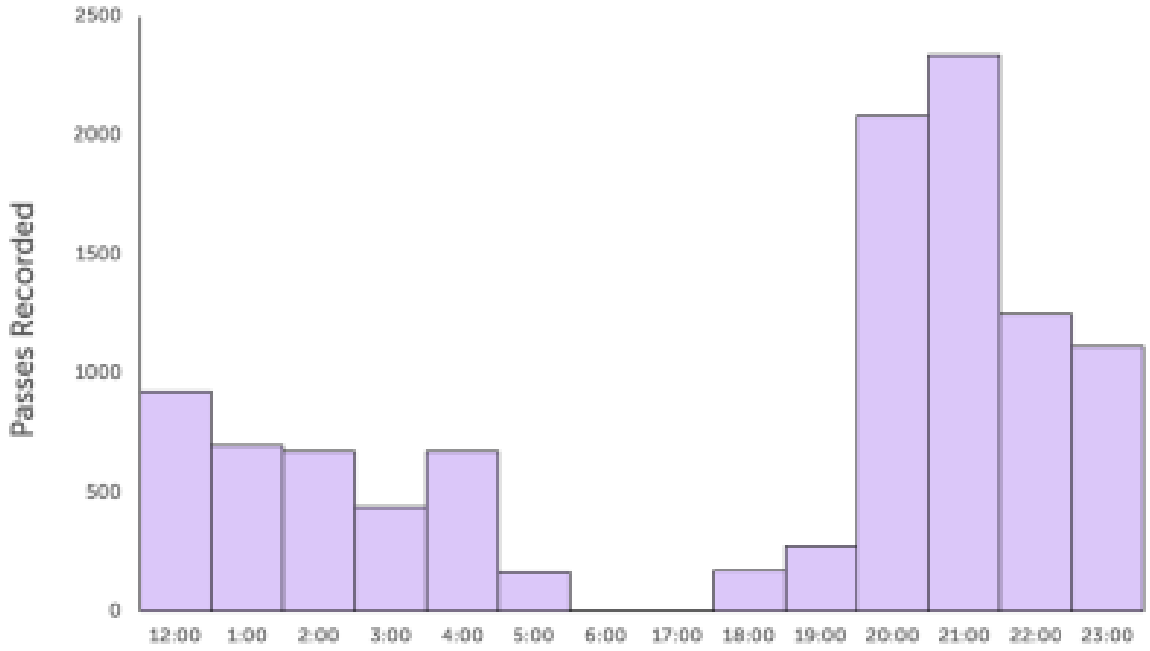


Figure 6. Bat passes recorded per hour.

ACTIVITY BY SEASON

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ACTIVITY BY WEEK

Activity in Madison Square Park began climbing in early May and peaked during the week of June 27 to July 3, with a mean 484 passes per day. A second peak occurred during the week of August 8 to 14. The majority of bat activity was recorded from mid- May to mid-September (Fig. 8)

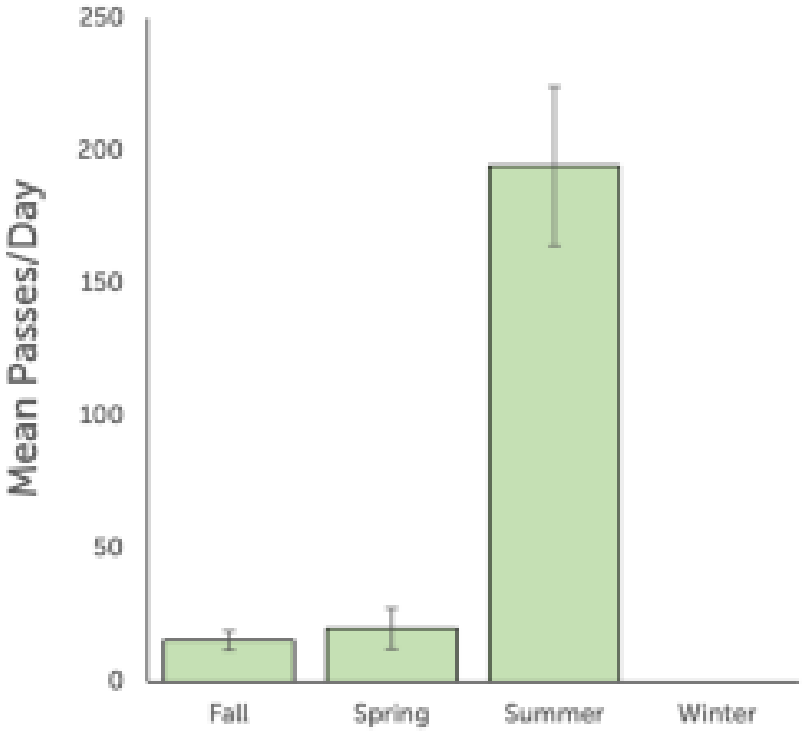

Figure 7. Mean activity (passes/day) +/- SE by season.

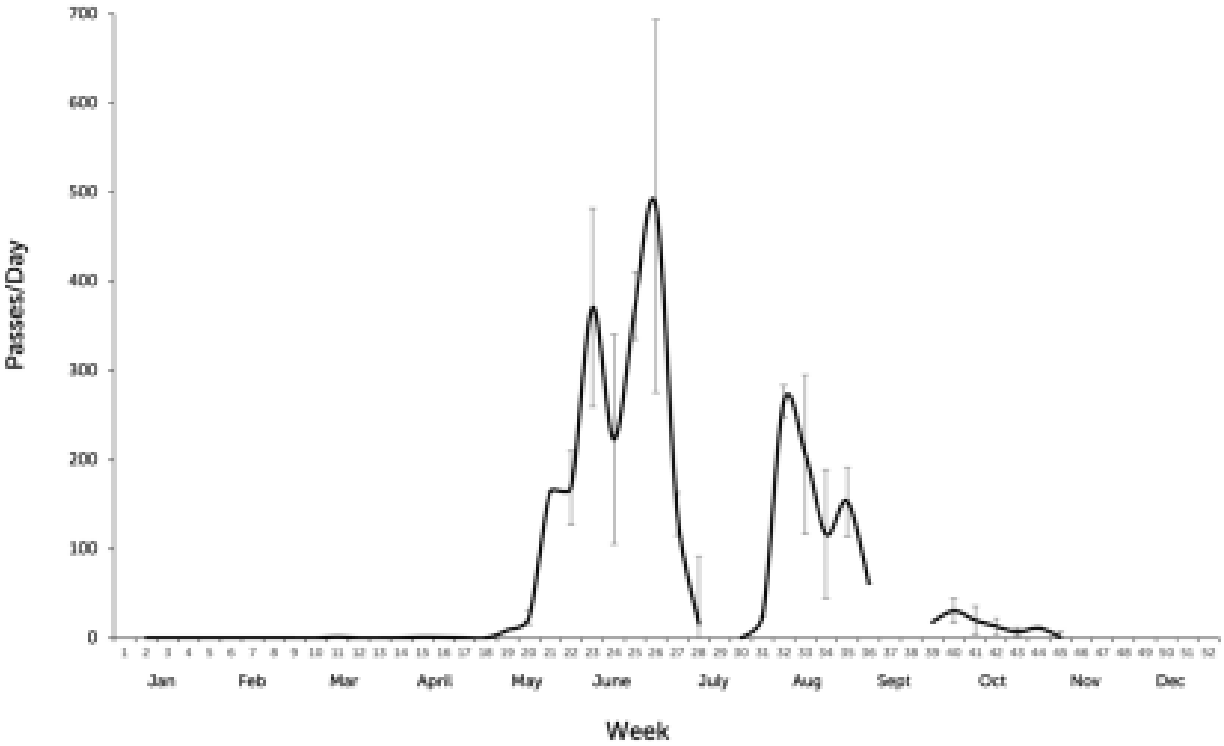

Figure 8. Mean activity (passes/day) +/- SE by Julian week

DISCUSSION

Species

Nine insectivorous bat species live in New York State (NYS), and five have recently been confirmed in NYC: Eastern Red Bat, Silver-haired Bat, Hoary Bat, Tricolored Bat, and Big Brown Bat (Parkins et al. 2014; 2016). Of those, four were confirmed in Madison Square Park during our study: Eastern Red Bat (Lasiurus borealis), Silver-haired Bat (Lasionycteris noctivagans), Hoary Bat (Lasiurus cinereus (or synonymously Aeorestes cinereus)), and Big Brown Bat (Eptesicus fuscus). Little Brown Bat (Myotis lucifugus), which was detected by the autoclassifier but not able to be confirmed, has not been confirmed in NYC in recent years. It was likely more common in NYC prior to the outbreak of White-nose Syndrome, which reduced their population by more than 78% in NYS (Dzal 2011) and may remain in some locations.

Eastern Red Bat calls make up most of the recorded passes. This bat is very common in NYC and, to my knowledge, is the most commonly recorded bat in all NYC locations where recording has taken place in the past decade. These bats are present year-round, but typically peak during the migration season, which begins in mid-July. Of the suite of species found in NYC, they tend to be the most tolerant to light pollution (Seewagen et al. 2021). This species was present during both summer and migration seasons. It is not possibly to know if the individuals in the park are male or female using acoustic sampling. The breeding season bats may be individual males or females with pups (male bats do not take care of the pups). During both breeding and migration this species roosts by hanging from a tree, resembling a dead leaf.

Big Brown bats were present mostly during the summer breeding season, with only a single pass in October. The Big Brown Bats present during the summer months may have been roosting in buildings or other man-made structures nearby (Agosta 2002). The females form maternity colonies in human structures, while the males remain solitary. Both males and females might have been present, but Patriquin et al. (2019) found that in an urban park in Toronto, males outnumbered females 2 to 1. In some species, male bats use lower quality habitat during the breeding season than females, suggesting that urban habitats may be low quality habitat selected by males (see management implications, below).

Silver-haired bats were present throughout the year, but their peak activity occurred in the spring and fall during the migration season. It is likely that this species is using Madison Square Park to forage as it moved through during migration. Hoary bat recordings were rare, and were likely individuals just passing through and possibly stopping for a snack on the way.

ACTIVITY TRENDS

Acoustic sampling does not give an absolute number of bats present at a location. Instead, we use activity (in terms of passes per period of time) to look at trends in activity and compare between months, years, or even locations. Bat activity can fluctuate significantly and is dependent on weather and insect availability, which explains the variability in activity from night to night. Bat activity was highest during summer months of June July and August. This period overlaps with both the breeding season and the beginning of fall migration season for the bats that were most active in the park. While this survey indicates activity is highest in the summer, ARU failures restricted our ability to record in September to just five days. September has high levels of bat activity, driven by Eastern Red Bats, in other NYC studies. It is possible that September was under-sampled and relative activity is actually much higher in the fall than we documented here. Regardless, we can see that there is significant bat activity during both breeding and migration seasons.

The high amounts of Eastern Red Bat, Silver-haired Bat, and Big Brown Bat activity detected, during which one or more bats stayed in the area for 30+ minutes at a time, coupled with the presence of feeding buzzes suggests that these bats are not merely passing through Madison Square Park. They are likely actively foraging on insects in the park. Since Madison Square Park has a variety of tree species, Eastern Red Bats may also be roosting in the park during the day.

It is difficult to draw conclusions based on the hour of activity because we did not account for time since sunset for each night of recording, but even without those data it is interesting that the majority of bat activity (and likely foraging) took place in the late evening hours between 8pm and 10pm. This was probably influenced by the high activity levels during summer, when sunset is at its latest. This timing could help inform scheduling of public bat programs, especially when combined with overall activity trends. Late June, late July, and early August could all be good times for scheduling bat walks beginning at sunset.

WINTER ACTIVITY

Most of the bat activity in Madison Square Park is from what are colloquially known as "tree bats." Eastern Red, Silver-haired, and Hoary Bats do not roost in buildings or hibernate in caves, as is commonly thought of all northern bat species. They are solitary bats, and roost in trees. They are migratory bats, spending the nonbreeding season (winter) in more southern and coastal areas of the US, and moving north in the breeding season. While many migrate to lower latitudes, both Eastern Red and Silver-haired have been recorded in NYC in the winter months (December-February) (Parkins et al. 2016). We did not record any winter activity in Madison Square Park, but we did not have the ARU running during the month of December, which means some activity could have been missed. Winter activity is rare and typically recorded on warm winter days. The 2022-23 winter season in NYC had mild days reaching 55°- 65°F in January so it was unexpected that we did not record any winter activity; however, detector failures might have coincided with the warmer days, limiting our ability to detect active bats. Bats also occasionally become active during daylight hours in winter when the ARU is not running. In future studies, we may consider daytime recording during the winter.

MANAGEMENT IMPLICATIONS

Despite some bat species seeming ability to make use of urban habitats, scientists suggest that urban areas can be a "trap" or "sink" for even seemingly synanthropic bat species (Russo & Ancillotto 2015; Patriquin et al. 2023). An ecological trap is a habitat that attracts a species but is not high quality enough to support survival and reproduction. Individuals are attracted to the habitat but fail to reproduce, and population declines result. As humans create habitat in urban spaces, we must be aware of the possibility of creating these traps and harming the species we mean to support. For example, Patriquin et al. (2019) found that Big Brown Bats in a Toronto park were in poor body condition and that beetles, their main prey item, were limited. To prevent ecological traps, management strategies can help increase survival and fitness (Zuniga-Palacios et al. 2021).

Several strategies could be used by the Conservancy to ensure that Madison Square Park is benefitting the bat species using it. Eastern Red Bat, the most common bat in the park, is known as "generalist" species but has a diet that consists mainly of moths (Clare et al. 2009). In NYC Eastern Red Bat activity has been shown to be correlated with moth abundance on green roofs (Partridge et al. 2020). Big Brown Bats have a diet of mostly beetles (Agosta 2002; Patriquin et al. 2019). Cultivating plantings that support native moths and beetles may help support bats in Madison Square Park. Reducing artificial light at night would be beneficial to light sensitive Big Brown Bats, which may be reproducing nearby and need high quality foraging habitat to sustain their young. The presence of tree cover can help mitigate the impact of light pollution for some species (Straka et al. 2019). Water is often predictive of bat activity in an urban landscape (Ancillotto et al. 2019),and can be a limiting resource in an urban environment. Wildlife rehabilitators have shared that bats found in NYC are often dehydrated. A clean fresh water source may be beneficial. Though we didn't record any bats December-February, Eastern Red Bats may be present during the winter months. They prefer to hibernate in leaf litter in winter. Leaf little is rarely left on the ground in urban and suburban areas. "Leaving the leaves" can be a strategy to support bats (and many other species) during the winter

Finally, I am often asked about installing bat boxes in urban parks, as a way to attract and provide a home for visiting bats. As of now I do not recommend bat boxes in NYC. Of the several existing boxes I know of, some of which have been present for nearly a decade, none have been occupied. Tree bats, which make up the majority of activity in the park, do not use bat boxes. Of the confirmed species only Big Brown Bat uses boxes. Bat boxes can also become an ecological trap if not installed and maintained correctly (Lausen et al. 2021). Other strategies, such as those mentioned above will be more beneficial to bats.

CONCLUSIONS

Bats are important components of the ecosystem, contributing to nutrient cycling and pest control among other services (Kunz et al. 2011). Urban areas, even small green spaces like Madison Square Park can provide habitat for bats. Management decisions that help support the bat community, such as cultivating native plants, providing safe water sources, and reducing artificial light, may also benefit other wildlife, such as native pollinators and birds.

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