# The effect of prescribed burning on bat activity in the Long Island Central Pine Barrens

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## ABSTRACT

Prescribed burns are a historically effective way of maintaining fire-adapted habitats, but its effects on animal life require more research due to modernized procedures (Ryan et al. 2013). This introductory investigation explores how bat activity is affected by prescribed fires in the Long Island pine barrens. Through the Environmental Protection Division at Brookhaven National Laboratory (BNL) and following the US Fish and Wildlife Service's survey guidelines for Indiana and Northern long-eared bats, six ultrasonic recorders were deployed for seven nights in plots under .5 $km^2$. Wildlife Acoustics' Kaleidoscope Pro software determined species richness and detected *Lasionycteris noctivagans, Perimyotis subflavus, Lasiurus borealis, Eptesicus fuscus,* and *Lasiurus cinereus*. The former three each displayed a significant preference, which is tentatively attributed to their roosting/foraging requirements. *P. subflavus* only used the plot burned least recently, which may have contained the foliage it prefers (Stegemann & Hicks nd). *L. noctivagans* used the plot burned a year ago, but it cannot be determined whether this was due to the burn history, the presence of water, or another unknown factor (BCI, 2023. Stegemann & Hicks nd). Though *L. borealis* was on all three plots, it preferred the plot burned most recently over the plot burned a year ago, likely due to the lack of obstacles preventing fast flight (https://www.chesapeakebay.net/discover/field-guide/entry/eastern-red-bat nd). *E. fuscus* and *L. cinereus* did not display a behavioral bias. This project contributes to the BNL environmental commitment of having regional sustainability expertise by conducting research on the behavior of local bat species. As BNL, and the country, begin to reintroduce prescribed burns to fire-adapted ecosystems, this project will provide important context for how northeast bat species may be impacted. Through this research project, the author became proficient in using various field equipment and data analysis software.

# INTRODUCTION

## US History of Fire

The US fire regime, or the long-term pattern, frequency, and intensity of fire, has changed dramatically due to differing types of human involvement. In the northeast, the local Native Americans used fire to stimulate their preferred, early successional, nutrient-rich foliage and sustain choice prey (Abrams & Nowacki 2008b). The Native American regime of fire promotion shaped the vegetative landscape of oak and pine forests, prairies, and savannas that now define the northeast (Abrams & Nowacki 2008b). European colonization saw an upheaval of this system that eventually settled into a new era of fire suppression (Nowacki & Abrams 2008a).

Environmental conditions and a new regime suppressed fire in the northeastern US. The deficiency in fire disturbance initiated a positive-feedback loop that favors moist, shady conditions and ousts fire-adapted species (Nowacki & Abrams 2008a). This has resulted in the creation of shady, moist, dense environments; an increase in shade-tolerant, fire-sensitive trees and plants; and the accumulation of potential fuel and forest litter (Nowacki & Abrams 2008a). The abundant fuel, increased density, and stunted saplings make it easier for fires to quickly expand vertically and horizontally (Keeley 2008). This causes modern wildfires, though infrequent, to be incredibly severe. Now, public sentiment is returning towards prescribed fire maintenance in order to clear dangerous fuel and increase pyrophytic species diversity.

## Bats and Burns

For many animals, the effects of prescribed burns are not clear cut. For example, most bats would likely find plentiful shelter in burned forests, but depending on the season of the burn and species of bat, fire could be to the detriment of local populations. Most bats choose to roost

and forage at the edge of forests or within open forest stands (Taylor et al. 2020). They benefit from reduced midstories and open overstories, which eliminates clutter blocking sunlight and warmth and removes obstacles in travel corridors (Taylor et al. 2020). A recently burned plot would be pruned of many of its trees and stripped of majority of it mid- and overstory, thereby providing a suitable habitat for bats (Taylor et al. 2020).

However, different species of forest bats prefer various shelter, like the foliage of live trees, the bark of dead trees, or the cavities of damaged trees (Taylor et al. 2020). Some bats also move between roosts frequently during the summer to avoid predators and parasites and adapt to changing weather conditions (Taylor et al. 2020). Certain bats may not be able to find sufficient live trees and foliage to roost in, at least in the initial aftermath of the fire (Taylor et al. 2020). Additionally, fires conducted from spring to early summer would put pups at risk (Taylor et al. 2020).

The many studies regarding the effect of prescribed burns on bat activity have not had a singular, conclusive result. One study on the effects of burning, thinning, and combining both treatments found that sites burned or thinned and burned did not experience a statistically significant increase in activity (Loeb & Waldrop 2008). Another study found that only one of their sample populations displayed preference for areas thinned burned, a bias dependent on the species and the season of treatment (Cox et al. 2016). A third report determined that their local *Nycticeius humeralis* had a strong preference for fire-maintained forests in the initial years after burn, likely due to improved foraging and roosting opportunities (Boyles & Aubrey 2006). This paper also mentioned previous studies sharing how *Lasiurus borealis* is negatively affected by fire, often with individuals and winter roosts being burned (Boyles & Aubrey 2006). The last study reviewed stated that fire had different effects based on species, with snag-dwelling bats

benefiting off fire, foliage-dwelling bats rendered vulnerable to fire, and cave-dwelling bats left relatively unaffected (Carter et al. 2002). The various conclusions reveal that there is clearly a gap in knowledge on this topic.

Based on knowledge of bat behaviors and recent prescribed burn research, this study hypothesizes that an area burned one-two years ago during late summer and fall would be best for promoting bat activities and populations, as it would have a diminished mid- and overstory and considerable herbaceous vegetation without endangering certain species or young. While this research project does not attempt to take a decisive stance on the relationship between prescribed burns and bat activity, it aims to provide more context on how native Long Island species may react.

## METHOD

This study used the US Fish and Wildlife Service's (USFWS) Range-Wide Indiana Bat and Northern Long-Eared Bat Survey Guidelines to structure the procedural design (2023). The guidelines detail how to determine presence or probable absence of two endangered species that are native to the New York region, but their protocols are applicable to all bat species.

### Site Selection

As this study is conducted through the Environmental Protection Division (EPD) at Brookhaven National Laboratory (BNL), the data was collected on BNL property. BNL boasts a mix of mostly pine barrens — pine-oak and oak-pine — and pockets of wetlands over its 5,265 acres property (Brookhaven Science Associates nd). Located in an aquifer recharge area, the topology, soil, and depth to water table create a medley of wet and dry areas, with little open water (Brookhaven Science Associates nd). The recent drought has exacerbated these conditions,

harming fish and amphibian species. BNL has identified 300+ plant, 80+ avian, 10+ reptilian, and 20+ mammalian species, a handful of which are endangered or threatened (Brookhaven Science Associates nd). Of the plants, there is a mix of *Vaccinium, Gaylussacia, Osmunda, Platanthera, Thelypteris,* and *Carex spp,* in addition to the pine and oak trees (Brookhaven Science Associates nd). These plants evolved with tough environmental conditions, like sandy soils, low nutrients, and periodic fires, which serve as a deterrent against invasive species (Brookhaven Science Associates, nd). The vegetation is also in various successional stages due to disturbances like development and fire (Brookhaven Science Associates nd). BNL began conducting burns nearly two decades ago to reduce fuel and benefit fire-adapted species, shifting to a regime of fire promotion (Brookhaven Science Associates nd). Of the mammals, a 1994 survey reveals there are 12 larger mammals, 11 smaller mammals, and seven bat species — *Eptesicus fuscus, Lasiurus borealis, Myotis leibii, Lasiurus cinereus, Myotis lucifugus, Myotis septentrionalis,* and *Lasionycteris noctivagans* (Brookhaven Science Associates nd).

The USFWS survey guidelines prefer that acoustic sites are 656 feet apart (2023). However, due to the burn plot grid at BNL, the most suitable sites were in close proximity to each other. Of these plots, three were burned in the last five years. Since studies have found that recent burns have the greatest effect on bat activity, these three plots were chosen as experiment sites (Boyles & Aubrey 2006). In accordance with USFWS guidelines, each plot was under .5 $km^2$ and had two acoustic monitors, thus requiring only a minimum of seven nights of data collection in each plot.

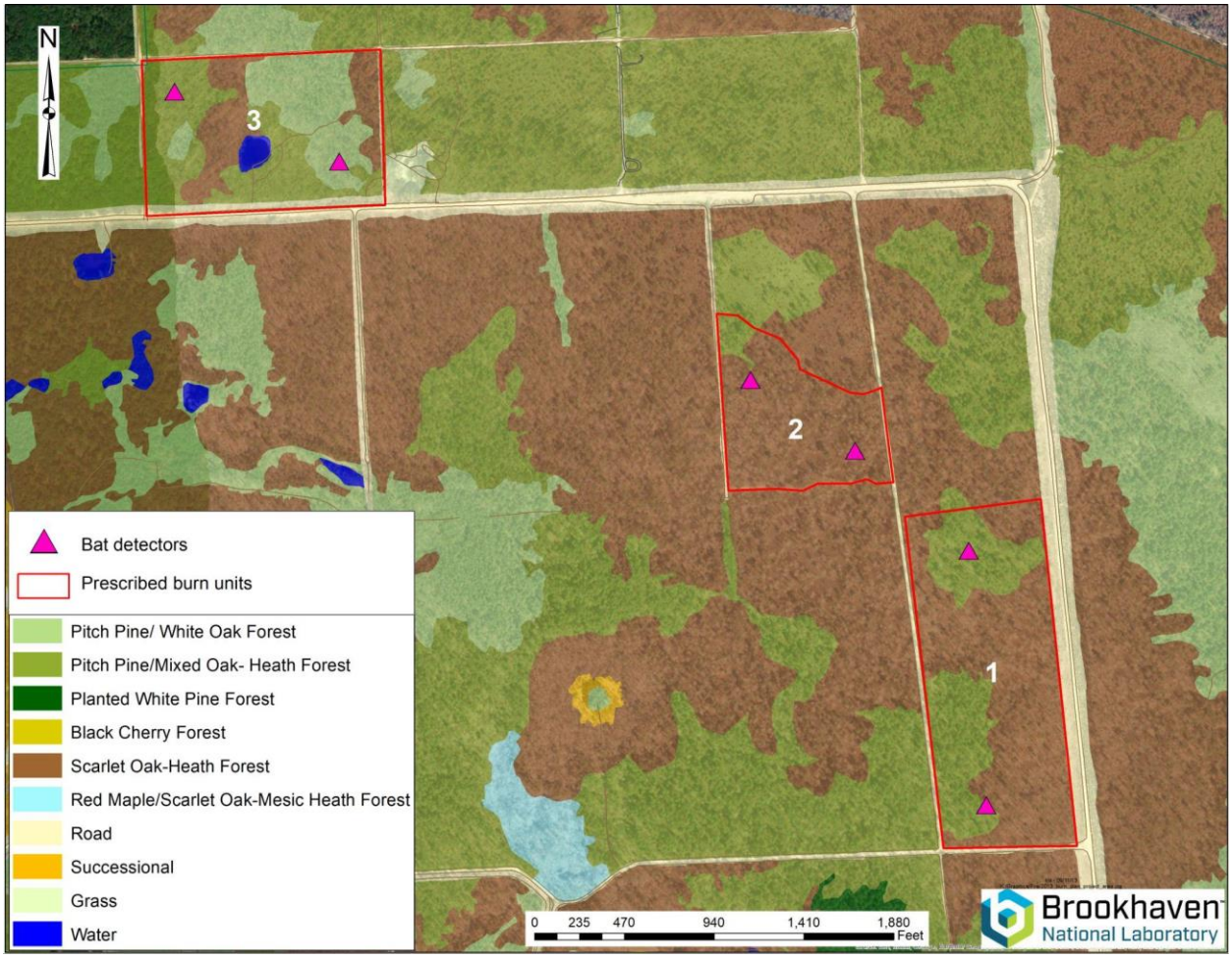


Figure 1: A map of the plots 1, 2, and 3, and where each monitor was deployed within its plot

Plot 1 was burned at moderate intensity in late spring 2017 and low intensity in fall 2005. This plot had tall, thick, abundant ground vegetation and a mix of live and dead trees. Plot 2 was burned at moderate intensity in July 2022. Some northwestern sections experienced wildfires in April 2012 and in April 2020. Plot 2 had ground vegetation, live trees with foliage, and some dead trees. Plot 1 and 2 also experienced fire in the 1930s, but since it occurred so long ago, the blaze likely has no effect on the current environment. Plot 3 was only burned in June 2023 at moderate intensity. This plot had minor live ground vegetation, only a few inches tall. It was sparsely populated with burnt trees, some of which had foliage. These plots are relatively small, only 29, 23, and 14 acres respectively.



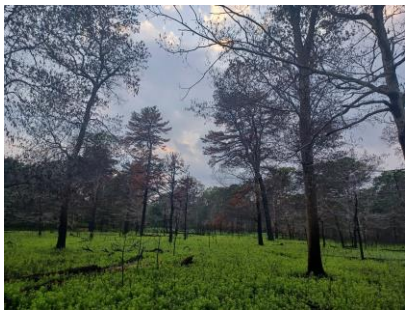

Figure 2a, b, and c: Environmental view of burn plots 1, 2, and 3, respectively

**Monitor Deployment**

Suitable locations for detectors include areas with canopy openings, water sources, recently logged forests, or woodland edges (US Fish and Wildlife Service 2023). They should be deployed 10 feet from obstructions, with minimal vegetation within 33 feet, and 49 feet from known roosts (US Fish and Wildlife Service 2023). The six Song Meter Mini Bat Ultrasonic Recorders used in this study were placed on forest edges with semi-open canopies near road corridors. However, it was difficult to ensure the full isolation of devices, so there may have been obstructions within the defined range.

USFWS also states that directional microphones should face the selected flight path to maximize detected pulses (2023). The monitors were placed at the corner of the plots and angled towards the center. Additionally, the guidelines note that while mounting the monitor at a height above 3 meters would improve recording quality, it would also result in decreased foliage to shield the monitor from the elements and curiosities of bats (US Fish and Wildlife Service 2023). As these are recently burned plots, with significantly decreased foliage, monitors for this study were positioned at just under 6 feet.

**Weather Conditions**

Several studies have revealed a correlation between foraging and weather conditions. One report on Brazilian free-tailed bats revealed that this species emerges to hunt earlier during dry,

cool days and later on moist, warm days (Frick et al. 2012). Another study in Costa Rican tropics determined that bat activity peaked in summer and dropped in spring (LaVal & Lawton 2021). The study also noted that an increase in wind was correlated with greater bat passes, whereas the presence of rain or bright moonlight decreased the number of bat passes (LaVal & Lawton 2021). Since weather factors can impact bat activity, the USFWS survey guidelines detail that nights with certain conditions — temperatures below 50, precipitation/fog, sustained winds of over nine mph — for 30 straight minutes or intermittently over five hours, must be repeated. The sample nights, from July 12th to July 20th, saw high moisture and warm temperatures (Meteorological Services 2023). While the majority of the max wind speeds exceed the nine mph threshold, they were either unsustained or occurred during the daytime (Meteorological Services 2023). While there were significant precipitation levels on 7/16/21, this was mitigated by the addition of an eighth sample night (Meteorological Services 2023). Otherwise, bat activities would have been normal during the recording period. Additionally, due to the procedural method of deploying all monitors at the same time, the confounding variable of daily weather conditions would have been minimized.

| Date | Temp Low (10 meter min) | Humidity (2 meter max) | Humidity (2 meter min) | Precipitation (inches) | Wind Speed (10 meter max) |
|---|---|---|---|---|---|
| 7/12/23 | 66.56 | 100.00 | 38.80 | N/A | 8.95 |
| 7/13/23 | 71.60 | 100.00 | 66.70 | N/A | 13.65 |
| 7/14/23 | 70.16 | 100.00 | 76.70 | .69 | 15.21 |
| 7/15/23 | 75.92 | 100.00 | 72.70 | N/A | 10.96 |
| 7/16/23 | 73.22 | 100.00 | 95.80 | 2.29 | 14.09 |
| 7/17/23 | 74.12 | 100.00 | 64.20 | N/A | 9.17 |
| 7/18/23 | 71.78 | 100.00 | 75.30 | .18 | 10.74 |
| 7/19/23 | 67.64 | 100.00 | 68.20 | N/A | 9.84 |

Figure 3: Weather chart of the sample nights

## DATA & RESULTS

After the monitors were collected, their acoustic data files were categorized by plot then night, and analyzed by Wildlife Acoustics' Kaleidoscope Pro software. Their bat analysis program uses high quality pattern recognition algorithms to aid in species detection, inventory, and monitoring. The Bat Auto-ID feature suggests potential bat species based on echolocation pulses, with more pulses ensuring a more accurate identification. Kaleidoscope typically struggles to identify high frequency calls, like the 40.6-95.1 kHz range of *M. leibeii*, the 37.0-104 kHz range of *M. septentrionalis*, and the 37.5-80.9 kHz range of *M. sodalis* (Humboldt State University Bat Lab 2011). In a more comprehensive study, an acoustic expert would have verified that the specified recordings had those bats. However, Kaleidoscope's capabilities are sufficient for this brief report.

The Bat Auto-ID feature also provides an analysis summary for the overall batch of files. The compiled results for each plot are recorded in the 3 charts below. Each bat species is recorded in the chart below using a shorthand format containing the first 3 letters of their genus and species. While the charts only show how many calls were detected for each species, Kaleidoscope also provides a p-value of the presence/probable absence of each species in the sample Using the standard significance threshold, any data values with an insignificant p-value above .05 were removed and replaced with '-'. The '*' represent activity values that were deemed outliers by R Studio.

| Plot 1 | | | | | | | |
|---|---|---|---|---|---|---|---|
| Night | EPTFUS | LASBOR | LASCIN | LASNOC | MYOLUC | MYOSEP | PERSUB |
| 1 | 148 | 9 | 35 | - | - | | 6 |
| 2 | 249 | 2 | 65 | - | - | | 7 |
| 3 | 286 | 5 | * | - | | | 13 |
| 4 | 188 | 5 | 34 | - | - | | 5 |
| 5 | 47 | | 8 | - | | | |
| 6 | 133 | 4 | 78 | - | - | | 5 |
| 7 | 170 | 15 | 60 | - | - | | - |
| 8 | 8 | 1 | 4 | - | | | |

| Plot 2 | | | | | | | |
|---|---|---|---|---|---|---|---|
| Night | EPTFUS | LASBOR | LASCIN | LASNOC | MYOLUC | MYOSEP | PERSUB |
| 1 | 116 | 18 | 113 | - | | | - |
| 2 | 136 | 7 | 49 | - | - | | - |
| 3 | 160 | 21 | 88 | 74 | - | | - |
| 4 | 120 | 9 | 82 | 53 | - | | - |
| 5 | - | | 19 | - | | | |
| 6 | 74 | 10 | 58 | 46 | - | | - |
| 7 | 62 | 14 | 37 | 31 | - | | - |
| 8 | 12 | 1 | 8 | - | | | |

| Plot 3 | | | | | | | |
|---|---|---|---|---|---|---|---|
| Night | EPTFUS | LASBOR | LASCIN | LASNOC | MYOLUC | MYOSEP | PERSUB |
| 1 | 260 | 31 | 71 | - | - | | - |
| 2 | 200 | 60 | 66 | - | - | - | - |
| 3 | 249 | * | 93 | - | - | - | - |
| 4 | 356 | 29 | 86 | - | - | | - |
| 5 | 62 | | - | - | | | |
| 6 | 234 | 64 | 122 | - | - | | - |
| 7 | 453 | 44 | 109 | - | - | | - |
| 8 | 25 | 2 | 7 | - | | | |

Figure 4a, b, and c: Charts recording the bats activity by species for each night on the specified plot

The charts above compile the analysis summaries from each monitor to better determine the species richness of these plots. The little brown bat *(Myotis lucifugus)* and Northern long-eared bat *(Myotis septentrionalis)* were not detected in the plots with any statistical significance, indicating probable absence. The species richness of these plots only include the silver-haired bat (*Lasionycteris noctivagans*), the tricolored bat/eastern pipistrelle (*Perimyotis subflavus*), the big brown bat (*Eptesicus fuscus*), the red bat (*Lasiurus borealis*), and the hoary bat (*Lasiurus cinereus*).

The *L. noctivagans*, and the *P. subflavus* were only detected in one of the three plots. *L. noctivagans* was detected with statistical significance on nights 3, 4, 6, and 7 in plot 2. *P. subflavus* was detected with certainty on nights 1, 2, 3, 4, and 6 in plot 1 (IUCN 2023). *E. fuscus*, *L. borealis*, and *L. cinereus* were determined as present in all plots for the majority of the sample nights. Due to the constraints of Kaleidoscope Pro data analysis, R Studio was used to determine a statistically significant difference in activity between burn plots. Of the three species, only *L. borealis* was shown to have a statistically significant variance in activity. The difference in activity between plot 1 and 3 had an adjusted, rounded p-value of .02. It should be noted that the difference in activity between plot 1 and 2 or 2 and 3 was not deemed significant.

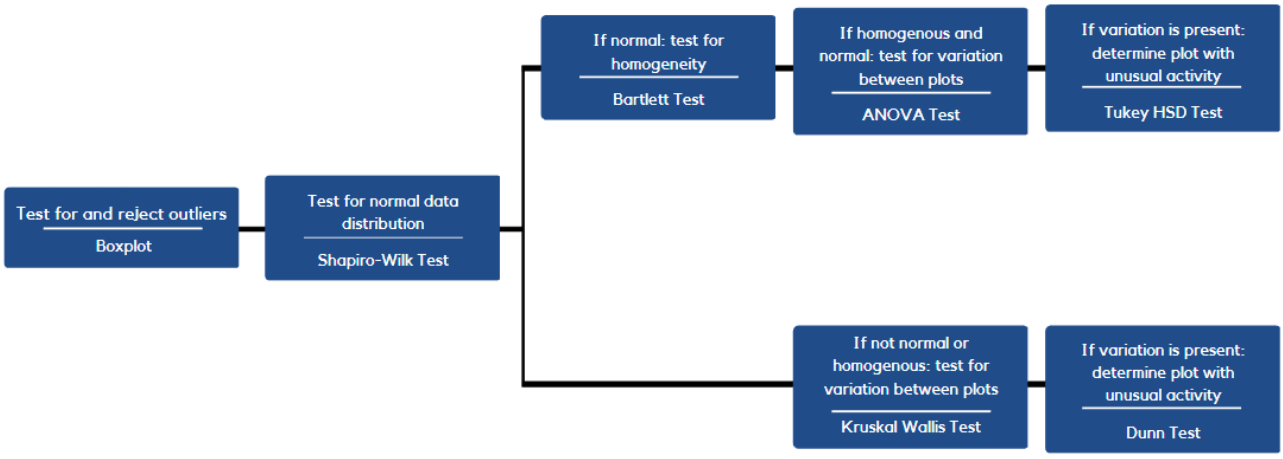


Figure 5: Flow chart on how statistical analysis was conducted for *L. borealis, L. cinereus,* and *E. fuscus*

## DISCUSSION

The absence of *M. lucifugus* and *M. septentrionalis* is likely because these species' populations have been reduced by over 90% by White-Nose Syndrome (WNS) (Communications & Publishing 2021, Communications & Publishing 2022). The WNS fungus operates by periodically awakening migratory bats, causing them to use up fat reserves, raise their body temperatures, and starve over winter (Communications & Publishing 2022, National Park Service nd). While WNS is most fatal during the winter hibernation period, it also results in reduced summer activity levels (Dzal et al. 2010). Therefore, it is reasonable to conclude that *M. lucifugus* and *M. septentrionalis* were not present and the species richness of these plots only include the *L. noctivagans, P. subflavus, E. fuscus, L. borealis,* and *L. cinereus*.

*L. noctivagans* tends to roost in riparian forests of coniferous and deciduous vegetation in a variety of life stages, preferring the loose bark of live and cavities of dead willow, maple, and ash trees (Bentley 2017, BCI 2023, Stegemann & Hicks nd). However, these bats prefer foraging in disturbed forests (BCI 2023). Plot 2 offers both old growth roosts and disturbed foraging grounds due to the prescribed fire a year ago. It is possible that the burn history of the plot attracted *L. noctivagans* for foraging or roosting.

Though decimated by WNS, *P. subflavus* was found with certainty in plot 1. These bats prefer roosting in the leaf foliage of deciduous hardwood trees, which tend to be less fire-adapted than pines and require greater time after fire to regrow foliage (Stegemann & Hicks nd). *P. subflavus* would not be able to locate appropriate shelter in recently burned plots, like plot 2 and 3. This may be why the species prefers the plot least recently burned.

Though *E. fuscus, L. borealis,* and *L. cinereus* were determined as present in all plots, *L. borealis* preferred plot 3 over plot 1 with statistical significance. *L. borealis* is one of the largest

and fastest bats in the region with a wingspan of 12” and a speed of 40 mph (Stegemann & Hicks nd, https://www.chesapeakebay.net/discover/field-guide/entry/eastern-red-bat nd). It’s possible that this species may have found the most recently burned plot more navigable.

## CONCLUSION

The goal of this research was to provide a species richness list of the present bat species and determine if they had any preference towards areas in different stages of post-burn. The study showed the presence of 5 different species — *E. fuscus, L. cinereus, L. borealis, L. noctivagans,* and *P. subflavus*. Of them, the latter 3 showed a significant bias in the location of their nightly activities. This biased behavior is likely due to different requirements in roosting and foraging areas, like live trees and foliage or sparse, open areas.

As an introductory exploration on the relationship between bats and prescribed burns, the presented results would benefit from a more in-depth research project with a greater chronological range of burns, more sample plots and nights, and an unburned control plot. Additionally, the small sizes of the plots may not significantly affect bat activity; the individuals could be passing through the burn plots on their way to foraging/roosting areas. The explanations for behavioral preferences are tentative, and could be verified by further research on each species’ spatial requirements.

Nonetheless, these findings provide important context for the behaviors of New York bats in the presence of burned plots. As prescribed burn strategies popularize in the Northeastern US, replacing the federal fire suppression regime and modernizing the Native American fire promotion methods, it is important for scientists to predict how these controlled fires might have

indirect, far-reaching effects on wildlife. This research will be an important foundation for future research on how bats will be affected as prescribed burns return to the Northeast.

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