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 eight 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, which suggests that it was attracted to the disturbed foraging grounds. 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 (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 Fire History

The US fire regime, or the long-term pattern, frequency, and intensity of fire, has changed dramatically due to differing types of human involvement. Local Native American tribes that stimulated nutrient-rich vegetation with a fire promotion regime helped shape the northeast US into a landscape of oak and pine forests, prairies, and savannas (Abrams & Nowacki, 2008). European colonization saw an upheaval of this system that eventually settled into a new era of fire suppression (Abrams & Nowacki, 2008).

Environmental conditions and a new regime eradicated fire in the northeastern US. The deficiency in fire disturbance initiated a positive-feedback loop that resulted in the accumulation of underbrush fuel, increase in forest density, and stunting of sapling growth makes it easier for fires to quickly expand vertically and horizontally (Keeley, 2008). This causes modern wildfires, though infrequent, to be incredibly severe and damaging. Now, public sentiment is returning towards the use of prescribed fire in order to clear dangerous fuel and increase pyrophytic species diversity.

Bats & 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 within open forest stands and edges because the reduced mid- and overstories eliminate clutter, blocking sunlight and impeding travel (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, certain bats may not be able to find sufficient live trees 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 relationship between prescribed burns and bat activity are affected by a myriad of factors, including the intensity, severity, and size of the fire and the bat species' requirements for foraging and roosting

Many previous studies have explored this relationship with their regional bat species. One study on various treatments found that sites burned or thinned and burned did not experience an activity increase in the primarily documented species: *Eptesicus fuscus, Lasiurus borealis,* and *Perimyotis subflavus* (Loeb & Waldrop, 2008). Another study found that their local *Nycticeius humeralis* had a strong preference for recently burned forests, likely due to improved foraging and roosting opportunities, but mentioned other reports of *Lasiurus borealis* being negatively affected by fire damaging individuals and winter roosts (Boyles & Aubrey, 2006). The last study reviewed stated that fire had different effects based on species, with snag-dwelling bats benefiting from 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, 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.

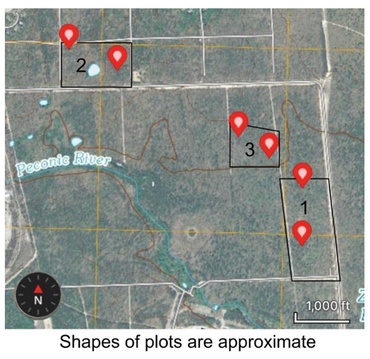
Methods & Materials

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).

Site Selection

The three sites chosen were the most recently burned plots at Brookhaven National Laboratory (BNL). Each plot, all under .5 km^2, had two acoustic monitors and over seven nights of data collection (2023).

The plots are populated with a mix of *Quercus spp., Pinus spp., Vaccinium spp., Gaylussacia spp.,* and *Carex spp.* Plot 1, in the southeastern corner of the map, 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, in the northwestern corner of the map, 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, above and right of plot 1, 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.



Shapes of plots are approximate

Monitor Deployment

The section on acoustic surveys details that 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, since these monitors were deployed in the forest, it was difficult to ensure the full isolation of devices, so there may have been obstructions within the defined range.

In placing the monitor onto an appropriate mast, directional microphones should face the selected flight path to maximize detected pulses (US Fish and Wildlife Service, 2023). Due to the nature of this survey, 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 10 feet 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 six 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). This adaptation may be linked to how insect availability differs with moisture and temperature (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 5 hours, must be repeated. The sample nights, July 12th to July 20th, saw high moisture and warm temperatures (Meteorological Services, 2023). While the max wind speeds exceeded the nine mph threshold, they were either unsustained or occurred during the daytime (Meteorological Services, 2023). Besides the significant rain on 7/16/23, bat activities would have been normal during the recording period (Meteorological Services, 2023). 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. Min	Humidity Max	Humidity Min	Precip.	Wind Speed
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

Data

After the monitors were collected, their acoustic data files were categorized by plot then night, and analyzed by Wildlife Acoustics' Kaleidoscope Pro software. The compiled results for each plot are recorded in the three charts below, with each bat species recorded in a shorthand containing the first three letters of their genus and species. Any data values with an insignificant p-value above .05 were replaced with '-'. Bats that were present in all three plots were analyzed for statistical significant variations in behavior through R studio. Any outliers were replaced with '*'.

Bat activity in Plot 1

Nights	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	-			

Bat activity in Plot 2

Nights	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	-			

Bat activity in Plot 3

Nights	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	-			

Results

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*).

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. The big brown bat (*Eptesicus fuscus*), the red bat (*Lasiurus borealis*), and the hoary bat (*Lasiurus cinereus*) were determined as present in all plots, but R Studio statistical analysis determined that *L. borealis* had statistically significant variance in activity, preferring plot 3 over plot 1. It should be noted that the difference in activity between plot 1 and 2 or 2 and 3 was not deemed significant.

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), making them endangered and near-threatened (Communications & Publishing, 2022. Communications & Publishing, 2021. IUCN, 2023). 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 is an agile bat that tends to roost in mature-growth, riparian forests but prefers foraging in disturbed forests (BCI, 2023. Bentley, 2017. Stegemann & Hicks, nd). Plot 2, burned in 2022, offers both old growth roosts and burned foraging grounds. It is possible that the burn history of the plot attracted *L. noctivagans* for foraging or roosting.

P. subflavus prefers 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 1 and 2. This may be why the species was present in the least recently burned plot.

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. 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 may be 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 certainty of the results are constrained by the small sample size and scale. Additionally, this report did not have a control plot. This project would benefit from a more in-depth research project with significantly more samples and a control plot. Additionally, 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 Western 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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