



Assessing Predation Threats and Foraging Flexibility of Imperiled Indiana Bats at Veterans Memorial WMA

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Introduction

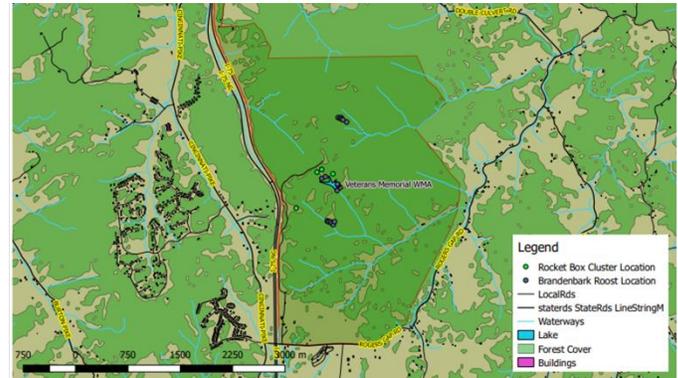
The Indiana bat (*Myotis sodalis*) has been listed as an endangered species since 1967 (1). Since 2010, populations of this species have declined by as much as 27% due to white-nose syndrome (WNS (2). To date, WNS has been found in 35 U.S. states and 7 Canadian provinces (3)

Roosting and Predation - Appropriate roosting habitat is required for all temperate bats to provide both shelter from the environment and protection from predators (4). Specifically, summer roosts used by maternity colonies of female Indiana bats typically consist of loose bark or tree crevices (5). The impacts of predators on bats (e.g., raccoons, semi-arboreal snakes, and raptors) have only been sparsely recorded (3,6,7,8), and few reports confirm predation on live bats (7,9). Given the increasing use of artificial roosts for Indiana bats, we investigated the potential for predation at such roosts.

Foraging Flexibility - A known factor threatening bats is loss of foraging habitat and urbanization (10). Foraging capabilities of various bat species is a consequence of morphological features and echolocation abilities (11). Aspects impacting bat foraging include foliage, morphology, and echolocation type (12). Passive monitoring of bat echolocation is a useful and effective method to understand foraging habitat selection across bat species (13). While Indiana bats return to preferred woodlands for foraging, they also use a variety of habitats (11,14,15). In order to better understand the habitats used by foraging Indiana bats, we assessed acoustic activity in a variety of forest conditions.

Methods

The study took place at Veterans Memorial Wildlife Management Area (VMWMA) in Scott



County, Kentucky (Fig. 1). This site is managed by Kentucky Department of Fish and Wildlife Resources and is situated in the Inner Bluegrass Region (16). The site is a focus for research and management, being used by multiple maternity colonies of Indiana bats (17).

Figure 1. Map of Veteran's Memorial Wildlife Management Area (18).

Roosting and Predation - Camera surveys were conducted from June-July 2020 to assess predator threats of roosting Indiana bats. Specifically, we targeted a cluster of six artificial (BrandenBark) roosts located on the northern portion of the ownership with a long history of use (19). Of these, three were randomly chosen to receive a guano trap (18). Browning Strike Force trail cameras were aimed at base of each roost (mean distance of 15 feet). Cameras ran day and night to record any predator visits to roosts. Images were then processed with Wild.ID (Wildlife Insights, TEAM Network).

Foraging Flexibility - The landscape of VMWMA was surveyed from June-July to assess activity of the Indiana bat. Song Meter 2 systems ("Bat+" Wildlife Acoustics, Maynard, MA) were used to record echolocation calls from 30 minutes prior to sunset until 30 minutes after sunrise in the relative vicinity of artificial roost clusters. Detectors recorded for ≥ 2 nights during a given deployment at all roosting sites visited (n=24 detector locations). To stratify

detector locations across the landscape, an artificial roost within each cluster at VMWMA was randomly selected and then a random azimuth and distance (50-150m) was used to determine the detector location. The detector's microphone was placed ~3 meters off the ground and directed toward an opening in foliage for optimal recording (20). Echolocation calls were filtered and processed using Kaleidoscope v.5.9g (Wildlife Acoustics, Maynard, MA) using the Kentucky-specific 'neutral' setting as per USFWS reporting guidelines (1). Resulting calls were identified to species-level, and Indiana bat calls were then summarized on a per-night basis. Additionally, we measured canopy density and basal area (densiometer and wedge prism, respectively) at each acoustic location.

Results and Discussion

Roosting and Predation - Images were collected across four weeks from our six camera traps, surveying across 180 trap days and resulting in 13,710 images. A total of 7 mammal species and 8 bird species were recorded. Mammals and birds were imaged across 48 events, and only 5 instances belonged to potential bat predators (Fig. 2). Importantly, guano traps at artificial roosts did not significantly influence predator visits on a weekly basis ($\chi_1^2 = 0.19$, $P = 0.67$).



Figure 2: Stacked bar chart of imaging events across vertebrate groups.

Foraging Flexibility - Acoustic surveys spanned four weeks and resulted in collection of 4,934 bat calls, of which 849 were identified as belonging to the Indiana bat. Highest activity levels were observed around the lake and near

artificial roosts along east- and west-facing forest edges (Fig. 3). Spearman tests indicated no correlation between Indiana bat activity and either basal area or canopy density ($P > 0.05$, Fig. 4). Canopy densities around roost were moderate to significantly cluttered. The data indicates slightly higher use of basal areas between ~45-75 m^2 per hectare, suggesting this habitat condition may be more selected by Indiana bats.

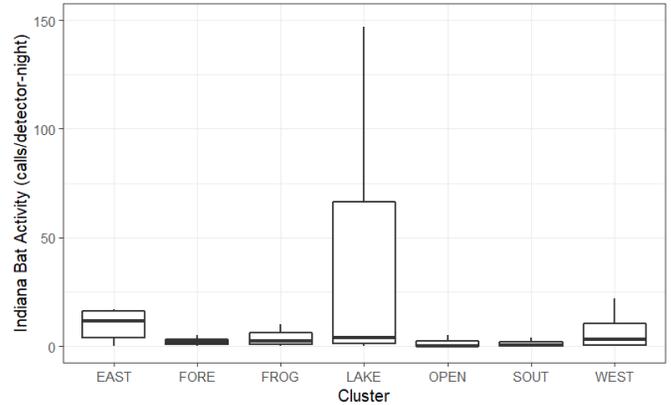


Figure 3: Boxplots of Indiana bat activity across roost clusters.

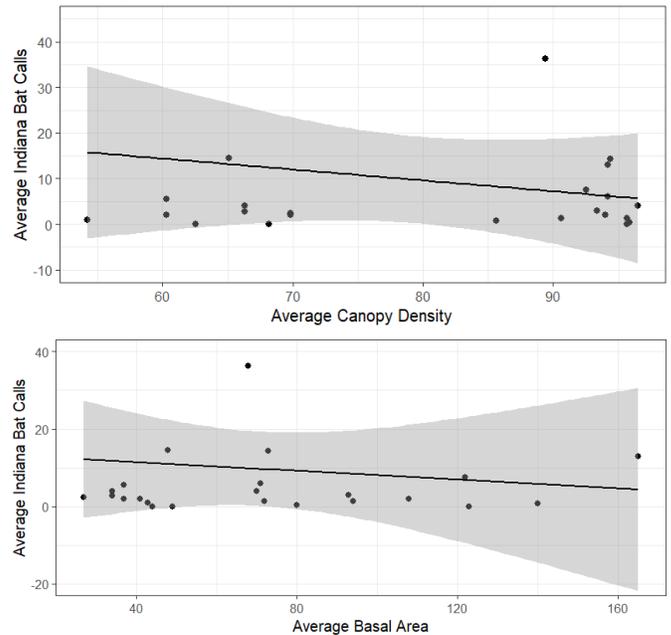


Figure 4: Relationship between Indiana bat activity and habitat conditions, with values averaged at each detector location.

Conclusions

Roosting and Predation - Guano traps did not elicit increased predation, nor were predator visits noted to be linked with the duration/progression of this study. These results

are promising, as they suggest guano traps will not unintentionally lure predators to a roost.

Foraging Flexibility –While canopy density did not appear to impact foraging by the Indiana bat, our data suggest basal area might have a clearer relationship. However, clear differences in activity were observed across the landscape. Given the results of this study, we conclude that corridors and edges are important habitat features for the Indiana bat, and we would highlight the survey areas with increased acoustic activity as important to foraging Indiana bats.

References

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