The Effects of Precipitation and Temperature on the Roosting Habits and Occupancy of Bats in the Beaverhill Natural Area

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Amélie Despins

Introduction:

Bat abundance across the globe is declining (Sherwin et al., 2012). Due to their slow reproduction cycles and heightened sensitivity to climate change and habitat loss, these species are producing smaller litters and seeing an increase in White-Nose Syndrome (WNS) cases (Sherwin et al., 2012). Bats are generally viewed as harmful, and many of their positive impacts on the ecosystem are overlooked. For instance, when bats make their homes (roosts) in buildings, they have little interaction and threat towards others, including humans and other animals (Government of Alberta, 2026). Furthermore, being nocturnal limits contact between humans and bats, leading to very few and far between incidents that occur (Government of Alberta, 2026). Not only do our bats mitigate insect levels, but they also support pollination and aid in seed dispersal, helping native and agricultural plants that we culturally and economically depend on (Government of Alberta, 2026). Bats also help facilitate the decomposition cycle and nutrient cycling by adding their rich organic guano to the soil (Sherwin et al., 2012). Although seemingly small, bats are also considered bioindicators. In the face of climate change, their diverse range allows monitoring to showcase habitat loss to signal other costly threats (Sherwin et al., 2012). Advocating to conserve and protect a species with a bad social image is difficult, yet when presented with how critical bats are to the ecosystem's health, shifting society's perception could be possible.

Alberta, ranging from the prairies to the boreal forests, houses nine species of bats, (Alberta Bat Community Program, 2026). Some species of bats often roost together in large groups, especially maternity colonies (Alberta Bat Community Program, 2026). Roosts are essential for bats and can be deeply affected by location and vulnerability to the elements. Roosts more exposed to sunlight promote the storage of metabolic energy. Yet, cooler roosts allow bats to go into a state called torpor, where they are able to have a lower metabolic rate and internal temperature, which is vital when insect activity is limited and during the winter hibernacula (Miller, 2018). The maternity colonies require warmer microclimates in the roosts, as entering torpor can negatively impact pregnancy and reduce lactation (Miller, 2018). Precipitation also has a significant impact on how the bats behave, their foraging success, as well as impacting research methods. Bats as well as their prey are less active under precipitation, (Holloway & Barclay, 2000). Bats as a whole are understudied; adding in the factor of precipitation creates technical challenges that come with researching bats (Holloway & Barclay, 2000).

The Beaverhill Natural Area (BNA) located east of Edmonton, provides habitat for a large diversity of birds and other wildlife. Within the BNA, the Beaverhill Bird Observatory (BBO), conducts bird monitoring and research programs as well as bat monitoring. Bat houses can be found in brown, green, or red, with a small, medium, or large size, can have single or multiple chambers, and are located in open, edge, interior, or clearing habitat types. Bat occupancy is surveyed and recorded every summer for research purposes. This report focuses on

how differing precipitation levels and daily temperatures affect the roosting habits and occupancy of bats in the BNA. Specifically, I looked at the conditions when bats roosted together, where that roost was located, and how temperature affected them: as well as comparing the bat population before and after large amounts of precipitation. Recent precipitation levels around the study area indicated high levels of water availability. I hypothesized a larger amount of aggregation in cooler temperatures, and a generally higher number of bats in multichambered houses where heat was better stored. I hypothesized houses placed in interior and shaded edge types would have higher amounts of aggregations, having the forest to help shield from the wind as well as some sunlight to provide warmth for maternity roosting. Precipitation may change the number of bats in each bat box due to the limited amount of prey available. I hypothesized that having more precipitation would result in a higher correlation with aggregation in multi- and single-chambered roosts.

Future implications for this study are to form an understanding of the impacts of temperature on roosting choices to understand where to build bat boxes to increase overall bat population. According to Bat Conservation International (2023), over the next 15 years, 82% of the bat species in North America will be affected by climate change. With the growing threat of climate change at hand, gaining knowledge on how the slightest temperature change causes catastrophe to the annual bat population count can help nonprofits like the BBO to create enriched environments and shelters for the local bat species. This study provides the BBO with recommendations on how bats respond to changes in weather, indicating what houses are favoured and how boxes should be built to support larger numbers and support maternity roosts for long-term survival.

Study Area:

All data was compiled at the Beaverhill Natural Area in Beaver County, 8 km east of Tofield. All data was collected from a 2-kilometer loop within the 1,013.1 acre area (Figure 1). The BBO built and placed 38 bat houses over the past decade. The bat houses varied in color (brown, green, and red), size (small, medium, and large), and amount of chambers present (Figure 2). The houses placed in an open habitat type were surrounded by an open field, edge types bordered the forest located near a water source, interior houses were fully surrounded by the forest, and houses in a clearing had an opening that was then surrounded by the forest (Figure 3).



Figure 1. Map of the 2 Kilometer loop with numbered bat houses located in the Beaverhill Natural Area, Multiple chambered houses indicated by an ‘M’ (Doris Audet, 2024).



Figure 2. Three different designs of bat houses in the BNA according to colour, size, and style – large brown single-chambered (ai), large brown multi-chambered (aii), medium green (b), small red (c) (Gualter and Halajian 2019).



Figure 3. The four different habitat types where the bat houses were located in the BBO-clearing (a), interior (b), edge (c) and open (d) habitat types (Gualter and Halajian 2019).

Data collection:

Bat boxes were surveyed weekly from May 20th to August 27th 2026; flooding throughout the summer interrupted surveys during the weeks of June 24th, July 1st, and July 31st, with a partial emergency survey July 16th (only surveying 6 houses). The highest amount of precipitation was 12.8mm in one day, however the BBO experienced more precipitation that was not recorded due to the flooding. Precipitation was measured from nearby stations, such as Tofield, however onsite precipitation could not be measured as the device still needs to be repaired. Data were collected within a 4-10 day period since the previous survey. Surveys took place in the afternoon and early evening. At the beginning of each survey, the daily weather was recorded: wind speed was measured using the Beaufort scale, start and end temperatures were recorded using the weather app, and cloud coverage was recorded through visual assessment. The maximum temperature (TMAX) and minimum were also recorded from the Shonti station. The surveys were conducted by walking to each house on the trail, standing directly underneath the house, and shining a flashlight directly into the bottom of the house. Houses having multiple chambers (2-4) were recorded, as well as which chambers were occupied by the bats (eg., 12 bats, chambers 2 and 4). Most houses were easily counted; however, a couple of houses had blockages either from plant growth or cobwebs, making the counting slightly challenging.

Data Analysis

An analysis was done to view the relationship between TMAX daily temperature and occupancy in single vs. multichambered houses; as well as how occupancy changed based on precipitation throughout the summer.

Results:

Occupancy results of 2026

A total of 1040 Little Brown Bats were counted throughout 11 surveys beginning in late May spanning to the end of August (Figure 4). July 21st had the highest occupancy count, standing at 191. The lowest weekly count was the last survey done on August 27th, having one bat counted. There was a dip in numbers after June 17th, which happened to have the highest precipitation numbers of the surveys throughout the summer. A steady decline follows July 21st to the last survey, with no peaks throughout.

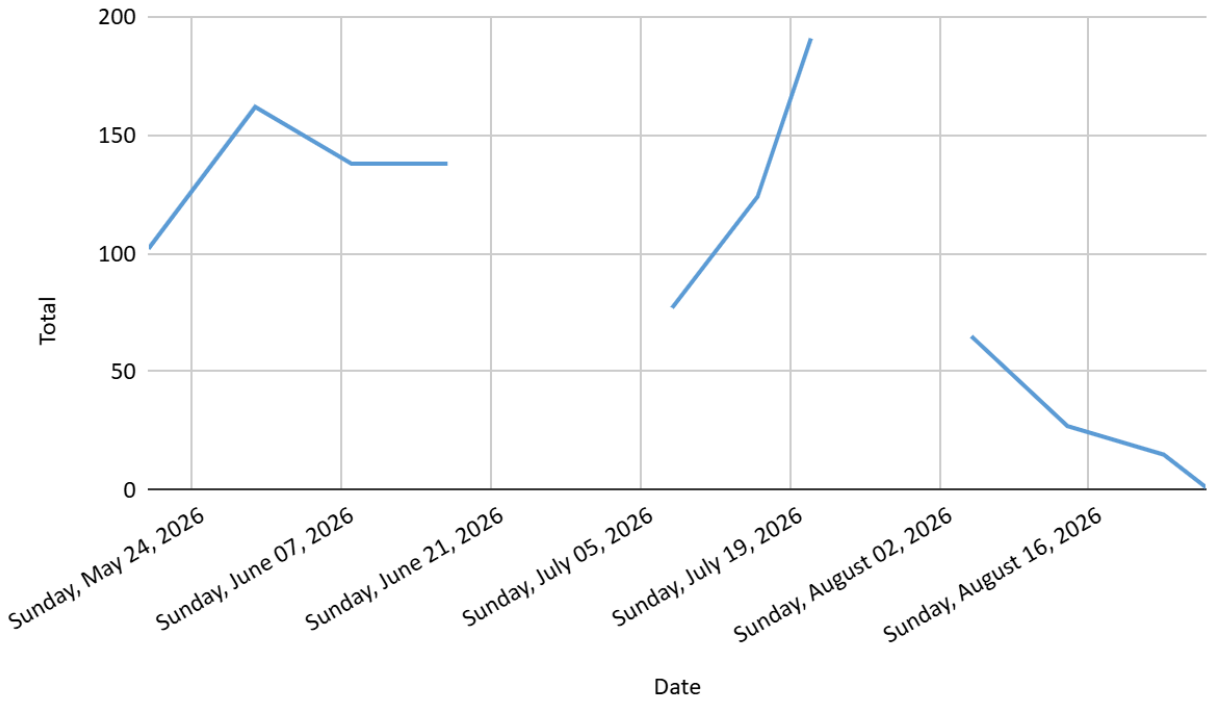

Figure 4: Bat Occupancy Numbers with gaps included from May-August 2026

The highest bat count was in the multi-chambered box M41 in a clearing. However, throughout the summer the Edge type habitat had the highest occupancy rates compared to the other types (Figure 5). It is important to take into consideration the number of houses present at each location type, edge type having the most available houses to offer. As seen in the Appendix under Table 1, the edge type has a greater average number of bats per box.

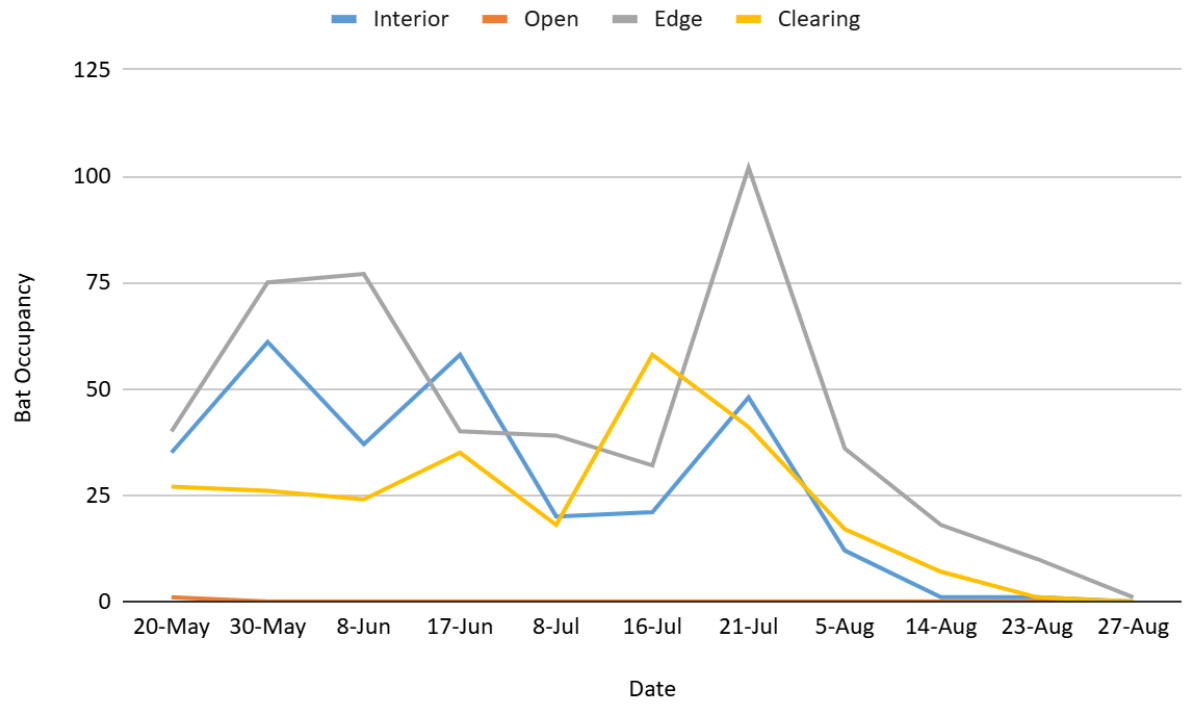

Figure 5: Bat Occupancy (number of bats) at differing habitat types from May- August 2026

Bat boxes 13, 21, 23, 33, 34, 35, 36, 38, had 0 bats recorded over the surveys, all of which are single chambered houses. Multichambered boxes hosted 90.3% of the bats, leaving single chambered houses with 9.7% (Figure 6).

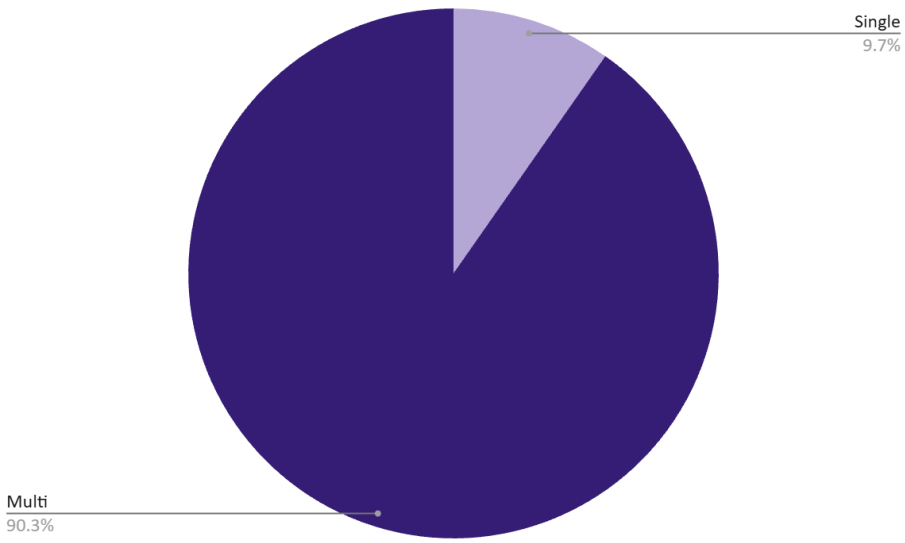

Figure 6: Occupancy of Single vs. Multichambered bat boxes

Temperature and Precipitation

In general, as the temperature increased, occupancy dropped (Figure 7). Single chambered houses reached their peak at the same time as multichambered houses did (one of their peaks). Occupancy numbers were the highest when temperature was between 14-20°C TMAX

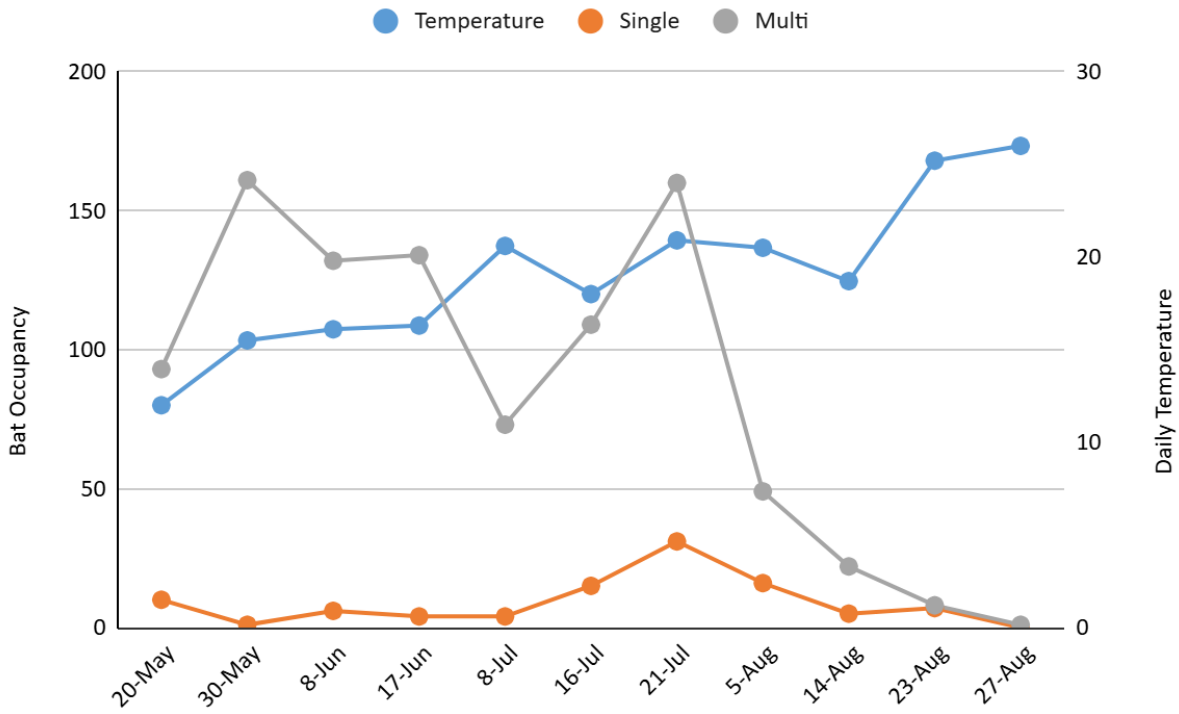

Figure 7: Occupancy and Temperature counts from May-August 2026

From the 11 surveys recorded, after precipitation occurred, occupancy would dip (Figure 8). After the flood, when precipitation decreased, occupancy increased.

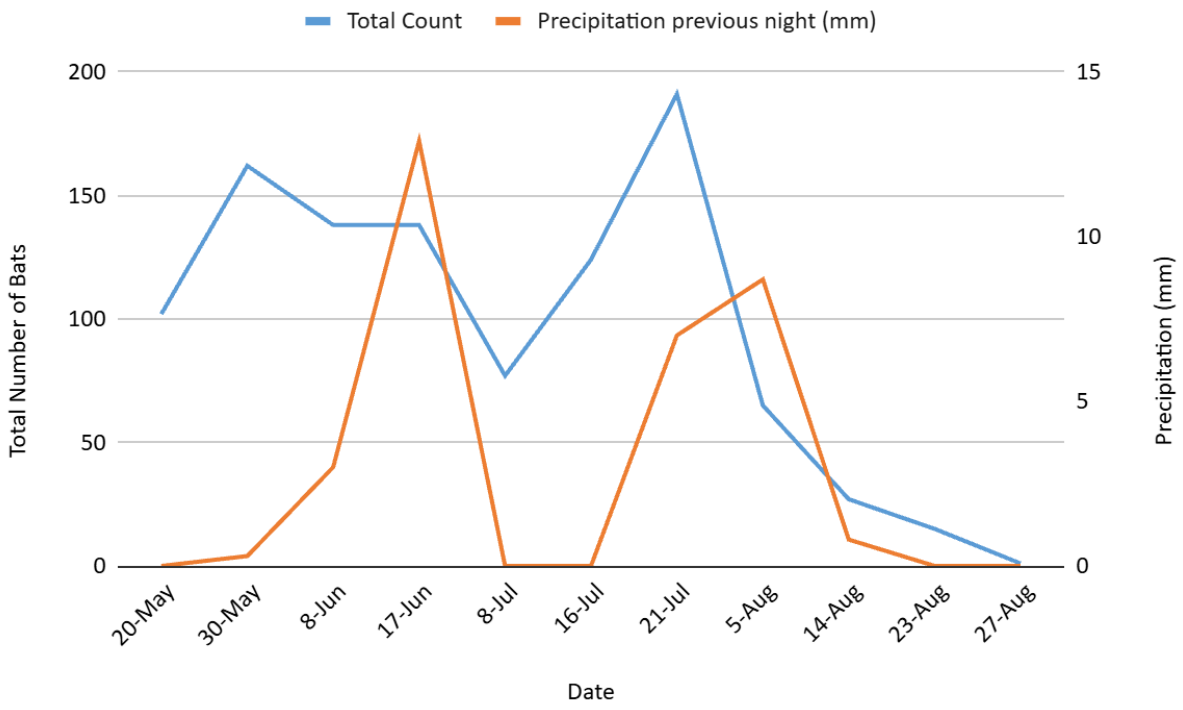

Figure 8: Precipitation (mm) and Bat count from May-August 2026

Discussion

The 2026 surveys found fewer bats compared to the 2025 surveys (Sonefeld, 2025). Due to the large amount of precipitation, the 2026 surveys had less data collected compared to 2025, impacting the total count. However, general numbers per survey were much higher the previous year compared to 2026 (Sonefeld, 2025). Numbers dropped significantly after the highest count on July 21st, most likely due to fledging season (Uy, 2024). The aggregation that occurs in maternity roosts in the larger multi-chambered boxes are utilized for pups. Towards August these pups are able to fledge and leave.

I hypothesized a higher number of bats in multichambered houses as well as in houses placed in interior and shaded edge types. The results of this year and the 2 previous years indicated a much higher percentage of multi chambered boxes being used compared to single chamber boxes (Sonefeld, 2025: Uy, 2024). Edge and interior type houses had the highest amount of occupancy rates over the summer, which is also where the multichambered boxes are located. However, the high numbers in the edge habitat were not surprising, as most of the houses at the BBO were located in edge types. Edge types were hypothesized to hold more bats

because of protection and ability to access prey. Boxes in clearings experienced little to no bats, but high water after and during the flood did not allow us to get to the two boxes located in the clearing type.

Temperature throughout the survey season was relatively stable, remaining mostly within 15-25 degrees. Bat numbers climbed when temperature stayed around 20 degrees, warm enough to supportmaternity roosting, yet not cool enough to impact lactation or prey levels. (Miller, 2018). The precipitation with cloud cover likely provided a shield from the sun, slightly lowering temperature this summer.

I hypothesized that having more precipitation would result in a strong relationship with aggregation in multi- and single-chambered roosts. As precipitation increased, bats' counts decreased. However, many studies experienced less bat hunting activity during rainfall (Voigt et al., 2011: Burles et al., 2009). If bats are not out during rainfall I hypothesized they would be in the houses, yet numbers indicate otherwise. Voigt et al., 2011, suggested that the bats retreat into the vegetation instead of foraging when precipitation occurs, impacting bat occupancy in boxes. Both studies, Voigt et al., 2011 & Brigham et al., 2009 concluded that rainfall could make echolocation more difficult, the lowered temperature from precipitation increases energy costs associated with flying, as well impacting insulation values. All these reasons could be impacting bat activity at the BNA, creating hunting difficulties for the bats. Heavy rainfall also deters prey, lowering the amount of food available during the night rainfalls. This rainfall season could have severely impacted the BNA bats, perhaps forcing them to go into torpor in order to conserve energy while waiting to forage due to the rain (Brigham et al., 2009). Continuing monitoring during these events is important to be able to detect large behavior or occupancy changes.

Limitations

This survey season was severely limited due to the rainfall that occurred over the summer. Not only does the rainfall prevent bat outings and hunting, it limits counts due to the flooding. Many of the trails were completely flooded and completely enabled the survey of many houses. In 2025 the open type houses, 12 and 13 had the highest counts across the summer (Sonefeld, 2025), this year they had the lowest, as we were unable to survey them for many of the weeks from the flooding. During the surveys the amount of precipitation impacted mosquito numbers greatly, adding an element of discomfort while counting the bats, compared to before the large rainfalls.

The types of houses present are not equal, having more open and clearing types present may give the bats more options which could allow results to conclude whether it's the location or the number of houses of each type present that affect the preference.

Recommendations

For future studies and monitoring I would recommend installing more location types to even out the distribution. I would also recommend having precipitation be monitored at the BBO, as the precipitation meter was not operating, instead of relying on farther stations. It would also

be useful if the temperature within boxes used for maternity roosting had their own thermometers. As well as conducting the surveys later in the afternoon, to avoid the sun at noon interfering with checking the bat boxes yet have daylight for navigating the forest.

Conclusion

This study concluded that multi-chambered boxes house larger numbers of bats than single-chambered boxes. As well as precipitation affecting bat numbers, the exact reasons cannot be concluded from this study and would have to be routinely monitored and measured to form a solid understanding on how bats react to precipitation.

Continuing monitoring the bats in the BNA is important to track how well the species is doing, which helps us determine how well the ecosystem as a whole is doing. Consistent monitoring of occupancy, temperature, and precipitation will help determine how to best protect and support the species in this area.

Appendix

Table 1. Average Number of Bats Per Box Across All Surveys

Box-Habitat Type	Average # Bats Per box
2-interior	0.7
3-interior	0.3
6-interior	0.7
7-interior	0.1
9-interior	0.1
10-interior	0.1
11-clearing	1.63
12-open	0.1
13-open	0
14-clearing	1.72
15-interior	1.6
16-interior	0.2
18-edge	0.2
20-edge	0.2
21-edge	0
23-edge	0
25-edge	0.1
26-edge	0.3
27-edge	0.2
30-edge	0.3
32-edge	0.2
33-edge	0
35-edge	0
36-edge	0
37-edge	0.5
38-interior	0
39-clearing	0.1818
M8-interior	10.45
M17-interior	7.8
M19-edge	5.8
M22-edge	10.5
M24-edge	2.8
M41-clearing	20.72
M42-interior	2.4
M43-interior	3.6

M44-edge	11.7
M45-edge	8.7
M46-edge	5.4

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