Occupancy Monitoring of Bat Houses at Beaverhill Bird Observatory in 2017

Final Report

Erin Low

Introduction

Bats play an integral role in the ecosystem as one of the main predators of nocturnal flying insects (Nagorsen & Brigham, 1993). Bats can consume their own body weight in food nightly and it has been estimated that if we were to lose North America's insectivorous bats, there would be an increased reliance on pesticides resulting in a multi-billion-dollar loss in agricultural productivity (Boyles, Cryan, McCracken, & Kunz, 2011). Despite our reliance on bats, the threats that they are facing are increasing yearly (Fenton, 1997; Boyles et al., 2011). This includes habitat degradation, fatalities at wind energy facilities, and mortality associated with white-nose syndrome (WNS) (Fenton, 1997; Boyles et al., 2011). Bats are a long-lived species with records of hibernating bats living up to at least 39 years, however females have one pup annually, and not until their second or third summer (Hobson, 2014). The increasing number of threats to their survival, combined with their low reproductive rates raises concern as to the future of bats in Alberta.

Both food and availability of roosts are limiting factors that influence the population of cavity-roosting bats (Fenton, 1997). Bats are associated with aquatic environments such as wetlands and lakes where they forage on the abundance of insects associated with these areas (Naughton, 2012). Bats typically use multiple roosting sites and regularly alternate between roosts (Dillingham, Cross and Dillingham, 2003). It has been suggested that roost switching lowers their predation and ectoparasite risk, reduces commuting distance between day roosts and foraging area, and is used as an adaption to the fluctuating microclimate and structural conditions of the roost (Dillingham, Cross and Dillingham, 2003). Having multiple cavity-roosting options within a natural area enables this behaviour.

In central Alberta, there are at least six different species of bats, including two species commonly known to roost in bat houses: Little Brown Myotis (*Myotis lucifugus*) and Big Brown Bat (*Eptesicus fuscus*). Other bat species may roost in bat houses in Alberta, but there are currently few reports to support this (Olson, 2016). A study in Indianapolis reported occupancy of bat houses by Northern Myotis, Big Brown Bat, Little Brown Myotis and Silver-haired Bat (*Lasionycteris noctivagans*) (Whitaker, Sparks, and Brack, 2006). One of the species to roost in bat houses in Alberta, the Little Brown Myotis has recently been listed as Endangered under the

Species at Risk Act because of high mortality associated with WNS (Blehert et al., 2009; Environment Canada, 2015). By installing bat houses in an area, the number of available roosting opportunities increase, as well as there is an accurate and straightforward way to monitor bat activity.

Five small bat houses have been present In the Beaverhill Natural Area for many years, with the addition of six new bat houses in 2015 and thirty new bat houses installed in 2016. All the boxes were install and are maintained by the Beaverhill Bird Observatory (BBO). Passive monitoring of bats, using a Song Meter SM2BAT+, has occurred for a few years as a means to identify the species of bats roosting in the area. Hoary Bats (*Lasiurus cinereus*), Big Brown Bats / Silver Haired Bats, as well as Little Brown Myotis have all been identified either visually or acoustically in the area. The purpose of this study was to monitor bat house occupancy of BBO bat houses. I hypothesize that there will be a difference in occupancy rates based on size and habitat type, with larger houses being occupied more frequently than small ones, and houses that are located close to the weir being occupied more often than those that are far away. My hypothesis is based on other studies suggesting bats prefer houses with a wider thermal range of conditions and ones that are within 500 meters of water (Lourenco and Palmeirim, 2004; Entwistle, Racey and Speakman, 1997).

Methods

The Beaverhill Natural Area is situated in the parkland ecoregion, dominated by trembling aspen, balsam poplar, white spruce, willow species, fireweed and wild rose. It is located, east of Tofield, Alberta and BBO was established in 1984. As part of its mandate, the BBO plays an integral role in the long-term monitoring of the floral and faunal biota in the region. BBO supports a variety of research initiatives including studies on birds, amphibians, insects, as well as mammals such as bats.

Bat House Monitoring

Bat houses were monitored by briefly shining a light into the bottom of the house and counting the number of roosting bats (Figure 1). Occasionally, an exact number of bats could not be determined due to how close the bats were huddled together, therefore an estimated range was

Figure 1. Checking the bat house by briefly shining a light into the bottom.
– Mary Blair

recorded as the halfway point between the two numbers. Other observations were recorded during the weekly checks including species, time, weather variables and comments (Appendix A).

BBO currently has thirty-eight bat houses set up throughout the natural area, offering roosting opportunities, and as a way to monitor bat house occupancy. Thirty-seven bat houses were monitored weekly from May 25 to September 21, 2017; primarily in the evening but before emergence (Figure 1). The weekly checks concluded in September after no bats were found in any of the houses for three weeks in a row. The south side of the BBO field station was occasionally checked as bats have have been found roosting there in past years. There was a thirty-eighth bat house, however it was across the weir and due to safety concerns of crossing the water it was not monitored. The other bat houses that had been installed in the area previously are no longer set up due to damage, wasp nests or they were attached to trees that have now fallen.

Distribution and Characterization of Bat Houses

The bat houses are distributed along the different walking paths throughout the BBO area (Figure 2). Specific measurements and observations were taken for each bat house including size and colour of bat house, habitat type, orientation, sunlight exposure as well as height from the ground and other obstacles (Figure 3; data found in Appendix B). For analysis of occupancy preferences, the bat house habitats have been grouped into three different types: open, interior and edge, as well as sizes: large and small single-chamber houses (Figures 4 and 5). The edge habitat is characterized by young aspens and willow species; the interior habitat has primarily both poplar species and white spruce; the open habitat is in a grass pasture frequented by cattle.

Temperature data including maximum temperature, minimum temperature, total precipitation (mm), as well as wind speed (km/h) and direction of wind were obtained from the weather station at Elk Island National Park (Appendix D). BBO is 43 kilometers southeast of Elk Island National Park and therefore assumed to be affected by the same weather fronts and temperature patterns.

Figure 2. Beaverhill Bird Observatory bat house distribution.


Figure 3. Recording specific measurements and observations about the bat house.
– Kelsey Low


Figure 4. Single-chambered bat houses, one large (left) and one small (right), located in the interior habitat.


Figure 5. Open, edge and interior habitat photos (left to right).

Statistical Analysis

Statistical analysis was conducted by hand and in Excel using a variety of tests. An ANOVA for habitat type to compare the means of open, interior and edge habitats as well as a T-test to compare the occupancy means of large and small bat house sizes was originally planned to determine the significance of the results. However, when the variance ratio was calculated for each test, the *F*-ratio was larger than the *F* critical for both comparisons, suggesting unequal variances. As the assumptions of normality and homoscedasticity cannot be met for either data set, non-parametric methods were used to determine the significance of the results. A Mann-Whitney U test was used to compare the occupancy distribution of bat house sizes and a Kruskal-Wallis test was used to compare occupancy distribution of the different habitat types (Appendix E).

Results

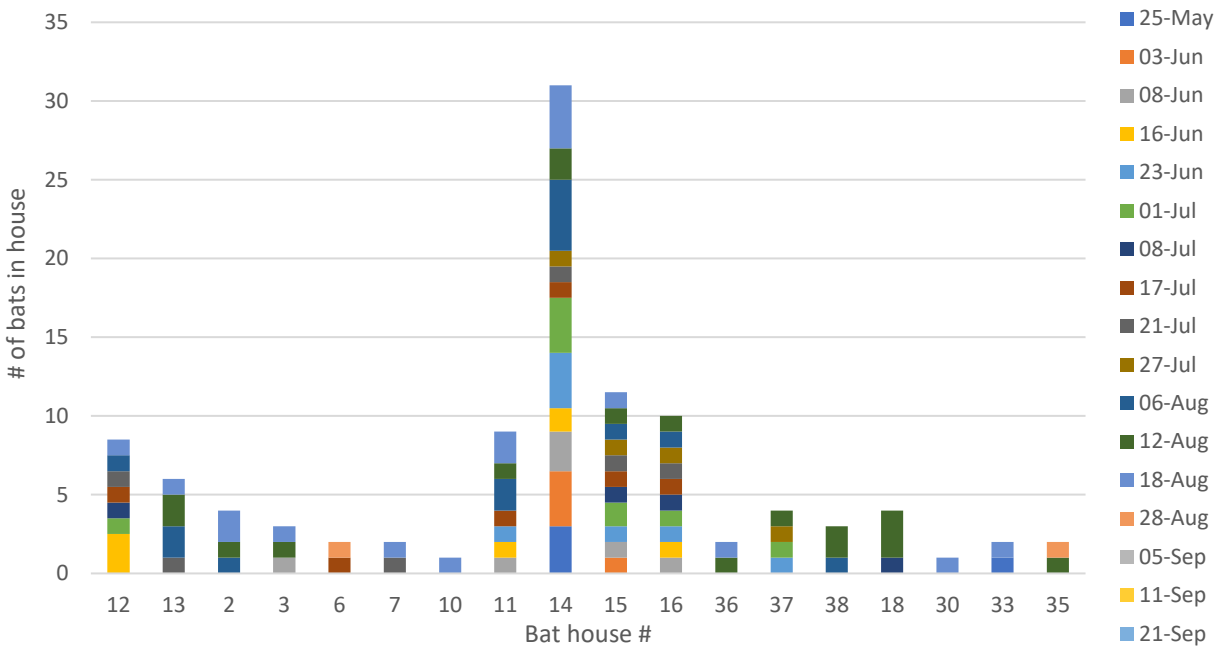
Distribution and Characterization of Bat Houses

The majority of the bat houses are the small style with eleven being the larger design of single-chamber house (Figure 4). Most of the bat houses are dark red in colour, however, seven houses are dark brown and an additional four are dark green in colour. Twenty-one bat houses are painted on the inside as well, which could affect occupancy preferences. All but one of the bat houses are at least two and a half meters from the ground, however some houses have dense / tall

vegetation growing directly beneath the bat house, thereby causing obstructing clutter and essentially decreasing the height of the bat house from the ground. Most of the houses are oriented southerly, maximizing the amount of solar exposure they receive each day. However, due to canopy cover and placement of the bat house on the tree there are variations about how much sun or shade each bat house receives per day. Fifteen houses are in locations that receive 'mostly shade (minor sun)', fifteen are located where they receive 'partial sun (only morning or afternoon sun)', four are in locations that are 'mostly sunny (minor shade)', two are located in 'full sun (no shade)', and one is in 'full shade (no direct sun). Sixteen houses are located in the interior habitat, nineteen along the edge, and two are installed in an open field. Bat house characteristics for each house can be seen in Appendix D.

Bat House Occupancy

With the exception of the first check, May 25, when the protocol for checking the houses was still being determined, the average number of bat houses checked every week was 36.1. Houses were occasionally missed or could not be completed due to safety concerns with incoming thunderstorms. Of the 37 houses set up, eighteen were visually confirmed to have bats roosting in them. Bats were never observed roosting in houses 4, 8, 9, 17, 19 – 29, 31 – 32, 34 and 39; all houses were of the small design, except for bat house number four which was a different design from the rest and had screen instead of grooves for the bats to climb on. Most unoccupied bat houses were red in colour, painted on the inside, and were in edge habitat. Houses 2, 3, 6, 7, 10 – 16, 18, 30, 33, and 35 – 38 have all had bats observed roosting in them at least once (Figure 6). Most of these houses were the large design and between 600 meters and one kilometer to the weir. Of the eighteen houses that were occupied, two houses were only occupied once, and eleven houses were occupied more than twice. It was determined that bats had a significant preference for large bat houses (Mann- Whitney U test; U=12.50; $p < 0.05$) and there was a difference in occupancy rates of the different habitat types with the open habitat being the suggested preference (Figure 7; Kruskal Wallis test; H=12.70; $p<0.05$). The results obtained suggest that the bats at BBO prefer certain habitat types over others, however a post-hoc test could not be conducted due to the data set not meeting the required test assumptions. However, by finding the mean occupancy of open, edge and interior bat houses, 7.25, 0.47, and 5.16, respectively it can be suggested that the data appears to support that open is the more preferred habitat with edge being the least favoured habitat.



NC – bat house not checked for occupancy

Background colours: Yellow – Open habitat, Green – Interior habitat, Blue – Edge habitat

Font colours: Blue – Large house, Red – Small house

Figure 6. Bat houses observed from May 25 to September 21 with bats roosting inside, separated by date.

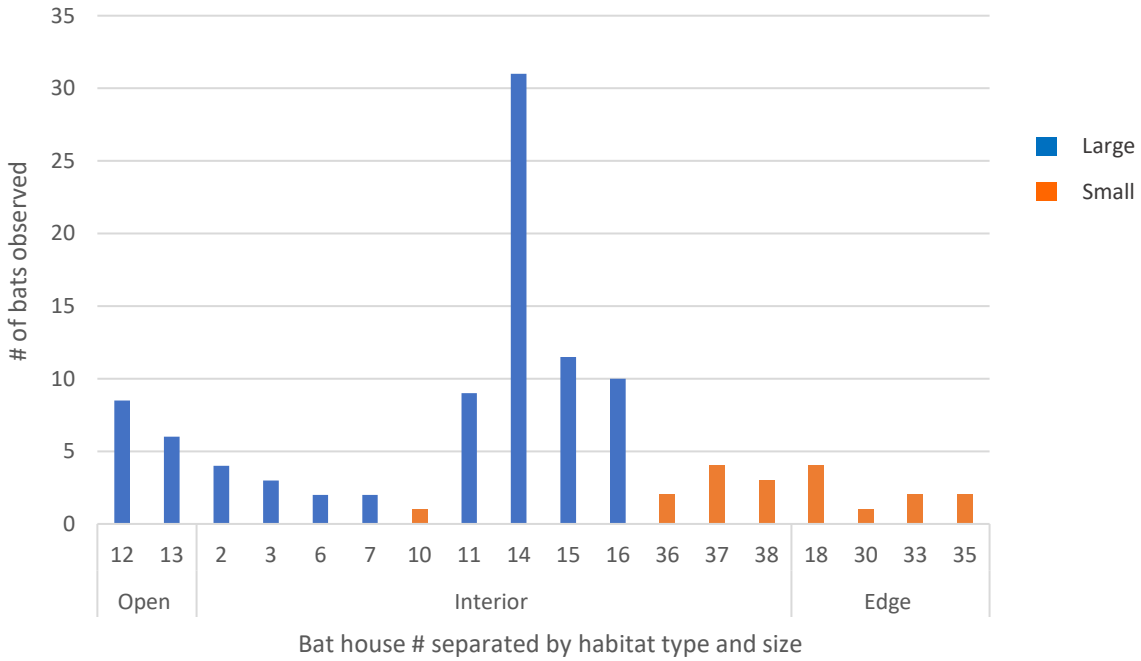


Figure 7. Occupied bat houses from May 25 to September 21, separated by habitat type and size.

To determine if there was a correlation between temperature and occupancy rates, the number of bats observed was plotted against the maximum daily temperature (Figure 8). An R^2 value of 0.0657 was determined, suggesting that there is minimal correlation between temperature and occupancy rates.

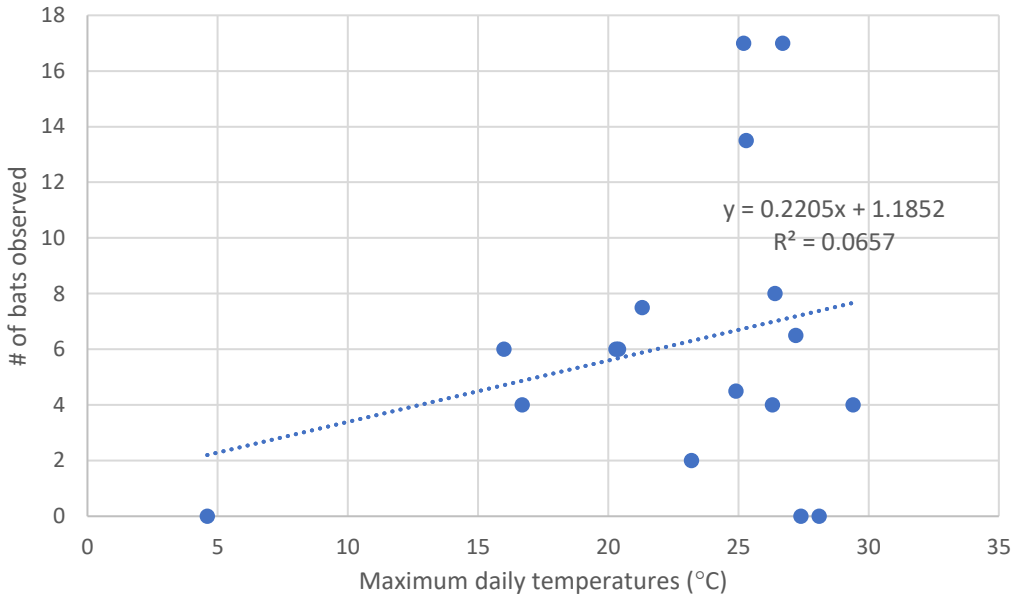


Figure 8. Number of bats observed plotted against the maximum daily temperatures from May 25 to September 21.

Other Bat Occupancy

Bats were also observed roosting in the House Wren boxes along Grid A (Figure 9). One bat was observed in nest box C2 on June 12, and A1 on June 17, and two bats were observed in A1 and D5 on June 26. All bats observed, including the bats in the bat houses and nest boxes were a *Myotis* species, with the greatest likelihood of being Little Brown Myotis. Although it cannot be determined definitively, it is suspected that the bat houses set up throughout the area are being used by males or non-reproductive females and not by maternity colonies.

Figure 9. *Myotis* species observed in a House Wren box. – Shyla Golly

Discussion

The results of the bat house occupancy monitoring from May 25 to September 21 suggest that the bats prefer the larger style of BBO bat houses and may select open habitat as the most favoured type, followed by interior habitat, with edge being the least selected for habitat. The bat houses further away from the weir had higher occupancy rates, however this may have been a result of having the more selected for larger styles set up further from the weir, and not a result of a preference for increased distance to a waterbody.

The significance of the results obtained from the nonparametric tests suggest that different sizes of bat houses are preferred as well as different habitats, however, there are various confounding variables that could make the interpretation difficult. The bat houses were different colours, some were painted on the inside, they were oriented different directions, had varying amounts of sunlight exposure and possible obstructions to the entrance to the house, as well as were varying heights off of the ground. Some of these variables may have played a role in why certain bat houses were more highly selected for than others. The five houses that had the largest number of bats roosting in them throughout the study period, between 8.5 – 31 bats, were all large in size and painted brown, however they had between partial and full sun, were in both open and interior habitat and were associated with different trail junctions. The fact that some houses were occupied almost every week, and some were never occupied suggest that there may be additional variables affecting bat house selection. In addition, the sample sizes of the number of bat houses set up in a specific habitat varied from two observed in the open habitat and sixteen and nineteen for interior and edge habitat respectively.

There did not appear to be a correlation between temperature nor other weather-related events, either with increased or decreased usage of the houses. In addition, bats were observed hanging on the landing board out of the chambers of the bat house on July 8 and August 28, dates where the observed temperature was lower than on other days where bats were not seen outside of the chambers.

Bat house usage peaked between August 3 and 24, with the highest occupancy occurring between August 12 and 18. These dates coincide with other documented information indicating that bats were migrating and returning to their overwintering hibernacula during this time (Schowalter, 1980). These dates also contained bat houses that had never been used before and

were in the least selected for habitat, edge. This suggests that the bats that are migrating through the area are likely opportunistic and chose houses that were suitable for a short-term daytime roost and that the summer residents are more selective.

Bat house occupancy studies are limited for reports in western Canada, however there have been similar studies looking at variables that might influence occupancy selections conducted in the United States. A study in California suggested that location, including solar exposure and distance to water, was the biggest factor for occupancy of different bat houses, even over size, colour, and height (Long, Kiser, and Kiser, 2006). The study also suggested that pregnant and lactating females were much more selective of their roosting sites than males and non-reproductive females, and the reproductive females selected roosts with morning sun and sites that were within 400 meters of water (Long, Kiser, and Kiser, 2006). Proximity to water did not appear to be a strong attractant to the bats at BBO, however, it is also suspected that the bats observed in the houses were either males or non-reproductive females.

A study in southwest Oregon supported that the orientation and bat house colour at BBO maximized occupancy. The Oregon study suggested that houses painted a dark colour and oriented south to east were the most highly selected for as the most sun was received in the morning during the coolest part of the day and shade was received in the afternoon when the bat houses risked overheating (Dillingham, Cross and Dillingham, 2003).

A study examining bat house occupancy in Colorado had similar results as the ones obtained at BBO. The Colorado study concluded that bats preferred bat houses that were mounted on mainly undisturbed buildings, had minimal canopy cover and had large landing areas (White, 2004). This study also suggested that colour, orientation, and sunlight exposure had minimal effect on roosting selection (White, 2004). It was hypothesized that as bat houses are primarily occupied by solitary males, high temperatures are not required as the individuals can enter torpor if the temperatures are too low (White, 2004). The study conducted at BBO did not have any building mounted bat houses; however, canopy cover could be indirectly measured by the score that was given as to how much sunlight each bat house received, as well, the larger bat houses would have a larger landing area. Consistent with the Colorado study was that the BBO bats preferred the larger style of bat houses, and also did not seem to make roosting selections that were strongly influenced by the amount of sun received.

Recommendations and Future Work

Based on the results of this study the bats at BBO prefer the larger style of bat houses and the open and interior habitats are likely more selected for than the edge habitat. Future bat house installations should contain the smaller and larger style of bat houses set up in open habitat to address the small sample size available in the open habitat, as well as the larger style set up in edge habitat to address whether the deterrence of the edge habitat is the habitat type or the absence of the more preferred larger style of house. It has been suggested that bats roosting in anthropogenic structures prefer designs with multiple roosting areas over single roosting options as well as that 40°C is often quoted as the uppermost temperature limit that bats can withstand (Dillingham, Cross and Dillingham, 2003). Larger multi-chambered bat house styles could also be set up in efforts to attract maternity colonies instead of single or small groups of males; this would also address any potential overheating risks. The branches that obstruct the entrances to bat houses sould be cleared prior to next spring to increase the potential of boxes being occupied. It has also been suggested that most houses are occupied within the first two years of placement, therefore if the same bat houses are not occupied again next year, moving the unoccupied houses to a different location should be considered (Long, Kiser, and Kiser, 2006).

It has been suggested that the bat species that use bat houses may be provided a competitive advantage over the species that are the more tied to natural cavity roosting options, however further research is required to determine this conclusively (Rueegger, 2016). Overall bat houses provide a reliable way to monitor bat populations and look at yearly trends, therefore weekly monitoring should occur in future years, ideally beginning earlier in the year when bats first arrive and through to the end of their migration. Updates to Appendix F should be made each year, including changes to sunlight exposure due to foliage and any required maintenance should be addressed yearly.

Acknowledgements

I would like to thank the Beaverhill Bird Observatory for the opportunity to participate in this important project, Geoff Holroyd for initiating the bat box program at BBO, as well as the staff, Kevin Methuen, Sara Pearce Meijerink and Meghan Jacklin for their support. I am very appreciative of the help from my mentor for the project, Jody Rintoul, as well as family and friends who came out with me to monitor the bat houses and provide edits to the report: Kelsey

Low, Mary Blair, Caitlin Low, Gareth Villanueva and Emily Gillmore. Thank you to Geoff Holroyd and Laurie Hunt for organizing the internship, as well as Serving Communities Internship Program (SCiP) for providing the funding for the project. Thank you also to the House Wren interns Shyla Golly and Zach Antoniw who shared their observations of bats in the House Wren nest boxes.

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Appendix A

2017 Beaverhill Bird Observatory Bat House Occupancy Check

Date:

Start time: **Finish time:** **Start temp:** **Finish temp:**

BatBox ____________			
Time:	Wind (S/D):	Cloud %:	Precip:
# present: 0 1 2 3 4 5		Sp: Unknown Myotis MYLU EPFU	
Comments:			

BatBox ____________			
Time:	Wind (S/D):	Cloud %:	Precip:
# present: 0 1 2 3 4 5		Sp: Unknown Myotis MYLU EPFU	
Comments:			

BatBox ____________			
Time:	Wind (S/D):	Cloud %:	Precip:
# present: 0 1 2 3 4 5		Sp: Unknown Myotis MYLU EPFU	
Comments:			

BatBox ____________			
Time:	Wind (S/D):	Cloud %:	Precip:
# present: 0 1 2 3 4 5		Sp: Unknown Myotis MYLU EPFU	
Comments:			

BatBox ____________			
Time:	Wind (S/D):	Cloud %:	Precip:
# present: 0 1 2 3 4 5		Sp: Unknown Myotis MYLU EPFU	
Comments:			

Appendix B

<table>
<tr><td>Bat house ID:</td><td>Date characterized:</td><td colspan="2">Installation date:</td></tr>
<tr><td rowspan="2">Type of bat house:
☐ Single chamber (small)
☐ Single chamber (large)
☐ Other (describe):</td><td rowspan="2">What is the bat house attached to?
☐ Building
☐ Tree
☐ Pole/post</td><td colspan="2">Colour of bat house:</td></tr>
<tr><td colspan="2">Description of bat house:</td></tr>
<tr><td>Exterior finish of bat house:
☐ Raw wood
☐ Painted
☐ Stained

☐ Painted on inside
☐ Not painted on inside</td><td>Habitat type:
☐ Open
☐ interior
☐ edge
☐ Other: _____

☐ Forested %
☐ Shrubland %
☐ Grassland %
☐ Other: _____ %</td><td>Direction the roost faces:
☐ North
☐ Northeast
☐ East
☐ Southeast
☐ South
☐ Southwest
☐ West
☐ Northwest</td><td>Nearest water source:
☐ Ditch/canal
☐ Dugout
☐ Watercourse (stream, creek, river)
☐ Pond/slough/marsh
☐ Other (describe)</td></tr>
<tr><td>ibuttons:
☐ Yes
☐ No</td><td>Forest age:
☐ Young
☐ Medium
☐ Old</td><td>Understory:
☐ Thin
☐ Medium
☐ Thick</td><td>Dominant spp:</td></tr>
<tr><td>Sunlight exposure:
☐ Full sun (no shade)
☐ Mostly sunny (minor shade)
☐ Partial sun (only morning or afternoon sun)
☐ Mostly shade (minor sun)
☐ Full shade (no direct sun)</td><td>Distance from bottom of bat house to ground (meters):</td><td colspan="2">Distance to (in meters):
• nearest water: _____
• nearest trees/obstacles: _____
• nearest bat house: _____</td></tr>
<tr><td colspan="4">☐ Drawing of bat house location in relation to major features
☐ General habitat photo
☐ Additional comments</td></tr>
</table>

Appendix C

Table 1. Bat houses observed from May 25 to September 21 with bats roosting inside.

	Open		Interior												Edge				
Date	**12**	**13**	**2**	**3**	**6**	**7**	**10**	**11**	**14**	**15**	**16**	**36**	**37**	**38**	**18**	**30**	**33**	**35**	**Daily Total**
25-May	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	1	0	**4**
03-Jun	0	0	0	0	0	0	0	0	3.5	1	0	0	0	0	0	0	0	0	**4.5**
08-Jun	0	0	0	1	0	0	0	1	2.5	1	1	0	0	0	0	0	0	0	**6.5**
16-Jun	2.5	0	0	0	0	0	0	1	1.5	0	1	0	0	0	0	0	0	0	**6**
23-Jun	0	0	0	0	0	0	0	1	3.5	1	1	0	1	0	0	0	0	0	**7.5**
01-Jul	1	0	0	0	0	0	0	0	3.5	1.5	1	0	1	0	0	0	0	0	**8**
08-Jul	1	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	**4**
17-Jul	1	0	0	0	1	0	0	1	1	1	1	0	0	0	0	0	0	0	**6**
21-Jul	1	1	0	0	0	1	0	0	1	1	1	0	0	0	0	0	0	0	**6**
27-Jul	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0	**4**
06-Aug	1	2	1	0	0	0	0	2	4.5	1	1	0	0	1	0	0	0	0	**13.5**
12-Aug	0	2	1	1	0	0	0	1	2	1	1	1	1	2	3	0	0	1	**17**
18-Aug	1	1	2	1	0	1	1	2	4	1	0	1	0	0	0	1	1	0	**17**
28-Aug	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	**2**
05-Sep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
11-Sep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
21-Sep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
House Total	**8.5**	**6**	**4**	**3**	**2**	**2**	**1**	**9**	**31**	**11.5**	**10**	**2**	**4**	**3**	**4**	**1**	**2**	**2**	**106**

Background colours: Yellow – Open habitat, Green – Interior habitat, Blue – Edge habitat
Font colours: Blue – Large style, Red – Small style

Appendix D

Table 2. Temperature data recorded by the weather station at Elk Island National Park for each day the bat houses were checked. Data was obtained from Historical Data reported by the Government of Canada.

Date	Max Temp (°C)	Min Temp (°C)	Total Precip (mm)	Dir of Max Gust (10s deg)	Spd of Max Gust (km/h)
25-May-17	16.7	5.3	0	36	44
3-Jun-17	24.9	7.1	0		<31
8-Jun-17	27.2	14.9	0	16	35
16-Jun-17	20.3	10.5	0		<31
23-Jun-17	21.3	4.1	0		<31
1-Jul-17	26.4	10.4	0.6		<31
8-Jul-17	26.3	16.4	0		<31
17-Jul-17	16	8.5	0.7	29	32
21-Jul-17	20.4	11.3	0		<31
27-Jul-17	29.4	13.7	2.9	6	50
6-Aug-17	25.3	9	0		<31
12-Aug-17	26.7	13.3	0	15	35
18-Aug-17	25.2	9.5	2.8	28	82
28-Aug-17	23.2	11.4	0		<31
5-Sep-17	27.4	6	0		<31
11-Sep-17	28.1	6.1	0		<31
21-Sep-17	4.6	1.8	12.5		<31

Appendix E

Nonparametric statistical tests used on the bat house occupancy data set:

Mann – Whitney U-test

$$U_1 = n_1 n_2 + \frac{n_1\,(n_1 + 1)}{2} - R_1$$

$$Z = \frac{2U - n_1 n_2}{\sqrt{n_1 n_2 (n_1 + n_2 + 1)\,/\,3}} - R_1$$

Kruskal – Wallis test

$$H = \frac{12}{N(N+1)} \sum_i \frac{R_i}{n_i}^{n} - 3(N-1)$$

X^2 distribution with k – 1 degrees of freedom

Appendix F

Bat house ID	Size	Attachment	Colour	Inside Painted?	Habitat Type	Direction	Sunlight exposure
19	small	tree (aspen)	red	yes	edge	south	mostly shade (minor sun)
18	small	tree (aspen)	red	yes	edge	south	partial sun (only morning or afternoon sun)
17	small	tree (aspen)	red	no	edge	southwest	mostly shade (minor sun)
10	small	tree (aspen)	red	yes	interior	south	partial sun (only morning or afternoon sun)
9	small	tree (aspen)	red	yes	interior	south	partial sun (only morning or afternoon sun)
14	large	post	brown	no	interior	southeast	mostly sunny (minor shade)
6	large	tree (aspen)	green	no	interior	west	mostly sunny (minor shade)
7	large	tree (aspen)	green	no	interior	southwest	mostly shade (minor sun)
15	large	tree (balsam)	brown	no	interior	southwest	partial sun (only morning or afternoon sun)
16	large	tree (balsam)	brown	no	interior	southeast	partial sun (only morning or afternoon sun)
11	large	tree (aspen)	brown	no	interior	south	mostly sunny (minor shade)
39	small	tree (aspen)	red	lightly painted	interior	south	mostly sunny (minor shade)
13	large	post	brown	no	open	southwest	full sun (no shade)
12	large	post	brown	no	open	southwest	full sun (no shade)
2	large	tree (balsam)	green	no	interior	southeast	partial sun (only morning or afternoon sun)
3	large	tree (balsam)	green	no	interior	east	mostly shade (minor sun)
38	small	tree (balsam)	red	lightly painted	interior	east	mostly shade (minor sun)
37	small	tree (aspen)	red	yes	interior	southeast	partial sun (only morning or afternoon sun)
36	small	tree (aspen)	red	no	interior	southeast	mostly shade (minor sun)
35	small	tree (aspen)	red	yes	edge	south	partial sun (only morning or afternoon sun)
34	small	tree (aspen)	red	yes	edge	southeast	mostly shade (minor sun)
33	small	tree (aspen)	red	lightly painted	edge	southeast	partial sun (only morning or afternoon sun)
32	small	tree (aspen)	red	no	edge	southeast	partial sun (only morning or afternoon sun)
31	small	tree (aspen)	red	no	edge	southeast	mostly shade (minor sun)
30	small	tree (aspen)	red	yes	edge	southeast	mostly shade (minor sun)
29	small	tree (aspen)	red	no	edge	southeast	mostly shade (minor sun)
28	small	tree (aspen)	red	yes	edge	southeast	mostly shade (minor sun)
27	small	tree (aspen)	red	yes	edge	southeast	partial sun (only morning or afternoon sun)
26	small	tree (aspen)	red	yes	edge	south	mostly shade (minor sun)
25	small	tree (aspen)	red	yes	edge	southwest	partial sun (only morning or afternoon sun)
24	small	tree (aspen)	red	yes	edge	south	mostly shade (minor sun)
23	small	tree (aspen)	red	yes	edge	south	partial sun (only morning or afternoon sun)
22	small	tree (aspen)	red	yes	edge	southeast	mostly shade (minor sun)
21	small	tree (aspen)	red	yes	edge	south	partial sun (only morning or afternoon sun)
20	small	tree (aspen)	red	yes	edge	southwest	partial sun (only morning or afternoon sun)
4	medium	tree (aspen)	brown	yes	interior	south	full shade (no direct sun)
8	small	tree (aspen)	red	no	interior	southeast	mostly shade (minor sun)
BBO station	building	building	red	yes	interior	south	mostly sunny (minor shade)

Bat house ID	Height off ground	Distance to tree / obstacle	Nearest bat house	Distance to weir (m)	Notes
19	7' plus 3' bush	2'	not sighted	520	branches could obstruct entrance to house
18	9' plus 1' to bush	5'	not sighted	550	branches could obstruct entrance to house
17	9'	8'	not sighted	625	branches could obstruct entrance to house
10	8'	5'	not sighted	654	3 way walking path junction
9	9.5'	5'	not sighted	675	
14	10'	28'	not sighted	720	on top of BBO sign; 3 way walking path junction
6	5' plus 3' vegetation	5'	not sighted	695	branches could obstruct entrance to house
7	8'	3'	not sighted	700	
15	9'	4'	not sighted	775	
16	8'	4'	not sighted	890	
11	8'	10'	10’	840	
39	10'	3'	10’	845	
13	10'	20'+	not sighted	980	
12	10'	20'+	not sighted	835	
2	10'	2'	not sighted	890	
3	8.5'	3'	4’	740	
38	8.5'	2'	4’	735	
37	8.5' plus 2' vegetation	1'	25’	735	
36	10'	6'	25’	730	
35	10'	2'	not sighted	700	branches could obstruct entrance to house
34	10'	3'	not sighted	625	
33	9'	6'	not sighted	575	
32	10.5'	3.5'	not sighted	550	
31	9'	2'	not sighted	500	15' off walking path
30	9' plus 1' bush	3'	not sighted	475	
29	7.5' plus 2' dense grass	4.5'	20’	435	
28	7' plus 2.5' dense grass	2'	20’	430	
27	10'	3'	20’	350	
26	9'	3'	20’	340	
25	3' to obtruding branches	1.5'	not sighted	330	branches could obstruct entrance to house
24	8' plus 3' bush	2'	not sighted	335	
23	9' plus 3' bush	5'	not sighted	340	
22	9'	3'	not sighted	345	
21	10'	3'	not sighted	350	
20	8' plus 1' bush	2'	not sighted	355	
4	5'	1'	not sighted	210	different build (screen whole way up)
8	9'	4'	not sighted	775	branches could obstruct entrance to house
BBO station	10'	20'+	not sighted	860	