Habitat preferences and acoustic behaviours of bats in the Beaverhill Natural Area in 2021

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Introduction

Bats, as we would recognize them today, have been around since the early Eocene (Simmons et al., 2008) and have since evolved into over one thousand different species (Schipper et al., 2008). Bats have a number of distinct attributes and have been classified based on feeding strategies (McNab 1971), a collection of multiple factors such as wing-shape and echolocation behaviours (Norberg and Rayner 1987), and habitat use (Neuweiler 1984).

Echolocation is an important sensory tool used by bats, which can have highly influential effects on their ecology. The ecomorphology of an individual species will constrain what habitat types they will use. This occurs as a consequence of the number of objects (vegetation) within a habitat which influences how the bat is receiving and perceiving the returning vocal signal (Findlay and Barclay 2020). This means that species occupying more densely forested areas will try to minimize overlap between their call and its own echo by producing shorter echolocation vocalizations (Schumm and Neuweiler 1991, Schnitzler and Kalko 2001, Jung et al., 2007). The degree of openness in a habitat will also alter the relative advantage in having echolocation vocalizations that are able to travel further distances. This means that bats occupying more open habitats will use longer echolocations at lower frequencies to increase the possible distance the signal can travel (Fenton 1990).

Habitat selection can be influenced by two main factors: how well suited a species is to coping with numerous objects in their environment, and how different habitats influence prey distribution (Fenton 1990). Focusing on the first point, certain echolocation characteristics and the wing morphologies are better adapted to different degrees of clutter in an environment. Open habitats are more likely to be occupied by high wing-loading species such as *Lasiurus cinereus* whereas more dense forest habitats are more likely to be occupied by low wing-loading bats such as *Myotis* species (McGowan et al. 2016). This means that acoustic traits can be a major contributor in habitat selection in addition to wing shape adaptations.

There are some instances where echolocation is not explicitly important for navigation as bats are capable of navigating in open areas without the use of echolocation (Fenton 1990). However, they could be using information acquired through previous echolocation vocalizations to form spatial memory (Verboom et al., 1999), further stressing the importance of echolocation, and the broad scope of information we can gain by collecting and analyzing it.

Bats that pursue and catch their prey mid-flight typically use three distinct types of echolocation calls: the search phase, approach phase and feeding buzzes. The search phase is used while commuting and consists of using short bursts of vocalizations followed by relatively long pauses that allows them to process the information contained in the echo (Russo et al. 2018) (Fig. 1a). The approach phase allows the bat to improve signal resolution as they begin to approach the target by increasing the pulse rate of the vocalization (Russo et al. 2018). The last phase is the feeding or terminal buzz which allows for the greatest accuracy of signal information as the bat moves closest to the prey item (Russo et al. 2018) (Fig. 1b).

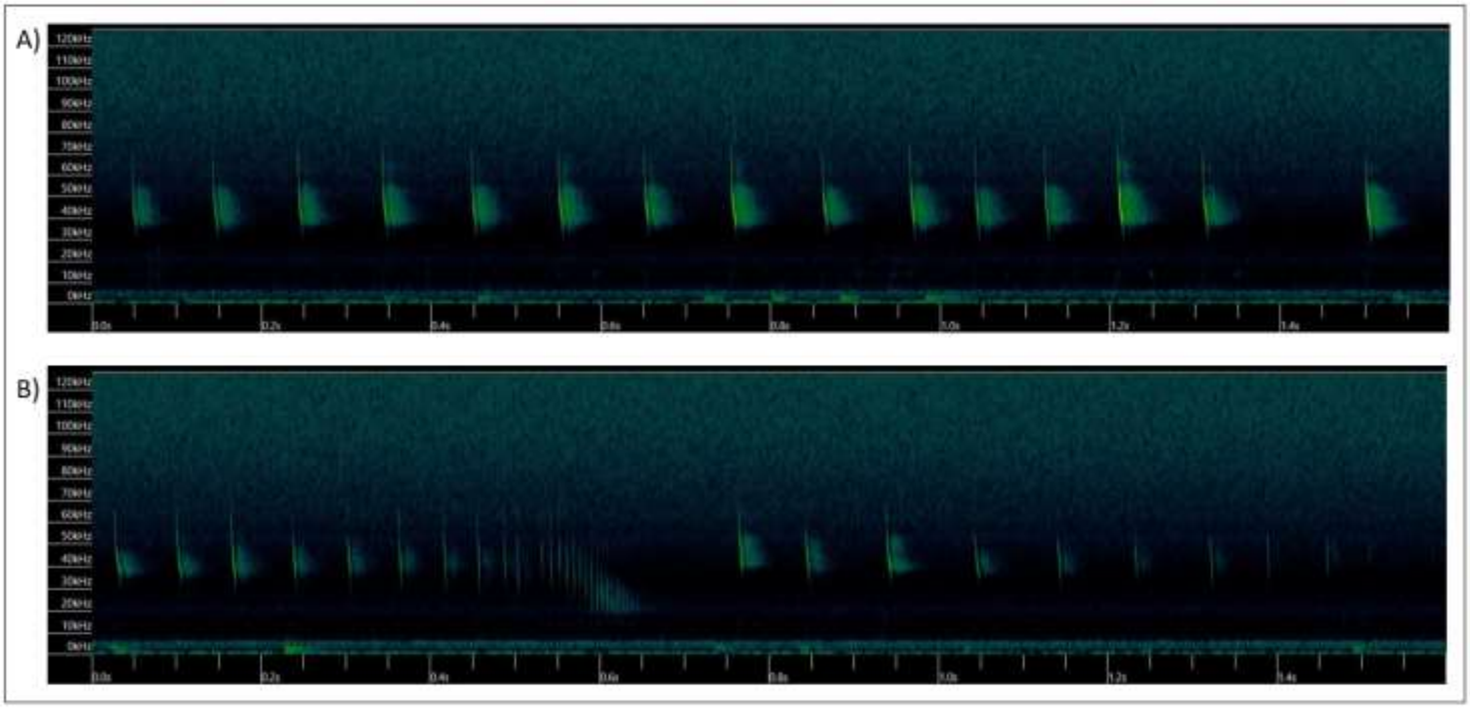

Figure 1. A) Sonogram of a high frequency bat search phase call. **B)** Sonogram of a bat feeding buzz phase.

There are several stages of vocalization leading up to a feeding buzz: search (pulses have even spacing), approach (pulses become closer together), and then the feeding buzz (vocalizations are very compact and drop in frequency (Low, 2017; Waldron, 2021b).

Acoustic monitoring of species can provide insight about many factors of bat biology. Recording and interpreting echolocation vocalizations can aid in the identification of species (O'Farrell and Miller 1997, Fenton and Bell 1981, Jones et al., 2000). Additionally, phylogenetic relationships between species can be better understood through investigating bat echolocation vocalizations (Kingston et al., 2001). Since echolocation can be used for hunting, acoustic monitoring can also allow us to better understand the foraging behaviours of bats (Faure and Barclay 1994).

Investigating echolocation vocalizations in bats can give us insight into many aspects of their biology, however, collecting acoustic data on bats can be challenging due to the considerable variation in their behaviours over time (Hayes 1997). Furthermore, physical, geographical, and temporal differences in species can lead to variation in bat call signals (Russo et al., 2018). On the opposite side of the spectrum, interpreting echolocation vocalizations can be challenging due to similarities between species since echolocation call characteristics can be convergent due to adaptive pressures from similar habitat types resulting in much species overlap (Obirst 1995).

Public opinion of bats has traditionally been misunderstood (Kunz et al., 2011); however, they can play vital roles within their respective ecosystems. Additionally within the agricultural industry bats can play a major role in controlling harmful insect populations. The resulting insect control can be conservatively estimated to provide over three billion dollars a year in ecosystem services (Boyles et al., 2011). Beyond their direct functional importance to humans, bats are also significant species occupying both predator and prey roles in many ecosystems (Kunz et al., 2011) and decreases in their abundance, or extirpation could alter the community structure and have cascading effects on the system as a whole (Schmitt, et al., 2021).

This study focused on collecting acoustic data from the bat populations within the Beaverhill Natural Area (BNA). This was done through the acoustic monitoring of the bats species, *Myotis lucifugus* (Little Brown Myotis), *M. septentrionalis* (Northern Myotis), *Lasiurus cinereus* (Hoary bat), *L. borealis* (Eastern Red Bat), *Lasionycteris noctivagans* (Silver-haired Bat), and *Eptesivus fuscus* (Big Brown Bat) which all occur within the BNA. Gathering these data will provide insight into the habitat use by each of these bat species, which can ultimately be used to inform decisions of habitat protection and restoration in the future. Collecting these acoustic data will also increase our understanding of acoustic behaviours of these species as the data will be compiled into the long-term monitoring that is ongoing at the Beaverhill Bird Observatory (BBO).

Methods

Study area

This study was conducted within the BNA (Figure 2) approximately 60 km east of Edmonton, Alberta. The BNA is located in the Central Parkland subregion of the Parkland region of Alberta. The region is dominated by *Populus tremuloides* (Trembling Aspen), *Populus balsamifera* (Balsam Poplar), understory shrubs and forbs, and cultivated and native grasses (Downing & Pettapiece, 2006). A primary feature adjacent to the BNA is the large, shallow Beaverhill Lake, which provides valuable habitat for migratory birds and wildlife (Beaverhill Bird Observatory, 2021a). Various habitat types in the natural area were surveyed during this study consisting of grasslands, riparian, forest, and transition habitats.

Acoustic monitoring experimental design

Sixteen stations located along a designated route were monitored from May 16, 2021 to September 14, 2021. Monitoring was performed weekly to maintain consistency; however, due to technology failures, surveys were not performed during the weeks of July 18, 2021 and August 22, 2021. As well, incomplete surveys occurred on August 3, 2021 due to stormy weather and August 17, 2021 due to technology failure. The route was approximately 3 km in length and began at the Observatory. Each week the route was completed in the opposite direction to prevent one habitat type from being only surveyed early or late in the evening every week. Four stations each of four habitat types were surveyed including grasslands, riparian, forested, and transition habitats (Figure 3). See Appendix A. for precise coordinates of each station.

Figure 2. Map of the Beaverhill Natural Area and location of the Beaverhill Bird Observatory which is located approximately 60 km east of Edmonton, Alberta (Beaverhill Bird Observatory, 2021b).

The grassland stations were located in the upland area south of Beaverhill Lake; the riparian stations represented several wetland sites in the BNA; the forest stations were located along the trails of BNA; the transition (edge) stations represented areas where forested areas opened to clearings. Examples of each habitat type can be seen in Figure 4.

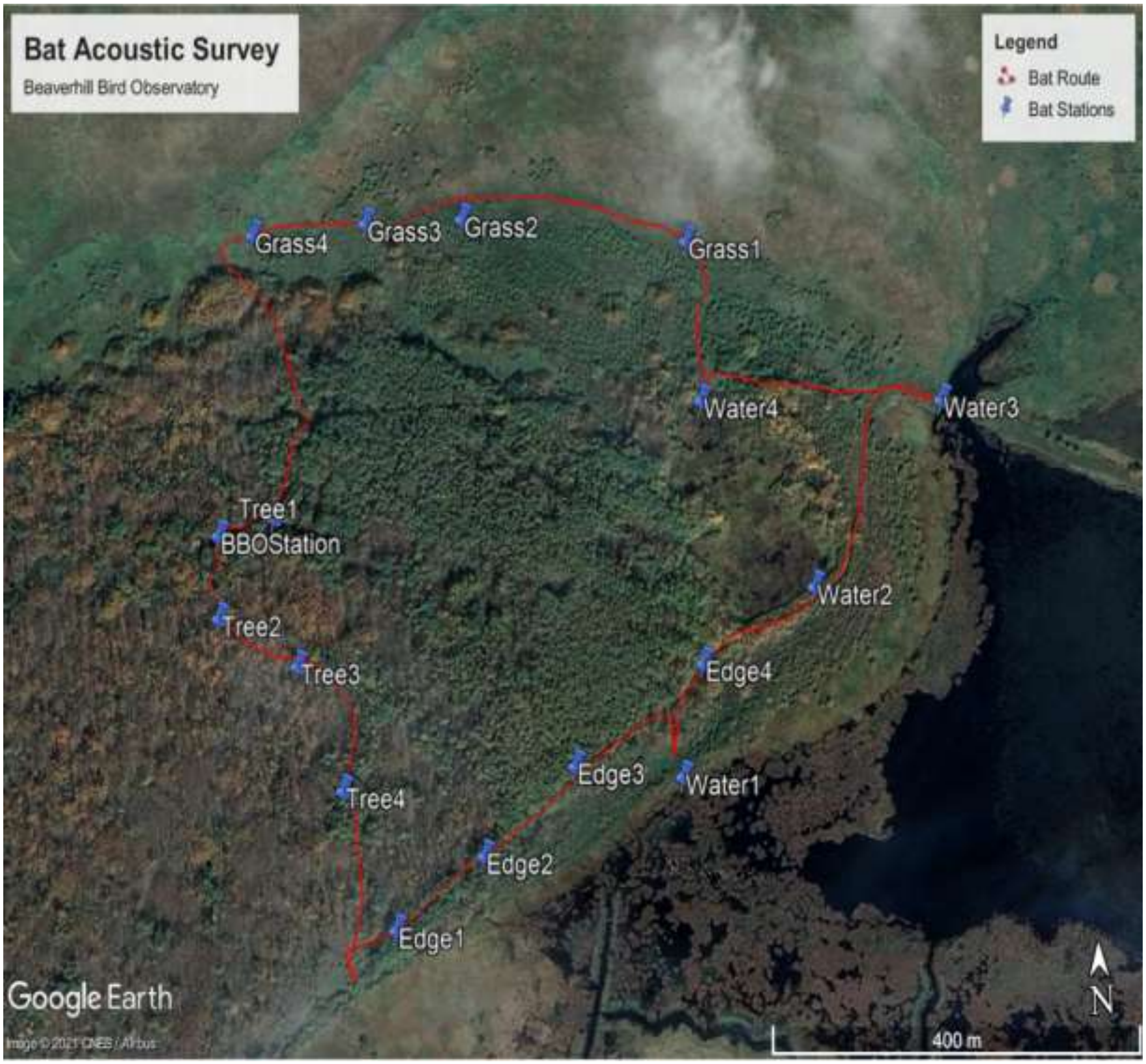

Figure 3. The acoustic bat survey route in the Beaverhill Natural Area is about 3 km in length and consists of 16 stations, 4 in each of four different habitat types including: grasslands (Grass 1-4), forested (Tree 1-4), transition (Edge 1-4), and riparian (Water 1-4) (Low, 2021a).

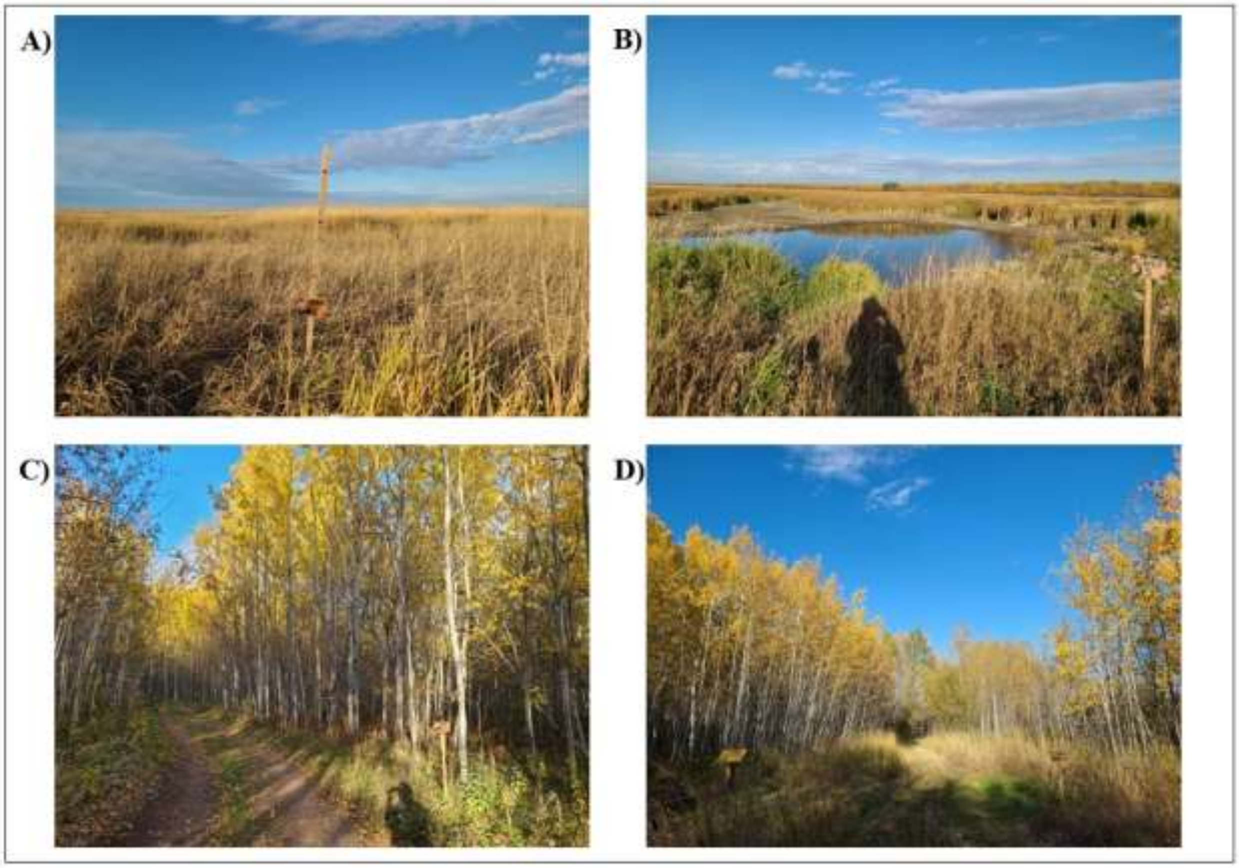

Figure 4. A) Example of acoustic survey location 'Grass 4', located in the open grasslands of the Beaverhill Natural Area, dominated by *Phleum pratense* (Timothy Grass) and *Phalaris arundiacea* (Reed Canary Grass). **B)** Example of acoustic survey location 'Water 3' located in the riparian zone at the Weir. **C)** Example of acoustic survey location 'Tree 1' located along Weasel Wind in the Beaverhill Natural Area, dominated by *Populus tremuloides* (Trembling Aspen) and *Populus balsamifera* (Balsam Poplar). **D)** Example of acoustic survey location 'Edge 4' located along Harrier Highway in the transition habitat in which forest transitions to clearings or wetlands. (Waldron, 2021a).

The surveys began no earlier than 45 minutes after sunset when there was neither moderate to high winds or precipitation. At the beginning and end of the survey, environmental conditions were recorded including precipitation (mm), cloud cover (%), wind speed (Beaufort scale) and direction, and temperature (°C). Start, end, and sunset times were also recorded. See Appendix B. for sample datasheet. Surveys were performed with an Echo Meter Touch 2 Handheld Detector, on an Amazon Kindle Fire HDX 3rd Generation tablet. Detector settings that were used can be found in Appendix C. The Echo Meter contains a semi-unidirectional microphone and therefore the device was pointed in the direction of the habitat type being surveyed. The Echo Meter was used to record for three minutes at each station. Data were recorded live; however, recordings were saved to the tablet for later verification if required. If bats were detected at the station, the species, number of passes, and call type (search phase or feeding buzz) were recorded on the datasheet (Table 1).

Table 1. The bat species detected in the Beaverhill Natural Area and their corresponding echolocation frequency, mass, diet and types of roosts they occupy. (Anthony et al. 1981, Black 1974, Fenton and Barclay 1980, Burnett and August 1981, van Zyll de Jong 1985, Barclay at al. 1988, Reimer et al. 2010, Clair et al. 2014)

Approximate frequency (kHz)	**Species**	**Species Code Recorded in Datasheet**	**Mass (g)**	**Diet**	**Roost Type**
18	*Lasiurus cinereus* (Hoary Bat)	LACI	25-30	Lepidoptera, Coleoptera, Odonata, Hymenoptera, and Diptera	open foliage
25	*Eptesicus fuscus* (Big Brown Bat), *Lasionycteris noctivagans* (Silver-haired Bat)	EPFULANO	12-15	Lepidoptera, Diptera, Homoptera, Hemiptera, Hymenoptera, Coleoptera, and Neuroptera	tree crevices
<30	Low frequency bat	LowF	NA	NA	NA
>30	High frequency	HighF	NA	NA	NA
40	Myotis species	Myotis	5–13	Lepidoptera, Diptera, Ephemeroptera, Trichoptera, and Coleoptera	Anthropogenic structures, tree cavities

Statistical Analysis

A Chi-square Goodness-of-fit test was conducted in Microsoft Excel (ver. 2108) to determine if there was a significant difference in habitat use across four habitat types, by each of the bat species found in the BNA. The habitat types included in the analysis were grass, water, tree, and edge (Fig. 3). Only the species (*E. fuscus*, *L. noctivagans*, *L. cinereus*, *Myotis* sp. and unidentifiable high frequency vocalization within the range of >30 kHz) detected over the course of the survey period (May 16- September 14, 2021) were included in the analysis. The analysis investigated the effect of habitat type and species on the habitat selection using the sums of overall acoustic activity for each species within each habitat type.

A one-way Analysis of Variance was conducted in Microsoft Excel (ver. 2108) to test for significant differences in the mean number of *Myotis* calls identified between all four habitat types (Edge, Grass, Tree, Water; Fig. 3); as well as for testing for differences in calls identified across *all* species between all four habitat types (Edge, Grass, Tree, Water; Fig. 3).

Results

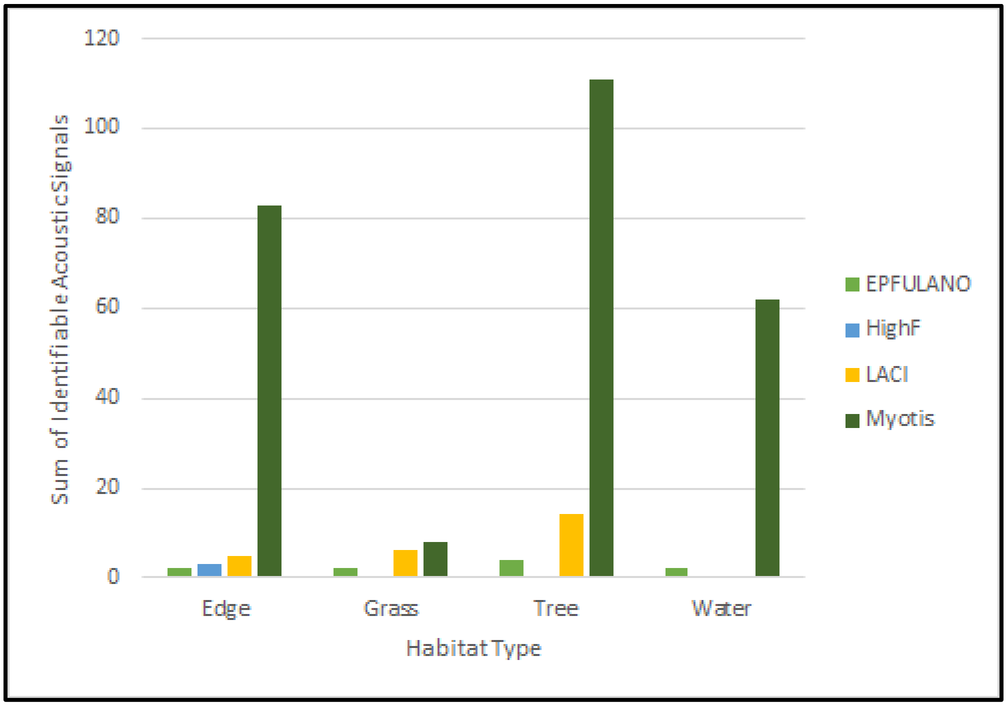

Figure 5. Acoustic activity refers to the sum of the identifiable acoustic signals collected from May 16-September 14, 2021(combining search phase echolocations and feeding buzzes) for a specific species within a specific habitat type collected weekly over the course of 5 months for 4 categories of bats (Table 1.) EPFULANO (*E. fuscus*, *L. noctivagans*) HighF (unidentifiable high frequency vocalization within the range of >30 kHz), LACI (*L. cinereus*), and Myotis (*Myotis* sp.) across four habitat types (Fig. 3).

Myotis species had the highest number of detections with 264, followed by LACI (*L. cinereus*) with 25, EPFULANO (*Eptesicus fuscus, Lasionycteris noctivagans*) with 10, and lastly HighF (Unidentifiable High frequency vocalization within the range of >30 kHz) with 3 total detections. There was a significant difference in the total number of identifiable acoustic signals for each species within each of the four habitat types using a p-value of 0.05 (Goodness-of-fit Chi-square x^2= 38.29, df= 9, p= 1.55E-05). Strictly looking at the raw counts, the tree sites had the highest acoustic activity when considering all four species combined with 129 detections, followed by edge sites with 93, water sites with 64 and finally grass sites with 16, and the results of the ANOVA show there is a significant difference in the total identifiable acoustic signals within the four habitat types when all four bat species are pooled (F(3,52)= 3.79, p=0.02). *L.cinereus* were never detected at the water sites over the course of the survey period. *Myotis* species had a fairly similar number of detections at the tree, edge, and water sites (111, 83, and 62 respectively) but were seldom detected at the grass sites (only 8 detections over the course of the whole survey period). The ANOVA results found that there was no significant difference for habitat preference within *Myotis* species (F(3,29)=1.82, p=0.17) .

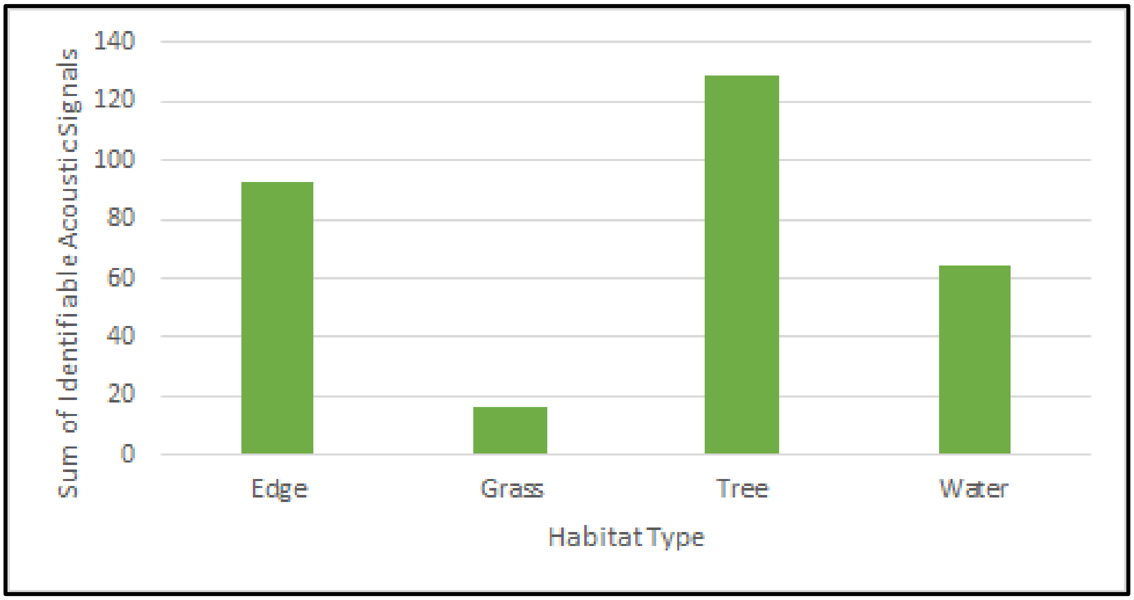

Figure 6. The sum of the identifiable acoustic signals collected weekly for all bat species collected (Table 1.) over the survey period (from May 16-September 14, 2021) within four different habitat types (Edge, Grass, Tree, Water; Fig. 4).

Table 2. Acoustic detections (combining search calls and feeding buzzes) within each of the four habitat types: edge, grass, tree, and water for the four bat species detected over the course of the survey period from mid May- mid September 2021. The acoustic surveys took place along the survey transects within the Beaverhill Natural Area.

	EPFULANO	HighF	LACI	Myotis	Total
Edge	2	3	5	83	93
Grass	2	0	6	8	16
Tree	4	0	14	111	129
Water	2	0	0	62	64
Total	10	3	25	264	302

Table 3. Total number of feeding buzzes within each of the four habitat types: edge, grass, tree, and water for the four bat species detected over the course of the survey period from mid May- mid September 2021. The acoustic surveys took place along the survey transects within the Beaverhill Natural Area.

	EPFULANO	HighF	LACI	Myotis	Total
Edge	0	0	0	12	12
Grass	1	0	0	1	2
Tree	0	0	2	12	14
Water	0	0	0	5	5
Total	1	0	2	30	33

A higher number of search calls were detected compared to the number of feeding buzzes detected (269:33 respectively). This pattern is true for each of the four bat species encountered in the BNA. For more rarely detected species like the EPFULANO and HighF categories, no feeding buzzes were detected (Table 3.). The tree sites had the highest number of recorded feeding buzzes with 14 filled by edge habitat with 12, water with 5, and lastly grass with 2.

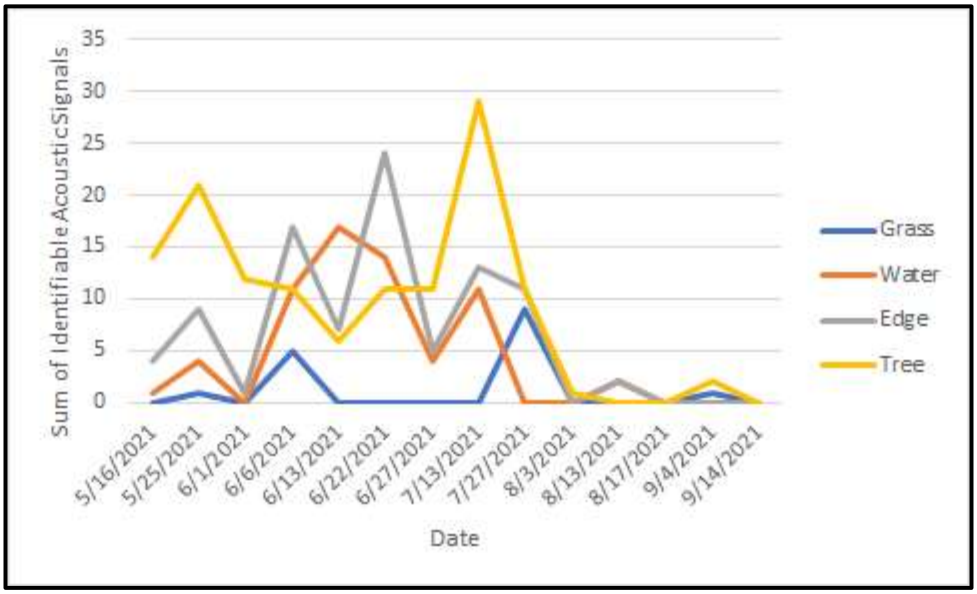

Figure 7. Overall counts (combining search calls and feeding buzzes) of acoustic activity detected at each of the four habitat types (Fig. 3) over the course of the data collection period from mid May-mid September for all species of bats.

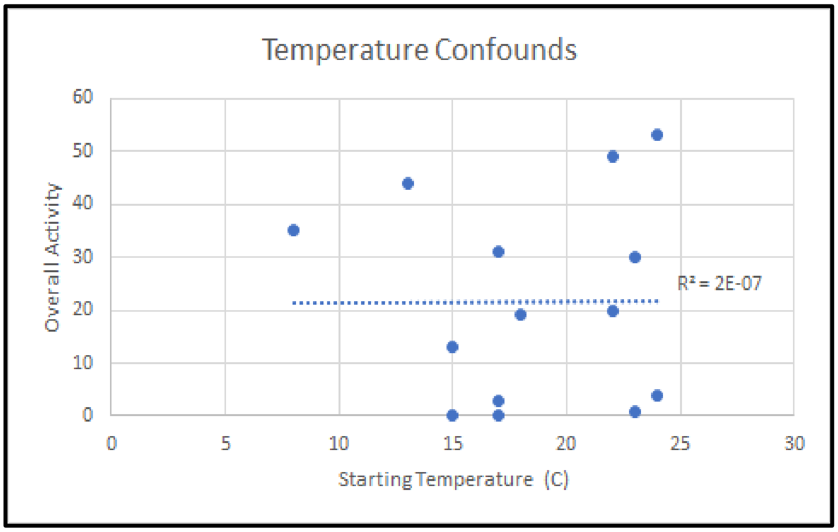

Figure 8. Scatter plot of overall bat acoustic activity plotted against the recorded temperature (°C) at the beginning of each acoustic survey. The percentage of bat activity being explained by the temperature variable is represented by the R^2 value (2E-07).

In order to address potential confounding variables such as nightly weather conditions, the overall activity during each of the survey dates was compared to the temperatures recorded at the start of each of the acoustic surveys. The low R^2 value (2E-07), and nearly flat slope in the regression (Fig. 7) indicates no confounds associated with temperature.

We also inspected the data for confounds arising from site order (Fig. 9). There was a switch between acoustic activity levels that occurred sometime between June and July. Higher activity was recorded when surveys were carried out in a counterclockwise direction in the first half of the data collection period (mid May to the end of June). Acoustic activity was higher in the second half of the data collection period (July to mid September) when surveys were carried out in a clockwise direction. We also inspected these results within the context of the four habitat types (Fig. 10, 11) and found that bats were never observed in the grass sites when surveys were conducted in a clockwise direction.

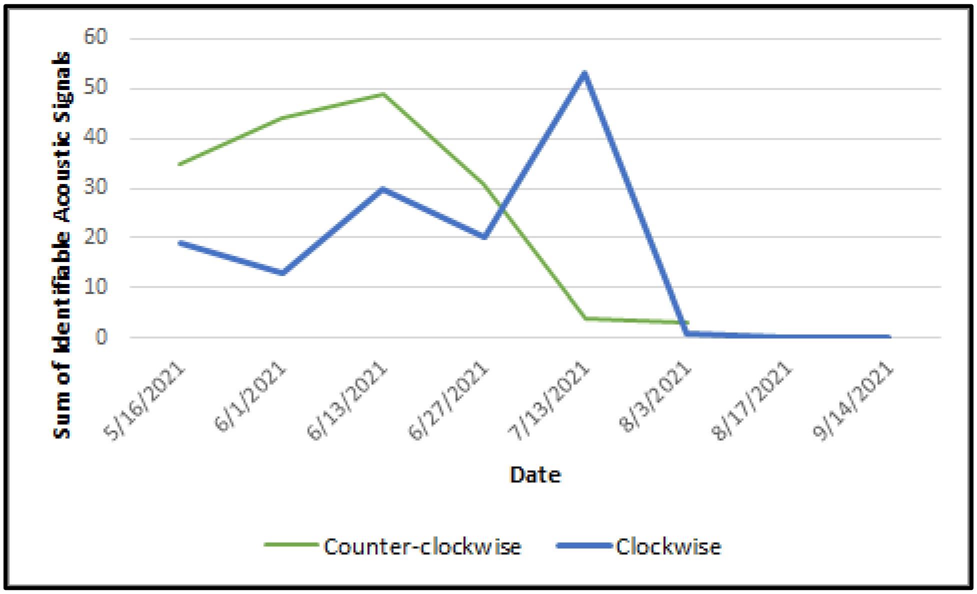

Figure 9. Comparison of the overall counts (combining search calls and feeding buzzes) of the total number of identifiable acoustic signals for all species of bats summed across all four habitat types between surveys moving in counterclockwise direction (grass, water, edge, and tree) against clockwise direction (tree, edge, water, grass) over the course of the data collection period from mid May-mid September 2021.

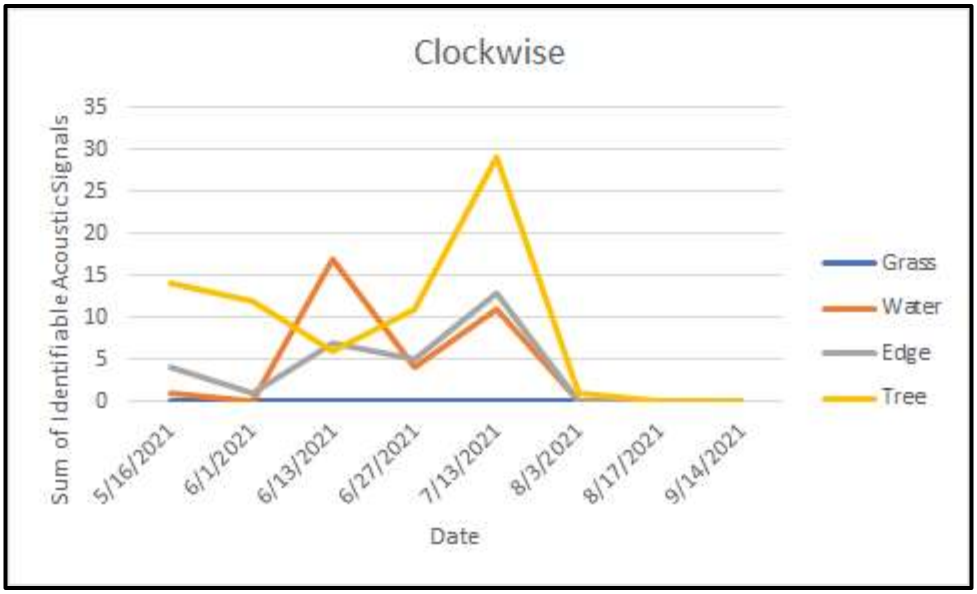

Figure. 10 Overall counts (combining search calls and feeding buzzes) of the total number of identifiable acoustic signals for all species of bats within each of the four habitat types for surveys moving in clockwise direction (grass, water, edge, and tree) over the course of the data collection period from mid May-mid September.

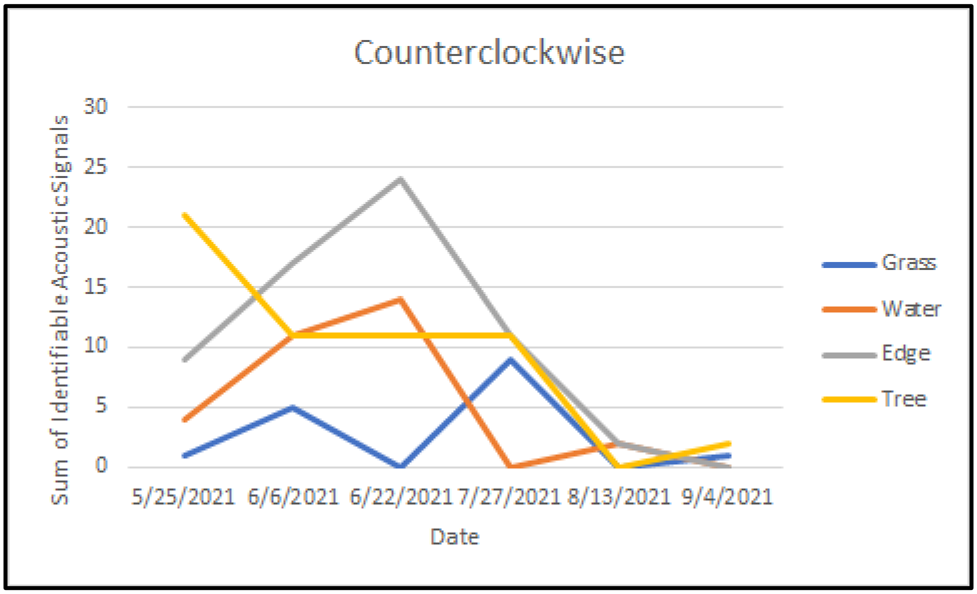

Figure 11. Overall counts (combining search calls and feeding buzzes) of the total number of identifiable acoustic signals for all species of bats within each of the four habitat types for surveys moving in counter clockwise direction (tree, edge, water, grass) over the course of the data collection period from mid May-mid September 2021.

Discussion

Our results show that *Myotis* species had the highest level of detection compared to the other species found in the BNA. This points to a larger *Myotis* population in this area which could arise from the number of bat houses located in the BNA. Since *Myotis* are the primary users of the bat boxes (Anthony et al. 1981) this provides a greater number of optimized roosting opportunities compared to other species such as LACI which typically prefer to roost in trees (Burnett and August 1981). Investigation into whether the higher proportion of *Myotis* in the BNA is exclusively occurring due to the roosting opportunities found there or a combination of prey availability, vegetation density, in addition to roosting opportunities would need to be the topic of future studies. We found a significant difference in the habitat use when looking at all bat species combined, which points to a preference for the forested areas compared to the more open grass type habitats (Fig. 6). This preference could be arising due to the bat boxes along the transects which are primarily located in forest or edge of forested areas (The BBO has 38 bat boxes, 27 of which are located in forested or bordering on forested areas) which are ideal roosts for *Myotis* species. However this pattern does not arise solely from the *Myotis* data because the ANOVA results investigating the differences in habitat use *only* looking within *Myotis* showed no significant differences; meaning that the significant difference in the habitat use is being driven by the other species.

One interesting pattern in our data is the bats in the LACI category were never detected at the water habitat type. This seems to go against other results which state that they should have a preference for open areas (Jantzen and Fenton 2013, McGowan and Hogue 2016). The differences in results could be due to the smaller number of LACI detections. The lower detection probability for this species category does not allow us to make meaningful interpretations of their habitat preference (i.e., since we are less likely to detect LACI in general, they may *actually be* occupying the more open habitat types, but we are simply not detecting them).

The results of the acoustic survey conducted at the BBO in 2019 share some similarities and some differences with our own data (Halajian and Gualter, 2019). Their methodology involved gathering acoustic data at two bat house locations within each of the four bat box habitat types (clearing, interior, edge, and open) rather than at four sites within each of our four habitat types (edge, grass, tree, water) (Fig. 3). They found *Myotis* species had the highest number of detections (likely due to the fact that acoustic data was collected at the bat boxes which are only used by Myotis species (Anthony et al. 1981) which matches the pattern in this study (Fig. 5). However, the patterns for habitat preference were quite different as their data showed the “clearing” habitat type had highest preference by a large margin; our study design did not have a direct comparison to this habitat type, but some of the water sites had a similar make-up (open space surrounded by trees). Where our data showed a high number of detections in the tree habitat type, the analogous “interior” sites in the 2019 study showed a much lower number of detections.

The results of Fig. 7 show the existence of a relationship between high activity nights and the direction of the survey which is further explored in Fig 9 where we see a switch in rates of acoustic activity depending on the time of year, and direction the surveys are carried out. The grass sites (Fig 3.) had zero bat activity recorded when surveys were conducted in a clockwise direction (Fig 10.), which could be due to the bats preferring the cover of the forest until it becomes fully dark later in the night. In terms of the counterclockwise surveys (Fig 11.). The tree sites (Fig. 3) show the same general pattern of switching from high to low activity between June and July seen in (Fig. 9) which makes sense considering tree sites had the highest activity, meaning they will have more influence on the overall shape of the curves (Fig 9.). We recommend that future interns should carry out the surveys in a counter-clockwise direction as grassland sites appear to be used later in the evening.

The results of Fig. 7 also illustrate the differences in habitat preferences on a week to week basis. For example some nights the Edge sites had more activity than the other sites (6/6/2021) or Water sites had the highest activity for a particular night (6/13/2021), despite being less popular overall. Although there are broad patterns like “tree sites show higher activity across all species overall” there are still instances where other sites have higher activity on certain nights. This graph is a nice visualization of the relatively low detections during the beginning and end of the survey period due to the spring and fall migrations, hibernation periods, and population growth due to births.

It was an unusually hot summer this year, with very little precipitation, however, this did not seem to affect the bats (Fig. 8) This could be due to the fact that the acoustic surveys are conducted 45 minutes after sunset which allows the temperatures to begin to cool off to a more reasonable range even if there were above average temperatures during the day.

There was a great horned owl frequently occupying the area around one of the large brown maternity boxes (M22) towards the second half of the survey period. It is possible that the owl was picking them off as they emerged from the bat boxes during sunset, which would ultimately make the acoustic detections lower as the survey period continued. We were unable to find pellets to determine if the bats were being preyed upon by the owl, or if the owl was altering their behaviour in any other ways. However, it does not look like there is a trend in our data that would point to this occurring (Fig. 7).

One of the limitations of this study comes from the acoustic recording equipment, as the recording device only captures sounds in a single direction which would inherently decrease the likelihood of detecting a bat (i.e bats can be missed unless they fly across where the detector is pointing). This issue arises again with the limited range of the detector also decreasing the likelihood of detection. Another limitation comes from the fact that humans are designating boundaries between different habitats, and that these designations may not be at the same scale at which a bat experiences them (Gannon et al., 2003). It is important to keep this idea in mind as we discuss the preferences between the different habitat types investigated in this study. Being unable to definitively measure whether a bat is intentionally occupying a space, or if they just happen to be moving through a space can provide challenges with interpreting the data, however with a large enough sample size this problem should be minimized.

Conclusions

To summarize our results, *Myotis* species had the highest detection rates by far among all bat species found over the course of our acoustic surveys conducted from May 16 through September 14, 2021. When all bats species were pooled we found a preference for the tree sites, however there were no significant preferences when only looking at *Myotis*. These results point to a large population of *Myotis* species found in the Beaverhill Natural Area, and a preference for densely forested habitat types among the larger bodied bat species. Future studies should explore this preference in greater detail, distinguishing which specific characteristics of the tree habitat type create this preference, so that this information can be used to make more informed decisions regarding bat conservation strategies in the future.

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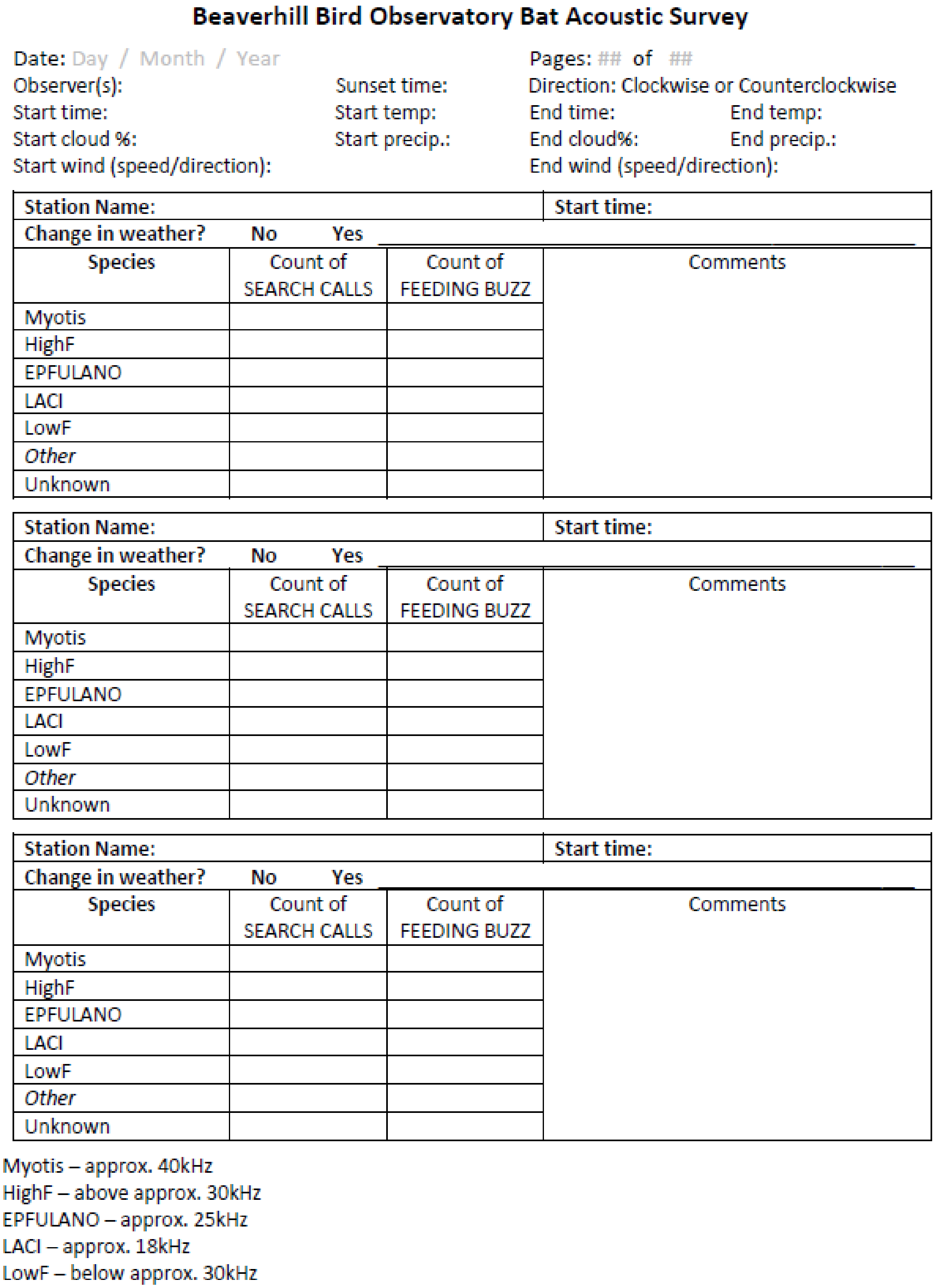
Appendix

Appendix A. Coordinates of each acoustic survey location.

Bat Acoustic Stations	**Latitude**	**Longitude**
Edge1	53.377336	-112.524331
Edge2	53.377899	-112.522864
Edge3	53.378588	-112.521335
Edge4	53.379366	-112.519192
Grass1	53.382789	-112.519249
Grass2	53.383051	-112.522911
Grass3	53.383051	-112.524498
Grass4	53.382997	-112.526349
Tree1	53.380699	-112.526129
Tree2	53.379907	-112.527069
Tree3	53.379493	-112.525806
Tree4	53.378475	-112.525126
Water1	53.37846	-112.519579
Water2	53.379942	-112.517331
Water3	53.381407	-112.515157
Water4	53.38149	-112.519084

Appendix B. Sample datasheet for acoustic surveys (Low, 2021b).



Beaverhill Bird Observatory Bat Acoustic Survey

Date: Day / Month / Year
Pages: ## of ##
Observer(s):
Sunset time:
Direction: Clockwise or Counterclockwise
Start time:
Start temp:
End time:
End temp:
Start cloud %:
Start precip.:
End cloud%:
End precip.:
Start wind (speed/direction):
End wind (speed/direction):

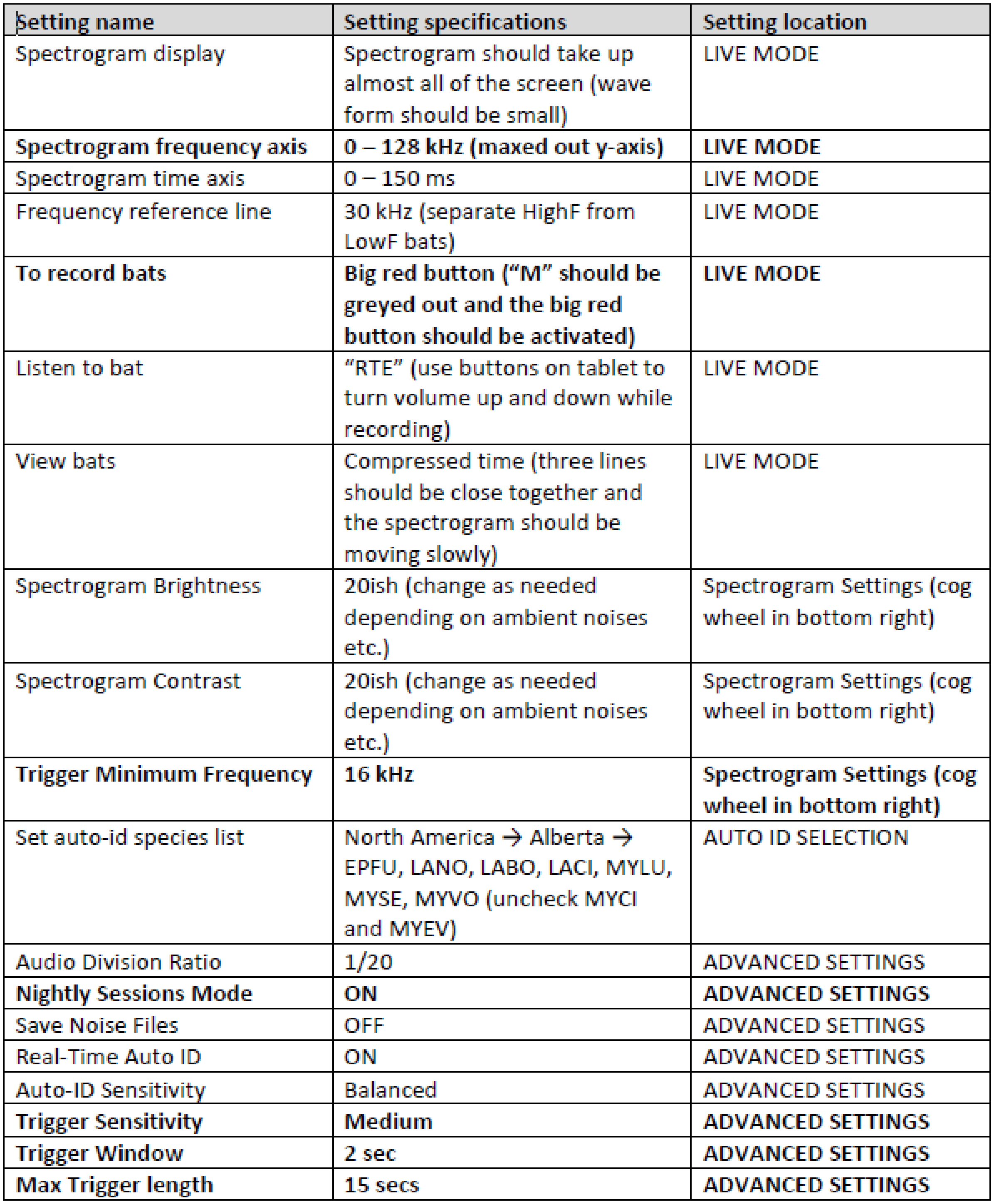
Station Name:			**Start time:**
Change in weather?	**No**	**Yes**	
Species	Count of SEARCH CALLS	Count of FEEDING BUZZ	Comments
Myotis			
HighF			
EPFULANO			
LACI			
LowF			
Other			
Unknown			

Station Name:			**Start time:**
Change in weather?	**No**	**Yes**	
Species	Count of SEARCH CALLS	Count of FEEDING BUZZ	Comments
Myotis			
HighF			
EPFULANO			
LACI			
LowF			
Other			
Unknown			

Station Name:			**Start time:**
Change in weather?	**No**	**Yes**	
Species	Count of SEARCH CALLS	Count of FEEDING BUZZ	Comments
Myotis			
HighF			
EPFULANO			
LACI			
LowF			
Other			
Unknown			

Myotis – approx. 40kHz
HighF – above approx. 30kHz
EPFULANO – approx. 25kHz
LACI – approx. 18kHz
LowF – below approx. 30kHz

Appendix C. Settings used with the Echo Meter Touch 2 Handheld Detector and Echo Meter Touch Bat Detector, Recorder & Analyzer App from Wildlife Acoustics on an Amazon Kindle Fire HDX 3rd Generation tablet (Low, 2021b).



Setting name	Setting specifications	Setting location
Spectrogram display	Spectrogram should take up almost all of the screen (wave form should be small)	LIVE MODE
Spectrogram frequency axis	**0 – 128 kHz (maxed out y-axis)**	**LIVE MODE**
Spectrogram time axis	0 – 150 ms	LIVE MODE
Frequency reference line	30 kHz (separate HighF from LowF bats)	LIVE MODE
To record bats	**Big red button ("M" should be greyed out and the big red button should be activated)**	**LIVE MODE**
Listen to bat	"RTE" (use buttons on tablet to turn volume up and down while recording)	LIVE MODE
View bats	Compressed time (three lines should be close together and the spectrogram should be moving slowly)	LIVE MODE
Spectrogram Brightness	20ish (change as needed depending on ambient noises etc.)	Spectrogram Settings (cog wheel in bottom right)
Spectrogram Contrast	20ish (change as needed depending on ambient noises etc.)	Spectrogram Settings (cog wheel in bottom right)
Trigger Minimum Frequency	**16 kHz**	**Spectrogram Settings (cog wheel in bottom right)**
Set auto-id species list	North America → Alberta → EPFU, LANO, LABO, LACI, MYLU, MYSE, MYVO (uncheck MYCI and MYEV)	AUTO ID SELECTION
Audio Division Ratio	1/20	ADVANCED SETTINGS
Nightly Sessions Mode	**ON**	**ADVANCED SETTINGS**
Save Noise Files	OFF	ADVANCED SETTINGS
Real-Time Auto ID	ON	ADVANCED SETTINGS
Auto-ID Sensitivity	Balanced	ADVANCED SETTINGS
Trigger Sensitivity	**Medium**	**ADVANCED SETTINGS**
Trigger Window	**2 sec**	**ADVANCED SETTINGS**
Max Trigger length	**15 secs**	**ADVANCED SETTINGS**