Appendix D – Environmental Reference Materials

Appendix D-1: Acoustic Survey for Endangered Bats – Meaford, Ontario (2023)

Document included:
Survey for Endangered Bats: Meaford, Ontario – An acoustic survey of the local bat community, prepared by Susan L. Holroyd, M.Sc., for Save Georgian Bay Association, October 2023.

Contextual summary:
This acoustic bat survey was conducted in August 2023 in the Niagara Escarpment and Georgian Bay shoreline area northwest of Meaford, within a few kilometres of the proposed Ontario Pumped Storage Project site. Using stationary acoustic monitoring and a driving transect in accordance with North American Bat Monitoring Program (NABat) protocols, the study documented relatively high bat diversity and activity levels across the survey area.

Endangered bat species detected include **Little Brown Myotis (*Myotis lucifugus*)** and **Tricolored Bat (*Perimyotis subflavus*)**, both listed as Endangered under provincial and federal legislation. Migratory bat species — **Hoary Bat, Eastern Red Bat, and Silver-haired Bat** — were also detected at relatively high levels; these migratory species were assessed by COSEWIC as Endangered in May 2023 and are under consideration for protection under the federal *Species at Risk Act*.

The study identifies the Meaford area as providing high-quality summer roosting and foraging habitat, in close proximity to known and potential hibernation sites associated with the Niagara Escarpment. The report notes that this combination of habitat features may represent a **local bat biodiversity hotspot** and identifies potential sensitivity to large-scale land disturbance, artificial lighting at night, habitat loss, and alteration of escarpment features.

This material is provided **for contextual and background purposes only**. It is not submitted as expert evidence or as a site-specific impact assessment for the proposed project. Its inclusion highlights the existence of documented Species at Risk presence and underscores the importance of comprehensive baseline studies and effects assessment in the Project Description.

Appendix D-2: Sediment Disturbance and Legacy Contaminant Mobilization (Contextual Background)

Document referenced (contextual only):
Chattopadhyay, S. & Chattopadhyay, D. (2015). *Remediation of DDT and Its Metabolites in Contaminated Sediment. Current Pollution Reports*, 1:248–264.

Purpose and Scope

This appendix provides **general scientific context** regarding the behaviour of persistent, legacy contaminants in sediment–water systems when sediments are disturbed. It is included to illustrate well-established contamination pathways and risk mechanisms that are relevant to large-scale excavation, dredging, blasting, or sediment disturbance activities.

This material is **not submitted as expert evidence**, does **not assert the presence of specific contaminants at the project site**, and is **not relied upon for factual conclusions** in the main submission.

Summary of Relevant Context

Peer-reviewed literature documents that many historic contaminants — including chlorinated organics such as DDT and its degradation products — strongly sorb to sediments and organic matter and can persist for decades. Once sediments are disturbed, these contaminants may be remobilized through resuspension, changes in redox conditions, erosion, or altered hydrodynamic regimes. Disturbance can increase bioavailability, facilitate transport through aquatic systems, and elevate ecological risk even where contaminants were previously sequestered.

The literature further describes that sediment remediation and disturbance activities (including dredging, excavation, and construction near or within water bodies) have repeatedly been associated with short- and medium-term increases in contaminant exposure to aquatic organisms, including benthic invertebrates and higher-trophic-level species. This has been observed across a wide range of freshwater, estuarine, and near-shore environments.

Relevance to Information Sufficiency at the IPD Stage

This contextual material is provided solely to underscore why federal project descriptions are ordinarily expected to address:

- baseline sediment quality and contamination screening,
- mechanisms by which sediment disturbance could mobilize legacy contaminants,
- interactions between sediment disturbance and aquatic ecosystems, and
- cumulative effects pathways affecting fish, wildlife, and Species at Risk.

The absence of such baseline characterization or pathway analysis in an Initial Project Description limits the ability of the Agency, Indigenous communities, and the public to understand potential risks or determine whether proposed mitigation measures are conceptually adequate.

Appendix D-3: Preliminary Community-Based Species Context (Non-Technical Reference)

Appendix D-3: Preliminary Community-Based Species Context (Non-Technical Reference)

Species At Risk (4CDTC Meaford)

Species	COSSARO Status	COSEWIC Status	SARA Schedule 1	In TCE IPD Report	NHIC Records
Butternut	Endangered	Endangered	Endangered	Yes	Yes
Red-headed Woodpecker	Endangered	Endangered	Endangered	No	Yes
American Ginseng	Threatened	Endangered	Endangered	No	Yes
Canada Warbler	Special Concern	Special Concern	Threatened	Yes	Yes
Eastern Wood-pewee	Special Concern	Special Concern	Special Concern	Yes	Yes
Silver Lamprey* (Great Lakes - Upper St. Lawrence population *	Special Concern	Special Concern	Special Concern	Yes	Yes
Grasshopper Sparrow	Special Concern	Special Concern	Special Concern	Yes	Yes
Barn Swallow	Special Concern	Special Concern	Threatened	Yes	Yes
Bobolink	Threatened	Special Concern	Threatened	Yes	Yes
Eastern Meadowlark	Threatened	Special Concern	Threatened	Yes	Yes
Eastern Milk Snake	NAR	Special Concern	Special Concern	Yes	Yes
Snapping Turtle	Special Concern	Special Concern	Special Concern	No	Yes
American Hart's-tongue Fern	Special Concern	Special Concern	Special Concern	No	Yes
Lake Sturgeon (Great Lakes - Upper St. Lawrence River	Endangered	Threatened	Not Listed	Yes	Yes
Wood Thrush	Special Concern	Threatened	Threatened	Yes	Yes
Golden-winged Warbler	Threatened	Threatened	Threatened	Yes	Yes
Eastern Whip-poor-will	Special Concern	Threatened	Threatened	Yes	Yes
Bank Swallow	Threatened	Threatened	Threatened	Yes	Yes
Chimney Swift	Threatened	Threatened	Threatened	No	Yes
St. Lawrence population)	Threatened	Threatened	Threatened	No	Yes
Eastern Small Footed Bat	Endangered	Candidate	Not Listed	Yes	No
Little Brown Myotis	Endangered	Endangered	Endangered	Yes	No
Tri-colour Bat	Endangered	Endangered	Endangered	Yes	No
Northern Myotis	Endangered	Endangered	Endangered	Yes	No
Hoary Bat	Endangered	Endangered	Under Review	Yes	No
Eastern Red Bat	Endangered	Endangered	Under Review	Yes	No
Silver Haired Bat	Endangered	Endangered	Under Review	Yes	No
Monarch	Special Concern	Endangered	Endangered	Yes	No
Yellow-banded Bumblebee	Special Concern	Special Concern	Special Concern	Yes	No
Northern Brook Lamprey	Special Concern	Special Concern	Special Concern	Yes	No
Deepwater Sculpin	NAR	Special Concern	Special Concern	Yes	No
Black Ash	Endangered	Threatened	Under Review	Yes	No
Western Chorus Frog	NAR	Threatened	Threatened	Yes	No

* 1987 Record in NHIC dataset

SURVEY FOR ENDANGERED BATS: MEAFORD, ONTARIO

An acoustic survey of the local bat community.

ABSTRACT

The area acoustically sampled for bats had relatively high bat biodiversity and abundance. Endangered bat species, Little Brown Myotis and Tricolored Bat were both detected. The three migratory bat species (Hoary, Eastern Red and Silver-haired Bat) were all detected as well at relatively high numbers. These migratory bats have recently been assessed as endangered by COSEWIC and are being considered for protection under the Federal Species at Risk Act. The driving transect indicated that there relatively high numbers of bats occur across the sampling area. There is excellent bat habitat in the area and with the relatively close proximity of known and potential hibernation sites to good summer habitat, the area could represent a biodiversity hotspot for bats (Findley 1995). This report makes recommendations for future bat research and inventory and comments on the potential effects of a large-scale development on local bats.

Prepared by: Susan L. Holroyd, M.Sc.

Prepared for "Save Georgian Bay Association" October 2023

Summary

In response to a local request for information about the composition of the local bat community in the area, an acoustic survey was completed using both a stationary acoustic recording unit and a driving transect (following NABat protocols Loeb et al. 2015) in an area just west of Meaford, Ontario, adjacent to Georgian Bay and within a few kilometres of the site of a large, proposed development. The stationary detector was deployed for six nights, and acoustic data was analyzed using two different call identification software programs; reported results reflect the classifications that were confirmed and in agreement by both programs. Big Brown Bats were the most common species detected followed by Eastern Red Bats and Hoary Bats. A large number of endangered Little Brown Myotis were also detected along with Silver-haired Bats. Endangered Tricolored Bats were detected in very low numbers, but these bats are typically rare and finding them in the area is significant. Provincially endangered Eastern Small-footed Myotis and federally endangered Northern Myotis could also be present in the area, however a more intensive, targeted survey effort would be required to detect these very rare species. The driving transect detected bats almost every two minutes of sampling which is indicative of a good number of bats flying and living in the area. The availability of both good summer roosting habitat, good foraging habitat (small creeks, wetlands and lakeshore riparian) and nearby caves, crevices and known hibernation sites to support winter populations, suggest that this area could be a biodiversity hotspot for bats due to the close availability of this mosaic of necessary bat habitats (Findley 1995).

Acknowledgements

Thank you to Cory Olson for analyzing the acoustic data. Thanks to the homeowner who allowed us access to their property for the stationary acoustic monitoring and to the other homeowners in the area who volunteered their sites as well. Thank you to Tom Buck for helping with the initial setup and coordination. Thank you to Fay Gieg for encouraging the study and for the use of a vehicle for transporting field gear and conducting the driving transect and for an editorial review. Thanks also to Toby Thorne for evaluating the Tricolored Bat calls and to Derek Morningstar for a good discussion about Ontario bat communities.

Cover photo: Little Brown Myotis (by Jason Headley)

Contents

Introduction

In response to a local request for information about the composition of the local bat community in the area, an acoustic survey was completed using both a stationary acoustic recording unit and a driving transect (following NABat protocols Loeb et al. 2015).

Ontario has eight bat species, and all are potentially found in the sampling area (Table 1). Three of these species, Little Brown and Northern Myotis and Tricolored Bat are all listed as Endangered both provincially and federally. Eastern Small-footed Myotis are considered Endangered provincially in Ontario. Populations of migratory bats (Hoary, Eastern Red and Silver-haired Bats) are currently considered secure in Ontario; however, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) recently assessed these species as Endangered (May 2023) and that recommendation will be considered by the Federal Government to determine if these species will be federally protected under the Species at Risk Act (SARA) as endangered.

Table 1. The bats of Ontario and their federal and provincial status.

Common Name	Scientific Name	Species Abbreviations Kaleidoscope (Sonobat)	Status in Ontario (Federal Status)	Date last assessed provincially
Little Brown Myotis	*Myotis lucifugus*	MYOLUC (MYLU)	Endangered (Endangered)	24 January 2013
Northern Myotis	*Myotis septentrionalis*	MYOSEP (MYSE)	Endangered (Endangered)	24 January 2013
Tricolored Bat	*Perimyotis subflavus*	PERSUB (PESU)	Endangered (Endangered)	15 June 2016
Eastern Small-footed Myotis	*Myotis leibii*	MYOLEI (MYLE)	Endangered (NA)*	27 June 2014
Big Brown Bat	*Eptesicus fuscus*	EPTFUS (EPFU)	Secure (NA)	7 Nov 2013
Silver-haired Bat	*Lasionycteris noctivagans*	LASNOC (LANO)	Secure** (NA)	12 Dec 1995
Eastern Red Bat	*Lasiurus borealis*	LASBOR (LABO)	Secure** (NA)	12 Dec 1995
Hoary Bat	*Lasiurus cinereus*	LASCIN (LACI)	Secure** (NA)	31 Dec 2020

*NA = not assessed; **Assessed by COSEWIC May 2023 as Endangered.

Methods

Survey Area

The survey area is situated on the Niagara Escarpment adjacent to Georgian Bay just northwest of Meaford, Ontario (Figures 1 and 2). The area includes the bluff area, known as Irish Mountain Scenic Lookout, the area above the bluff towards the main gate used to access the Meaford Tank Range on Grey Road 112, the farmland and bush areas below the bluff and the forested areas to the east towards the Georgian Bay shoreline at Georgian Beach and Kiowana Beach and area (Figure 2). The area sampled is a mix of rural residential areas with clearings, agricultural land, and forest areas of varying ages. There are mature trees present that could provide roosting habitat for resident bats and older structures that may be used by building-using species such as Little Brown Myotis and Big Brown Bats.

Stationary Acoustic Detector

The stationary detector was set approximately four kilometres south of gate to the Meaford Tank Range (4th Canadian Division Training Centre) on the 9th Line (Grey Road 112) (Figure 1). The detection site was in a mowed hayfield about twenty-five metres away from a forest edge (a line of mature trees that were part of the riparian zone along a small creek area, Figure 3) to reduce capturing bouncing echoes of bat calls from the solid boundary. The stationary detector used was a Song Meter Mini Bat Detector (Wildlife Acoustics, USA). The bat detector was equipped with four fully charged AA batteries and a 64GB SanDisk flash card to store data. The settings used were the standard NABat settings (Loeb et al. 2015, Appendix 1). The bat detector was set to record 30 minutes before sunset until 30 minutes past sunrise. The unit was attached to a pole, (we used electrical conduit, guyed with string in three directions, set in place with a 0.75 metre piece of rebar pounded into the ground) and the detector was installed 4.5 metres above the ground (Figure 4). The detector was deployed between the 5th and 11th of August 2023 (six nights).

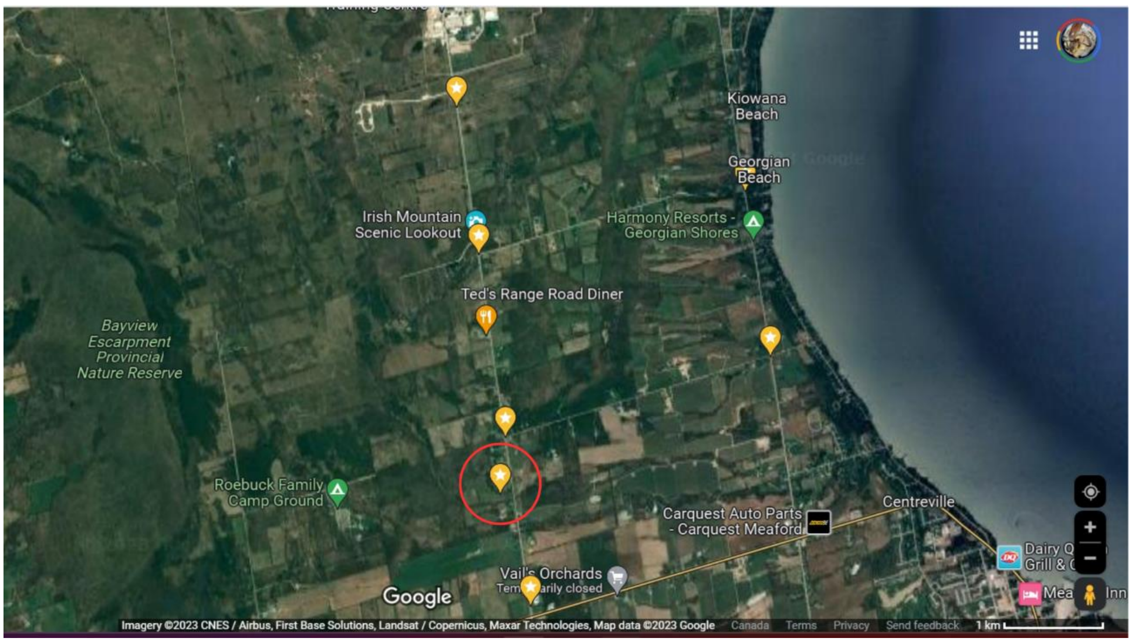


Figure 1. The study area with sampling sites marked with yellow pins. The yellow pin with the red circle denotes the stationary sampling site (Song Meter MiniBat Detector, Wildlife Acoustics). The remaining yellow markers denote the route of the driving transect.

Figure 2. The study area looking towards Georgian Bay from Irish Mountain Scenic Lookout.

Figure 3. The location of the stationary acoustic detector which was located in a mowed hayfield next to a small riparian area. Property was located along Grey Road 112.

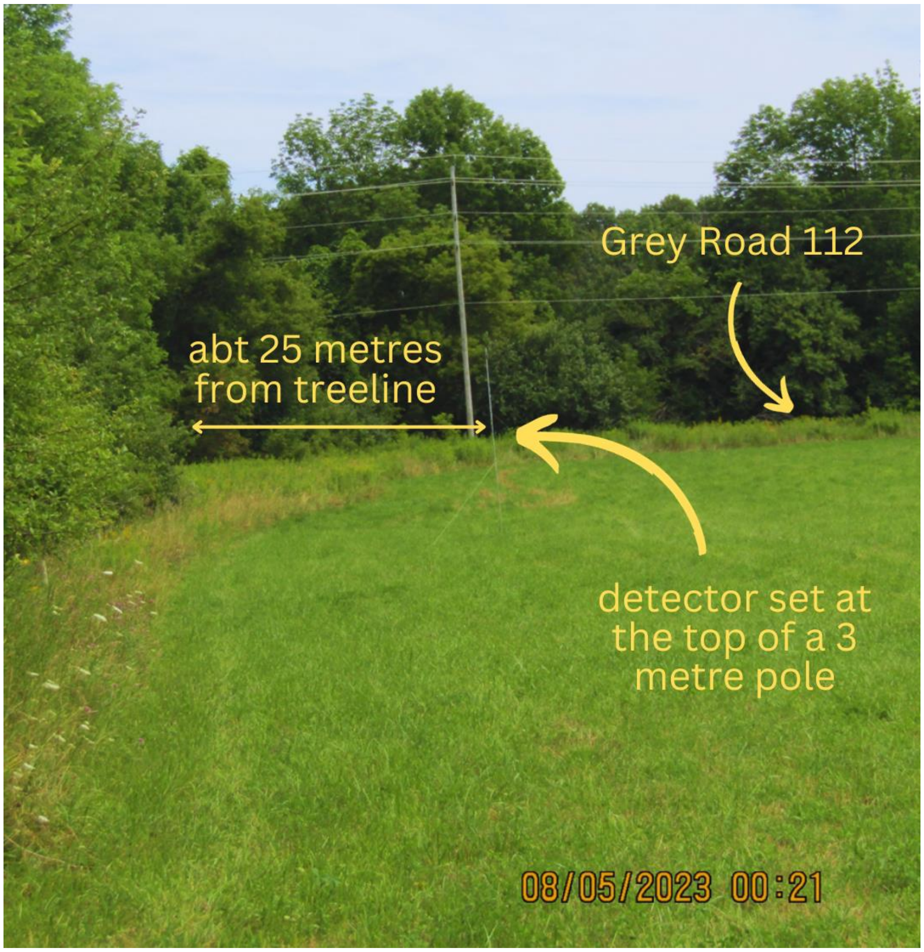


Figure 4. Stationary detector was set at the top of a pole (attached with zipties) approximately 25 metres from the treed edge of a small creek.

Driving Transect (Mobile Bat Detector)

The driving transect was conducted on the night of August 11th between 21:00 and 21:45, using an Echometer Touch 2 unit (Wildlife Acoustics) attached to an Amazon Fire tablet via a 1.5 metre cable. The ultrasonic microphone unit was taped firmly to a wooden dowel that was extended through the sunroof of the vehicle. The vehicle maintained a speed of approximately 30km/hour as suggested in the NABat survey protocols for driving transects for bats (Loeb et al. 2015). The settings for the autoID function were for Ontario bats. All bats detected were recorded. Unfortunately, we were unable to take advantage of the GPS recording feature. This unit records the time a bat is detected, the length of the call recording and the date. The auto-identification feature matches known bat echolocation calls and shapes with those recorded. There is some degree of error in identifying species, however generally, the myotis bats are easily discriminated from the other species, Eastern Red Bats may be confused with myotis bats, and Silver-haired and Big Brown Bats are often confused by this device. Visual examination of recorded calls can refine call identification and can certainly confirm that bats are being recorded (versus random sounds such as insects or frogs). The route driven for this transect is illustrated in Figure 5.

Figure 5. Route of the driving transect starting at point #1 and proceeding in order to point #7. Vehicle speed was maintained at 30km/hr as per the North American Bat Monitoring Program protocols for driving transects for bats (Loeb et al. 2015).

Acoustic Analysis

Stationary Detector

Acoustic analysis followed the recommended protocols found in Reichert et al. (2018) established for the North American Bat Monitoring Program. Two different acoustic analysis software programs were used to analyze the echolocation call data, Kaleidoscope and Sonobat. Both were set to use conservative thresholds to avoid false positives (i.e., mis-identifications) as much as possible. Bats can be identified to species using their echolocation calls; however, identification is based on an ideal “search phase” call that is in relatively close proximity to the recording device. Bats have variation in the calls that they produce, distance from the detector and other factors can affect the quality of the call recorded (which can make identification challenging). For the Myotis species, there can be some overlap in the call parameters used to discriminate between species, which makes this species group difficult to identify. However, in Ontario, all the myotis are considered species at risk – so all myotis calls are of interest. Other species pairs that both software packages are prone to confuse are Hoary Bat (LACI) with Big Brown Bat (EPFU), as well as Big Brown Bat with Silver-haired Bat (LANO). Running both packages with the auto-identifiers set in a conservative setting and using the output based on the agreed identifications by both programs is a conservative approach. If further work is done to survey bats in the area using acoustic detectors, it would be useful to have a sub-sample of calls evaluated manually as well. More detectors and more sampling nights would yield a more robust result.

Sonobat was set to an “acceptable call quality of 0.8 and sqnc decision threshold was set to 0.9”. The output of the settings for Kaleidoscope are available in Appendix 1.

Driving Transect

The acoustic files recorded during the driving transect were not formally analyzed using any alternate software programs. The Echometer Touch 2 unit uses the Echometer software (Wildlife Acoustics) from the downloadable application available for free online (Google Play Store). Identifications of bat species are less reliable using this unit/software combination; however, it is quite sensitive to bat calls and is good at picking up any bat calls in the area (generally, bat calls in the range of about 50 metres from the unit are detectable).

The advanced settings for the Echometer Touch were set as:

- Auto Division Ratio: 1/20
- Nightly Sessions Mode: On
- Save Noise Files: Off
- Real-time AutoID: On
- Auto-ID sensitivity: Balanced
- Trigger Sensitivity: Medium
- Trigger Window: 3 sec
- Max Trigger Length: 15 sec

The reported results will include species identified during the survey and the number of calls heard at approximately ten-minute intervals along the route.

Results

Weather

Night-time low temperatures remained well above 10˚C for the entire sampling period (Figure 6, Table 2). Bat activity can drop when temperatures fall below 10˚C as insect activity can diminish with cool temperatures, reducing prey available to aerial-hawking bats. There was significant over-night rainfall on the 7th and 8th of August but the bats at the sampling site found time to hunt and fly before or after active rain periods as activity was recorded every night sampled (Figure 6, Table 3). There is quite a bit of variation in the number of bat calls recorded before and after midnight and this likely reflects the overnight rains that were consistent through the week of sampling (Figure 6).

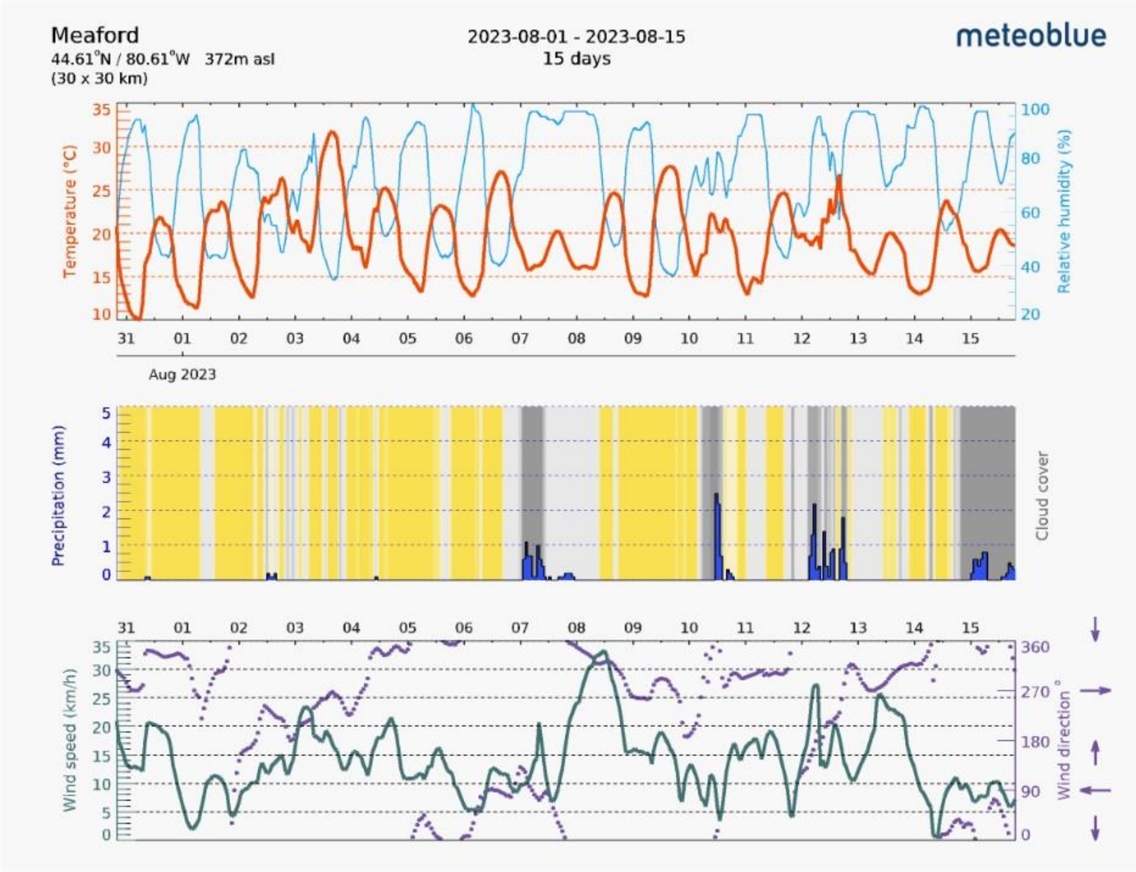


Figure 6. Temperature, rainfall and wind data for the study area for the month of August. Taken from an online weather data archive (https://www.meteoblue.com/en/weather/historyclimate/weatherarchive/meaford_canada_6071497?fcstlength=-15&year=2023&month=8).

Stationary Acoustic Detector

Table 2. Summary data from the stationary acoustic detector. The detector unit provides additional information including the time the call was recorded and the current ambient temperature.

Date (start of session)	Time (first bat)	Temperature C (first bat)	Date (end of session)	Time (last bat)	Temperature (last bat)	Total # Bat calls/night
5 Aug 2023	20:13 pm	19	6 Aug 2023	6:43 am	11.0	195
6 Aug 2023	20:12 pm	20.75	7 Aug 2023	6:45 am	18.25	390
7 Aug 2023	20:11 pm	18.75	8 Aug 2023	6:46 am	17.25	201
8 Aug 2023	20:09 pm	21	9 Aug 2023	6:47 am	14.75	180
9 Aug 2023	20:08 pm	23	10 Aug 2023	6:48 am	17.75	392
10 Aug 2023	20:06 pm	25	11 Aug 2023	6:49 am	13.5	206
11 Aug 2023	20:05 pm	25.2	Driving transect			

Table 3. Number of files recorded by date (with information given before midnight and after midnite on each sampling night). Not all files recorded were bats and not all files provided identifiable to species bat calls (but were obviously a bat and not simply noise).

Date	Period pm = sunset-midnite am = midnite-dawn	Total Files	No ID	Noise	Total Bat Files	Total Bat Files with ID
5th Aug 2023	pm	63	11	3	60	49
6th Aug 2023	am	136	7	1	135	128
6th Aug 2023	pm	234	42	12	222	180
7th Aug 2023	am	182	50	14	168	118
7th Aug 2023	pm	150	21	6	144	123
8th Aug 2023	am	65	6	8	57	51
8th Aug 2023	pm	144	15	10	134	119
9th Aug 2023	am	50	16	4	46	30
9th Aug 2023	pm	174	25	17	157	132
10th Aug 2023	am	256	58	21	235	177
10th Aug 2023	pm	146	14	9	137	123
11th Aug 2023	am	72	20	3	69	49

Species Detected

Big Brown Bats (EPFU/EPTFUS) were the most detected species, followed by Eastern Red Bats (LABO/LASBOR) and Hoary Bats (LACI/LASCIN, Table 4). The two acoustic analysis programs found that of the 533 bats classified as Big Brown by Kaleidoscope and the 557 calls classified as Big Brown by Sonobat, both agreed that 448 calls should be classified as Big Brown Bat (Table 4). Likewise, 86 calls were classified by both as Eastern Red Bats and 79 as Hoary Bats (Table 4). Little Brown Myotis (MYLU/MYOLUC, 60 calls) and Silver-haired Bats (LANO/LASNOC, 32 calls) were also detected with relatively high numbers (Table 4). Tricolored Bats (PESU/PERSUB) were detected, but of the few calls that were recorded, only one call met the call identification standards of both programs (Kaleidoscope and Sonobat; Table 4).

Kaleidoscope identified a couple of calls as Eastern Small-footed Myotis (MYLE/MYOLEI), however the call parameters for this species overlaps with the other myotis species to the extent that to truly identify that this species was present would require more intensive sampling and more type-specific calls confirmed.

Table 4. Acoustic files were analyzed using two bat call analysis programs, Kaleidoscope and Sonobat (both are regularly used for call analysis by bat professionals). Grey boxes indicate the species identifications confirmed by both programs. See Table 1 for bat species abbreviations.

		Kaleidoscope Identifications										
	Bat Species	**EPTFUS**	**LASBOR**	**LASCIN**	**LASNOC**	**MYOLEI**	**MYOLUC**	**MYOSEP**	**NoID**	**PERSUB**	**(blank)**	**Grand Total**
Sonobat Identifications	**EPFU**	448	1	37	18				53			557
	LABO		86				2		31	1		120
	LACI	9		79					14			102
	LANO	3			32				6			41
	MYLE						1		5			6
	MYLU		5				60	1	5			71
	~~MYSE~~											
	~~NOID~~											
	PESU									1		1
	(BLANK)	73	105	108	40	2	66	1	183	5		583
	Grand Total	533	197	224	90	2	129	2	297	7		1481

A Note on Tricolored Bats

There are at least three acoustic files that have been identified as Tricolored Bat (either by both sound analysis programs or by only one of the programs). Screen captures of the sound analysis window have been included below (Figure 7). The flagged calls were manually vetted by two bat acoustic experts (Cory Olson, WCS Canada, and Toby Thorne, Toronto Native Bat Program). The two acoustic analysis programs (Kaleidoscope and Sonobat) agreed that one call was that of a Tricolored Bat, but another two calls were flagged as potentially Tricolored Bat, and these were included in the manual vetting process. After evaluation by experts in bat call analysis, we can confidently say that this species was present, albeit in low numbers. Sonograms of Big Brown Bats, Hoary Bats and Little Brown Myotis are distinctive (Figures 8, 9 and 10).

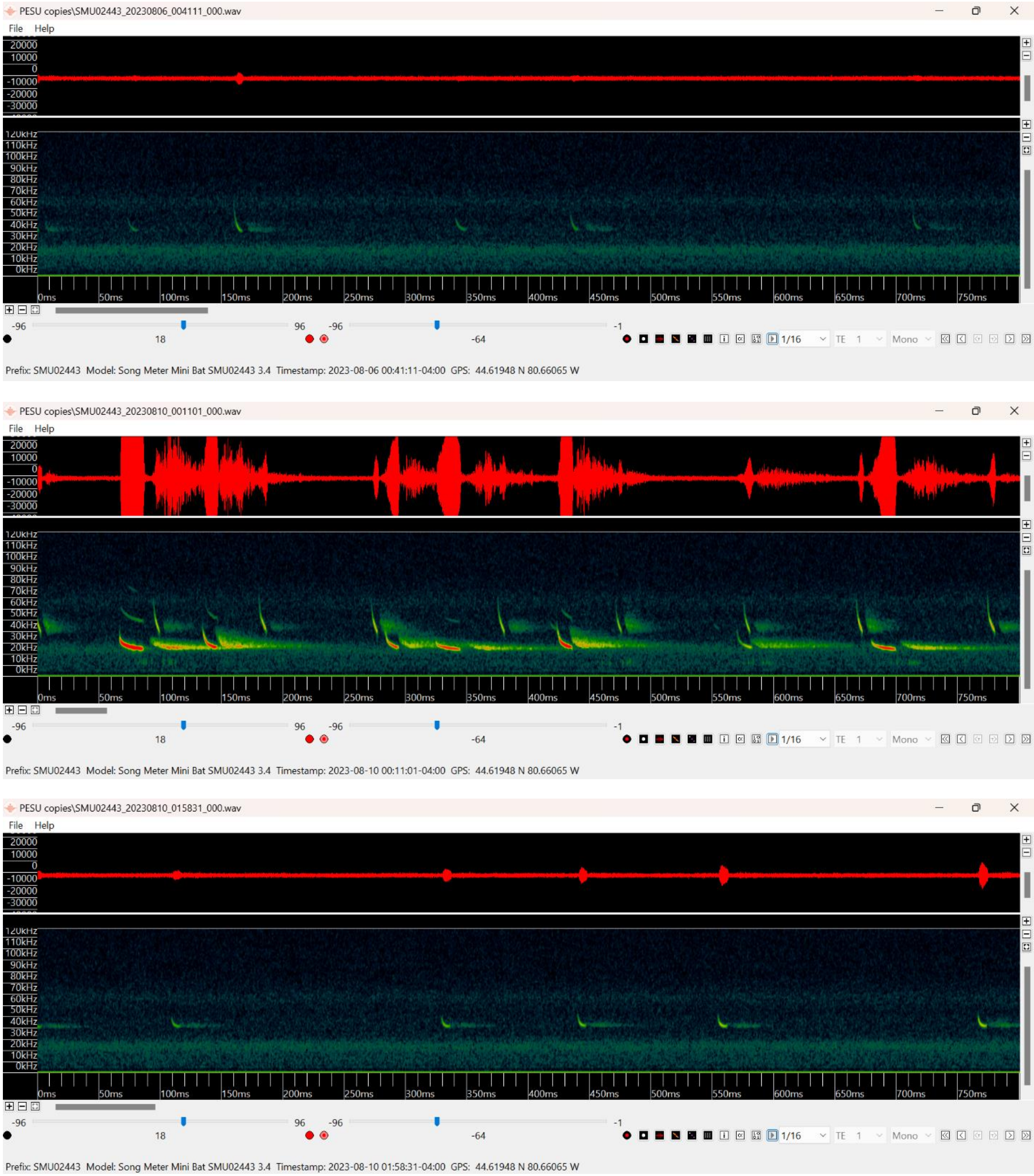


Figure 7. Top, middle and bottom images all depict Tricolored Bat calls (middle image is a mixed species recording with Hoary Bat, Big Brown/Silver-haired Bat and Tricolored Bat calls present). Top and bottom images show only Tricolored Bat calls.

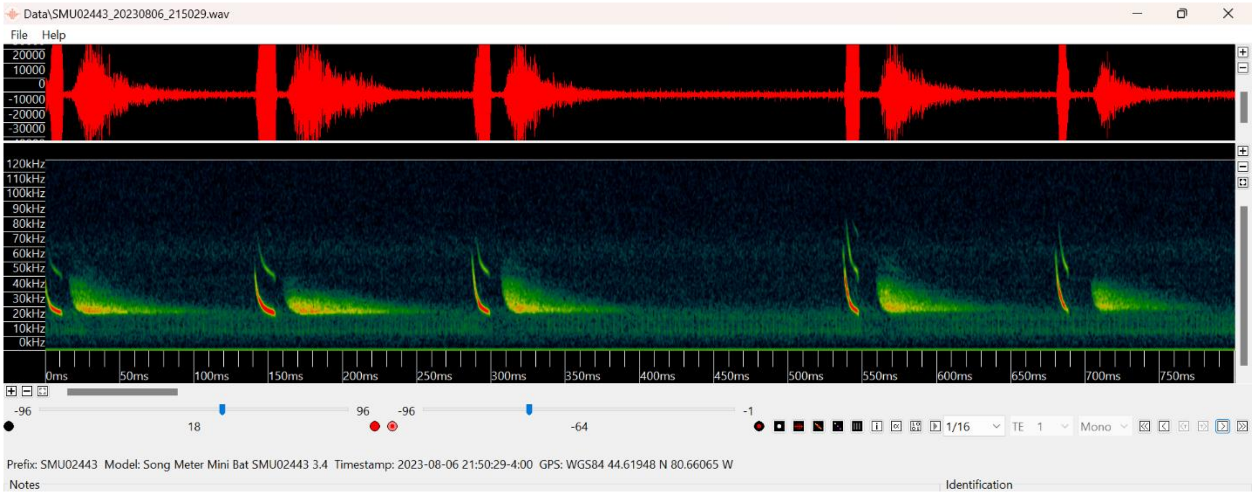


Figure 8. A typical call of a Big Brown Bat (identified by both call analysis software programs as Big Brown Bat).

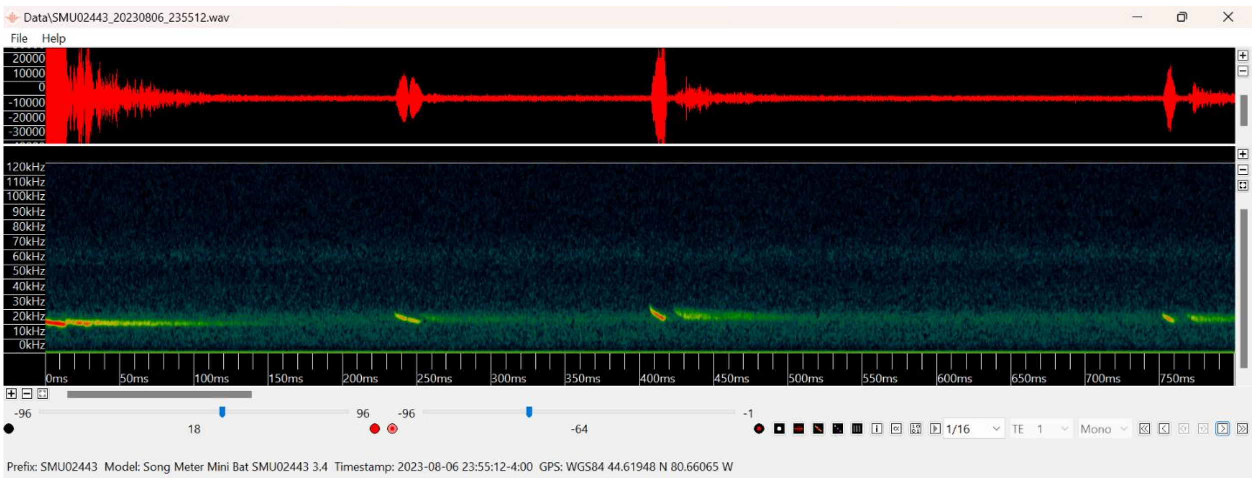


Figure 9.A typical call of a Hoary Bat (low, flat call at around 20kHz). Both acoustic analysis programs confirmed this call as Hoary Bat.

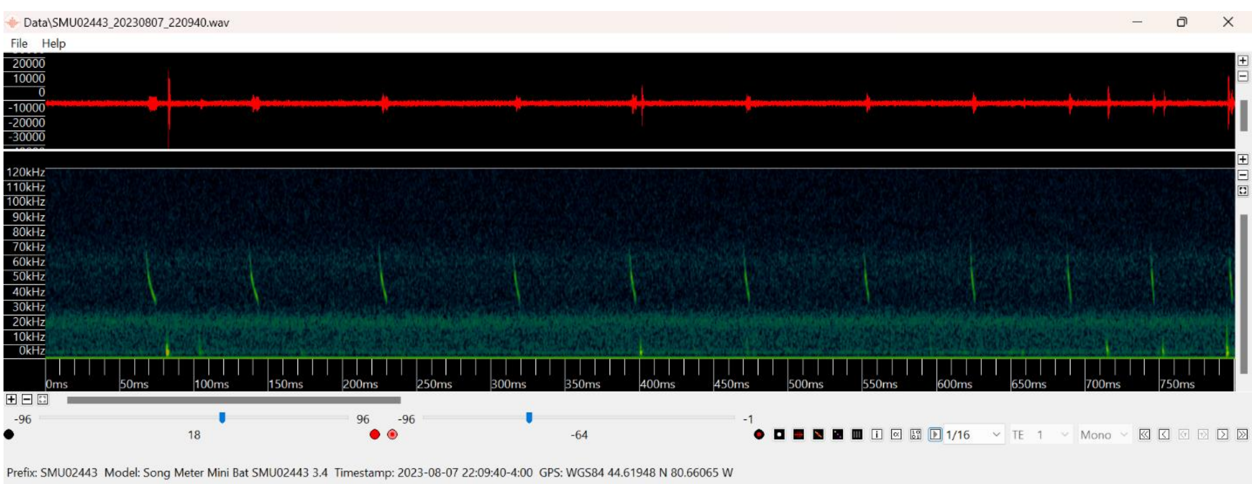


Figure 10. Typical call of a Little Brown Myotis (steep calls at 40kHz). Both acoustic programs confirmed this call as Little Brown Myotis.

Driving Transect

Surveyed between 21:00 and 21:45 following the route depicted in Figure 5. There were 102 files recorded in the ~45-minute sampling period. There were a large number of noise files and possibly low frequency recordings of amphibians calling and/or insects. Bat calls can be identified by manually reviewing each file. All files were manually vetted and files that included bat calls but with no identification were included in the count for each 10-minute sampling period. Call identification to species using the Echometer Touch 2 is about 60% reliable; but there is 100% confidence that each call in Table 5 is from a bat. The consistent driving speed of 30km/hr is supposed to ensure that each call sampled is a new bat, with the assumption that the vehicle is moving faster than foraging bats. There was a bat encountered (on average) about every two minutes along the survey transect.

Table 5. Summary of driving transect results (using an Echometer Touch 2- Wildlife Acoustics and a driving speed of 30km/hr).

Sampling Period	Total # of Bat Recordings/~10-minute sampling period	Time Call was Recorded	Species Detected	Call ID Number
21:00 to 21:10	6 bats	21:04	Eastern Red Bat and Little Brown Myotis	210423
		21:06	Silver-haired Bat	210631
		21:07	Hoary Bat	210706
		21:08	NO ID (Bat)	210857
		21:09	Eastern Red Bat	210909
21:11 to 21:20	10 bats	21:13	Silver-haired Bat	211346
		21:14	Big Brown Bat	211411
		21:14	Silver-haired Bat	211429
		21:16	Eastern Red Bat	211601
		21:18	Silver-haired Bat	211833
		21:18	Big Brown Bat	211850
		21:19	NO ID (Bat)	211916
		21:19	Hoary Bat	211920
		21:20	Little Brown Myotis	212041
		21:20	Little Brown Myotis	212050
20:21 to 20:30	12 bats	21:21	Eastern Red Bat	212115
		21:23	NO ID (Bat)	212331
		21:23	Big Brown Bat	212347
		21:24	Hoary Bat	212429
		21:25	Big Brown Bat and Myotis sp.	212510
		21:25	Little Brown Myotis	212534
		21:27	Eastern Red Bat	212745
		21:28	Big Brown Bat	212854
		21:29	Eastern Red Bat	212949
		21:29	Big Brown Bat	212955
		21:30	Big Brown Bat	213030
20:31 to 20:41	8 Bats	21:31	Little Brown Myotis	213132
		21:32	Big Brown Bat	213255
		21:33	Silver-haired Bat	213355
		21:36	NO ID (Bat)	213645

		21:38	Big Brown Bat	213857
		21:39	Big Brown Bat	213921
		21:40	Big Brown Bat	214035
		21:41	Silver-haired Bat	214109

Discussion

Based on the results of both stationary and mobile bat acoustic sampling, there appears to be good bat species diversity and abundance in the area sampled. It is not surprising that Big Brown Bats now dominate the bat community in a post-white-nose syndrome area as this has been observed elsewhere (O'Keefe et al. 2019). At one time, Little Brown Myotis dominated the bat community across Canada but the extremely high overwinter mortality rates of 90-95% from white-nose syndrome and extremely slow rates of reproduction, has resulted in their endangered species status (O'Keefe et al. 2019, Environment and Climate Change Canada 2018). Most bats produce only one pup each year per female and half of the young bats do not make it through their first winter (Barclay et al. 2003) As well, first and second year females may fail to support a pregnancy due to low body weights upon emergence from hibernation in spring; however, bats balance this slow reproductive rate with a long lifespan (Barclay et al. 2003). Records for Little Brown Myotis in Alberta have reported a record of 39 years for one previously banded male (pers. comm. D. Hobson). This life history strategy, however, does flag bats as a conservation risk because recovery of populations can take an exceptionally long time and for Little Brown Myotis, we may never see populations recover to original levels (Russell et al. 2015).

Big Brown Bats appear to be resistant to white-nose syndrome and populations remain robust in areas with the disease (Frank et al. 2014). With the loss of Little Brown Myotis, there is reduced competition for insect prey and Big Brown and Eastern Red Bats appear to benefit (Johnson et al. 2021).

The migratory bats are not affected by white-nose syndrome but are significantly affected by wind energy developments (Thurber et al. 2023). It is estimated that 166,000 bats are killed at wind energy sites in Ontario each year (Thurber et al. 2023). Curtailment (involving the feathering of rotor blades which leaves rotors motionless at low windspeeds) is an effective mitigation tool to prevent bat deaths but is often not deployed (Thurber et al. 2023). The recent (May 2023) assessment by COSEWIC that the migratory bats should be listed as endangered is a sign that these bats also need effective conservation measures to ensure survival. All three of these bat species were recorded at the sampling site (Eastern Red Bat, Silver-haired Bat and Hoary Bat). The sampling period for our study falls into the very start of the window of time when migratory bats initiate migration from northern breeding areas to southern wintering sites. Bats may use topographic features such as ridgelines, shorelines, rivers and riparian zones or large natural areas to determine their flight paths especially during fall migration (Thurber et al. 2023). Further monitoring would be needed to determine if numbers of migratory bats increase in the study area during the fall migration period, however, based on the proximity to the bay and height of land, this area should be evaluated to determine if there are siting concerns. Avoiding negative impacts to bats during the migration period (such as increased lighting at night or construction of wind turbines) may be a priority along with establishing setback distances from topographic features (Saskatchewan Ministry of Environment 2016).

Northern Myotis, an endangered species (both federally and provincially in Ontario) have high frequency echolocation calls and are likely to refrain from echolocating while hunting or they may emit very quiet calls (Faure et al. 1993, Miller and Treat 1993, Broders et al. 2003). This makes them very difficult to detect with either passive or active acoustic surveys/echolocation surveys, and acoustic survey alone is not enough to detect the presence of this bat species (Thorne et al. 2021). This species was not detected during this survey. Any future survey work for Northern Myotis needs to be extensive, specialized, and targeted to sample habitats specific to them. In the USA, the USFWS calculated level of effort required to detect the presence of Northern Myotis with 90% confidence was at least fourteen detector nights or sixteen net nights for non-linear projects (Armstrong et al. 2022). There are remnant patches of older aged forest on the north end of the Meaford Tank range and along the Bayview Escarpment Natural area that could potentially provide suitable habitat for Northern Myotis. A survey of these areas is strongly recommended.

Short Profiles of the Species at Risk Bats

It is important to understand some of the basic ecological characteristics of species at risk to understand how habitat changes might affect basic things like survival and reproduction. These animals need sufficient foraging habitat, good roosting habitat, a clean drinking water source and space that is not disrupted by artificial lighting at night (ALAN, Voigt et al. 2021) or human activity. Avoidance is the best mitigation strategy to prevent any negative impacts of development on species at risk, especially species that have seen significant population declines and have a slow rate of recovery (like bats). Avoiding any impacts to key foraging areas, avoiding fragmentation of habitat used by roosting bats, and avoiding the destruction of summer and winter roosting habitats should be a priority for recovery of these bat species. Finding roost trees for bats can be a challenging and time-consuming task. Tree-roosting bats use multiple trees in a roost area. Retention of suitable roost areas (with suitable, available potential roost trees) is a key conservation strategy for these species. The following species profiles provide information on timing of lifecycle events and descriptions of the types of habitats and the size of habitat areas needed to support colonies (which can be quite species-specific).

Little Brown Myotis (*Myotis lucifugus*)

Figure 11. Little Brown Myotis (Myotis lucifugus) in flight. Photo: Charles Francis.

Little Brown Myotis (*Myotis lucifugus*) also known as the "Little Brown Bat" was once the most common Myotis species across North America and was abundant across Ontario (van Zyll de Jong 1985, Thorne 2017, Figure 12). Populations have been decimated by an introduced, invasive fungal disease called "white-nose syndrome" and this species is currently listed as endangered.

Ontario Records of Little Brown Myotis

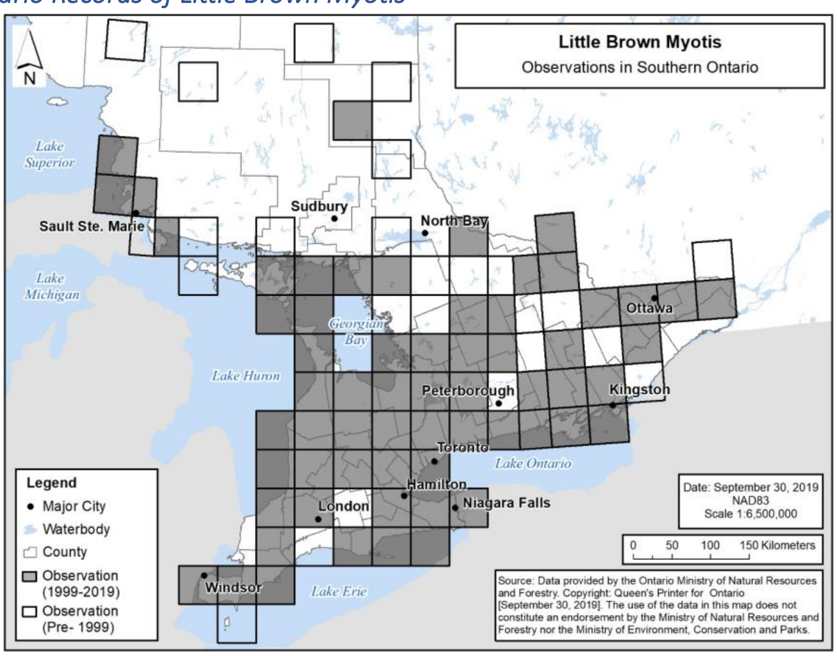


Figure 12. Map of southern Ontario showing general areas where Little Brown Myotis have been observed (Humphrey and Fotherby 2019). Current (1999-2019) and historic (pre-1999) maternity, foraging and migratory occurrence of Little Brown Myotis in Ontario. Each 50 km by 50 km standardized UTM grid square contains at least one element occurrence, i.e., maternity colony, foraging site or location associated with migration.

Habitat types used by Little Brown Myotis

Little Brown Myotis are found across Ontario in all forest zones and common in urban and rural environments (Coleman and Barclay 2011, Humphrey and Fotherby 2019). They are associated with older age class forests, riparian areas, wetlands, pools and edge habitats (Fenton and Barclay 1980, Jantzen and Fenton 2013).

Summer Roosting Habitat

Female Little Brown Myotis are flexible in the types of sites used as maternity and nursery roost sites. Large and smaller diameter trees (although larger trees are preferred for maternity roosting), buildings, rock crevices, bat houses, bridges, hollows, and cracks in large tree snags of older stands and woodpiles have all been documented for Little Browns (Fenton and Barclay 1980, Kurta 2017, Olson and Barclay 2013, Lausen et al. 2022, 2023). Males and nonbreeding females may use similar types of features but roost separately from maternity colonies in cooler sites. Maternity colonies benefit from roosting in large numbers and these bats will often seek out sites that will accommodate large numbers of bats (Olson 2011, Olson and Barclay 2013, Kurta 2017, Lausen et al. 2022). Little Brown Myotis appear to be most productive when using habitats in a rural-urban interface (Coleman and Barclay 2011).

Foraging/Drinking Habitats

Little Brown Myotis are aerial insectivores. They are nimble flyers that forage 1-3 m above the water or shrub layer (Fenton et al. 1980, Herd and Fenton 1983, Saunders and Barclay 1992). Their diet consists of primarily aquatic insects, midges, mosquitoes, mayflies (Ephemeroptera), flies (Diptera), caddisflies (Trichoptera) but also of insects found in upland areas such as beetles (Coleoptera), lacewings (Neuroptera), and moths (Lepidoptera) (Belwood and Fenton 1976, Anthony and Kunz 1977, Herd and Fenton 1983, Saunders and Barclay 1992, Whitaker and Lawhead 1992, Rainey 2005, Clare et al. 2011). Foraging activity for Little Brown Myotis has been found to be highest within 40 m of woodland edges (Jantzen and Fenton 2013). Thomas et al. (2019) found that Little Brown Myotis used thinned stands in the boreal forests of the Yukon. Foraging and commuting bats may avoid dense forest stands (especially those with basal areas >40m^2/ha, Thomas et al. 2019).

Home Range Size

Home range of a colony is an estimate of the area that bats may travel for food each night. Little Brown Myotis most often fly more than 2 km from their roost to forage but generally range between 5-8 km from their day-roosts (B.C. Ministry of Environment 2016a, Anthony and Kunz 1977; Fenton and Barclay 1980; Rainey 2005, Kunz and Reichard 2010), up to 15 km (Falxa 2005, Towanda and Falxa 2007). They have an estimated home range size of about 143 ha, however lactating bats may range closer to the roost covering 13-26 ha (Coleman et al. 2014, Henry et al. 2002, Slough and Jung 2013).

Little Brown Myotis are capable of making very long movements between summer and winter habitats. In Ontario, records show movements of 50–200 km in Ontario (Fenton and Barclay 1980), in New England, 1.6–80.5 km (Davis and Hitchcock 1965) and in Manitoba, seasonal movements ranged between 10-647 km (Norquay et al. 2013).

Table 6. Timing of lifecycle events for Little Brown Myotis.

Lifecycle Event	Timing of Event
Maternity colony formation	Beginning of June (Fenton and Barclay 1980).
Birth	Timing of birth varies depending on geographic region and local climatic conditions (gestation is typically 50-60 days, Fenton and Barclay 1980) but once births start at a site, most females produce pups in a three-week window (Fenton and Barclay 1980).
Volancy (first flights of young-of-the-year)	First flights start at about three to four weeks after birth (Kurta 2017).
Maternity colony dispersal	Occurs soon after young become volant. Colonies disband in late summer (Fenton and Barclay 1980).
Mating	Also known as swarming, occurs in October/November (Fenton and Barclay 1980).
Hibernation	Can begin in early September and may continue to mid-May (Fenton and Barclay 1980).
Spring Activation	April to mid-May (Fenton and Barclay 1980).

Current Status of Little Brown Myotis

- Listed as Endangered in Canada under Schedule 1 of the *Species at Risk Act* (SARA, c. 29) in November 2014 by an emergency listing order (Environment and Climate Change Canada 2018).
- Listed as Endangered in January 2013 on the Species at Risk in Ontario (SARO) List (O. Reg. 230/08) under Ontario's *Endangered Species Act*, *2007* (OMNRF 2015).
- Receive protection under Ontario's *Fish and Wildlife Conservation Act*, *1997* as specially protected mammals.

Primary Threats to Little Brown Myotis Populations

Fatality rates from white-nose syndrome (WNS) for Little Brown Myotis range from 90-95% (www.whitenosesyndrome.org) and this fungal disease currently represents the biggest threat to this species. However, some hibernation sites in Ontario have reported a complete loss of bats (Environment and Climate Change Canada 2018). Subsequently, all other threats to this bat represent significant additive mortality and mitigation is required to minimize impacts to populations. These additional threats include loss, fragmentation or degradation of forest roosting habitats, loss or degradation of foraging habitats (riparian along any sized waterways or lake edges and wetlands), improper or poorly timed exclusions of bats from buildings, mortality from domestic cats and vandalism at roost sites. This list may not include all possible threats to this species; however, these are the primary threats.

SARO defines maternity habitat for Little Brown Myotis as all of the connected habitat (either within a natural ecosite or a site modified by humans) where there are known observations of roosting adult females and juveniles between May 15 and July 31. The sites are considered in use by bats unless the habitat is no longer suitable, and bats are not using the location. An active and suitable maternity site is identified if two or more bats are observed occupying or leaving a site. For Little Brown Myotis, the area within 2400 m of the roost is considered important foraging habitat (but this area does not exceed 1800 ha in terms of the habitat regulation) (Humphrey and Fotherby 2019).

Little Brown Myotis is likely the most common bat species to use buildings in Canada. This species requires “bat-friendly” management practices if maternity colonies are to be excluded (e.g., Alberta Community Bat Program 2019). Improper exclusion practices could have significant negative effects on local populations.

Tricolored Bat (*Perimyotis subflavus*)

This species is very uncommon in Ontario. Any detections or observations of this species are significant. Any location that harbours any type of roosting site for this species should be a high priority for protection and conservation. Canada represents the northernmost edge of the species range.

Tricolored Bats may be sensitive to habitat fragmentation; these bats prefer contiguous areas of mature forest with permanent or ephemeral water features within the forested area and generally avoid areas of cleared forest or open areas such as agricultural fields (Farrow 2007).

The oldest Tricolored Bat on record was a banded male who was 14.8 years old on recapture (USFWS 2022).

Figure 13 Tricolored Bat in flight. Photo: Charles Francis.

Habitat Types Used by Tricolored Bats

Tricolored bats are generally associated with the Deciduous and Great Lakes-St. Lawrence Forest Regions of Ontario. The Deciduous Forest region is dominated by agriculture and urban areas, and totals almost 3 million ha (Government of Ontario 2022). In Ontario, this region has been largely cleared but retains scattered woodlots on sites too poor for agriculture and is seeing some areas with “bush regrowth” where agriculture has ceased. The current study site is located in the Great Lakes-St. Lawrence Forest Region, which is a mix of deciduous and coniferous forests. Cooler than the Deciduous Forest Region, it is characterized by large tracts of pines as well as stands of northern hardwoods, (maple, beech, and birch) mixed with evergreen trees, especially fir and hemlock (Kurta 2017). Much of the forest in the Great

Lakes–St. Lawrence Forest is uneven aged, meaning that young and old trees can be found within the same group of trees (Government of Ontario 2022).

Tricolored Bats range extensively across eastern and central North America, but nowhere does it form large colonies. In Ontario, Tricolored Bats are known primarily from southern and southcentral and eastern Ontario (Fujita and Kunz 1984, van Zyll de Jong 1985, Kurta et al. 2007, Environment and Climate Change Canada 2018), however recent work indicates that this bat may range much further north, well north of Sudbury (Laying et al. 2019). The current study site is within range of known bat hibernation sites along the shores of Georgian Bay towards Bruce Peninsula National Park (pers. comm. D. Morningstar). Proximity to known or potential hibernation sites can elevate the importance of summer roost habitat. If Tricolored Bats are using summer roosts in the Meaford area, these are likely important sites for this species in Ontario because of their proximity to hibernacula.

Ontario Records of Tricolored Bats

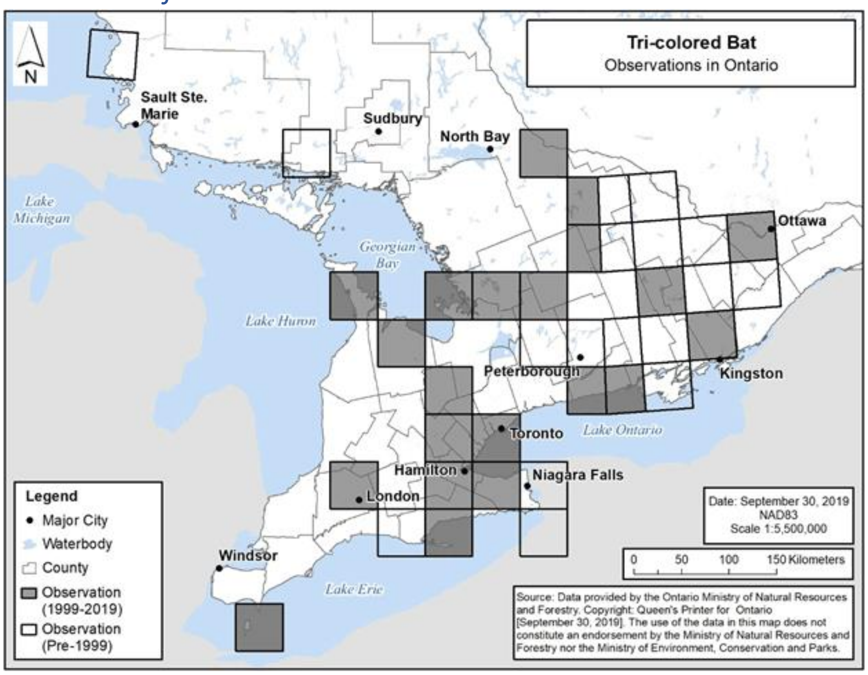


Figure 14. Map of Tricolored Bat occurrences compiled by the Ontario Ministry of Natural Resources and Forestry (from the Ontario Species Recovery Plan, Humphrey and Fotherby 2019).

Summer Roosting

Summer maternity colonies for this species are generally small, 2-4 individuals (Kurta 2017) and females exhibit high site fidelity, returning to the same roosting area, year after year (USFWS 2022). These bats may use a number of different tree roosts in a roost area (USFWS 2022). Typically, the air space below the roosting site is uncluttered (i.e., free of branches or other obstacles) allowing the bats to easily "drop and fly" to attain airspeed with the help of gravity (Kurta 2017).

Tricolored Bats use many different types of roosts but are primarily known for roosting in small groups in tree foliage. Across their range, Tricoloreds have found in:

- Dead leaf clusters in the shape of an umbrella, including dead leaf clusters belonging to broken branches, those formed by natural causes, and from the clusters of dead leaves and other material used in Eastern Gray Squirrel (*Sciurus carolinensis*) nests (Veilleux et al. 2003, Davis and Mumford 1962, Findley 1954, Perry and Thill 2007). In Ontario, Tricolored Bats were found roosting in a squirrel nest in eastern white cedar (*Thuja occidentalis*) in a mixed forest (Derek Morningstar, pers. comm.)
- Dense clusters of live foliage, especially oaks (*Quercus* spp.) (Veilleux et al. 2003, Perry and Thill 2007), but also pines (*Pinus* spp.) (Perry and Thill 2007).
- Arboreal lichens (*Usnea* spp.) or epiphytes (Davis and Mumford 1962, Poissant et al. 2010), especially close to water (Poissant et al. 2010).
- Buildings, including along outside walls beneath overhangs (e.g., porches, decks) and in garages, sheds, and barns (these observations are all outside of Ontario, Whitaker 1998, Whitaker et al. 2014, Kurta 2017).
- Rock crevices (Lacki and Hutchinson 1999).

Generally, Tricolored Bats may benefit from retention of mature stands and/or buffer zones near perennial streams with a diversity of forest age classes retained over the surrounding landscape (O'Keefe et al. 2009). Older trees within 185 meters to non-linear openings or close to streams are preferred by breeding females in sites in the southern part of their range (O'Keefe et al. 2009). Tricolored bats are not usually found in open fields or deep forests (Schmidly 1991, Nowak 1999).

It is unknown if Tricolored bats will use bat houses or buildings in Ontario during summer. Bat house use is anecdotal outside of Canada and exceptionally rare. Tricolored Bats have been observed using culverts over a buried stream in the Burlington, Ontario area in winter (Derek Morningstar, pers. comm.) which suggests that Tricolored bats could be more common in Ontario than has been thought previously. These bats should be considered an obligate tree-user in summer; the use of bat houses to compensate for the loss of maternity roosting habitat is not recommended.

Foraging/Drinking Habitats

The Tricolored Bat forages high over water (natural streams and ponds; Broders et al. 2003) and above fields and along the forest-field edge for insects (van Zyll de Jong 1985, Kurta 2017) or along forest borders (Thorne 2017). In many studies, they are found foraging close to water, especially in forested settings (Brack and Mumford 1984, Broders et al. 2003, 2006, Davis and Mumford 1962, Ford et al. 2005, Fujita and Kunz 1984, Laval et al 1977) and avoid foraging in open areas (such as those cleared for agriculture or urban areas; Farrow 2007, Environment and Climate Change Canada 2018).

Home Range Size: Foraging and Roosting

Tricolored Bats are faithful to small (<78 ha) roosting areas within and between years (Poissant 2009). In Indiana, females returned to the same area (0.4 ha) each summer and used the same 4-6 trees each year, suggesting value in familiar (and possibly limited) roost trees (Veilleux and Veilleux 2004). This species may move up to five kilometres between roost and foraging areas on any given night (Quinn and Broders 2007).

Table 7. Timing of lifecycle events for Tricolored Myotis.

Lifecycle Event	Timing of Event
Maternity colony formation	Starts at the beginning of June (or even a couple of weeks earlier); key period 15 May to 31 July (Humphrey and Fotherby 2019, SARO Recovery Strategy).
Birth	Gestation is 50-66 days. Birth occurs between June to mid-July (Fujita and Kunz 1984, Kurta 2017). Tricolored Bats may give birth to one or two pups in a single litter each summer (Fujita and Kunz 1984, Kurta 2017, Thorne 2017).
Volancy (first flights of young-of-the-year)	First flights start at about three weeks of age and pups are totally weaned by four weeks (Kurta 2017).
Maternity colony dispersal	Occurs soon after young become volant. Colonies disband in late summer (Kurta 2017).
Mating	Also known as swarming, October/November (Wisconsin Department of Natural Resources 2013a, Kurta 2017).
Hibernation	Late to go into hibernation compared to other bats. Early to late November. Movements of up to 136 km between summer and winter roosts, with northern populations often moving southward to hibernate (Kurta 2017).
Spring Activation	1 April to 31 May (Wisconsin Department of Natural Resources 2013a).

Current status of Tricolored Bats

Tricolored Bats are listed as vulnerable in Ontario but critically imperiled in all other provinces (Natureserve 2023). Approximately 10% of their global range is in Canada (Environment and Climate Change Canada 2018). They are Federally listed as an Endangered Species under the Species at Risk Act.

- Global Rank: G3/G4 (last reviewed in 2021)
- Canada Rank: N2/N2
- Listed as Endangered in Canada under Schedule 1 of the *Species at Risk Act* (SARA, c. 29) in November 2014 by an emergency listing order.
- Receives protection under Ontario's *Fish and Wildlife Conservation Act*, *1997* as specially protected mammals.
- Currently listed as "Proposed Endangered" under the *Endangered Species Act* in USA (as of September 2022; USFWS 2022).

Primary Threats to Tricolored Bat Populations

- **White-nose Syndrome:** Overwinter fatality rates from WNS are estimated to be over 90% for Tricolored Bats (Perea et al. 2022). Significant and marked declines in numbers were recorded after 2006 due to WNS. There is no expectation that lost Canadian populations of Tricolored Bats (that have been severely impacted by WNS) will be "rescued" by immigration of Tricolored Bats from moving from the USA to Canada, as populations of these bats have been depleted from WNS throughout their range (COSEWIC 2012).

  "The degree to which the Tri-colored Bat population will be able to fully recover to its historical levels is uncertain. The long-term population objective is based on the expectation that, even if individuals develop resistance or a treatment for WNS is found, the slow

population growth rate of this species means populations would require many generations (i.e., hundreds of years) to recover." (Environment and Climate Change Canada 2018)

In areas where bats have been affected by WNS, the significance of threats other than WNS to populations is elevated (Environment and Climate Change Canada 2018).

- **Wind Energy:** This species has experienced significant losses due to wind turbines at wind energy facilities as well (Johnson et al. 2003, Fiedler 2004, Johnson 2005, Kunz et al. 2007, Arnett et al. 2008). Arnett and Baerwald (2013) estimated that wind turbines killed roughly 45,000-94,000 Tricolored Bats across the United States and Canada between 2000-2011. The threats from wind energy continue to increase with continued growth of this industry.
- **Habitat loss/degradation:** Destruction or degradation of winter and summer roosting habitats (this was ranked as a high risk in the Federal recovery strategy, Environment and Climate Change Canada 2018), degradation of foraging habitat (identified as a medium threat, Environment and Climate Change Canada 2018).
- **Intentional harm/vandalism:** high threat, (Environment and Climate Change Canada 2018).
- **Research or recreational activities:** moderate to high threat, (Environment and Climate Change Canada 2018).
- **Industrial disturbance from localized activities:** like forestry or mining or other types of habitat clearing (moderate threat, Environment and Climate Change Canada 2018).
- **Other factors:** pollution (chemicals, metals, light), climate change effects on prey availability, collisions with vehicles, mortality from feral cats (Beattie et al. 2022, Wilson et al. 2022). Tricolored Bats may have a greater risk of collision with vehicles due to their characteristic low, slow, and erratic flight pattern (Abbott et al. 2015).

Paths to Recovery

- Forest management could help to keep populations stable by increasing areas for roosting and foraging (from the IUCN assessment, Solari 2018).
- The Canadian Federal Recovery stated a concern regarding whether there is sufficient suitable summer roosting/foraging or winter hibernation habitat to support this species within its Canadian range (Environment and Climate Change Canada 2018). Objectives for this species under this recovery strategy include:
    - *To restore (then maintain) the pre-WNS extent of occurrence (the area that encompasses the known geographic distribution of the species in Canada as depicted in Figure 14).*
    - *To maintain (and where feasible increase) the population at its current level over the next 10 years.*
    - *And ultimately to have self-sustaining, resilient, and redundant populations.*

- **The Ontario Recovery Strategy** identifies "maternity habitat" for Tricolored Bats as the important habitat around a maternity site including all of the connected habitat (either within a natural ecosite or a site modified by humans) where there are known observations of roosting adult females and juveniles between May 15 and July 31. An active and suitable maternity site is identified if two or more bats are observed occupying or leaving a site. For Tricolored Bats, the area within 920 m of the roost is considered important foraging habitat (and this area does not exceed 265 ha in terms of the habitat regulation) (Humphrey and Fotherby 2019).

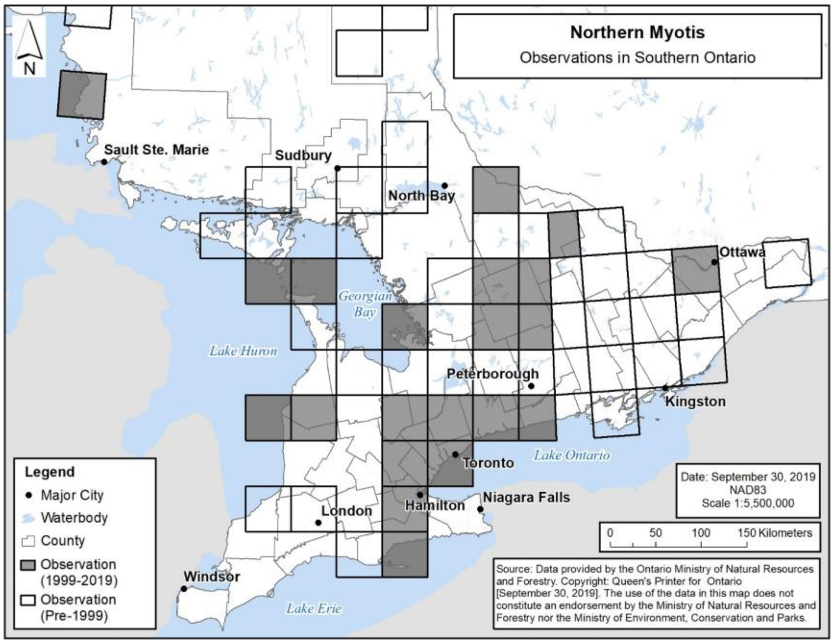
Northern Myotis (*Myotis septentrionalis*)

Northern Myotis (*Myotis septentrionalis*) (Figure 15) has a wide distribution through eastern Canada and the USA and the boreal forest region of Canada. The entire eastern portion of its range has now been affected by WNS although there are still patchy areas within its distribution that have retained small, unaffected populations (Manning and Ando 2022). Where the fungus has infected bats, overwinter mortality rates at hibernation sites have been measured up to 98% and there are concerns that this species may face extirpation and possibly extinction in affected areas (Environment and Climate Change Canada 2018).

Figure 15. Northern Myotis (Myotis septentrionalis) captured in a mist net in an Ontario study. Photo: Christina Davy.

Ontario Records of Northern Myotis

There are records for Northern Myotis in all of the forest regions of Ontario (Figure 16). The lack of records from northern Ontario is likely an artifact of lower sampling rates as this species is found across Canada within the boreal forest region (Environment and Climate Change Canada 2018).



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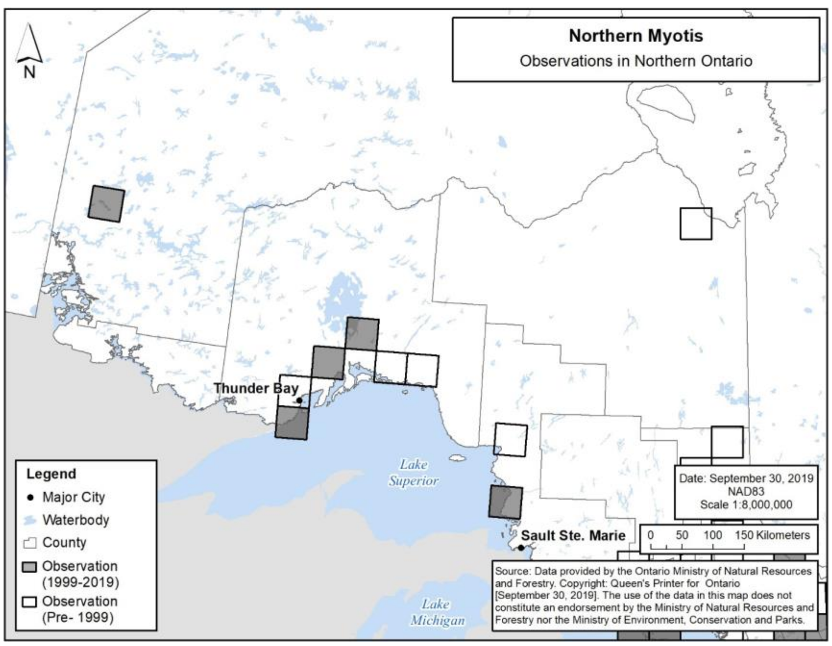


B.

Figure 16. Maps of A. Northern and B. Southern Ontario showing general areas where Northern Myotis have been observed in Ontario (from the Ontario Species Recovery Plan, Humphrey and Fotherby 2019). Current (1999-2019) and historic (pre-1999) maternity, foraging and migratory occurrence of Northern Myotis in Ontario. Each 50 km by 50 km standardized UTM grid square contains at least one element occurrence, i.e., maternity colony, foraging site or location associated with migration.

Habitat Types Used by Northern Myotis

Summer Roosting Habitat

Northern Myotis require intact forest patches and show long-term fidelity to roost areas (Silvis et al. 2016) and they are considered an interior forest-using species (LaVal et al. 1977, Caire et al. 1979, Jung et al. 1999, Kurta 2017). Mature stands with large, (live or dead) older age class trees are preferred; this bat is flexible in the tree species used (Jung et al. 2004). Maternity roost spaces occur in tree crevices or cavities formed either through actions of primary cavity excavators (e.g., woodpeckers) or through natural decay process that result in cavities, cracks or peeling bark (Patriquin and Barclay 2003, Broders et al. 2006, Psyllakis and Brigham 2006, Olson 2011, Kurta 2017, Thorne 2017). Northern Myotis roost in these features in trees found in upland forests (Carter and Feldhamer 2005, Lacki et al. 2009, Olson 2011, Rojas et al. 2017, Lausen et al. 2022), ridgetops (Silvis et al. 2016) but also near wetlands (Foster and Kurta 1999) and riparian areas (Thorne et al. 2021). Northern Myotis are not normally associated with urban areas but have been found using forest remnants (e.g., Rouge National Urban Park, Thorne et al. 2021, coastal New York, Gorman et al. 2022a) near or within urban areas, however in both cases, bats chose roost trees in forest interior conditions and were not found to use anthropogenic structures.

Maternity colonies of Northern Myotis are relatively small averaging between around four to thirty bats (but ranging between 2-65 bats; Sasse and Pekins 1996, Menzel et al. 2002, Broders et al. 2006, Olson 2011). This species also appears to depend on a network of maternity tree roosts in a roost area and the colony will move between roosts every 2-3 days in a fission-fusion movement pattern (Patriquin et al. 2010, Olson 2011, Johnson et al. 2012, Silvis et al. 2014). The roost area size used by maternity colonies in contiguous forest varies between 1.3 and 58.3 ha (mean 38.05 ± 20 SD ha, Silvis et al. 2015), and 1.45–35.33 (mean 12.6 ± 9.9 SD ha, Johnson et al. 2012).

Migrations between winter and summer roosting habitat is usually 100 km or less, and as a result, they are often more abundant in areas near hibernation sites (Kurta 2017). One study conducted in Pennsylvania suggested that this species may overwinter in the same trees used as maternity roosts in summer and that higher density forests near riparian habitat is favoured (Lewis et al. 2022).

Foraging/Drinking Habitats

Northern Myotis tend to forage within forests, below the canopy, but above shrub layer and sometimes over ponds (Kurta 2017, Dykeman 2018) usually 1 to 3 m above the surface of the ground or water (Nagorsen and Brigham 1993, Sasse and Pekins 1996, Caceres 1998ab, Foster and Kurta 1999). This species is known as a gleaner but is capable of aerial foraging (Caceres and Pybus 1997, Caceres 1998ab, Lee and McCracken 2004, Kurta 2017). Kurta (2017) notes that small moths are especially important to this species and their diet includes species of moth considered pests to agriculture and forestry (e.g., leaf rollers, tent caterpillars and spongy moths). After a five-year study in mature Virginia forests, Gorman et al. (2022b) concluded that Northern Myotis are highly dependent on forested riparian habitat, and this was especially true for colonies of breeding females.

For Northern Myotis, the area within 450 metres of the roost is considered important foraging habitat (but this area does not exceed sixty-three hectares in terms of the habitat regulation) (Ontario Species Recovery Plan, Humphrey and Fotherby 2019).

Home Range Size

Northern Myotis also appear to have relatively small foraging and roosting home range sizes (around 5 to 50 hectares), but this appears to be variable (Owen et al. 2003, Broders et al. 2006, Henderson and

Broders 2008, Silvis et al. 2014, Divoll et al. 2022). In the Toronto region, Northern Myotis ranged on average within 500-800 m of water sources (Thorne et al. 2021). In other sites, this species made short foraging flights of about 1.1 kilometres from maternity day roosts in fragmented forested areas (Prince Edward Island, Henderson and Broders 2008). But foraging areas range up to 300 hectares (Olson 2011).

Large forest patches with mature, interior forest cover are likely to be an important resource for Northern Myotis and that this species will require habitat protection to prevent habitat loss or further fragmentation in Ontario, especially in landscapes experiencing rapid urbanization (Thorne et al. 2021).

Lifecycle

Table 8. Lifecycle events and timing for Northern Myotis.

Lifecycle Event	Timing of Event
Maternity colony formation	Late April-May (Caceres and Barclay 2000).
Birth	Single pup born in June or July (Caceres and Barclay 2000, Owen et. al. 2002).
Volancy (first flights of young-of-the-year)	Four to six weeks after birth (colonies disperse shortly after juveniles gain flight; Caceres and Barclay 2000).
Maternity colony dispersal	Occurs soon after young become volant. Colonies disband in late summer.
Mating	Also known as swarming, October/November (Caceres and Barclay 2000).
Hibernation	Late October to April (Caceres and Barclay 2000).
Spring Activation	April-May emergence (Wisconsin Department of Natural Resources 2013b).

Current status of Northern Myotis

- Listed as Endangered in Canada under Schedule 1 of the *Species at Risk Act* (SARA, c. 29) in November 2014 by an emergency listing order (Environment and Climate Change Canada 2018).
- Listed as Endangered in January 2013 on the Species at Risk in Ontario (SARO) List (O. Reg. 230/08) under Ontario's *Endangered Species Act*, *2007* (OMNRF 2015).
- Protected under Ontario's *Fish and Wildlife Conservation Act*, *1997* as specially protected mammals.

Primary Threats to Northern Myotis Populations

Highest concerns for Northern Myotis include impacts from white-nose syndrome with mortality rates measured as high as 98% for some populations. However, pollution, renewable energy impacts (i.e., mortality at windfarms), and impacts from agriculture are also listed as a concern (Environment and Climate Change Canada 2018). Additive mortality may significantly hamper recovery of populations and even low impact activities should be carefully considered (Environment and Climate Change Canada 2018).

1. **White-nose syndrome:** Overwinter mortality rates for Northern Myotis estimated as high as 98% (www.whitenosesyndrome.org) have led to very founded concerns of extinction for this species.

In some hibernacula in Canada, Northern Myotis have completely disappeared (Environment and Climate Change Canada 2018).

2. **Forestry and/or Forest Clearing:** Northern Myotis will be impacted by forestry practices with stand rotation cycles that are too short to provide mature trees with appropriate roost structures for bats. Management strategies need to include a plan for eventual recruitment and retention of older age class trees with appropriate bat roosting features. Harvesting affects forest structure leading to changes in bat activity and foraging patterns (Barclay and Brigham 1996, Lauzon 2019). Forest harvesting and forest clearing removes roost trees and alters and/or removes foraging habitat (Barclay and Brigham 1996). Harvesting may also result in direct mortality.
3. **Herbicide and pesticide application:** Northern Myotis are threatened by pesticide applications (from sources such as agriculture, forestry efforts to control moth pests and municipal insect control) that may reduce or eliminate insect prey. Herbicides and pesticides may change habitats, insect diversity and abundance (Bruhl et al. 2021). Declines in insect availability may potentially affect the fitness of bats (Davy et al. 2022). There may also be direct impacts of pesticides on bat health and survival, however more research is needed in this area (Environment and Climate Change Canada 2018).

Eastern Small-footed Myotis (*Myotis leibii*)

Eastern Small-footed Myotis are small bats (3-6 grams), with yellow-brown fur and a black mask that are considered rare in Ontario and not well-known (Humphrey 2017, Figure 17). It is an aerial insectivore that eats small flying insects (Humphrey 2017). The current longevity record for this bat is 12 years (USFWS 2013) which comes from an Ontario record (Humphrey 2017). Like other Myotis bats, this species gives birth to only one young per year and exhibits a low female survivorship which may explain why this species has been historically uncommon (van Zyll de Jong 1985, Humphrey 2017).

Figure 17. Eastern Small-footed Myotis (Myotis leibii) in flight. Photo: Brock Fenton.

Ontario Records of Eastern Small-footed Myotis

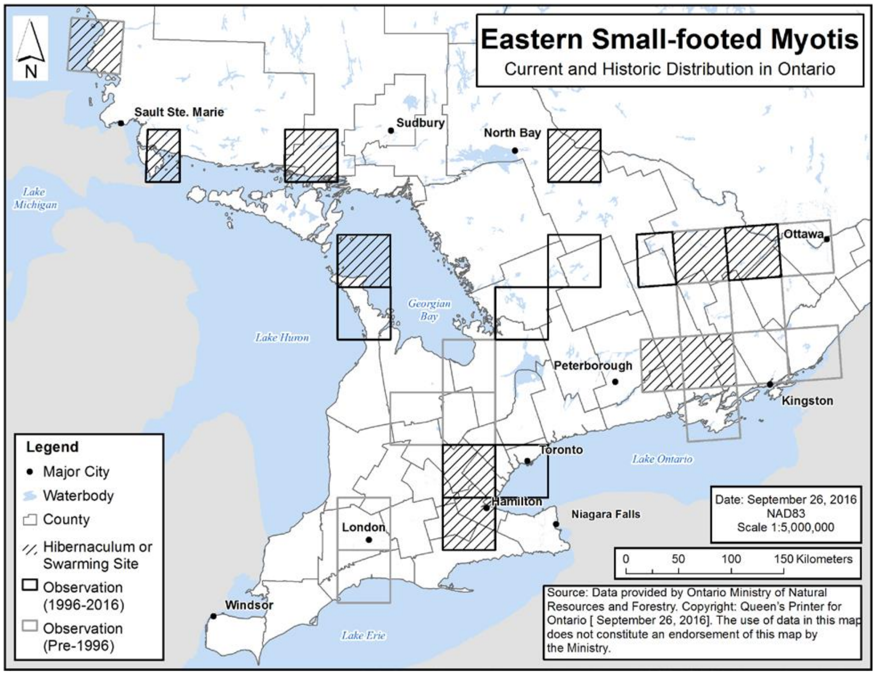


Figure 18. Current and historic distribution of Eastern Small-footed Myotis in Ontario (from Humphrey 2017). Each 50 km by 50 km standardized UTM grid square contains at least one observation record or element occurrence (i.e., record of an Eastern Small-footed Myotis).

Habitat Types Used by Eastern Small-footed Myotis

Wintering/Hibernation Habitat

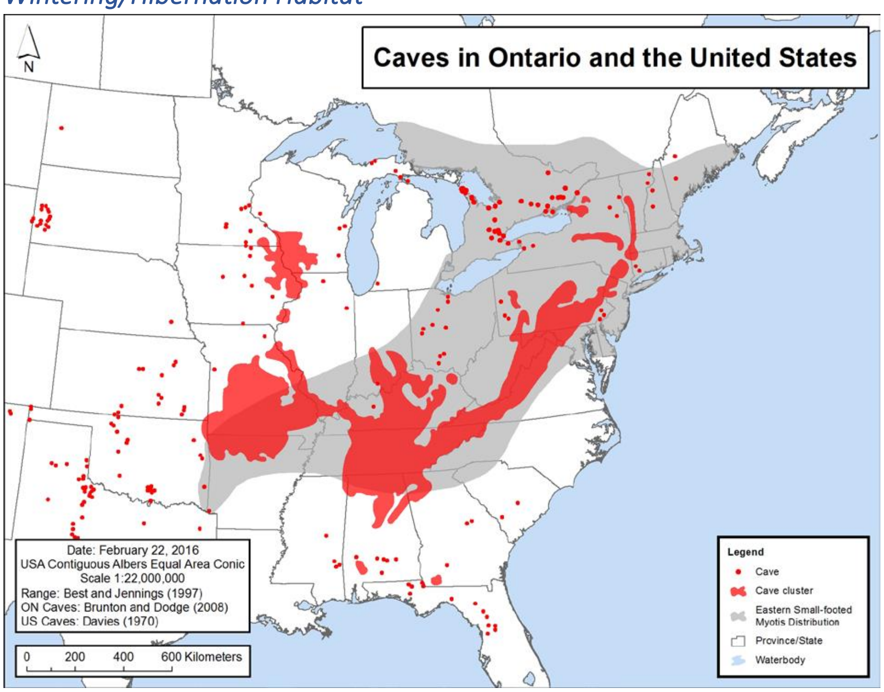


Figure 19. Map of locations of caves across eastern Canada and the USA along with the distribution of Eastern Small-footed Myotis (from Humphrey 2017).

This species hibernates and overwinters in caves and abandoned mines. There are only about a dozen known locations of hibernacula in Ontario (Humphrey 2017). Bruce Peninsula National Park has been investigating (and locating) bat hibernation sites along the Georgian Bay shoreline. This is within one hundred kilometres of the Meaford area, and there is similar cave/escarpment habitat in the immediate area on the Meaford peninsula that may support hibernating bats as well. The close proximity of summer and winter roosting habitat may be a factor that restricts the distribution of Eastern Small-footed Myotis. The Meaford peninsula may offer this combination of habitats and is a potentially suitable site for this species.

Summer Roosting Habitat

Eastern Small-footed Myotis is associated with open, sunny rock habitats where it uses rock crevices for roosting; buildings may also be used occasionally (Humphrey 2017). It is not known to use bat houses anywhere in its known range (Mering and Chambers 2014).

Foraging and Drinking Habitats

The foraging ecology of this bat species is not well-known in Ontario. Information from other parts of its range indicates that it may forage over a variety of habitats including, forested sites (within forests, over ponds and riparian areas), occasionally over agricultural fields and generally within 0.8 to 13 kilometres from their day roost (Chenger 2008, USFWS 2013).

Home Range Size

Home range sizes vary widely for this species (from 100 hectares to over 1,000 hectares or more) however none of this information arises from studies completed in Ontario (Humphrey 2017). The Recovery Strategy for this species in Ontario recommends further research and tracking to get a better grasp on the habitat requirements for Eastern Small-footed Myotis (Humphrey 2017).

Current Status of Eastern Small-footed Myotis

- Ontario: **Endangered**, listed in 2014, Species at Risk in Ontario (SARO) List, and receives protection of both habitat and species under the *Endangered Species Act, 2007* (ESA).
- Federally: Eastern Small-footed Myotis are not currently listed as a species at risk nationally.

Primary Threats to Eastern Small-footed Myotis Populations

Several factors have been identified as threats to Eastern Small-footed Myotis including:

- **White-nose syndrome** (WNS), a disease caused by the fungus *Pseudogymnoascus destructans* was first detected in Ontario hibernacula in 2010. Infected Eastern Small-footed Myotis were detected in Ontario in the late winter/spring of 2016 (Humphrey 2017).
- **Alteration of habitat**, especially hibernacula. Quarrying, mining, agriculture, construction or forestry activities that take place near caves (e.g., escarpment features) or abandoned mines could cause or contribute to changes in microclimate, airflow, or hydrology within these features, even if the activities are not occurring directly within or above the site (Environment and Climate Change Canada 2018).
- **Wind Energy** developments have been shown to cause mortality for this species.
- **Human Disturbance** (especially at hibernacula) can negatively affect this bat.
- **Toxins** that may migrate up through the food chain (especially from foraging over aquatic environments) can expose bats to hazardous materials (Humphrey 2017).

From the Species Recovery Plan for Ontario (Humphrey 2017), the recovery goal and objectives are as follows:

- to maintain a self-sustaining provincial population and to maintain sites currently and historically used for swarming, hibernation or maternity roosting in Ontario, unless habitat is no longer suitable.

The protection and recovery objectives to meet the goal are to:

1. Inventory and monitor abundance of known Ontario populations.
2. Conduct surveys in suitable habitat for the species to identify its Ontario distribution, range and abundance.
3. Increase understanding of the species' ecology through inventory, monitoring, and research.
4. Monitor the impacts of threats on the populations and increase understanding of the effects of WNS on the species.
5. Protect and maintain, and enhance or restore, suitability of summer and winter habitats.
6. Promote stewardship, education, and increased awareness of Eastern Small-footed Myotis, other rare and at-risk bat species, and their habitats and threats.

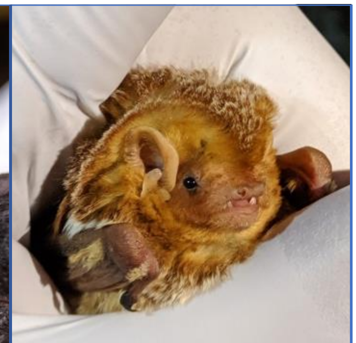
"The short-term recovery approaches should focus on accurately identifying baseline information for Ontario on distribution, population and habitats used by the species, and, at the same time, mitigate potential threats, actively conduct research and develop long-term management activities to ensure the goal will be achieved. It is recommended that foraging areas, hibernacula and swarming sites and maternity sites be prescribed as regulated habitat for the species" (from Humphrey 2017).

Migratory Bats: Hoary, Red and Silver-haired Bats

In May 2023, the Committee on the Status of Endangered Wildlife in Canada made an official assessment that was given to the federal government to list the Eastern Red Bat, Hoary Bat and Silver-haired Bat as Endangered under the federal Species at Risk Act. The federal environment minister (Environment and Climate Change Canada) must evaluate the recommendation by COSEWIC and determine if these bats will be listed as Endangered under the Canadian Species at Risk Act (SARA).


Hoary Bat (*Lasiurus cinereus*)


Silver-haired Bat (*Lasionycteris nocitvagans*)


Eastern Red Bat (*Lasiurus borealis*)

Habitat Types Used by Migratory Bats

All three of these migratory bats range widely across North America and are likely to be found across Ontario. All three are strongly associated with forested landscapes. Both the Hoary and Red Bat are solitary foliage-roosting species that roost high in the tree canopy from small twigs. They require tall trees with open spaces below their roost location where they can drop and fly. Silver-haired Bats roost in cavities and tree crevices in mature trees (usually trees have some sort of defect but may include both live and dead trees of various species). Hoary and Eastern Red bats commonly forage high above the treetops over forest, field and wetlands. They can easily fly up to twenty-five kilometres from the roost and back again over a night of hunting (Barclay 1985). Silver-haired Bats forage in open-air situations as well, but likely at treetop level and are often associated with riparian areas or over water.

Primary Threats to Migratory Bats

Wind energy represents the biggest threat to migratory bats. A summary of the threats identified by COSEWIC as part of their latest assessment of these bats is summarised in Table 9.

Table 9. Current status evaluation of the three "migratory" bat species in Canada (assessment May 2023, COSEWIC).

Bat Species	Reason for Designation as Endangered*
Eastern Red Bat	*"Although there is considerable uncertainty regarding exact rates of decline for these bats across Canada, declines in carcass counts at wind energy facilities suggest declines far in excess of 50% over three generations. The planned increase in wind power capacity will increase this threat but mitigation is possible. Additional threats include habitat loss and degradation, habitat change and pesticide use, and widespread declines in prey insect abundance."*
Hoary Bat	*"Seasonal migration exposes individuals to a variety of threats including a high risk of mortality at wind energy facilities. Although there is considerable uncertainty regarding the exact rates of decline for these bats across Canada, declines in carcass counts at wind energy facilities suggest declines far in excess of 50% over three generations. The planned increase in wind power capacity will increase this threat but mitigation is possible. Population viability modeling*

	estimates the probability of extinction is at least at the 20% threshold by 2050 (3 generations). Additional threats to this species include ongoing and widespread declines in insect abundance, loss of forested roosting and foraging habitat, and pollution."
Silver-haired Bat	*"Some individuals overwinter in British Columbia and southern Ontario; however, most migrate out of Canada annually. This seasonal migration exposes individuals to a variety of threats including risk of mortality at wind energy facilities. Although there is considerable uncertainty regarding the exact rates of decline for these bats across Canada, declines in carcass counts at wind energy facilities suggest declines far in excess of 50% over three generations. The planned increase in wind power capacity will increase this threat but mitigation is possible. Other threats to this species include ongoing and widespread declines in insect abundance, loss of forested roosting and foraging habitat, and pollution."*

*Text in italics and quotes is directly from: https://www.cosewic.ca/index.php/en-ca/assessment-process/detailed-version-may-2023.html This is a recent designation and these bat species are currently under review as potentially endangered species under the federal Species at Risk Act (SARA).

Mitigation for Wind Energy Projects

There are several mitigation strategies that can be implemented to reduce mortality rates of migratory bats at wind energy sites. Two of the primary strategies include:

1. **Use siting strategies to avoid conflict with migrating bats** (B.C. Ministry of Environment 2016b)**.** Avoid choosing project sites at sites with topographic features or locations known to be used by migratory bats.
    a. **Large water ways** (rivers, lake edges, smaller water ways that orient north-south, wetlands).
    b. **Large natural areas** (these may be zones where dark skies are prevalent and native insect populations are more productive).
    c. **Ridgelines, and mountain front slopes** (this topography can either direct or funnel bats, especially if they run in a north-south direction however note that hibernating species may also make significant movements between summer and winter habitat, and they may move in different directions than the long-distance migratory bats).
    d. The Saskatchewan Government currently recommends that wind energy proposals consider a set back of five kilometres from identified waterways and natural areas to protect migratory bats (Saskatchewan Ministry of Environment 2016).
2. **Curtailment of rotor speed** from 20 minutes before sunset to 30 minutes after sunrise.
    a. Rotor cut-in speed can be programmed to 6 m/s between dusk and dawn, or blades can be feathered (i.e., pitch angle of the blade is adjusted) resulting in the blades remaining idle at low wind speeds (Arnett et al. 2008, Baerwald et al. 2009), or low-speed idling can be implemented (Arnett et al. 2013). The intended result of these strategies is for the rotors to remain near motionless at low wind speeds. Research has indicated that

bats generally migrate when wind speeds are lower (Cryan and Brown 2007). Locking rotors in place or curtailing to limit rotor motion can substantially reduce bat mortality (50-89% reductions) (Baerwald et al. 2009, Arnett et al. 2011, Arnett et al. 2013) with potentially only a small drop in the overall annual energy output (<1%; Arnett et al. 2013, 0.42% Thurber et al. 2023) depending on the cut-in speed, the duration of the treatment, and the number of turbines included.

b. The period for applying curtailment should be based on bat fatality and activity data under advisement from a qualified bat biologist. When no data is available, use the active period in Canada (15th March to 15th October) from 20 minutes before sunset to 30 minutes past sunset (under conditions of low wind, no rain and warm ambient temperatures, i.e., >10C).

c. Smart curtailment may fine tune the conditions under which curtailment should be implemented (Hayes et al. 2023).

d. When mitigation does not reduce fatalities below set threshold levels, problem turbines or the entire array can be shut down 30 minutes before sunset to 30 minutes after sunrise for the entire bat migration period (B.C. Ministry of Environment 2016b).

Conclusions and Recommendations and Comments

The area acoustically sampled for bats had relatively high bat biodiversity and abundance. Endangered bat species, Little Brown Myotis and Tricolored Bat were both detected. The three migratory bat species (Hoary, Eastern Red and Silver-haired Bat) were all detected as well at relatively high numbers. These migratory bats have recently been assessed as endangered by COSEWIC and are being considered for protection under the Federal Species at Risk Act. The driving transect indicated that relatively high numbers of bats occur across the sampling area. There is excellent bat habitat in the area and with the relatively close proximity of known and potential hibernation sites (Figure 19) to good summer habitat, the area could represent a biodiversity hotspot for bats (Findley 1995).

Recommendations

1. Further acoustic sampling for bats in the area may help characterize various habitat types for bats. Remnant patches of older aged trees and original forest remain at a few sites. These locations could support endangered Northern Myotis but further, intense and targeted sampling would be required. In particular, there are remnant patches of older aged forest on the north end of the Meaford Tank range and along the Bayview Escarpment Natural area that could potentially provide suitable habitat for Northern Myotis. A survey of these areas (and any other remnant old forest in the area) is strongly recommended.
2. Characterization of habitat use and the bat community in the area will help with the development of habitat management plans. Ideally, creating contiguous areas of forest and connecting forest patches with forested riparian zones and other forested sites would help in the conservation of both Tricolored Bat and Northern Myotis populations. This type of management is recommended in the Ontario recovery plan for these bats (Humphrey and Fotherby 2019) and

this plan can be integrated with private land interests. In many cases, people with creeks, rivers or wetlands on their property are more than happy to leave these sites forested and would especially be empowered by information about the benefits of a community management plan for wildlife. Department of Defense properties can also be part of this larger management plan for the area. Habitat connectivity can only be achieved by incorporating the efforts of multiple partners.

3. Targeted monitoring for migratory bats would help identify if this area is especially important during fall migration. This information would be valuable in the potential scenario where wind energy developments are proposed for the site. Avoiding key fall movement areas is an important strategy for protection of these bats (Thurber et al. 2023).
4. Any large area developments in the area should consider how to avoid negative impacts to local bat populations. Avoiding the loss or degradation of summer roosting habitat (forested sites) and winter hibernation habitat (rock crevices and caves that are abundant in the Niagara Escarpment) should be a priority. Other threats such as artificial lighting at night (ALAN), degradation of drinking water sources, and loss of foraging habitats (such as insect-productive wetlands and seeps) also deserve consideration.
5. Promotion of bat-friendly building management practices should be encouraged for all sites that harbour bat colonies (e.g., www.albertabats.ca/resources "Managing Bats in Buildings").

Comments: Proposed Pumped Storage Reservoir

The incentive for this survey of bats in the area was in response to a proposal to build a large, pumped storage facility on top of the escarpment in the immediate area where bats were sampled in this study. While these comments do not represent a full assessment of the property and proposed development, there are a few comments that can be made about the potential impacts to bats from this kind of development.

- Habitat loss/degradation: loss of a large area of forest cover will remove potential summer maternity roosting habitat and foraging opportunities for some bat species.
- Artificial lighting at night (ALAN): most facilities of this kind have extensive lighting associated with it. ALAN can have negative impacts to some bat species, it can disrupt migration of both bats and birds and can fragment foraging habitat for bats such as Northern Myotis that are interior forest-using species.
- A reservoir is not bat habitat: typically, reservoirs have no vegetation margins, have fluctuating water levels, and fluctuating water temperatures. These characteristics fail to support diverse and productive aquatic insect communities. Aquatic emergent insects represent an important part of many bat diets, however the reservoir itself will likely not provide any such benefit to bats.
- Potential effects to the underlying escarpment and any hibernation habitat that may exist (in caves, cracks or crevices in the limestone rock). Removing overlying vegetation, blasting and digging the enormous basin for the reservoir could ultimately affect water drainage patterns. Limestone or karst deposits are sensitive to erosion by water and surface changes can significantly affect underground structures (B.C. Environment 2016c).

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Appendix 1. Settings output for the Song Meter MiniBat Detector

GUANO|Version:1.0

Firmware Version:3.4

Length:11.2

Make:Wildlife Acoustics, Inc.

Model:Song Meter Mini Bat

Samplerate:256000

Serial:SMU02443

Species Auto ID:LASCIN

SB|Classifier:northnortheastern US and southern Ontario

SB|Filter HP:5

SB|Region:Northeastern NA

SB|Species Auto ID:Laci

SB|Version:4.2.1

WA|Kaleidoscope|Auto ID:LASCIN

WA|Kaleidoscope|Classifier|Settings:{"min freq":14000,"max freq":120000,"min dur":0.002000,"max dur":0.050000,"cf max freq":0,"cf max bw":0,"min calls":3,"enhance":"off","sensitivity":"conservative","species":["EPTFUS","LASBOR","LASCIN","LASNOC","MYOLEI","MYOLUC","MYOSEP","PERSUB"]}

WA|Kaleidoscope|Classifier|Version:Bats of North America 5.4.0

WA|Kaleidoscope|Version:5.5.0

WA|Song Meter|Audio settings:{"rate":256000,"gain":12,"trig window":2.0,"trig max len":15.0,"trig min freq":16000,"trig max freq":128000,"trig min dur":0.0015,"trig max dur":0.0000}]

WA|Song Meter|Prefix:SMU02443

Appendix D-2

Preliminary Analysis - Dispersion of Contaminants

Preliminary Analysis of the Dispersion of 4 CDTC Contaminants

The construction and operation of the TCE project will perturb the contaminants from the 4CDTC military base. To understand the dynamics of this contaminant dispersion we need to consider:

1. Contaminant Types and Properties:
    - Heavy Metals: Often bind to sediments but can be disturbed by construction activities.
    - PFAS: Persistent in the environment, can dissolve in water and spread widely.
    - Benzene: Volatile and can disperse through air and water.
    - White Phosphorus: Reacts with water and oxygen, potentially harmful.
    - Asbestos: Fibers can be airborne and settle in water, posing health risks.

2. Dispersion Mechanisms:
    - Construction operations: Disturb the ground and water of the Bay, releasing contaminants.
    - Water Currents: Spread contaminants horizontally and vertically in the water column.
    - Stormwater Runoff: Washes disturbed contaminants into the Bay.
    - Sedimentation: Heavy particles settle to the bottom, while lighter ones remain suspended.
    - Atmospheric Deposition: Airborne particles eventually settle onto the water surface.
    - Biological Uptake: Contaminants absorbed by aquatic organisms can move through the food chain.

3. Environmental Factors:
    - Storms and Winds: Agitate the water, increasing dispersion and resuspension of sediments.
    - Fish and Other Aquatic Life: Can uptake and bioaccumulate contaminants, spreading them through movement and feeding.

Dr. Moe Qureshi, Ph.D
Director of Climate Policy and Research
Conservation Council of New Brunswick

Report requested by Save Georgian Bay, 2024