CARLTON COUNTY LAND DEPARTMENT
FOREST BAT SURVEY REPORT
CARLTON COUNTY, MINNESOTA

July 6 – August 24, 2016

Prepared for:

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF APPENDICES

INTRODUCTION

Carlton County Land Department (CCLD) contracted Western EcoSystems Technology, Inc. (WEST) to conduct acoustic and mist-net surveys for bats using two different pine plantation stands within Carlton County, Minnesota as summer habitat. The principle objective of summer bat surveys was to learn about bat activity and habitat, especially the federally threatened northern long-eared bat (*Myotis septentrionalis*; NLEB), within different pine plantation stands on Carlton County land at two different times during the maternity season (May 15 to August 15; survey site 1: July 6 – 8; survey site 2: August 23 – 24, 2016). The stand locations were selected by CCLD as areas of high interest for NLEB and general bat activity (Figures 1 – 4).

The pine plantation stands are located in Carlton County in east-central Minnesota within the Northern Lakes and Forests Ecoregion Level III Ecoregion (Figure 1). The Northern Lakes and Forests Ecoregion, is a rolling landscape of woods, wetlands, pasture, and crops that extends into northern Minnesota, northern Wisconsin, and northern Michigan (Omernik et al. 2000). Land cover in the Ecoregion is characterized by nutrient poor glacial soils and coniferous and northern hardwood forests, with lakes distributed throughout the region.

Based on consultations with CCLD, WEST sampled two pine plantation sites within Carlton County for bat activity. At each survey site acoustic stations and mist-net survey stations were sampled, and radio-telemetry was conducted on three bats (Appendix A). The following report summarizes the results of acoustic, mist-net, and radio-telemetry surveys conducted during the summer 2016.

Overview of Bat Diversity

There are seven species of bats are found in Minnesota. Those species include: the big brown bat (*Eptesicus fuscus*), silver-haired bat (*Lasionycteris noctivagans*), eastern red bat (*Lasiurus borealis*), hoary bat (*Lasiurus cinereus*), little brown bat (*M. lucifugus*), northern long-eared bat (*M. septentrionalis*), and tri-colored bat (*Perimyotis subflavus*). Of the seven species with the potential to occur in Minnesota, one (NLEB) is federally listed as threatened under the Endangered Species Act [ESA]. The NLEB, big brown bat, little brown bat and tri-colored bat are all considered Minnesota species of special concern (MN-DNR 2013).

METHODS

Acoustic Surveys

WEST conducted acoustic surveys following guidance in the *2016 Range-wide Indiana Bat Summer Survey Guidelines* (USFWS 2016a), which is also used for NLEB presence/probable absence surveys, and the *Northern Long-Eared Bat Interim Conference and Planning Guidance* (USFWS 2014). Bats were surveyed using full-spectrum SM3BAT™ ultrasonic detectors (SM3; Wildlife Acoustics, Inc., Maynard, Massachusetts). Acoustic monitoring began before sunset and continued for the entire night. Survey duration at each site was a minimum of eight detector

nights (four detectors for two nights each). If weather conditions, such as persistent rain (more than 30 minutes), strong winds (greater than nine miles per hour [mph; 14 kilometers per hour (kph)] for more than 30 minutes), or persistent cold temperatures (below 10 degrees Celsius [°C; 50 degrees Fahrenheit (°F)] for more than 30 minutes), occurred during the first five hours of a survey night, then that site was surveyed for an additional night (USFWS 2015). Weather conditions were checked with the following weather stations, which can be found on Weather Underground's Wundermap (http://www.wunderground.com/wundermap/): Carlton, MN. To maximize the quality of recorded echolocation calls, WEST positioned the detector microphones at least 3 meters (m; 10.0 feet [ft]) off the ground and 3 m (10.0 ft) from vegetation (Britzke et al. 2010; USFWS 2014, 2016).

WEST quantitatively identified bat calls using automated acoustic identification software, Kaleidoscope (version 4.0.0; Bats of North America classifier version 3.1.0; Wildlife Acoustics, Maynard, Massachusetts). While using Kaleidoscope, WEST selected the appropriate state (Minnesota) from the Bats of North America classifier (version 3.1.0), and the most sensitive (i.e., most liberal) setting was used. If a night exceeded the maximum likelihood threshold (p-value < 0.05) for NLEB presence, all files from that night received qualitative review were verified via qualitative call analysis by a biologist experienced with acoustic identification (Dr. Kevin Murray) and who met required USFWS qualifications (USFWS 2016a). If call sequences were not characteristic of NLEB bats, contained distinct calls produced by species other than NLEB bats, or were of insufficient quality, WEST reclassified the call sequences as another species or as unknown. NLEB were considered present at sites were probable NLEB calls were verified by qualitative review. NLEB were considered likely absent from sites with no probable NLEB bat calls or from sites with possible NLEB bat calls that were overruled by qualitative analysis.

Mist-Net Surveys

Mist-net surveys were conducted following guidance in the *2016 Range-Wide Indiana Bat Summer Survey Guidelines* (USFWS 2016). WEST conducted mist-net surveys between June 12 and August 24. Standard two-ply, 75 denier, polyester mist-nets with a mesh size of 38 millimeters (1.30 inches) were used at all mist-net sites. WEST began mist-netting at sunset and continued for at least five hours; nets were checked every 10 minutes. Net locations were typically established at least 30 m (98.4 ft) apart within each mist-net site whenever possible. Disturbance in the form of noise and movement were minimized at all net locations. WEST surveyed two to three mist-net locations per site for two nights for a total of net nights between the two net sites. Specific mist-net sites were determined by on-site by permitted bat biologists with NLEB research experience. If weather conditions, such as persistent rain (more than 30 minutes), strong winds (greater than nine mph for more than 30 minutes), or cold temperature (below 10 °C for more than 30 minutes) occurred during the netting period, then those net nights were re-surveyed. All mist-net surveys were performed by staff permitted by USFWS (Permit # TE234121-8) and Minnesota Department of Natural Resources: #19614) to capture and handle NLEB.

For each mist-net night the date, start and end time, site description, site coordinates, mist-net specifics, and weather data (temperature, cloud cover, wind speed, precipitation, and moon

phase) were recorded. WEST identified all captured bats to species. WEST also recorded the sex, age, reproductive condition, body mass (grams), forearm length (millimeters), and capture status (recapture/new) of each captured bat. To assess exposure to White-Nose Syndrome (WNS), a Reichard Index score (0-3) was recorded for all captured bats. To prevent cross contamination of captured bats with *Pseudogymnoascus destructans*, the fungus that causes WNS, WEST followed the USFWS WNS decontamination protocols for all mist-netting efforts (see White-Nose Syndrome.org 2016). Captured bats were measured and processed immediately and were usually released within 30 minutes. Species of bats captured were photo-documented. If any NLEB or little brown bats were captured, WEST took voucher photographs of species-specific identifiable features (e.g. head, body, calcar, foot, toe hairs etc.). Numbered metal forearm bands were attached to any captured NLEB.

Telemetry and Emergence Surveys

Telemetry surveys were conducted on NLEB and little brown bats (*Myotis lucifugus*; MYLU) at two stand locations, to determine how bats were utilizing areas in or near CCLD land as roost sites. Transmitters were only attached to adult females or juveniles. Adult males were not tracked, and no other bat species were tracked. Bats were outfitted with a radio-transmitter (model AG337; Lotek Wireless, Ontario, Canada) and tracked for up to five days or until the transmitter signal is lost. Transmitter signals were considered lost when no signal was detected for two or more days. For each roost tree, photographs, Global Positioning System (GPS) coordinates, roost type (e.g. tree, building), tree species, tree type (live, snag), tree diameter at breast height (DBH), approximate roost height, and roost location (cavity, crevice, bark) were recorded.

WEST conducted emergence counts at all documented maternity roost trees following USFWS guidelines (USFWS 2016). Emergence surveys began 30 minutes before sunset and continued for at least 60 minutes after sunset or until it was too dark to continue surveys. Emergence surveys were not conducted when: a) temperatures were below 50°F (10°C), b) precipitation (rain or fog) persisted for > 30 minutes, or c) average wind speed was > 9 mph (4 meters/second [m/sec]; 3 on Beaufort scale) and sustained for > 30 minutes during the emergence count survey period. For each emergence survey date, start and end time, roost name, number of bats exiting, and general weather conditions (temperature, precipitation, wind speed) were recorded. Two exit counts were performed on documented roost trees to determine the number of bats in the roost and to confirm the specific roost type and location.

RESULTS

Acoustic Surveys

WEST conducted acoustic surveys between July 6 and August 24, 2016. Surveys at site CC-1 were conducted from July 6 – 8 and, site CC-2 from August 23 – 24. Universal Transverse Mercator (UTM) coordinates and brief site descriptions for each site are listed in Table 1. Maps and photographs of acoustic survey sites are included in Appendices A and B, respectively.

Acoustic surveys were completed at two sites for a total of 20 detector nights. Some survey sites were surveyed for longer than the proposed two detector nights due to inclement weather. The number of bat calls per detector night varied between the survey sites (26.3 to 144.3 bat calls per detector night), with an average of 67.6 bat calls per detector night within the 2 survey sites in Carlton County (Table 2). Kaleidoscope identified 1,450 bat call files and identified 1,443 call files to species (99.5%; Tables 2 and 3).

Automated acoustic ID software identified potential NLEB calls at both surveyed stand locations and at all eight detector locations (Table 3). There were 9 nights at 5 of the survey locations with significant maximum likelihood threshold values (p-value < 0.05) out of a total of 20 survey nights (Table 4). Qualitative analysis of these significant nights determined that there were 126 confirmed NLEB calls. Only site CC-1 had confirmed calls present at a minimum of one survey location (Table 4). The night of July 8 at survey location CC1-4 had the most confirmed calls (66 confirmed NLEB calls), followed by the night of July 6 at the same survey location (CC1-4; 24 confirmed NLEB calls), then July 8 at survey location CC1-3 (20 confirmed NLEB calls; Table 4).

Mist-Net Surveys

Mist-nest surveys were completed at two sites between July 6 and August 24, 2016 for a total of 10 net nights (Table 5). Surveys at site CC-1 were conducted from July 6 – 8, and site CC-2 from August 23 – 24, 2016. Maps and pictures of mist-net sites are included in Appendices A and C, respectively. A total of 23 bats at two sites were captured, including 1 NLEB, 1 big brown bat, 19 little brown bats, and 2 silver-haired bats (Table 6). Three of the captured bats inspected for WNS exhibited signs of damage on the wings from WNS. Photos of captured bat species are included in Appendix D, and capture details for all bats can be found in Appendix F.

Radio-telemetry Surveys

One NLEB and two MYLU were radio-tracked to determine where day roosts were located and to determine if maternity colonies were present. Three MYSE roost trees were located during surveys (Table 7, Appendix A). Two MYLU roost trees were documented during surveys (Table 7, Appendix A), and emergence counts were completed at all located roosts trees (Table 7). A maximum of 55 bats exited one tree at one count, while the next night 41 bats emerged; zero to twenty-nine bats exited trees on all other counts (Table 7). Characteristics of the roost trees and results of the emergence counts are included in Table 7, while photographs of the roost trees are included in Appendix E.

CONCLUSION

To meet the objectives of the study, acoustic, mist-net and radio-telemetry surveys were conducted simultaneously to determine relative bat activity within two different pine plantation forest stands within Carlton County at two different times during the maternity season. In addition to relative bat activity, presence of northern long-eared bats was of interest within the

managed forest stands. Based on the acoustic and mist-net results, it was determined that there was summer presence of NLEB at one of the surveyed forest stands within Carlton County, Minnesota. While radio-telemetry surveys showed that NLEB and little brown bats are using varied species and tree types as roosts within Carlton County.

The results of the 2016 Carlton County summer bat surveys were relatively similar to the survey results of summer bat surveys taken place in Carlton County in 2015. In 2015, there was an average of 74.5 bat calls per detector night and in 2016 there was an average of 67.6 bat calls per detector night. In the 2015 summer surveys, there were a total of 21 bats captured at the same two pine plantation stands, while in 2016, 23 total bats were captured. However a total of 9 NLEB were captured in 2015, while in 2016 mist-net surveys, only a single NLEB was captured. In 2016, survey site CC-2 did not have any confirmed recordings or captures of NLEB, while in 2015, three of five sampled survey locations had confirmed NLEB calls. Summer surveys typically occur between May 15 and August 15, while CC-2 was surveyed from August 23 – 24. Sampling in late August may be the primary factor in the lack of NLEB presence within site CC-2. Surveys conducted during the height of the maternity season may show that NLEB are still present within this pine plantation. Two survey locations were used in Carlton County in 2016 bat surveys. Three of the five mist-net sites in Aitkin County captured a similar amount of bats to the two sites in Carlton County, while the other two sites in Aitkin County had less bat captures. A total of 23 bats were captured in Carlton County, while 38 were captured in Aitkin County with the same species being captured in both surveys.

All survey efforts within Carlton County resulted in NLEB being recorded, captured, and roosts located in 2016. The 2016 summer surveys show the presence of native bat species and their roost trees, including NLEB, within two pine plantation forest stands.

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TABLES

Table 1. Location and site description of 2016 bat acoustic survey sites within Carlton County, Minnesota.

Site ID	Detector	UTM Zone	Easting	Northing	Site Description
CC-1	1	15	504020	5165768	forest corridor
	2	15	503964	5165492	forest corridor
	3	15	503158	5165613	forest opening along bog
	4	15	503244	5165397	forest corridor
CC-2	1	15	526216	5165079	forest corridor
	2	15	526202	5164828	forest opening along trail
	3	15	525712	5165017	forest corridor
	4	15	525789	5164809	forest corridor

Table 2. Number of bat calls identified by Kaleidoscope during 2016 bat acoustic surveys within Carlton County, Minnesota.

Survey Site	Detector	Total Bat Calls	Calls Identified	Detector-Nights	Bat Calls/ Detector-Night
CC-1	1	79	79	3	26.3
CC-1	2	368	368	3	122.7
CC-1	3	224	222	3	74.7
CC-1	4	433	429	3	144.3
CC-2	1	57	57	2	28.5
CC-2	2	129	129	2	64.5
CC-2	3	54	53	2	27.0
CC-2	4	106	106	2	53.0

Table 3. Species identified by Kaleidoscope during 2016 bat acoustic surveys within Carlton County, Minnesota.
EPFU=Big Brown Bat; LANO=Silver-haired Bat; LABO=Eastern Red Bat; LACI=Hoary Bat;; MYLU=Little Brown Bat; NLEB=Northern Long-eared Bat; PESU=Tri-colored Bat; UNK=Unknown.

Site ID	Detector	EPFU	LANO	LABO	LACI	MYLU	NLEB	PESU	UNK	Total
CC-1	1	2	11	20	3	34	**9**	0	0	79
CC-1	2	25	20	107	12	193	11	0	0	368
CC-1	3	11	33	72	7	45	54	0	2	224
CC-1	4	8	13	32	3	231	142	0	4	433
CC-2	1	5	16	17	4	12	3	0	0	57
CC-2	2	21	35	35	0	33	4	1	0	129
CC-2	3	4	24	2	7	14	2	0	1	54
CC-2	4	5	29	16	3	49	4	0	0	106

Table 4. Number of recorded NLEB calls identified by Kaleidoscope and calls confirmed by qualitative analysis during nights that had significant maximum likelihood threshold values (p-value < 0.05) during 2016 bat acoustic surveys within Carlton County, Minnesota.

Survey Site	Night	Kaleidoscope NLEB Calls	Qualitative NLEB Calls
CC1-A1	July 8	8	6
CC1-A3	July 6	19	4
CC1-A3	July 7	11	2
CC1-A3	July 8	24	20
CC1-A4	July 6	46	24
CC1-A4	July 7	16	4
CC1-A4	July 8	80	66
CC2-A1	August 23	2	0
CC2-A2	August 24	3	0

Table 5. Location and site description of mist-net sites for the 2016 bat mist net surveys within Carlton County, Minnesota.

Site ID	Net	UTM Zone	Easting	Northing	Site Description
CC-1	A	15	503796	5165475	forest corridor
	B	15	503675	5165464	forest corridor
	C	15	503558	5165442	forest corridor
CC-2	A	15	526053	5164966	forest corridor
	B	15	526037	5165089	forest corridor

Table 6. Summary of bat captures at mist-net sites for 2016 bat surveys within Carlton County, Minnesota.

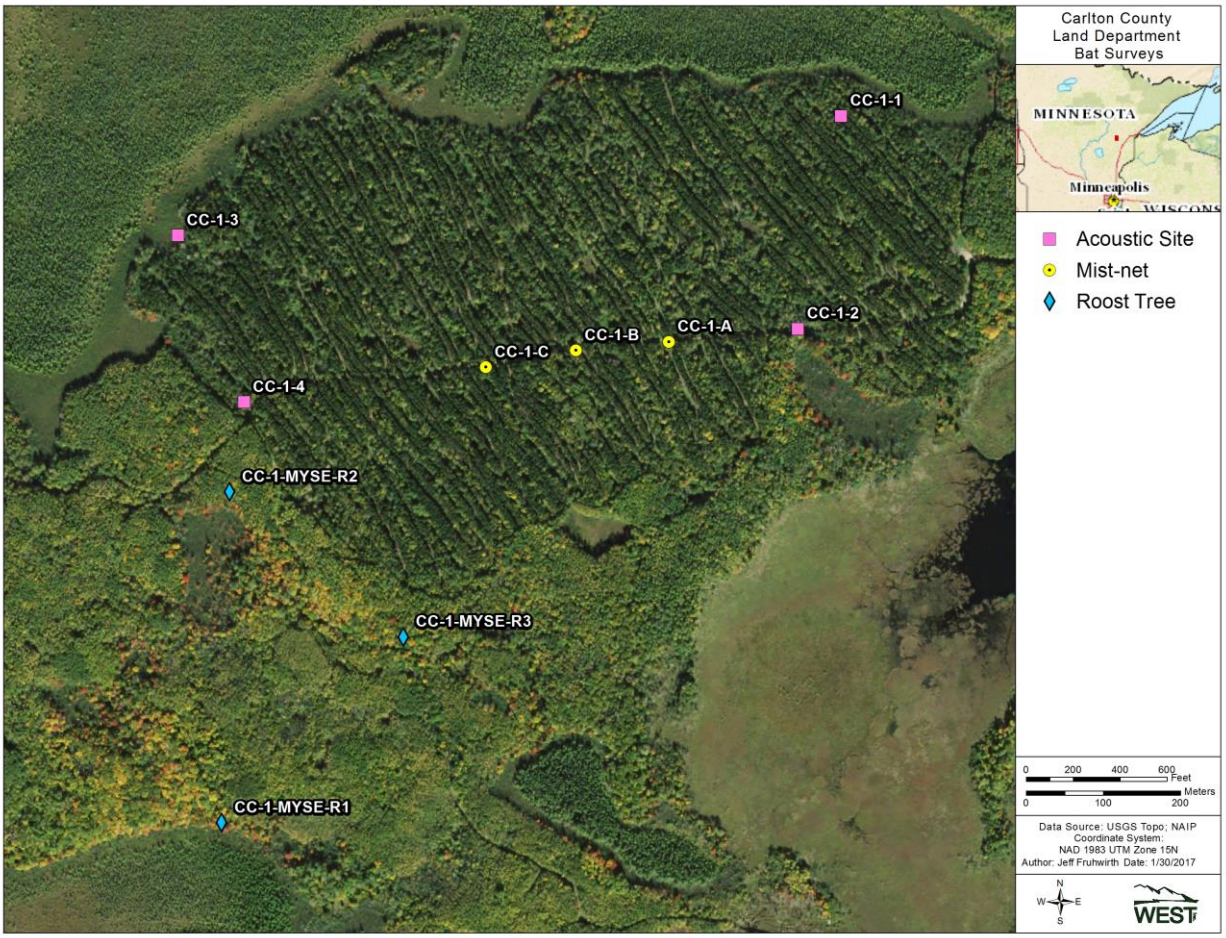
Site	Big Brown Bat	Eastern Red Bat	Silver-Haired Bat	Little Brown Bat	Northern Long-Eared Bat	Unknown	Total
CC-1	1	0	1	12	1	0	15
CC-2	0	0	1	7	0	0	8
Total	**1**	**0**	**2**	**19**	**1**	**0**	**23**

Table 7. Locations and characteristics of roost trees documented for 2016 bat surveys within Carlton County, Minnesota.

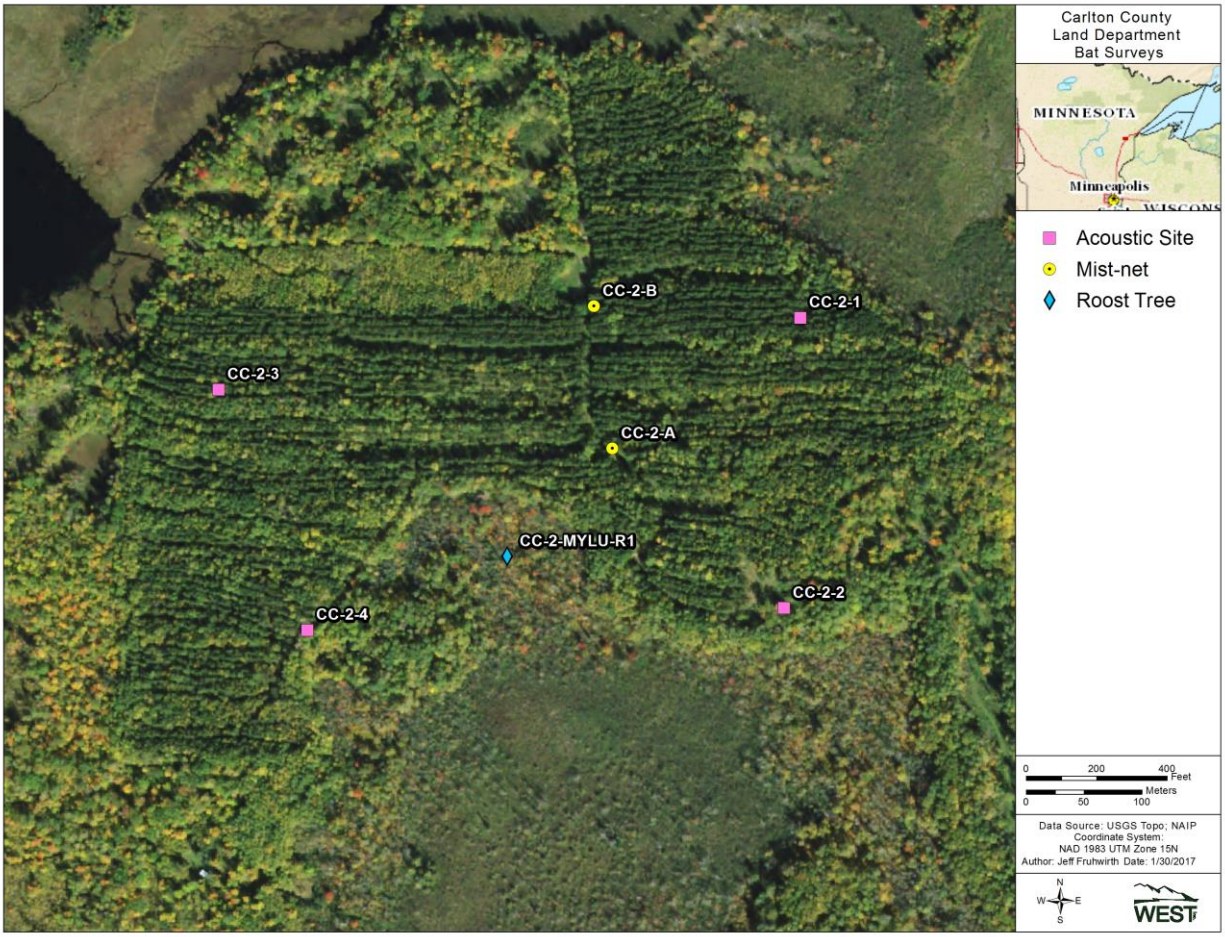
Tree ID	Bat Species	UTM	Species	Type	Height (m)	DBH (cm)	Exit Count 1	Exit Count 2
CC-1-MYSE-R1	NLEB	503215 5164852	*Acer saccharinum*	Live	7	38	0	0
CC-1-MYSE-R2	NLEB	503225 5165281	*Acer saccharinum*	Live	13	24	55	41
CC-1-MYSE-R3	NLEB	503451 5165093	*Acer saccharinum*	Live	19	22.8	29	0
CC-2-MYLU-R1	MYLU	525962 5164873	*Tilia Americana*	Live	15	92	1	NA

***UTM Zone 15, North American Datum 1983**

Appendix A. Carlton County Land Department Project Maps and Locations of Bat Surveys



Appendix A1. Aerial view of mist-net and acoustic sites used for bat surveys at Site 1 at the Carlton County Land Department Project.



Appendix A2. Aerial view of mist-net and acoustic sites used for bat surveys at Site 2 at the Carlton County Land Department Project.

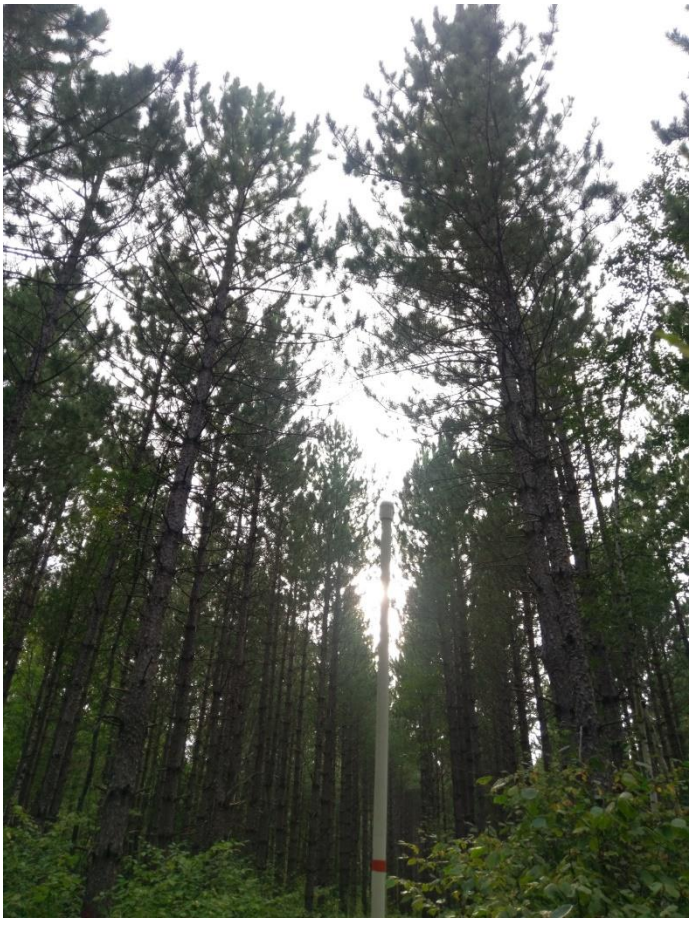
Appendix B. Photographs of Acoustic Survey Sites

Appendix B1. Acoustic survey site CC-1 detector 1.

Appendix B1. Acoustic survey site CC-1 detector 2.

Appendix B1. Acoustic survey site CC-1 detector 3.

Appendix B1. Acoustic survey site CC-1 detector 4.



Appendix B2. Acoustic survey site CC-2 detector 1.

Appendix B2. Acoustic survey site CC-2 detector 2.

Appendix B2. Acoustic survey site CC-2 detector 3.

Appendix B2. Acoustic survey site CC-2 detector 4.

Appendix C. Photographs of Mist-Net Survey Sites

Appendix C1. Bat habitat surveyed by mist-nets at site CC-1 net A.

Appendix C2. Bat habitat surveyed by mist-nets at site CC-1 net B.

Appendix C3. Bat habitat surveyed by mist-nets at site CC-1 net C.

Appendix C4. Bat habitat surveyed by mist-nets at site CC-2, net A.

Appendix C5. Bat habitat surveyed by mist-nets at site CC-2, net B.

Appendix D. Photographs of Captured Bats

Appendix D1. Photos of little brown bats captured at mist-net site CC-1.

Appendix D2. Photos of silver-haired bat captured at mist-net site CC-2.

Appendix D3. Photos of northern long-eared bat captured at CC-1

Appendix D4. Photos of little brown bat captured at CC-1

Appendix D5. Photos of silver-haired bat captured at CC-1

Appendix D6. Photo of big brown bat captured at CC-1.

Appendix E. Photographs of Roost Trees

Appendix E1. Photos of a CC-2-MYLU-R1 little brown bat roost .

Appendix F. Summary of Mist-Net Captures

Appendix F1. Details of bats captured at mist-net site CC-1; July 6 – 8, 2016.

Species	Sex	Age	Reproductive Status	Reichard Score	Weight (g)	Forearm Length (mm)
			July 6			
Big brown bat	Male	Adult	Non-reproductive	0	22.8	48.7
Little brown bat	Male	Adult	Non-reproductive	1	9.5	38.0
Little brown bat	Male	Adult	Non-reproductive	0	9.0	39.6
Little brown bat	Female	Adult	Lactating	0	9.5	39.2
Little brown bat	Male	Adult	Non-reproductive	0	8.5	36.4
Northern long-eared bat	Female	Adult	Lactating	0	7.3	8.5
			July 8			
Little brown bat	Female	Adult	Pregnant	0	10.5	38.0
Little brown bat	Female	Adult	Pregnant	0	10.5	39.8
Little brown bat	Male	Adult	Non-reproductive	0	9.0	38.3
Little brown bat	Male	Adult	Non-reproductive	0	8.7	37.5
Silver-haired bat	Male	Adult	Non-reproductive	0	12.0	40.5
Little brown bat	Male	Adult	Non-reproductive	0	9.0	37.9
Little brown bat	Male	Adult	Non-reproductive	0	8.5	36.9
Little brown bat	Male	Adult	Non-reproductive	1	8.5	39.3
Little brown bat	Male	Adult	Non-reproductive	1	8.5	38.1

---- = escaped from net or bag before identification and measurements

Appendix F2. Details of bats captured at mist-net site CC-2; August 23 and 24, 2016.

Species	Sex	Age	Reproductive Status	Reichard Score	Weight (g)	Forearm Length (mm)
			August 23			
Little brown bat	Male	Adult	Reproductive	0	11.0	39.2
Little brown bat	Male	Adult	Non-reproductive	0	10.8	37.5
Little brown bat	Female	Juvenile	Non-reproductive	0	9.3	39.6
Little brown bat	Male	Adult	Reproductive	0	9.8	36.9
Little brown bat	Female	Juvenile	Non-reproductive	0	7.5	39.6
			August 24			
Silver-haired bat	Male	Juvenile	Non-reproductive	0	11.0	40.4
Little brown bat	Female	Adult	Post-lactating	0	10.5	39.3
Little brown bat	Male	Juvenile	Non-reproductive	0	7.0	37.9

---- = escaped before measurements were complete