

Summary of Bat Research in Cedar Creek Ecosystem Science Reserve, MN 2016



Morgan Swingen¹, Ron Moen^{1,2}, and Richard Baker³

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Author Information:

¹Land, Water and Environment, Natural Resources Research Institute, University of Minnesota Duluth, Duluth, MN

²Biology Department, Swenson College of Science and Engineering, University of Minnesota Duluth, Duluth, MN

³Division of Ecological and Water Resources, Minnesota Department of Natural Resources, St. Paul, MN

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Summary

Crews from the University of Minnesota – Natural Resources Research Institute captured 18 bats in Cedar Creek Ecological Science Reserve from July 6th – July 8th, 2016. Bats of three species were captured during mist-netting surveys. We captured 10 individuals of our target species, the northern long-eared bat, and attached radio-transmitters to eight reproductive adult females. These eight bats were tracked to 27 unique roost trees of at least eight different species over eight days. During emergence counts we counted from 2 to 49 bats emerging from these roost trees. Roost trees varied in both DBH and height as well as decay stage. The roosting patterns we observed at Cedar Creek ESR were similar to roosting patterns we have observed in other areas of Minnesota, where bats appear to be using a variety of available trees. This report details work done Cedar Creek Ecosystem Science Reserve as part of a statewide study of northern long-eared bats. A report summarizing results of the statewide project will be available in early 2017.

Introduction

Bats are a critical component of Minnesota's ecosystems. A single bat may eat 1000 insects per hour, and the state's bats likely provide many millions of dollars in pest control each year (Boyles et al. 2011). Seven species of bats are known residents of Minnesota: little brown bats (*Myotis lucifugus*, MYLU), northern long-eared bats (*Myotis septentrionalis*, MYSE), big brown bats (*Eptesicus fuscus*, EPFU), tricolored bats (*Perimyotis subflavus*, PESU), silver-haired bats (*Lasionycteris noctivagans*, LANO), eastern red bats (*Lasiurus borealis*, LABO), and hoary bats (*Lasiurus cinereus*, LACI).

There are four Minnesota bat species (northern long-eared bat, tricolored bat, little brown bat, and big brown bat) that hibernate in caves during the winter, and then disperse widely across the state in spring, summer, and fall. Very little is known about the summer habitat use of these species. These four cave-hibernating bats are all Species of Special Concern in Minnesota.

The U.S. Fish and Wildlife Service listed the northern long-eared bat as Threatened under the federal Endangered Species Act in April 2015, largely due to the impact of white-nose syndrome on bat populations (U.S. Fish and Wildlife Service 2016). White-Nose Syndrome (WNS) is caused by the fungus *Pseudogymnoascus destructans* which leads to increased winter activity and extremely high mortality rates of cave-hibernating bats (Frick et al. 2010). WNS has been moving through bat populations in the eastern states and provinces, with range expansions of WNS occurring every year (Turner et al. 2011). *P. destructans* was detected in Minnesota in 2013, and bat mortalities from WNS were first recorded during January 2016 at Lake Vermilion - Soudan Underground Mine State Park, near Soudan, MN (Minnesota Department of Natural Resources 2013, 2016a).

Maintaining reproductive success will be critical to the viability of Minnesota's bat populations as WNS spreads in Minnesota. Obtaining knowledge about maternity roosts before a population decline occurs will be critical for future efforts to reduce negative impacts of forest management and provide high quality habitat to support recovery of bat populations. Even if mortality rates can be reduced, there is still likely to be a drastic reduction in bat populations. Implementing management strategies that minimize mortality will be important as WNS continues to affect Minnesota bats.

In 2015, the Minnesota legislature approved \$1.25 million in Environment and Natural Resources Trust Fund (ENRTF) funding for the project *Endangered Bats, White-Nose Syndrome, and Forest Habitat*, the goal of which is to collect data on the distribution and habitat use of the northern long-eared bat in Minnesota. This project is being conducted by the MN Department of Natural Resources (MNDNR), the University of Minnesota Duluth – Natural Resources Research Institute (NRRI), and the USDA-Forest Service (USFS). Data for this project are being collected from across the state during 2015–2017. Data from year 1 of this project were summarized in a report released in the fall of 2015 (Swingen et al. 2015). Cedar Creek Ecosystem Science Reserve (CCESR) served as one of 15 study sites for this project during 2016, with personnel from UMD-NRRI mist-netting bats and conducting radio-telemetry and roost tree characterization.

Methods

Bat Capture/Processing

Fine mesh mist-nets (Avinet Inc., Dryden, NY, USA) were set up along forested roads that could act as travel corridors for bats. Each night, 2–4 mist-nets were set up within 200 m of a central processing location. Mist-nets were opened after sunset, and checked every 15 minutes for 2–5 hours, depending on capture rates and weather conditions. Captured bats were placed in cloth bags until processing.

Figure 1. Photos showing the techniques for capturing and processing bats. Photo Credits: A – Superior National Forest; B, D – Brian Houck, NRRI; C – Peter Kienzler, NRRI.

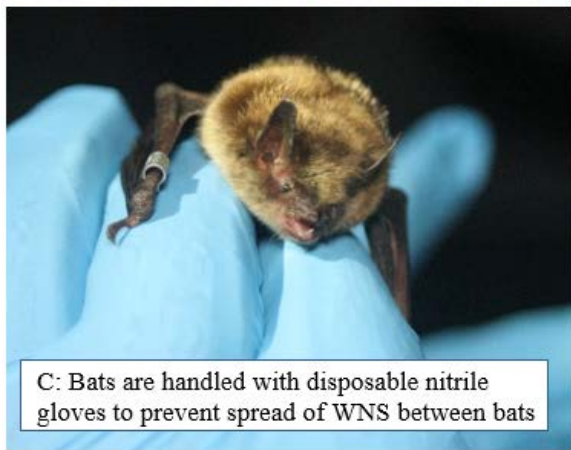
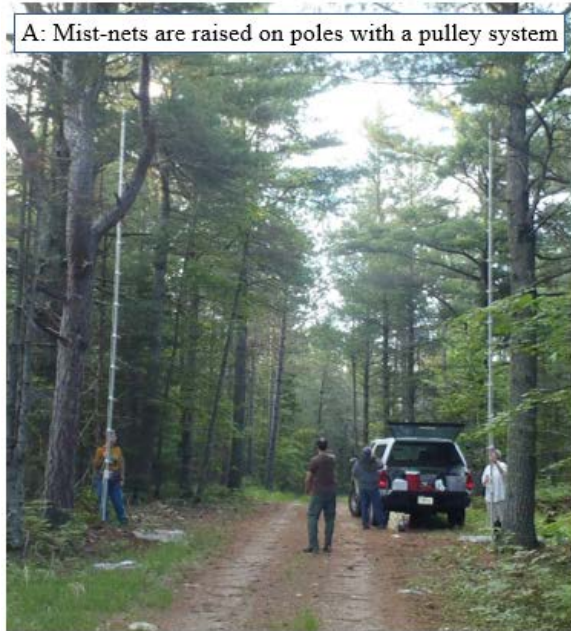
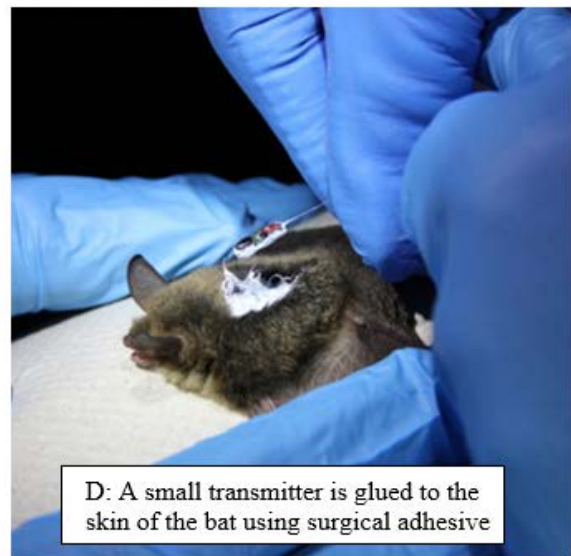
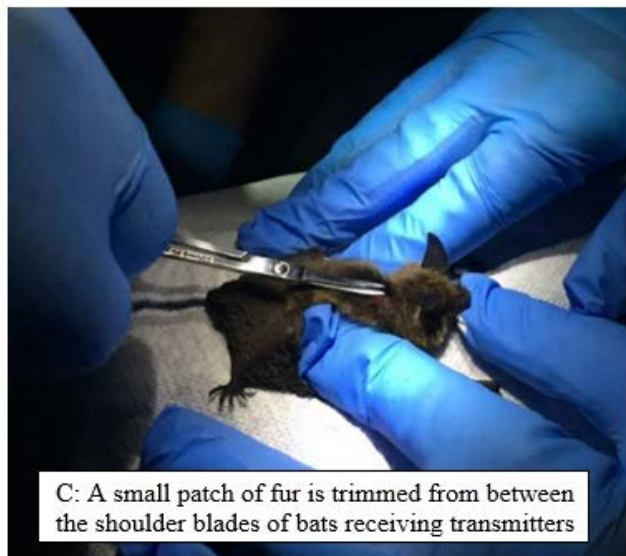


Figure 2. Photos showing techniques for processing bats and attaching bands and transmitters. Photo Credits: A – Christi Spak, MN DNR; B – Ryan Pennesi, USFS; C – Sarah Baker, NRRI; D – Morgan Swingen, NRRI.



We identified each captured bat to species by morphology, and determined sex, age, and reproductive condition by physical examination. Each captured bat was weighed and measured, and the wings were inspected for damage potentially caused by WNS (Fig. 1, Fig. 2). Each bat was then fitted with an individually-numbered lipped aluminum wing band (Porzana Ltd., Icklesham, United Kingdom).

Radio-transmitters (A2414 Advanced Telemetry Systems Inc., Isanti, MN, USA; or LB-2X, Holohil Systems Ltd., Carp, ON, Canada) were attached to reproductive adult female MYSE. We trimmed a small section of hair in the center of the back, and attached the transmitter to the skin using surgical adhesive (Perma-Type, Permatype Company Inc., Plainville, CT, USA, Fig. 2). Bats were released at the capture site after processing

Tracking/Roost Tree Characterization

Bats with radio-transmitters were tracked to their roosts each day until the transmitter failed or the transmitter fell off. Data recorded at each roost included roost type, tree species, and decay stage. At dusk, crews returned to the roost trees to conduct emergence surveys. During an emergence survey, personnel watched the roost tree from 30 minutes before sunset to 1 hour after sunset. During the emergence survey we recorded the number of bats emerging in each 10-minute interval, the location of the exit point, and whether or not the bat with the transmitter left the tree.

At a later point, crews returned to each roost tree to conduct a more detailed tree characterization. This included measuring roost diameter at breast height (DBH), tree height, decay stage, canopy closure, slope, aspect, and recording details about the vegetation surrounding the roost tree. All trees were marked with a numbered aluminum tree tag with the text “NLEB” (for Northern Long-Eared Bat) stamped on the tag (Fig. 3).

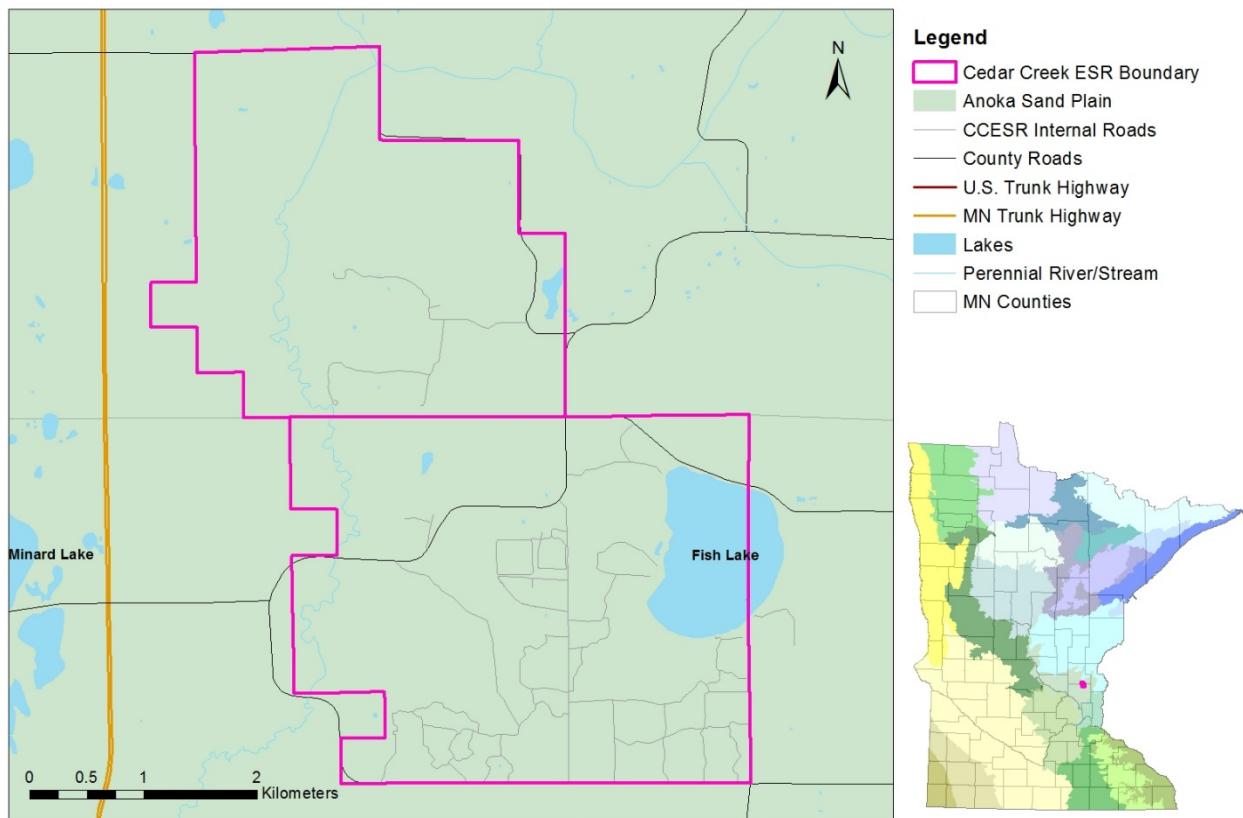
Figure 3. Photo of the type of aluminum tree tags used to permanently mark northern long-eared bat roost trees in Cedar Creek Ecosystem Science Reserve, July 2016.



Study Area

Bats were captured for the large-scale study at 15 locations around the state of Minnesota in 2016, including Cedar Creek Ecosystem Science Reserve (ESR). The Cedar Creek ESR is an ecological research facility managed by the University of Minnesota which covers over 5400 acres in Anoka and Isanti Counties. It contains a variety of plant communities including upland pine forests, oak savannas, and lowland swamps and bogs (Fig. 4).

Figure 4. Map showing the Ecological Subsections overlapped by Cedar Creek Ecosystem Science Reserve in Isanti and Anoka Counties in Minnesota.



Results

Mist-Netting

We mist-netted bats at three sites in the Cedar Creek ESR on the nights of July 6th, 7th, and 8th, 2016 (Fig. 5). We captured and processed 18 bats of three species over a total of 21 net-hours (Table 1). All of the captured bats were adults. Of the 15 females captured, 14 were lactating at the time of capture, and one was non-reproductive. Six of the 18 bats captured showed some evidence of wing damage consistent with WNS infection, but none of the damage appeared severe.

Figure 5. Map of bat mist-netting sites at Cedar Creek ESR, July 6th – 8th, 2016. The pie chart at each net site indicates the proportion of species captured at that site, and the size of the pie chart represents the total number of bats captured at that site relative to other sites.

Cedar Creek Ecosystem Science Reserve - 2016 Bat Mist-Netting Sites

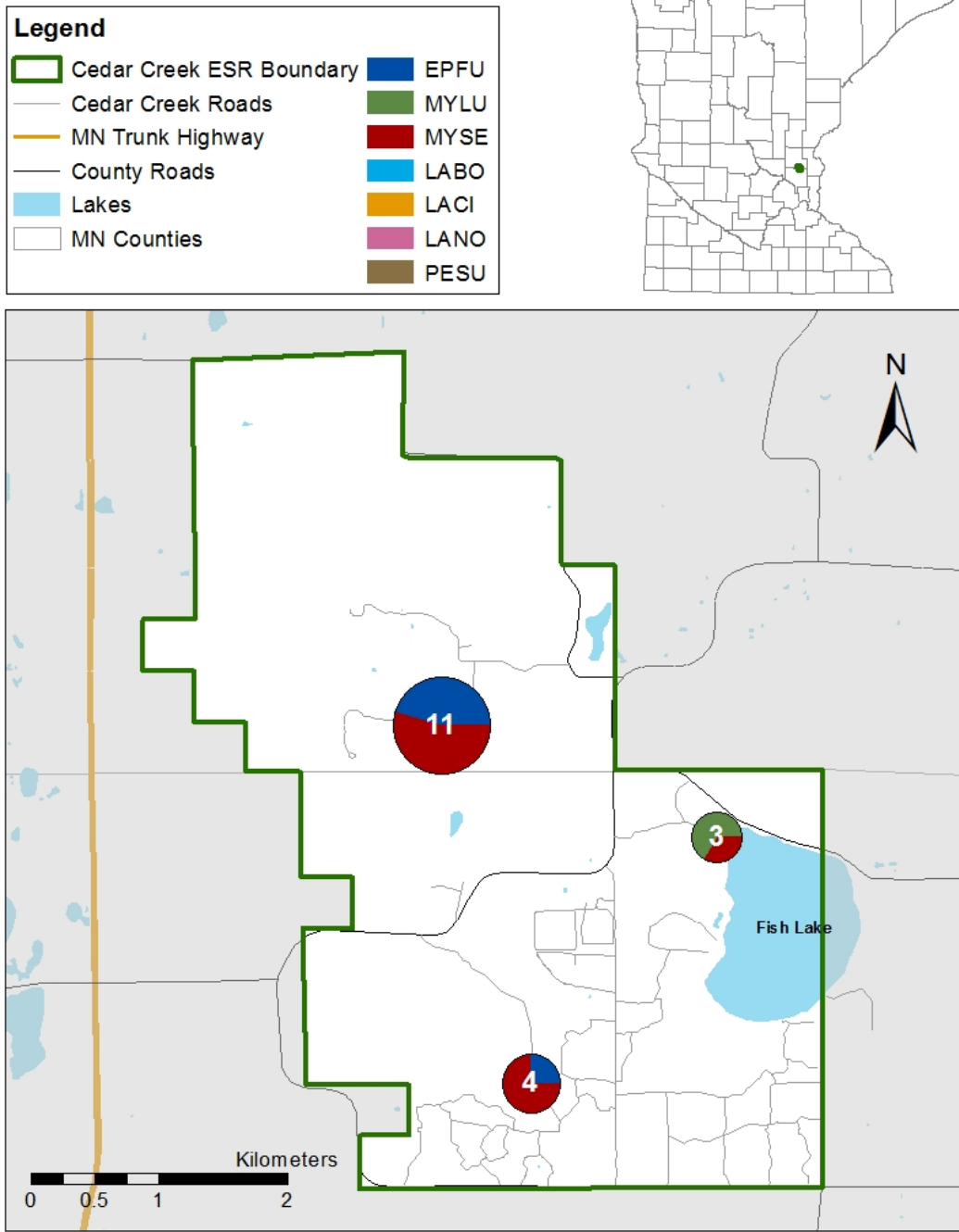


Table 1. Count of bats captured at Cedar Creek ESR, July 6th – 8th, 2016 by species and sex.

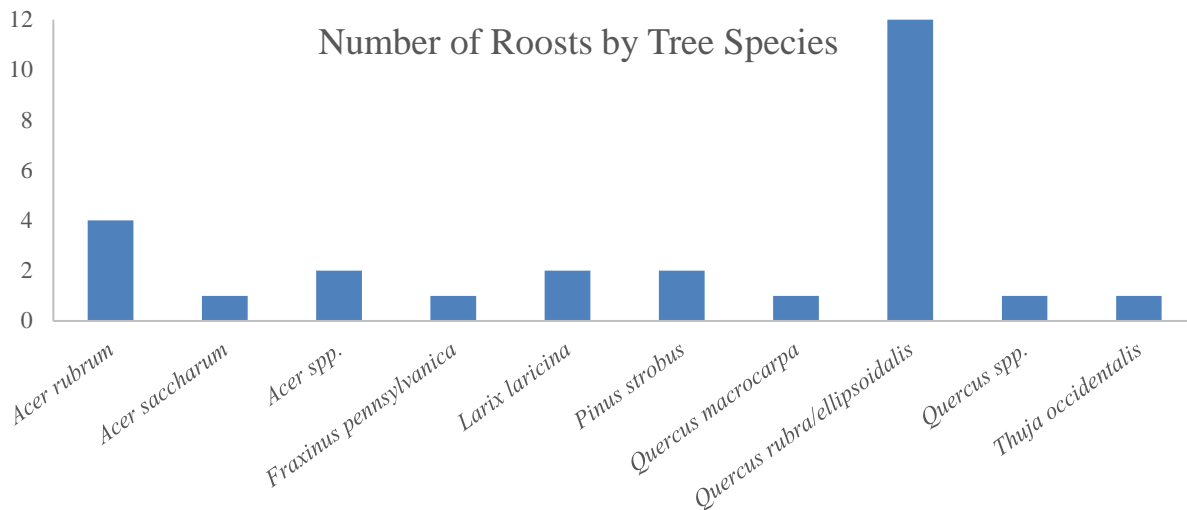
Sex	Species Code							Grand Total
	EPFU	LABO	LACI	LANO	MYLU	MYSE	PESU	
Female	3	0	0	0	2	10	0	15
Male	3	0	0	0	0	0	0	3
Grand Total	6	0	0	0	2	10	0	18

We attached radio-transmitters to 8 of 10 female MYSE captured; all bats given transmitters were lactating at the time of capture. Five of the transmitters were placed on bats near Big Buck Ridge on the night of July 6th. Two more were placed on bats along the north-south road on the night of July 7th. The final transmitter was placed on a bat captured near Fish Lake on the night of July 8th.

Radio-Telemetry/Tree Characterization

We tracked the eight bats with radio-transmitters to 27 unique roost trees of at least eight species (Fig. 6, Fig. 7). We were unable to identify species of some roost trees due to decay. Northern pin oak and northern red oak trees were grouped into one category due to the uncertainty of distinguishing these two species in the field because of their similar appearance and potential for hybridization. A list of roost trees is in Appendix A. Detailed map(s) of movements between roost trees by bats with radio-transmitters are in Appendix B.

Figure 6. Histogram showing the number of northern long-eared bat roosts by tree species at Cedar Creek Ecosystem Science Reserve, July 2016. Twenty-seven total roost trees were identified.



The average distance from the capture location to the first roost was 310 m (range: 117–587), and the average distance moved between consecutive roosts was 249 m (range: 10–669). An average of 4.1 roosts were identified per bat, and the eight bats spent an average of 1.2 days in each roost (of those roosting events with known start and end dates).

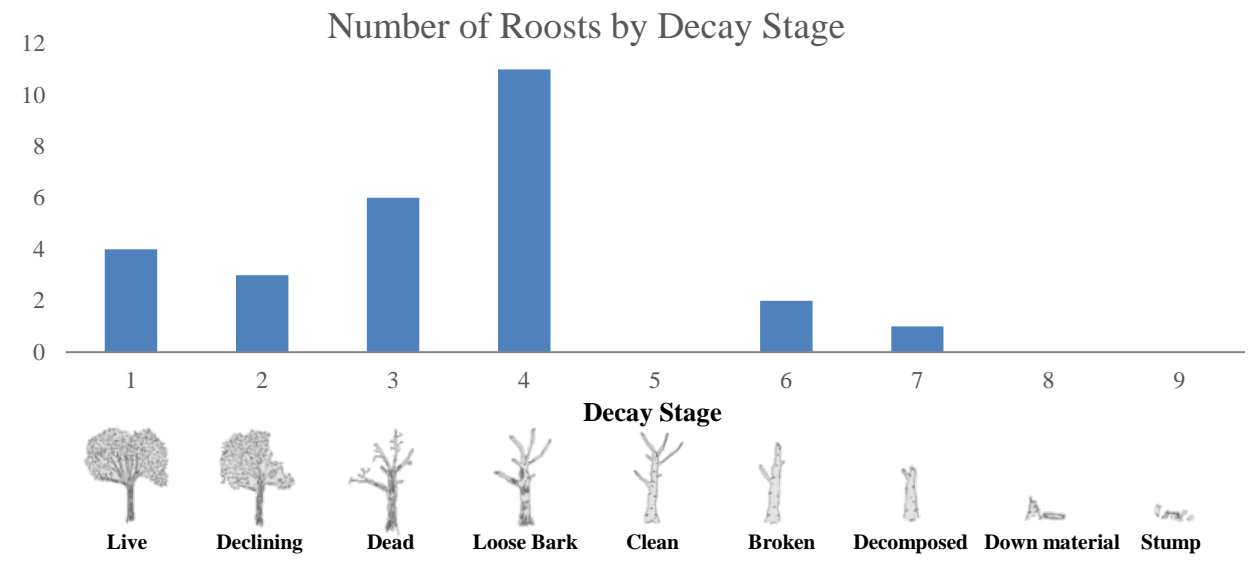
The roost trees varied in size from 18.9–73.9 cm diameter at breast height (DBH), with an average DBH of 43.0 cm. Roosts were located in both live trees and dead trees of varying decay stage (Fig. 7, Fig. 8). Roost tree height ranged from 3.1 m to 26.5 m with an average of 12.9 m.

Figure 7. Photos of three roost trees of different species at Cedar Creek Ecosystem Science Reserve, July 2016. From left to right: oak (*Quercus* spp.) snag, red maple (*Acer rubrum*) snag with obvious cavity, and live tamarack (*Larix laricina*).



Field crews were able to conduct 17 emergence counts on 17 of the identified roost trees. Bats were observed exiting the roost tree in 10 of the emergence counts. Colony size (number of bats observed in one emergence count) ranged from 2–49 in the 10 emergence counts, and averaged 14.

Figure 8. Histogram showing variation in decay stage among 27 northern long-eared bat roost trees identified at Cedar Creek ESR, July 2016.



Discussion

The eight bats with transmitters at CCEsr used a variety of roost trees, and moved often, which is consistent with findings both at other sites in this project and in other areas of the NLEB range. Many of the trees used were dead or declining red oaks (northern pin oak and/or northern red oak), which likely exist in higher numbers at CCEsr relative to snags of other tree species due to oak wilt infection. Under the Endangered Species Act, there are restrictions on tree harvest within 150 ft of known, occupied roost trees between June 1st and July 31st. For more details on these restrictions, please visit the website of the U.S. Fish and Wildlife Service (<https://www.fws.gov/Midwest/endangered/mammals/nleb/index.html>). We intend to use the data collected in this project to inform future management decisions regarding the northern long-eared bat as WNS continues to spread across the United States.

Crews captured 3 of the 7 species of bats resident in Minnesota at Cedar Creek ESR. None of the migratory tree bats (Eastern red bats, silver-haired bats, and hoary bats) were captured at CCEsr, although those species were all captured at Arden Hills Army Training Site in neighboring Ramsey County during this field season (Dirks et al. 2016). Tricolored bats (*Perimyotis subflavus*) were also not captured at CCEsr during this survey, which was not unexpected given their relatively limited range in the state. Tricolored bats have been observed hibernating in small numbers in southeastern Minnesota (Nordquist and Birney 1985), and at least two have been found hibernating in the northeastern part of the state (Knowles 1992). Summer captures of tricolored bats are uncommon – only one tricolored bat was recorded out of the more than 1000 individual bats captured over the past four summers as part of this project and pilot studies.

Also during the summer of 2016, the first capture of an evening bat (*Nycticeius humeralis*) in Minnesota was recorded at Arden Hills Army Training Site in Ramsey County (Dirks et al. 2016, Minnesota Department of Natural Resources 2016b). It is yet unknown if that capture represented a lone individual or a range extension for that species, however Wisconsin also recently documented the first maternity colony of evening bats in that state (Wisconsin Department of Natural Resources 2016).

The capture of six bats with wing damage consistent with WNS may suggest that these bats were either hibernating in one of the known hibernacula in MN or nearby states where WNS or *P. destructans* have been confirmed, or that there may be additional infected hibernacula in the state. Of the 646 bats captured during summer 2016 across Minnesota as part of the overall project, 43% showed some wing damage consistent with WNS.

This is one of 13 site-level reports from the 2016 field season, and is intended for use by the manager(s) and staff at Cedar Creek ESR. A report summarizing and discussing the results from all locations will be available in early 2017 (Swingen et al. 2016).

Acknowledgements

We would like to thank the managers and staff at Cedar Creek Ecosystem Science Reserve for accommodating our research. We would especially like to thank Research Coordinators Kally Worm and Troy Mielke for their help in logistical planning, and the facilities staff for their help in arranging housing for our crew while working on site. This fieldwork was conducted with the assistance of many field technicians and volunteers, including S. Baker, M. Berkeland, K. Hennig, A. Holleran, P. Kienzler, B. McAlpin, C. Reno, M. Swingen, and T. Upmann-Grunwald.

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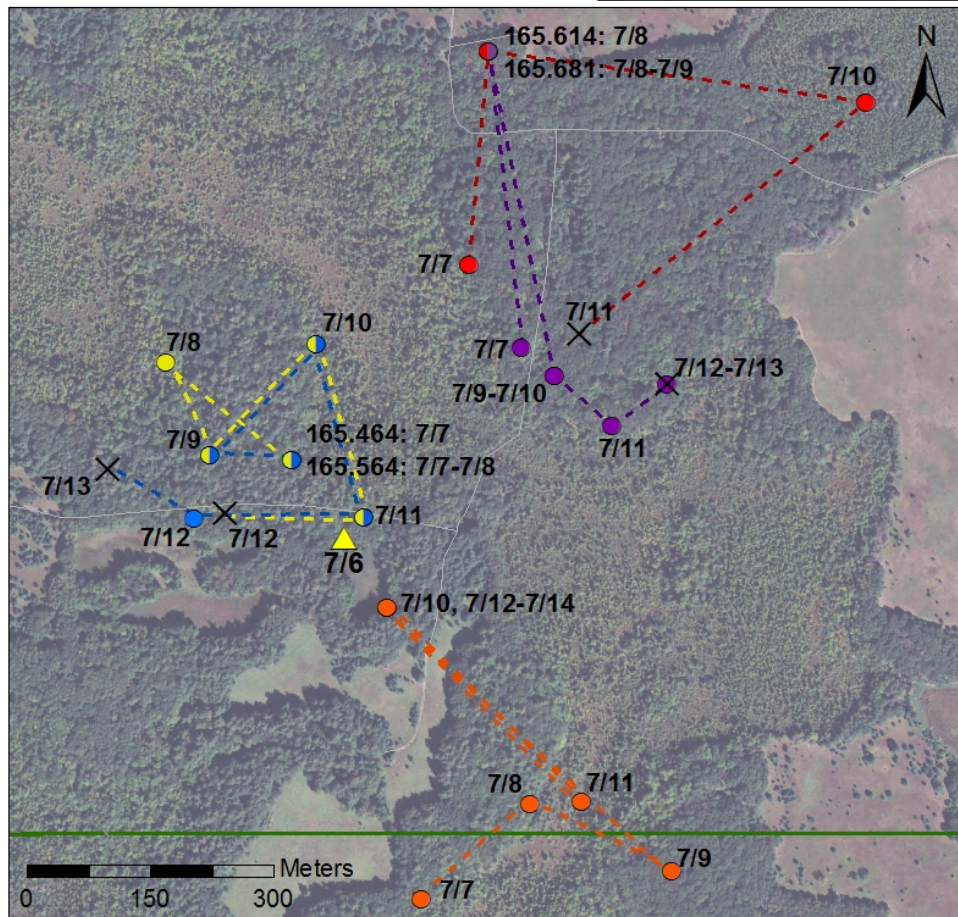
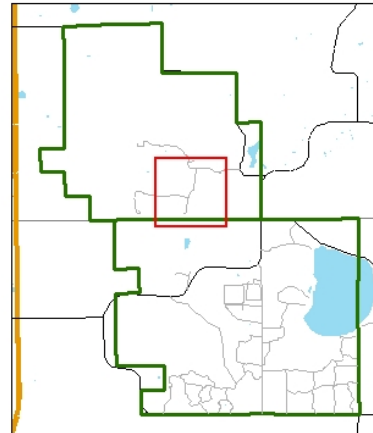
Appendix A. Table of NLEB Roost Tree Specifications

Roost Tree ID (Tag #)	Common Name	Species	DBH (cm)	Height (m)	Status	Decay Class
207	Red Maple	<i>Acer rubrum</i>	56.1	4.7	Dead	6
208	Red Maple	<i>Acer rubrum</i>	73.9	24.9	Dead	3
209	Maple (unknown spp)	<i>Acer</i> spp.	44.1	19.5	Dead	4
210	Northern Pin/Red Oak	<i>Quercus rubra/ellipsoidalis</i>	42.8	7.3	Dead	4
211	Northern Pin/Red Oak	<i>Quercus rubra/ellipsoidalis</i>	33.2	3.1	Dead	7
212	Green Ash	<i>Fraxinus pennsylvanica</i>	36.0	18.3	Live	1
213	Northern Pin/Red Oak	<i>Quercus rubra/ellipsoidalis</i>	67.0	22.9	Live	2
214	Northern Pin/Red Oak	<i>Quercus rubra/ellipsoidalis</i>	36.0	16.7	Dead	3
215	Northern Pin/Red Oak	<i>Quercus rubra/ellipsoidalis</i>	45.0	11.1	Dead	4
216	Northern Pin/Red Oak	<i>Quercus rubra/ellipsoidalis</i>	26.3	11.6	Dead	4
217	Northern Pin/Red Oak	<i>Quercus rubra/ellipsoidalis</i>	31.4	16.2	Dead	3
218	Red Maple	<i>Acer rubrum</i>	47.7	17.7	Live	2
219	Northern Pin/Red Oak	<i>Quercus rubra/ellipsoidalis</i>	43.1	7.8	Dead	4
220	Northern Pin/Red Oak	<i>Quercus rubra/ellipsoidalis</i>	48.9	26.5	Dead	4
221	Northern Pin/Red Oak	<i>Quercus rubra/ellipsoidalis</i>	45.9	14.1	Dead	4
222	Tamarack	<i>Larix laricina</i>	23.4	3.9	Dead	4
223	White Pine	<i>Pinus strobus</i>	53.7	5.0	Dead	3
224	White pine	<i>Pinus strobus</i>	68.0	14.1	Dead	4
225	Northern Pin/Red Oak	<i>Quercus rubra/ellipsoidalis</i>	38.1	16.8	Dead	4
332	Bur Oak	<i>Quercus macrocarpa</i>	44.9	22.3	Dead	3
333	Cedar	<i>Thuja occidentalis</i>	43.6	11.6	Live	1
334	Red Maple	<i>Acer rubrum</i>	33.3	12.0	Live	1
335	Tamarack	<i>Larix laricina</i>	21.8	9.1	Live	2
336	Maple (unknown spp)	<i>Acer</i> spp.	48.2	5.4	Dead	4
337	Sugar Maple	<i>Acer saccharum</i>	18.9	17.1	Live	1
338	Oak (unknown spp)	<i>Quercus</i> spp.	41.1	4.6	Dead	6
358	Northern Pin/Red Oak	<i>Quercus rubra/ellipsoidalis</i>	47.9	5.0	Dead	3

Appendix B. Maps of Bat Movement

Map showing the site at which bats were mist-netted on July 6th, 2016 (yellow triangle) in the central park of Cedar Creek Ecosystem Science Reserve. The map also shows locations of the roost trees (colored circles) used by the five female northern long-eared bats captured on July 6th and given radio-transmitters. Multi-colored circles denote trees used by multiple transmittered bats.









Cedar Creek ESR - 2016 Roost Trees

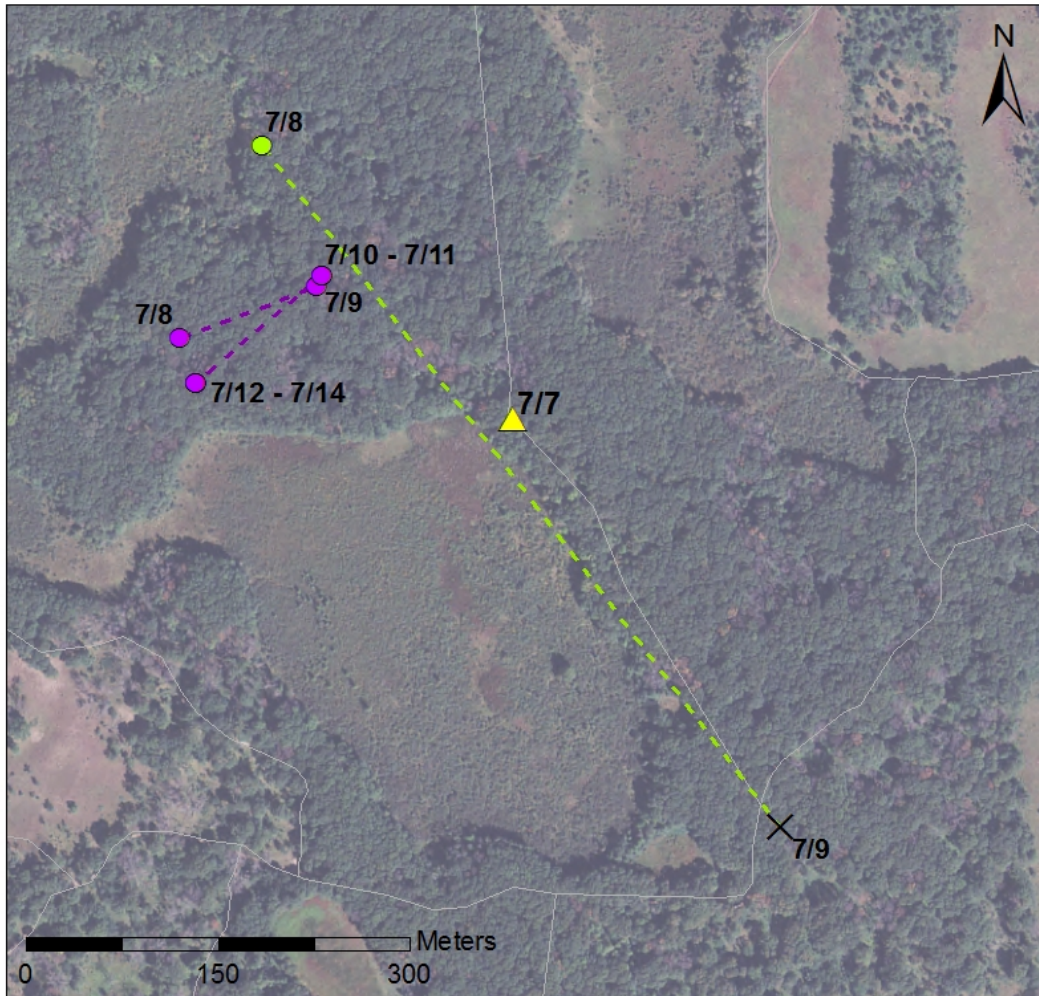
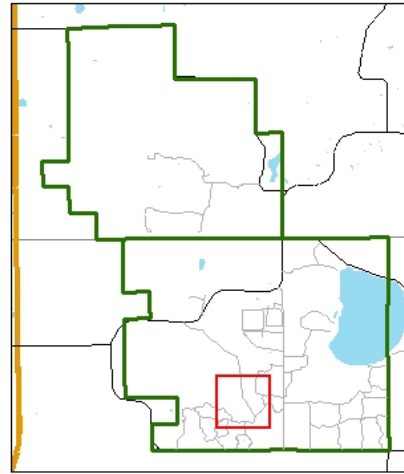


Map showing the site at which bats were mist-netted July 7th, 2016 (Yellow Triangle). The map also shows the locations of the roost trees used by the 2 female northern long-eared bats that were captured on July 7th and given radio-transmitters in the southwestern portion of Cedar Creek ESR.

Cedar Creek ESR - 2016 Roost Trees

Legend








	Mist-Netting Site		Transmitter Recovered
Roost Trees			
	164.554		CCESR Internal Roads
	164.960		DOT Roads - County Highways
			U.S. Trunk Highway
			MN Trunk Highway



Map showing the site at which bats were mist-netted on July 8th, 2016 (yellow triangle) near Fish Lake. The map also shows the locations of the roost trees used by the female northern long-eared bat that was captured on July 8th and given a radio-transmitter.

Cedar Creek ESR - 2016 Roost Trees

Legend

 Mist-Netting Site	 Transmitter Recovered
Roost Trees	 CCESR Internal Roads
 165.166	 DOT Roads - County Highways
	 U.S. Trunk Highway
	 MN Trunk Highway

