NLEB Basics

- Northern long-eared bat (NLEB)
- Occurs in 37 states
- Lives in caves and mines during winter
- Spends the summer feeding and raising young in **FORESTS**
- Long-lived (>19?), 1 young/year
- Eats hundreds of insects each day including many forest and agricultural pests
  - e.g., 150 big brown bats eat ~1.3 million pest insects/year (Whitaker 1995)
  - Value of all bats to Ag in Huron County: ~ $27.4 million/year (Boyles et al 2011)

WNS Basics

- White-nose syndrome (WNS) is primary threat to NLEB
- WNS is caused by a fungus that was likely introduced from Europe
- NLEBs exposed to WNS experience significant declines
- WNS currently found in 12 Counties in Michigan
- Winter die-offs occurred this winter at multiple sites
- Expected to lose 50-90% of cave dwelling bats over the next 2 years.

ESA Listing

- April 2, 2015 - NLEB as threatened with a interim Special Rule (="4(d)") under the ESA
- The NLEB interim 4(d) rule is still under review
- Additional comments accepted until July 1, 2015
- Finalized by December 2015

Interim 4(d) Rule: Exempted Activities

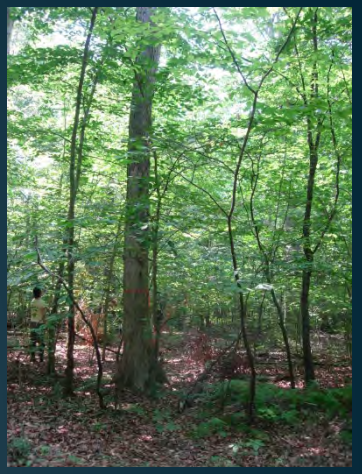
- Removal of NLEBs from human structures
- Removal of hazard trees for protection of human life and property
- Four types of activities when three conservation measures are followed.
  - Forest management
  - Maintenance and expansion of existing rights-of-way and transmission corridors
  - Prairie management
  - Minimal tree removal projects

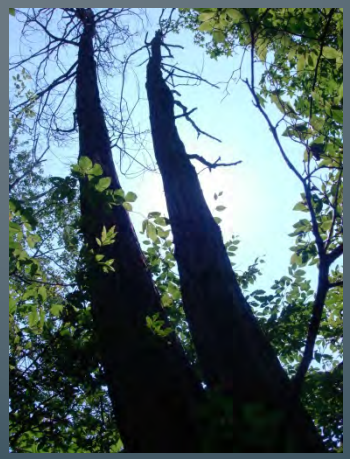
Conservation Measures

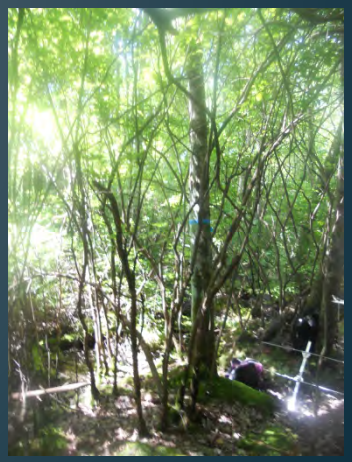
1. Occur more than 0.25 mile from a known, occupied hibernacula
2. Avoid cutting or destroying known, occupied roost trees during the pup season (June 1-July 31)
3. Avoid clearcuts within 0.25 mile of known, occupied roost trees during the pup season (June 1-July 31)

Examples of NLEB Roost Trees



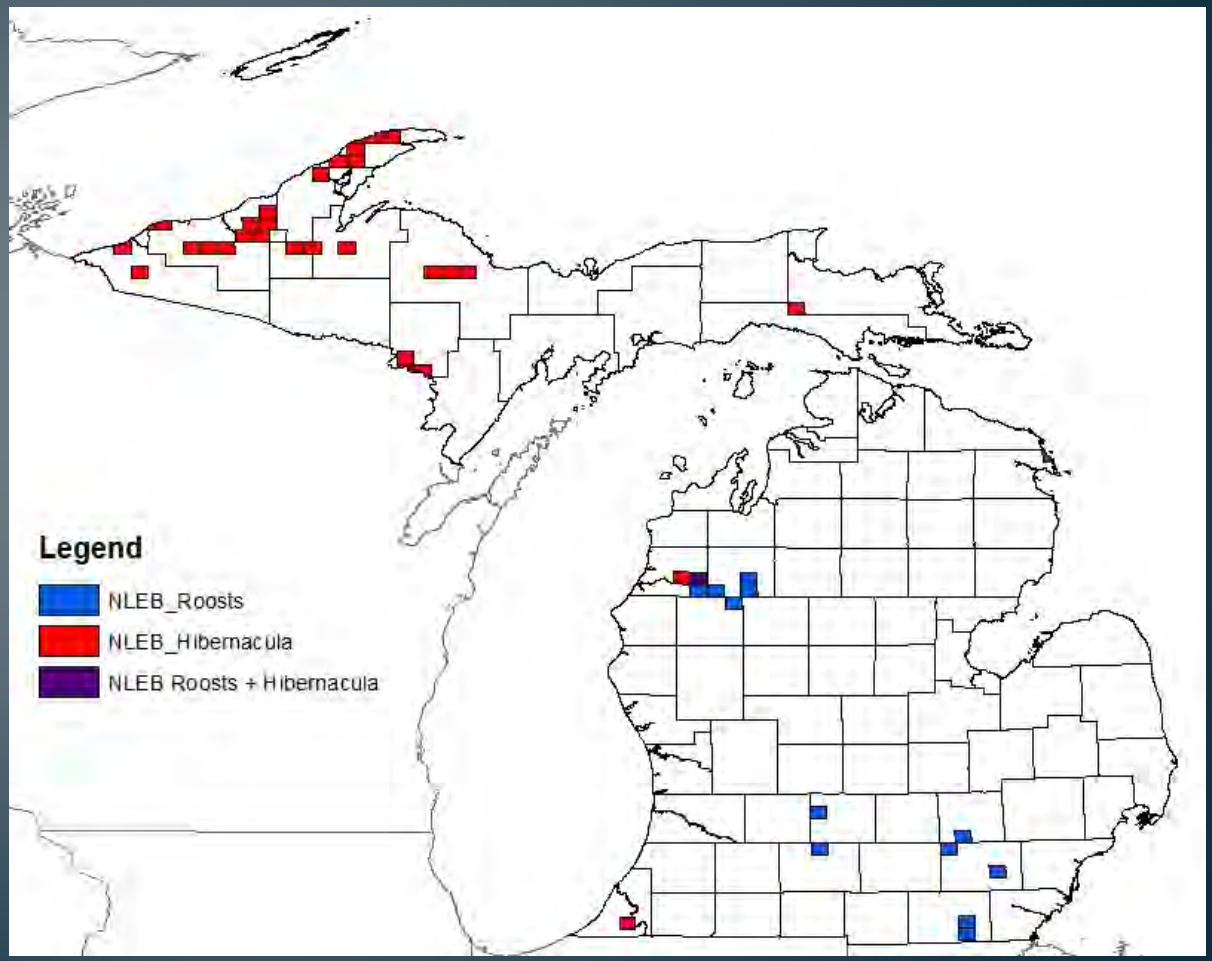








Photos: J. Bohrman

Michigan Known Hibernacula and Roosts (as of May 20, 2015)



NLEB generally, less likely in…

- Small isolated forest blocks (e.g., Canada - smallest forest fragment females were trapped in was 42 acres/males 39 acres; in one Ohio study 212 acres…)
  - For every increase of 100 hectares of deciduous stands, the odds of NLEB being present in a fragment increased by 160% in Canada.
- Trees < 4" dbh
- Trees > ½ mile from water

Not typically found in…

- Trees in urban setting (unless part of large forest block); Trees over lawn/turf grass; trees lacking cracks, crevices, cavities; trees covered with vines; rarely reported from some species (e.g., red pine, white spruce).

Individual Tree Cutting Summary

- If work will be in suitable habitat, check for any known locations, if none…
  - We encourage timing tree-cutting activities in forested areas during October 1 through March 31 when possible.
  - When that is not possible, we encourage tree-cutting in forested areas prior to June 1 or after July 31, as that will help to protect young bats that may be in forested areas, but are not yet able to fly.
  - If must cut-down tree with cavities, crevices, peeling bark etc., during the active season for bats, give warning.
  - Other wildlife considerations (e.g., migratory birds)

Forest Management & the Northern Long-eared Bat

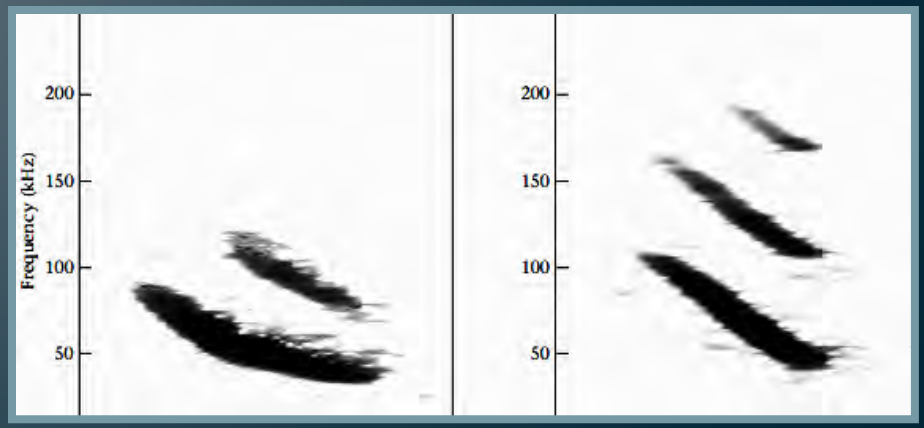
By Jenny Bohrman

What's NLEB's Niche?

Interior-Forest Adapted:

- Morphology and sonar adapted for cluttered environments
- Diet: Lepidoptera and coleoptera (less abundant in open habitats)
- "Gleaner" as well as "hawker" (Dodd et al. 2012: spiders and lepidopteran larvae = 12.7% of diet)

Photo: T. Brown



Little brown Northern long-eared

Spectrogram: Ratcliffe and Dawson 2003

What's NLEB's Niche?

- Several studies suggest preference for roosting and foraging in interior forest (Carroll et al. 2002, Yates and Muzika 2006, Winhold 2007)
- Henderson and Broders 2008: NLEB did not fly more than 78 m from contiguous forest edge on PEI

Challenges to Management:

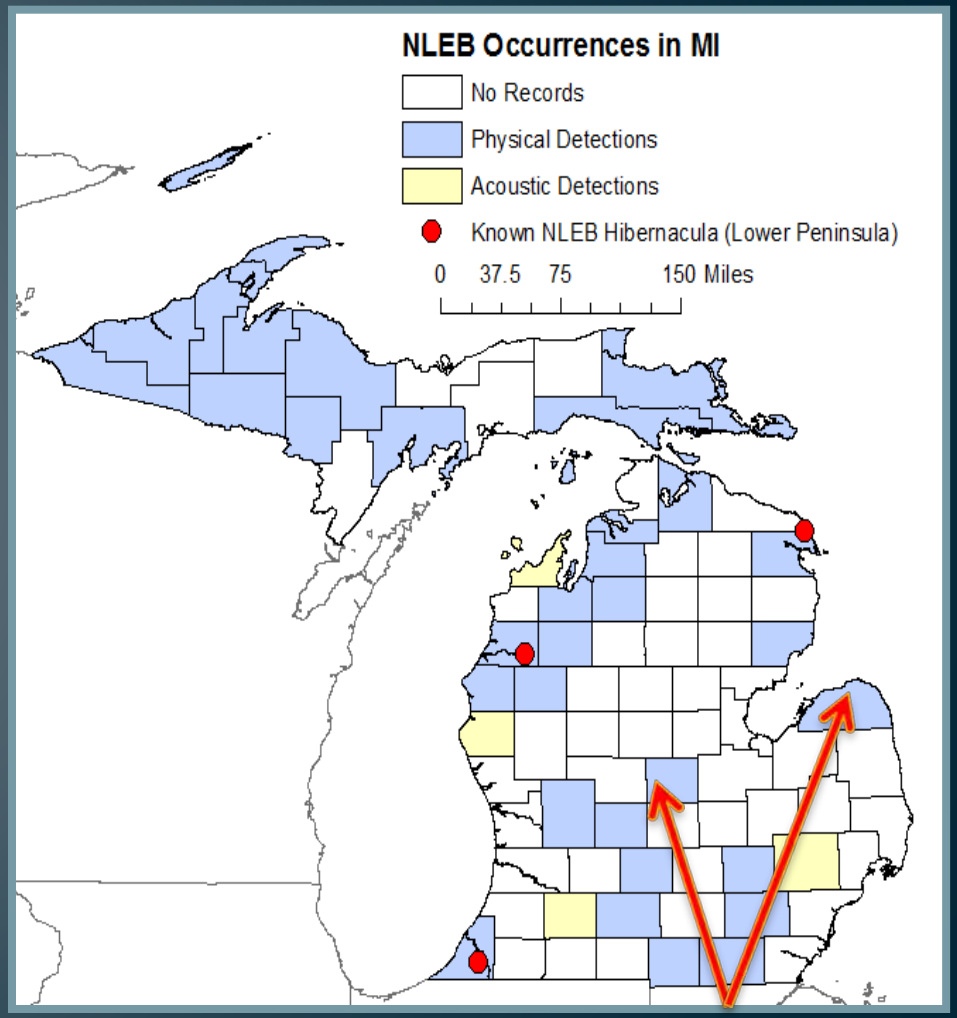
- Mysterious Hibernators
  - Consistently underrepresented in hibernacula counts
  - Tend to hibernate singly and “hide” well
  - Unlike Indiana bats, philopatric to multiple hibernacula between and within seasons
  - Undocumented hibernacula?

Photo: MO Department of Conservation

Challenges to Management:

Mysterious Hibernators

- Thought to migrate generally short distances (~60-90 km)
- However, evidence that they're either going further or using undocumented hibs
  - Johnson 2014: Weak genetic structuring and high gene flow among NLEB from across Atlantic Canada suggest that the species "is not restricted by distances up to 350 km."



Challenges to Management:

- "Frustratingly Flexible"
  - Greater variation in roost preferences compared with IBATs
  - >35 roost tree species documented (hardwoods & conifers)
  - Appear more tolerant of shade than Indiana bats (below canopy with higher % canopy cover)
  - Utilize cracks and crevices in addition to exfoliating bark
  - Often use live trees

Photo: Angela Sjollema

Challenges to Management:

- "Frustratingly Flexible"
  - Often use smaller trees than sympatric Indiana bats
    - Maternity roosts <3 inches dbh reported
  - Even reported using stumps and fallen logs (e.g., Olson 2011, Lowe 2012, Lereculeur 2013, USFWS 2014)
  - Occasionally use manmade structures (buildings, bridges)
  - Occasionally use forested roads and edges

Photo: Abby Gelb, FWS

So, all forests/trees = potential NLEB habitat?

- Not necessarily:
  - ~2% of forests within range are impacted by forest management annually (Boggess et al. 2014)
  - Species is patchily distributed throughout range (and will likely be even more so post-WNS)
  - Species' apparent plasticity may limit potential for adverse effects
  - Although data are limited, meta-analyses can refine species' preferences

Benefits of Flexibility

- Evidence that NLEB will utilize managed forests (e.g., Cryan et al. 2001, Menzel et al. 2002, Owen et al. 2002, Perry and Thill 2007, Dickinson et al. 2009, Badin 2014)
- Evidence that NLEB are adapted to respond to disturbances
  - Roosts are naturally ephemeral
  - Several studies have documented NLEB roosts in forests subject to natural disturbances (e.g., fire, floods, ice storms)
  - Dickinson et al. 2009: NLEB were seen flushing from roost trees shortly after ignition of prescribed fire in KY
  - Silvis et al. 2014: used simulations to demonstrate that >20% roost removal was required to fragment maternity social networks in KY
  - Silvis et al. 2015: Found support for 2014 model when roosts were experimentally removed during the dormant season
  - HOWEVER, we don't know how WNS may influence bats' ability to cope with stressors

Flexible ≠ No Preferences

Especially for females!

Although the species appears to be somewhat of a generalist, that doesn't mean we can't refine its preferences to focus conservation efforts

Photo: Hugh Broders

"Typical" Roosts

Sex/Status (# of studies)	# Radio-tagged Bats	# Roost Trees	% Dead	% Deciduous	dbh (in)	Tree Height (ft)	% Bark Remaining	Roost Type	Roost /Exit Height (ft)	Canopy Closure (%)
Reproductive Females[1-7] (n = 7)	15.4 (6-26)	28 (11-47)	61.8 (39-92)	88.2 (61-100)	14.9 (6-22)	59.7 (49-73)	≥50 (83%)	67% under bark (35-81)	44.6 (35-52)	73.7 (63-91)
All Females[1-25] (n = 25)	20.3 (3-70)	49.3 (1-259)	71.9 (29-100)	87.8 (0-100)	13.8 (7-26)	51.8 (30-73)	66.4 (60-79)	38% under bark (0-100)	34.4 (28-54)	65.9 (43-97)
Males[18,23,24,26,27] (n = 5)	13.8 (10-17)	30.2 (16-57)	58.3 (32-100)	49.1 (28-100)	12.4 (6-17)	53.1 (25-69)	61 (1 study)	52% under bark (7-85)	no data	60.6 (39-75)
All NLEB[1-36] (n = 36)	18.3 (3-70)	47.7 (1-259)	66.5 (22-100)	85.0 (0-100)	13.9 (6-26)	53.5 (27-97)	66.8 (59-78)	44% under bark (0-100)	31.5 (16-54)	68.1 (39-98)

1. Krynak Thesis 2010
2. Menzel et al. 2002/Owen and Menzel 2002/Owen et al. 2003
3. Sasse Thesis 1995/Sasse and Pekins 1996
4. Garroway and Broders 2008
5. Sinander 2012
6. Olson Thesis 2011
7. George and Kurta 2014
8. Foster and Kurta 1999
9. Brown 2013
10. Badin Thesis 2014
11. Carter and Feldhamer 2005
12. Lacki et al. 2009
13. Silvis et al. 2012
14. Johnson et al. 2009
15. Johnson et al. 2012
16. Yates et al. 2012
17. Bohrman and Fecske 2013/ Bohrman and Fecske, Unpublished Data
18. Broders and Forbes 2004/Broders et al. 2006/Broders and Forbes 2010
19. Park and Broders 2012
20. Henderson and Broders 2008
21. Perry and Thill 2007
22. Jackson Thesis 2004
23. O'Keefe Dissertation 2009
24. Cryan et al. 2001
25. Swier Thesis 2003
26. Ford et al. 2006
27. Jung et al. 2004
28. Winhold Thesis 2007
29. Kurta 2008
30. Schultes Thesis 2002
31. Scott Dissertation 2007
32. Dickinson et al. 2009
33. Lacki and Schwierjohann 2001
34. Lereculeur Thesis 2013
35. Timpone et al. 2010
36. Bales Thesis 2007

	# of studies (from which data were pooled)	Total # of roost trees	# of roost trees with given characteristic	% of roost trees with given characteristic
Deciduous	30[a] (21)	1443 (1005)	1227 (882)	85.0 (87.8)
Coniferous	30[a] (21)	1443 (1005)	216 (123)	15.0 (12.2)
Dead*	29[b] (19)	1387 (938)	922 (659)	66.7 (71.2)
Living*	29[b] (19)	1384 (938)	461 (267)	33.3 (28.8)
≥5 in dbh	13[c] (8)	375 (177)	333 (162)	88.8 (91.5)
<5 in dbh	13[c] (8)	375 (177)	42 (15)	11.2 (8.5)
≥10 in dbh	11[d] (7)	356 (179)	208 (109)	58.4 (60.9)
<10 in dbh	11[d] (7)	356 (179)	148 (70)	41.6 (39.1)
≥20 ft high	9[e] (5)	253 (119)	228 (112)	90.1 (94.1)
<20 ft high	9[e] (5)	253 (119)	25 (7)	9.9 (5.9)
≥30 ft high	9[e] (5)	250 (115)	190 (95)	76.0 (82.6)
<30 ft high	9[e] (5)	250 (115)	60 (20)	24.0 (17.4)
≥50% canopy cover**	8[f] (5)	299 (211)	218 (163)	72.9 (77.3)
<50% canopy cover**	8[f] (5)	299 (211)	81 (48)	27.1 (22.8)

*Females in parentheses

"Typical Roosts"

Proximity to open water:

- Mean distances of NLEB roosts to water: 225-1896 ft (10 studies)
  - Max distances of 600 ft (Foster and Kurta 1999) to 0.5 mi (Carter and Feldhamer 2005)

Proximity to roads:

- Numerous studies have reported high NLEB activity on or near minor roads
- NLEB roosts have been reported as closer to roads than random (Perry et al. 2008, O'Keefe 2009) and not closer to roads than random (Lacki and Schwierjohann 2001, Winhold 2007, Badin 2014)
- Mean NLEB roost-to-road distances to roads (paved or unpaved): 17 - 224 m (6 studies)

Important Characteristics

Roost Tree:

- Cavities and/or exfoliating bark present
- Dead or declining (e.g., broken top, dead limbs), with bark remaining
- Deciduous/hardwood
- Early successional, subcanopy species
- ≥50% bark remaining
- ≥5 in dbh
- ≥20 ft tall
- ≥50% canopy cover
- Absence of vines, low branches, or vegetative growth that would obstruct flight access to roost or facilitate predation
- Within or adjacent to contiguous, intact forest
- Within 0.5 mi of open water (e.g., stream, pond)

Photo: Jackie Dearborn, FWS

Important Characteristics

Roosting/Foraging Habitat:

- Mature forest
- Large, contiguous forest tract (not fragmented)
- Hardwood or mixedwood composition
- Structural complexity
  - Mix of tree species and age classes
  - Presence of canopy gaps (e.g., from fallen snags), allowing greater radiation to certain trees
  - Increased insect diversity and abundance
- Greater overstory than understory clutter (e.g., high canopy cover with flight space below)
- Available open water (e.g., pond, stream)
- Abundant snags present
- Forest subject to periodic disturbances (e.g., flooding, storms) or harvest regimes leading to continual snag creation

How will forest management affect important characteristics?

Clearcutting/Forest Conversion:

- In the short term, generally negative (habitat removal)
- In the long-term, snag creation from early successional species may create ideal roosting habitat if forest is allowed to regenerate
  - Silvis et al. 2012: high use of sassafras by NLEB in KY reflected the prominence of sassafras snags following extensive timber harvest from late 1700s- late 1800s, followed by decades of agricultural use and periodic fires from weapons ranges
  - In WV, where extensive clear-cutting in the early twentieth century favored the regeneration of black locusts, which were later shaded out by longer-lived canopy-dominant species, NLEB demonstrated a preference for black locusts snags (Menzel et al. 2002, Ford et al. 2006, Johnson et al. 2009)

How will forest management affect important characteristics?

Forest Thinning (Prescribed Burning, Targeted Tree Removal):

- Possible Adverse Effects
  - Could make forests more open than preferred by clutter-adapted NLEB
  - Could target suitable roost trees (e.g., snags, mature trees, diseased trees)
- Possible Benefits
  - Snag creation
  - Increased flight space in highly cluttered forests
  - Increased solar radiation to certain trees
  - Increased habitat heterogeneity and structural complexity
  - Increased prey abundance

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Take-Home?

Photo: Michael Patrikeev

We know more about NLEB than we think!

Rather than focusing on avoiding all potential adverse effects, we can focus on improving habitat through forest management

- Prioritize known roosting, foraging, and swarming/staging habitat
- Avoid cutting/burning when pups are nonvolant (e.g., June 1- July 31) where species known to occur
- Maintain and promote preferred habitat characteristics:
  - Contiguous, mature forest tracts
  - Vegetative diversity and structural complexity
  - Snags and hardwoods
  - Conditions necessary for snag creation

NLEB Habitat Examples

- Tour with Dr. Al Kurta, photos by Jenny Bohrman

NLEB Habitat

NLEB Habitat Continued

NLEB Habitat: Maternity Roost Tree

NLEB Habitat: Mixed Forest & Ag

NLEB Habitat: Mixed Forest & Ag

NLEB: Not Roost -- Vines