

Imperiled Bats in Northeastern Forests: balancing bat conservation with forest management

PIs: Shannon Farrell, René Germain

Affiliation: SUNY-ESF, 1 Forestry Dr., Syracuse NY 13210

Emails: sfarrell@esf.edu, rhgermai@esf.edu

Collaborators: Megan Gallagher, S. McNulty, V. Rojas.

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- While some conservation planners have expressed concern about the effects of some forest management and silviculture practices on bats, emphasizing the need for large tracts of unmanaged old growth forests, our results suggest that tending and regenerating even-aged forest management practices are compatible with providing suitable foraging habitat for multiple species of bats in the Adirondacks.
- All bat species were more likely to use sites with less canopy cover. High frequency bats, a group that includes many species of conservation concern, were more likely to use forest stands with lower canopy cover and sites that were either mature or recently harvested, compared to mid-age stands.

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<http://www.nsrcforest.org>

Project Summary

Several northeastern bat species have experienced significant population declines due in large part to the effects of white-nose syndrome. Several species have been listed as federally threatened or endangered, or are being considered as candidate species for listing. There has been limited research investigating summer habitat use of bats in managed forests in the Northeastern U.S. Thus, there is limited information to guide decisions makers and forest managers on what practices and conditions are compatible with bat habitat needs, how to manage forests to maintain or enhance bat habitat, or determine what practices limit negative impacts.

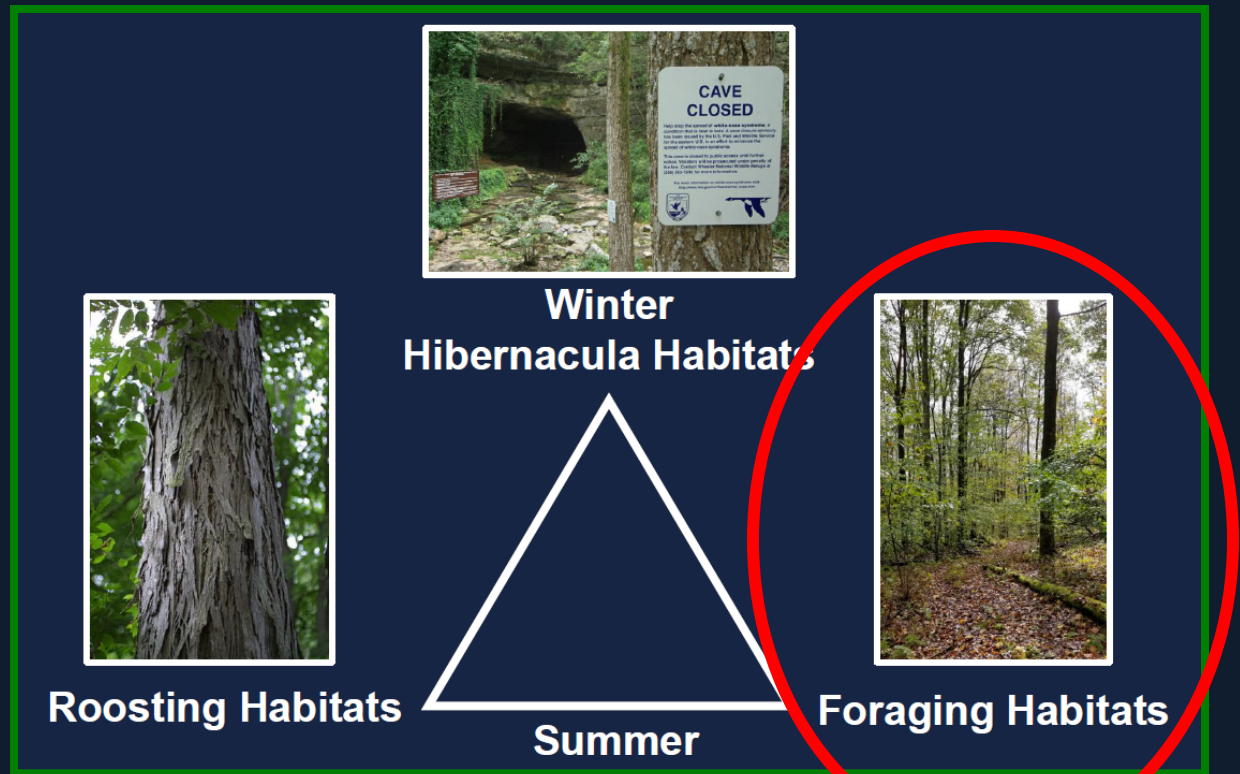
In this study we investigated what bats were present across a range of stand conditions and to determine what forest characteristics bats use in managed forests. In summer 2017–2018, we conducted repeated acoustic bat surveys at 126 sample points with a range of stand and landscape characteristics on managed forests in the Adirondack region of NY. We used best available new technologies to use acoustic recordings to accurately identify bat species or , when bats with similar calls were not distinguishable, phonic groups (groups of similar bats). We used contemporary statistical techniques to address the challenges of effectively detecting bats and to statistically test what forest features were associated with use by one or more bat species.

We detected 8 of the 9 bat species reported to occur in NY state including: We found all bats were more likely to use areas with less canopy cover. High-frequency bats (i.e. bats with similar high frequency calls, primarily *Myotis* species) were more likely to use recently-harvested sites (<10 years since harvest) or mature stands, rather than intermediate stages.

Our results support the idea that managed forests, including forests managed for harvest, can be compatible with bat habitat needs. Our results suggest that tending and regenerating even-aged forest management practices can provide suitable habitat for foraging bats in the Adirondacks. These findings provide a reason for optimism regarding the possibility that for many managed forests in the Northeast, meeting both bat conservation goals and silvicultural goals can be done simultaneously with thoughtful management approaches that incorporate our growing knowledge of bat habitat use.

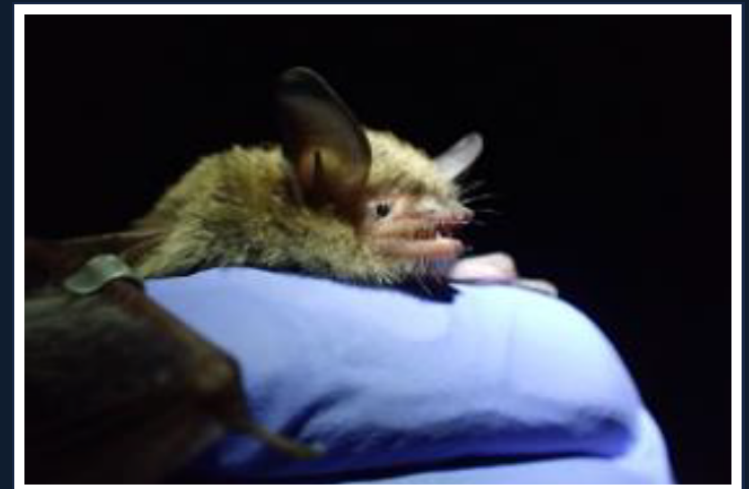
Background and Justification

- Several bat species have exhibited population declines and increasing attention is being given to protecting and restoring bat populations.
- During the summer, most North American bat species use forests to meet roosting and foraging habitat needs.
- There has been limited research investigating summer habitat use of bats in managed forests in the Northeastern U.S.



Background and Justification

- Bat species differ in their preferences for forest conditions
 - Different bat species use or prefer different areas and conditions for travelling routes and foraging sites,
 - Often these differences are associated with factors including body size and call structure.
 - For example, bats with larger bodies are less maneuverable and may be more likely to use open, uncluttered areas compared to smaller bats. Bat calls are adapted to work best for navigating certain conditions and locating specific prey types, so, for example bats may avoid areas where their calls are not as effective at navigating or finding food.
- Species may respond differently to forest management practices that alter canopy cover, vertical structure (i.e. clutter), and stand structure



Northern long-eared bat (*Myotis septentrionalis*)

Background and Justification

- Understanding what forest conditions are used by bats, and how they respond to forest management techniques, is essential...
- To contribute to our understanding of Chiroptera [bat] habitat ecology
- To provide grounds for evidence-based, effective, conservation and management policies and practices for bats.
- To provide data to guide efforts to support persistence of bat populations while avoiding unnecessary operational and economic impacts to forest managers and silviculture activities.

Harvested Areas

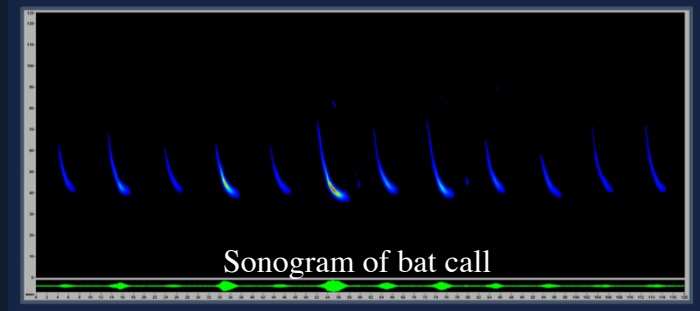


Non- Harvested Areas



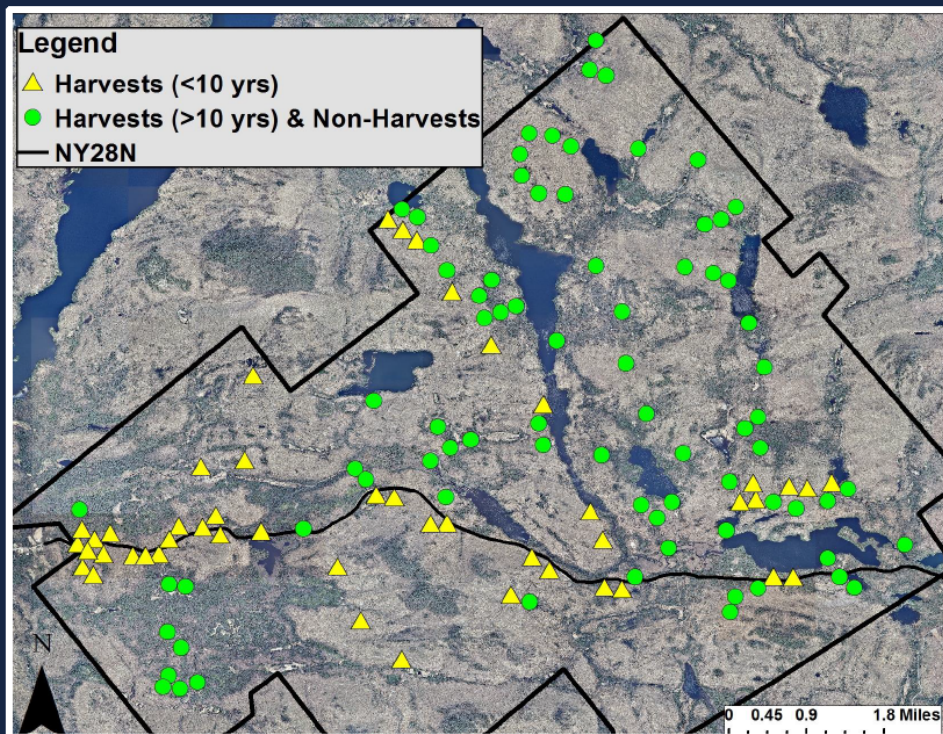
Methods

- We conducted acoustic sampling across 126 sample sites on 2 forest parcels in the Adirondacks (Huntington Wildlife Forest, managed by SUNY-ESF for research, and an industrial forest managed by the timber production company F&W Forestry) in 2017-2018 that represented a range of forest stand conditions and harvest histories.
 - Sampling used passive acoustic detectors (picture right) that recorded bat calls for 4 nights during the summer, 2 nights in early summer and 2 in late summer.
 - Bat call recordings were analyzed using best available techniques to identify bat species.
 - When species identification was uncertain, calls were assigned to “phonic groups”, groups of related bats with high, mid, or low-frequency calls.

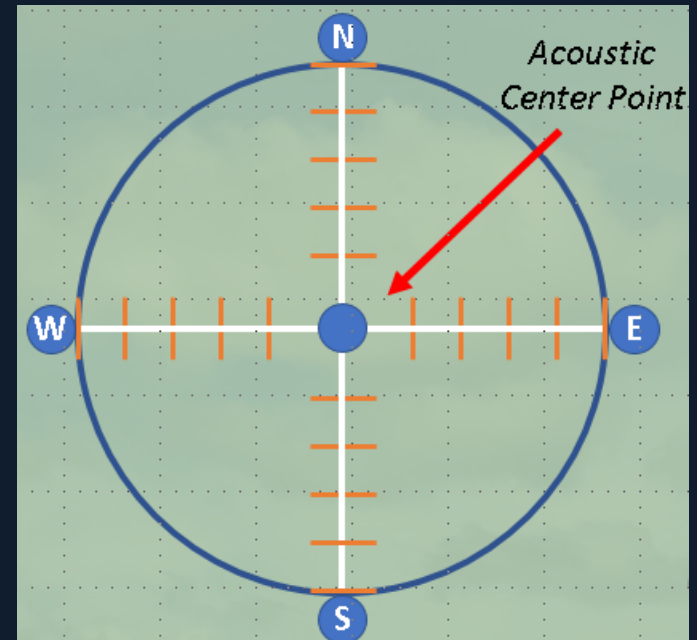


Methods

- We conducted vegetation sampling at all sample points to quantify the forest stand structure, including canopy cover, basal area, understory clutter within a 50 m radius of the acoustic detector location.
- We also measured landscape variables that may be important for bat habitat use including distance to roads and distance to water.



Locations of sample units in Huntington Wildlife Forest, managed by SUNY-ESF for research, and an industrial forest managed by the timber production company F&W Forestry.

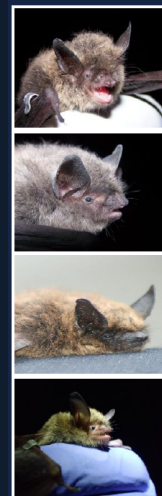


Methods

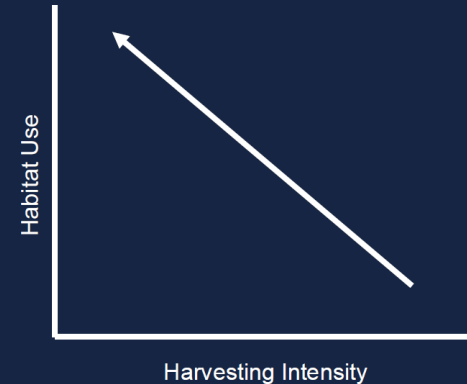
- We conducted occupancy modelling to determine which stand and landscape characteristics were associated with use by bat species.
 - Occupancy analysis is a rigorous statistical tool for understanding habitat use by wildlife species, and investigating what characteristics of an area may influence use by animals. In particular, this analytical approach helps to mathematically address challenges with studying rare, elusive, and difficult to detect species, like bats.

Some bat conservation planners have suggested that some bat species of concern (particularly in the genus *Myotis*, including high-frequency bats such as the Northern long-eared bat) require large areas of intact, interior, unharvested forest.

Thus we tested this hypothesis as well as others to determine what features bats were using in our study area



Myotis Species Habitat Use:
Working Hypotheses



Results/Project outcomes

- **We detected bats at 113 of 126 sample units (≈90%) across both FW and HWF during 504 sampling nights.**
- We detected 8 of 9 bat species thought to occur in NY state (did not detect tri-colored bats)
- Because it can be difficult to discern species identification from calls between closely-related species with perfect certainty, we chose to assign all calls to a “phonic group” rather than making insufficiently certain species IDs.

Table 1.

Phonic Group	Common Name	Scientific Name
High frequency > 40 kHz	Little brown bat	<i>Myotis lucifugus</i>
	Northern long-eared bat	<i>Myotis septentrionalis</i>
	Indiana bat	<i>Myotis sodalis</i>
	Eastern small-footed bat	<i>Myotis leibii</i>
Mid frequency 30–40 kHz	Eastern red bat	<i>Lasiurus borealis</i>
	Tri-colored bat	<i>Perimyotis subflavus</i>
Low frequency < 30 kHz	Big brown bat	<i>Eptesicus fuscus</i>
	Silver-haired bat	<i>Lasionycteris noctivagans</i>
	Hoary bat	<i>Lasiurus cinereus</i>

Results/Project outcomes

- **The high-frequency group used the most sample units (83%)**
- **This is the group that contains several species of major conservation concern, the *Myotis* species.**

For calls we could identify to species or species group with certainty in the high-frequency group:

- Little brown bats were detected at 57% of the sample units
- Because calls are so similar, a collective group of Indiana, eastern small-footed, and northern long-eared bats combined were detected at 12% of the sample units.



Little brown bat (*Myotis lucifugus*)

- The little brown bat (*Myotis lucifugus*) is a candidate species for federally threatened or endangered listing, currently being evaluated by the U.S. Fish and Wildlife Service
- Indiana bats (*Myotis sodalists*) are listed as federally endangered species
- Northern long eared bats (*Myotis septentrionalis*) are listed as federally threatened.
- Eastern small footed bats (*Myotis leibii*) may be considered for future federal status; currently listed as species of special concern in NY state

Results/Project outcomes

- **Bats in the low-frequency group used 64% of the sites we studied.**
- **Bats in the mid-frequency group used 32%.**

For calls we could identify to species with certainty in high-frequency group:

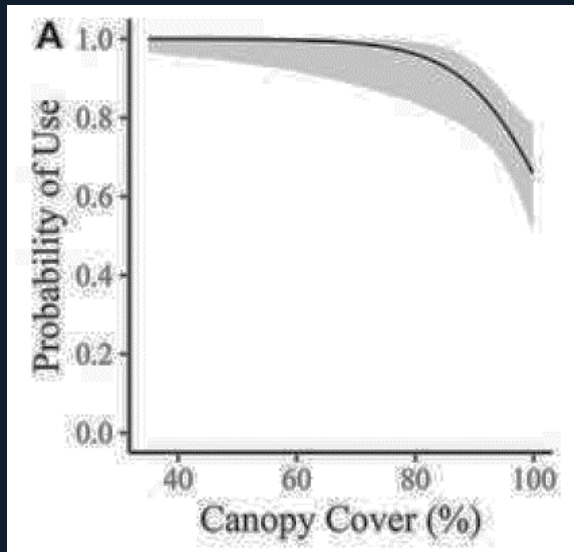
- Eastern red bat was the only species detected from the mid-frequency group and used 32% of the sample units.
- In the low-frequency group, hoary bats used 44%, silver-haired bats used 60%, and big brown bats used 53% of the sample units.
- Relatively little is known about many bat species habitat in NY, but silver-haired abts are perhaps the least studied.



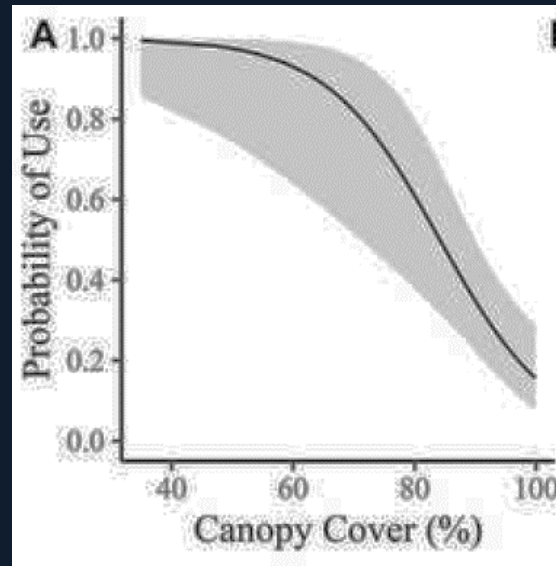
Silver-haired bat (*Lasionycteris noctivagans*)

Results/Project outcomes

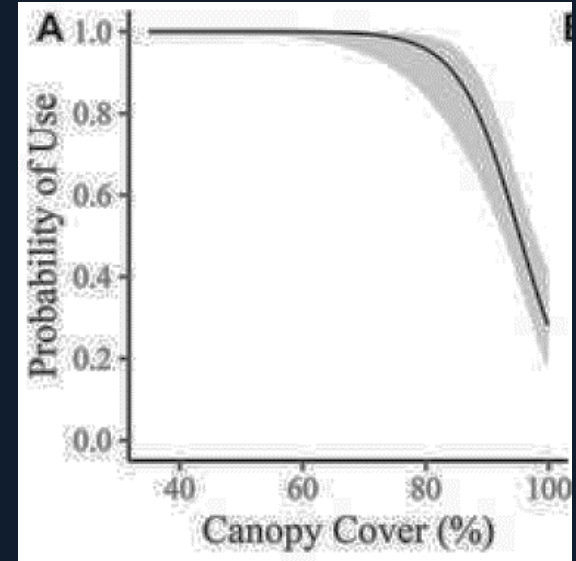
- All phonic groups of bats were more likely to use sites with less canopy cover.



High frequency bats



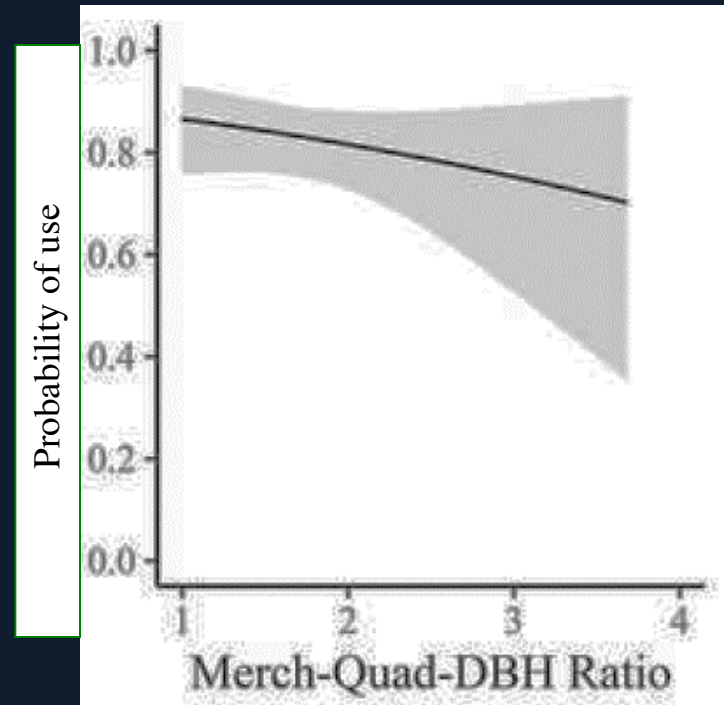
Mid frequency bats



Low frequency bats

Results/Project outcomes

- High frequency bats were more likely to use areas with less understory cover,
- This means they were more likely to use either mature stands or *recently harvested* stands (e.g., compared to older cuts with a second cohort).
 - As quantified by the Merch Quad DBH ratio
 - This metric depicts the ratio between merchantable quadratic dbh and quadratic mean dbh and helps discern between stands with similar basal area and merchantable quadratic mean dbh but distinctly different structures

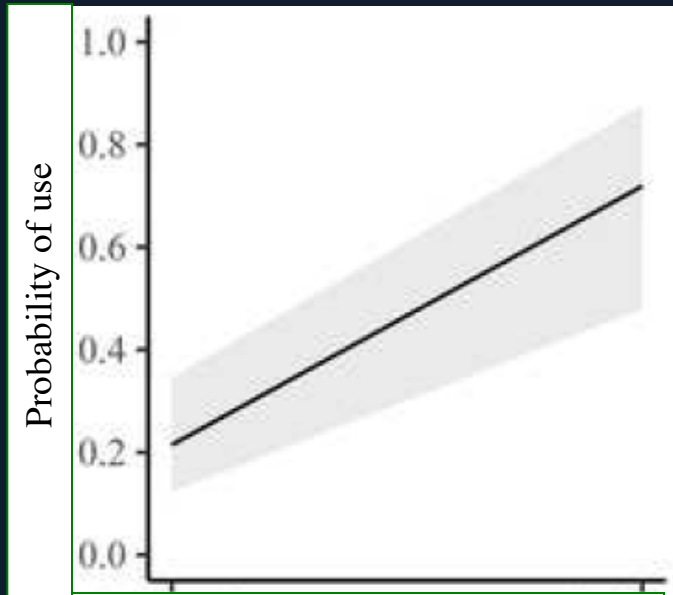


High frequency bats

Results/Project outcomes

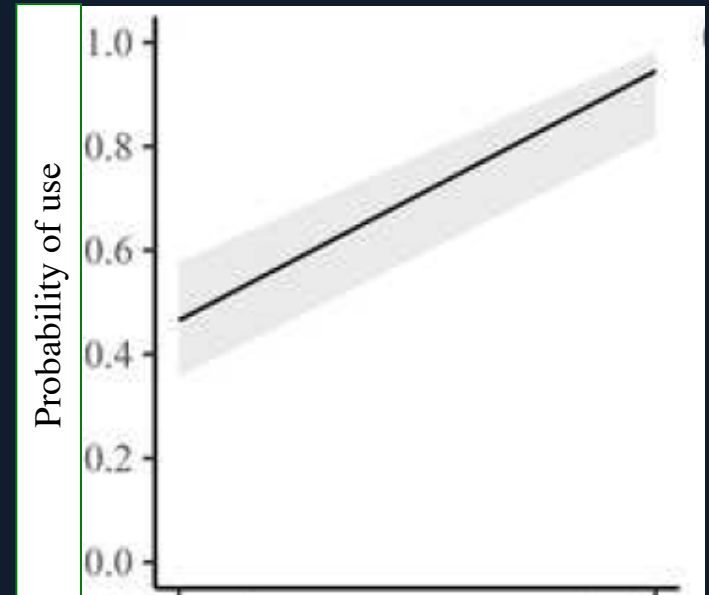
- Mid and low frequency bats were more likely to use sites that had been more recently harvested.

Mid frequency bats



Older harvests → more recent harvests

Low frequency bats



Older harvests → more recent harvests

Implications and applications in the Northern Forest region

We believe our study provides some interesting and encouraging results & conclusions...

- Despite legitimate concerns about the impacts of White-nose syndrome on bat populations in the northeast US, we found bats at most of our sites, including bats of conservation concern.
 - Populations of some species may indeed be declining seriously, but their continued presence at many sites in our study is an encouraging indicator of some population persistence in the region.
- Our results suggest that bats are using a varied array of stand conditions in Adirondack forests during the summer season, a key season when female bats nurse and eventually wean pups to become new adult recruits to the bat population.

Implications and applications in the Northern Forest region

We believe our study provides some interesting and encouraging results & conclusions...

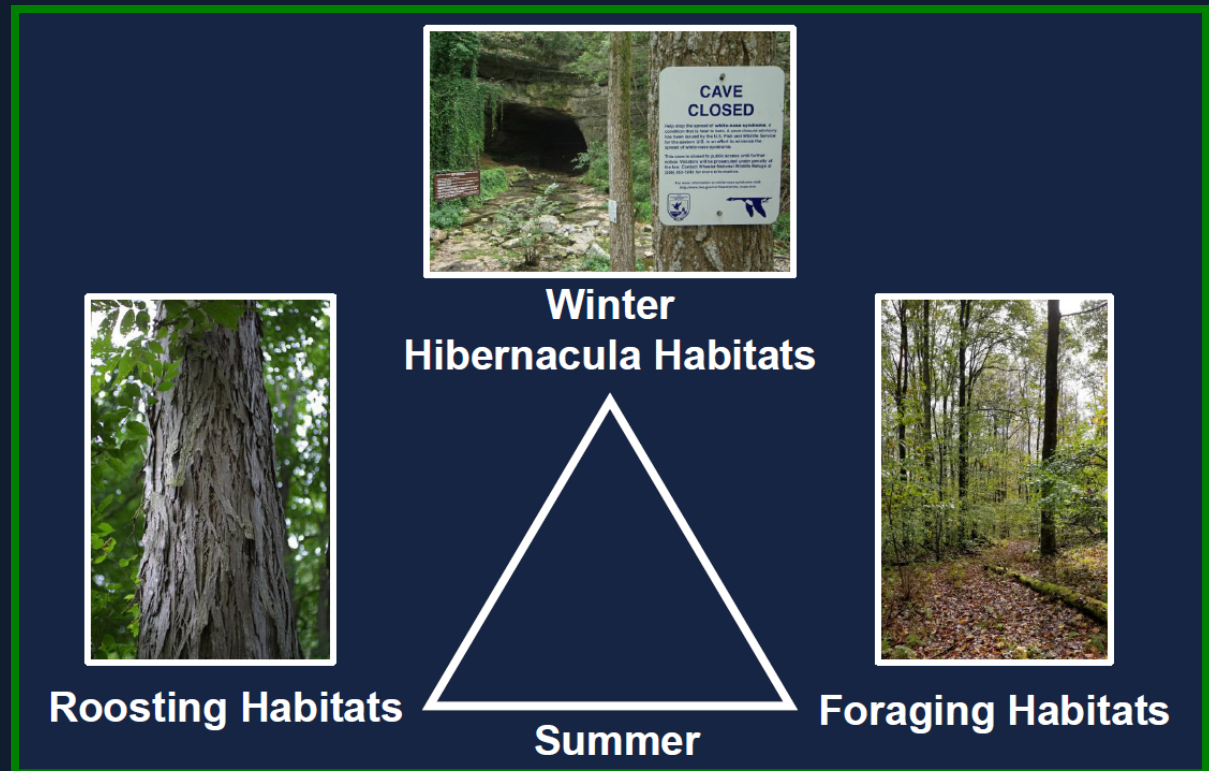
- Our results suggest that bats are likely to use both mature stands and stands with conditions such as recent seed tree or shelterwood regeneration cuts
- However they are less likely to use older regeneration cuts with successful regeneration or beech thicket invasion.

These results may suggest that:

- Tending and regenerating even-aged forest management practices provide suitable habitat for foraging bats in the Adirondacks.
- To support the array of bat species, maintaining a patchwork of forest stand conditions across the broader Adirondack landscape, alongside healthy water bodies for bats, can support continued occurrence of bats in the region.
- The effects of beech bark disease and consequent beech thicketting, creating dense understory conditions, *may* have adverse effects on bat use and should be investigated further.

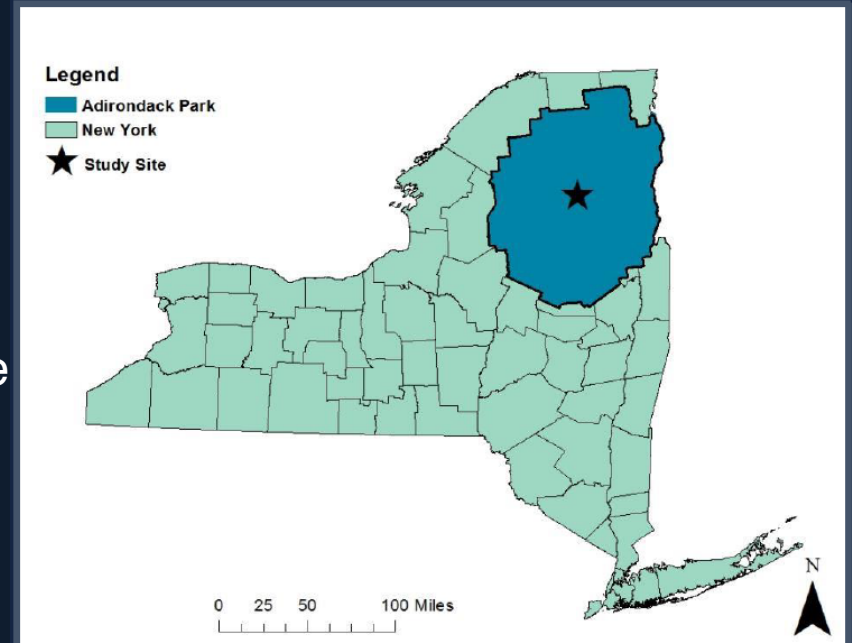
Future directions

- We hope to pursue future work investigating the roosting habitat use of bats in the Adirondack region, in various management contexts, will add an important piece to the full puzzle of bat summer habitat use.
- Additionally, work investigating the fall migratory movements and hibernacula selection of bats who summer in the ADKs will help provide the full annual picture of bat habitat needs as well as to better understand what bat populations may be most susceptible to white-nose syndrome exposure or most able to persist.



Future directions

- Our detailed study focused specifically in the Adirondack region, but a better understanding of bat summer habitat use and distributions is needed across NY state and the northeast.
- We are underway in a new effort in collaboration with NY DEC, NY NHP, and others to compile all existing data on bat occurrences across NY state, both recent and historical to assess broader statewide patterns and determine what types of forests and landscapes may be important for bats statewide.



List of products

- This project was supported by the Northeastern States Research Cooperative through funding made available by the USDA Forest Service. The conclusions and opinions in this paper are those of the authors and not the NSRC, the Forest Service, or the USDA.
- Peer-reviewed publications:
 - Gallagher, M., S. L. Farrell, R. H. Germain, and V. G. Rojas. Summer Bat Habitat Use and Forest Characteristics in Managed Northeastern Forests. *Journal of Forestry: Accepted.*
- Conference presentations:
 - Gallagher, M. E., S. L. Farrell,, and R. Germain. “Bat Foraging Habitat Use: Response to Forest and Landscape Conditions” New York Society of American Foresters Annual Meeting, Syracuse, NY . Jan 2019
 - Gallagher, M. E., S. L. Farrell,, and R. Germain. “Bat Foraging Habitat Use: Response to Forest and Landscape Conditions” Northeast Bat Working Group Annual Meeting, State College, PA . Jan 2019
 - Gallagher, M. E., S. L. Farrell,, and R. Germain. “Bat Foraging Habitat Use: Response to Forest and Landscape Conditions” The Wildlife Society’s Annual Conference (TWS), Cleveland, OH. Oct 2018
- Additional funding support for this project was provided by the Edna Bailey Sussman Foundation.