Northern long-eared bat (*Myotis septentrionalis*) management: Insights from a multi-year project at Fort Knox, Kentucky

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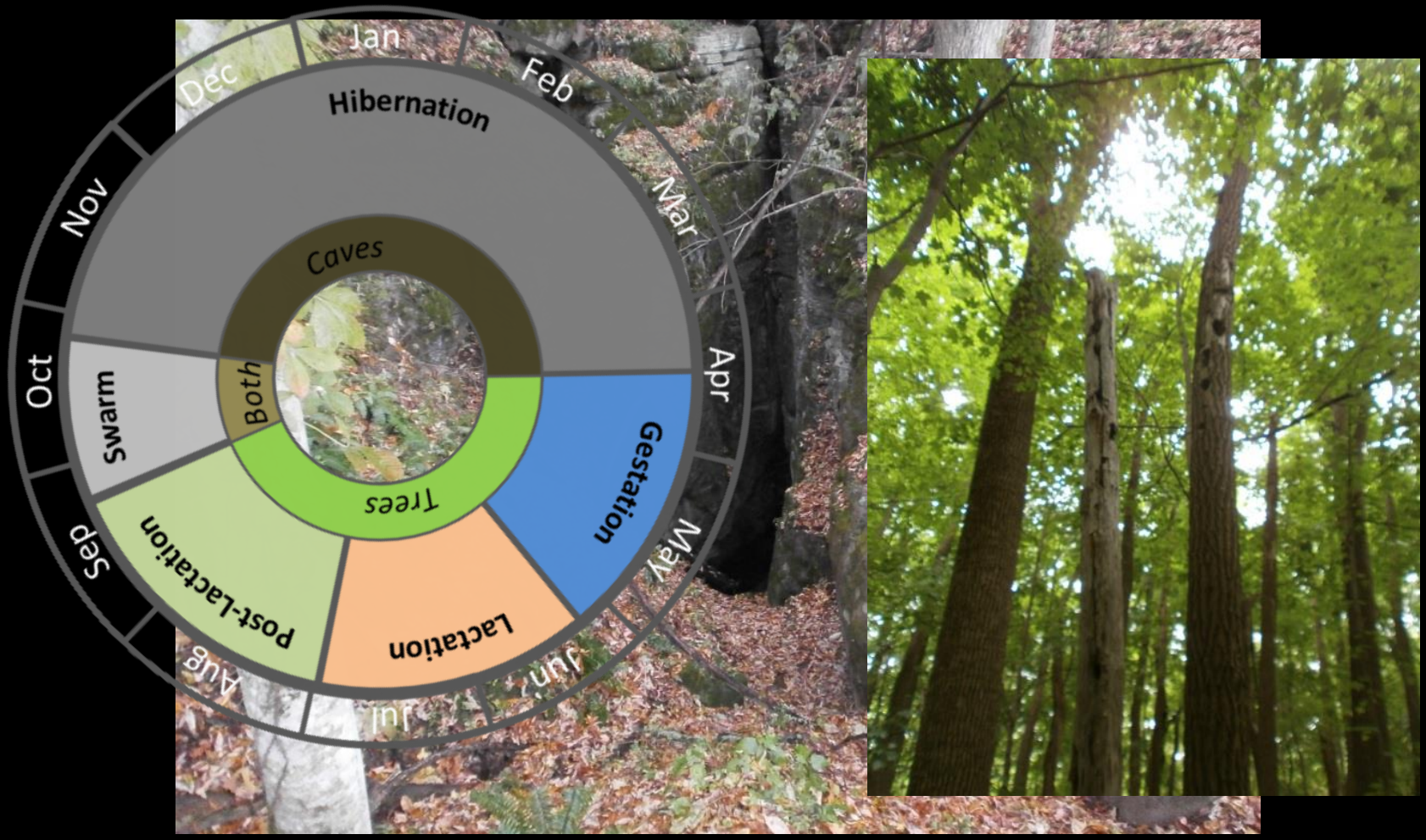
Home is where the heartrot is.



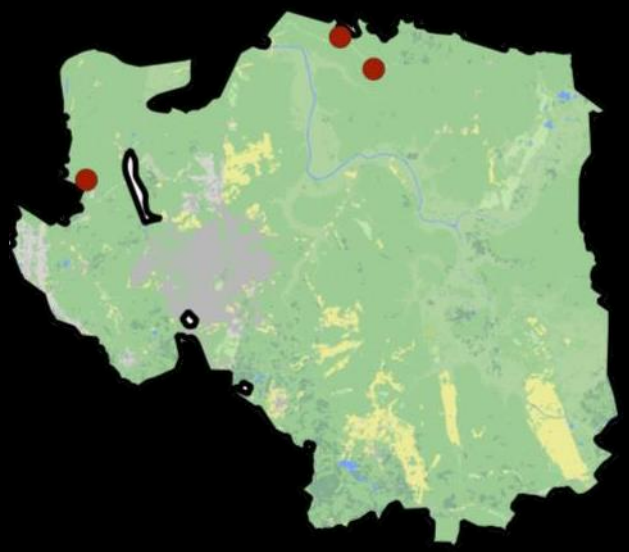
Current status – USFWS threatened, with 4(d) rule

- The 4(d) rule – Section 4(d) of the Endangered Species Act allows the USFWS to identify activities that would not be prohibited under section 9 of the Act
- Proposed exemptions-
  - Removal from human dwellings and authorized capture by permitted individuals
  - Incidental take in areas not affected by WNS
  - Take attributable to forest management practices and limited expansion of right-of-ways

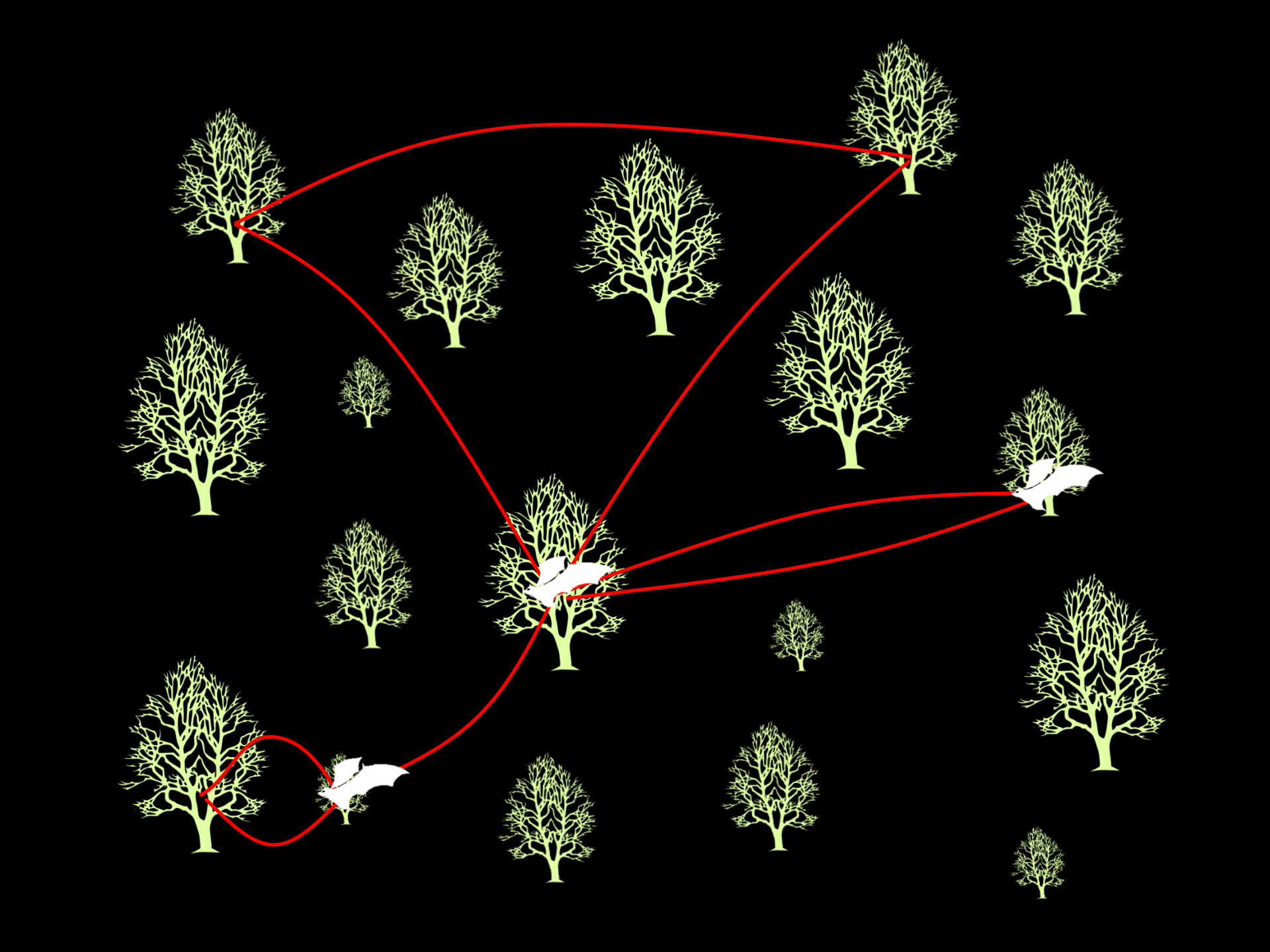
Roost functionality –

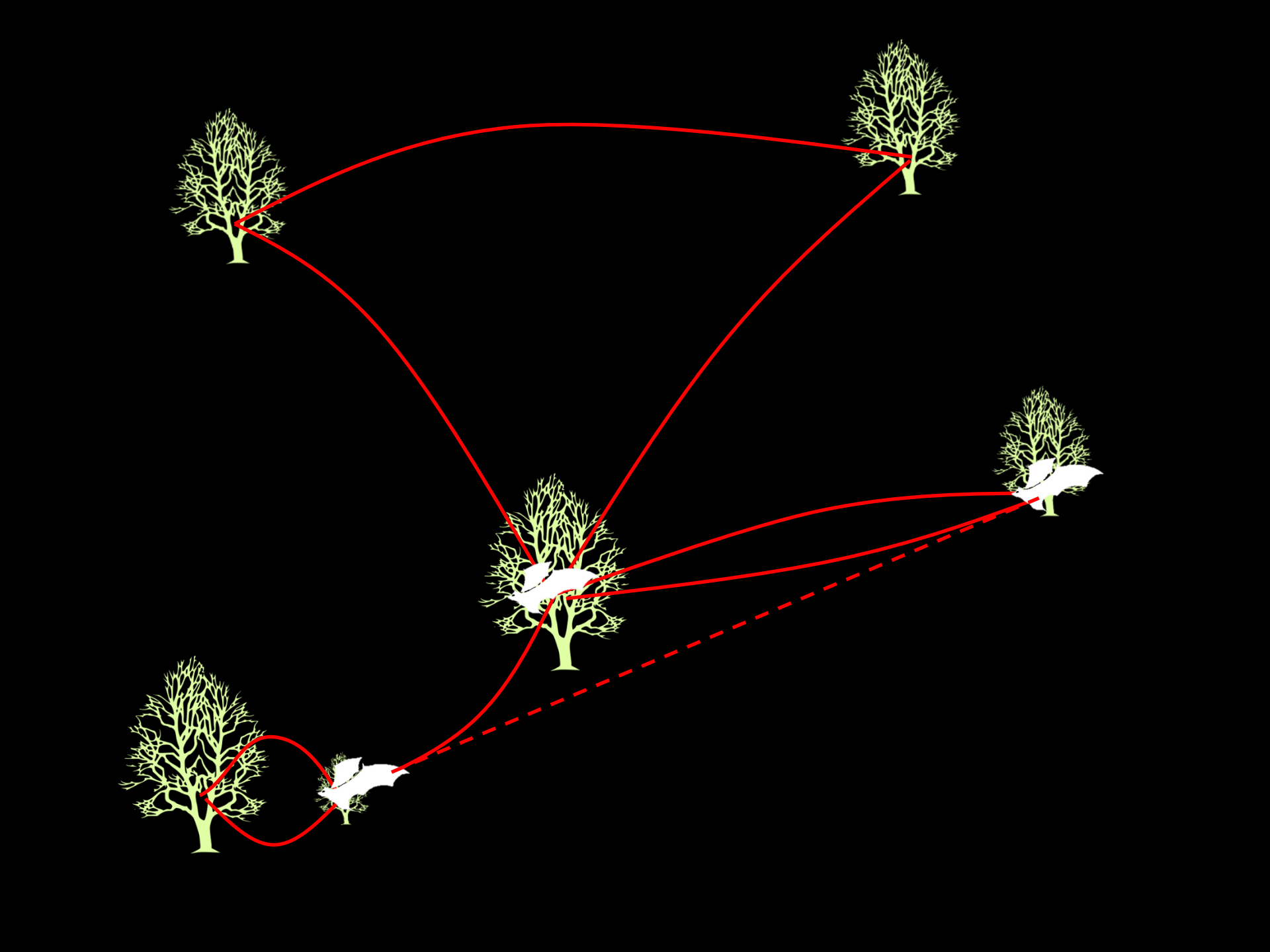
- Protection from weather
- Protection from predators
- Social interaction and survival
  - Mating
  - Social cohesion

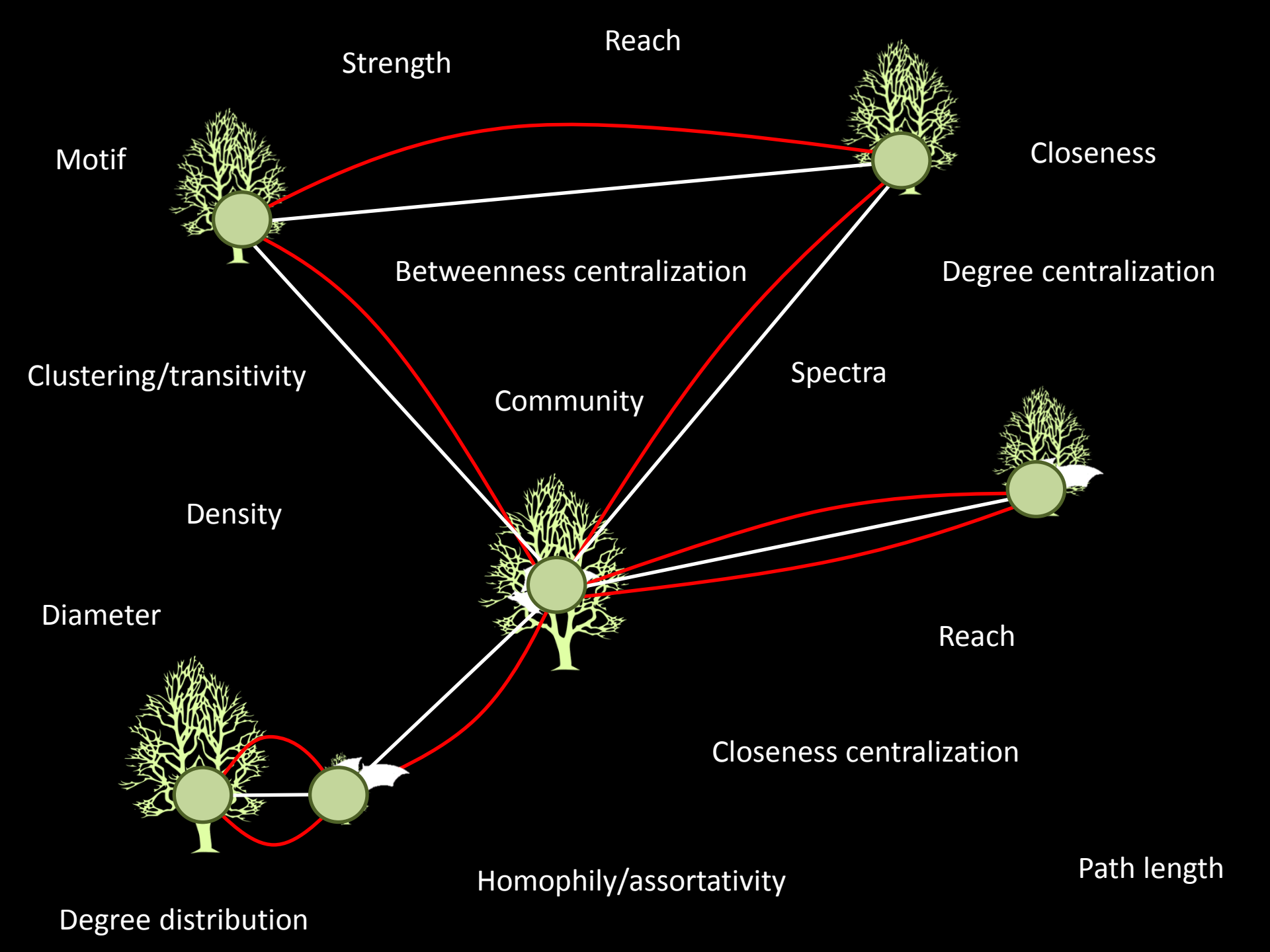
We conducted a 4 year study on the Fort Knox military reservation, Kentucky, USA

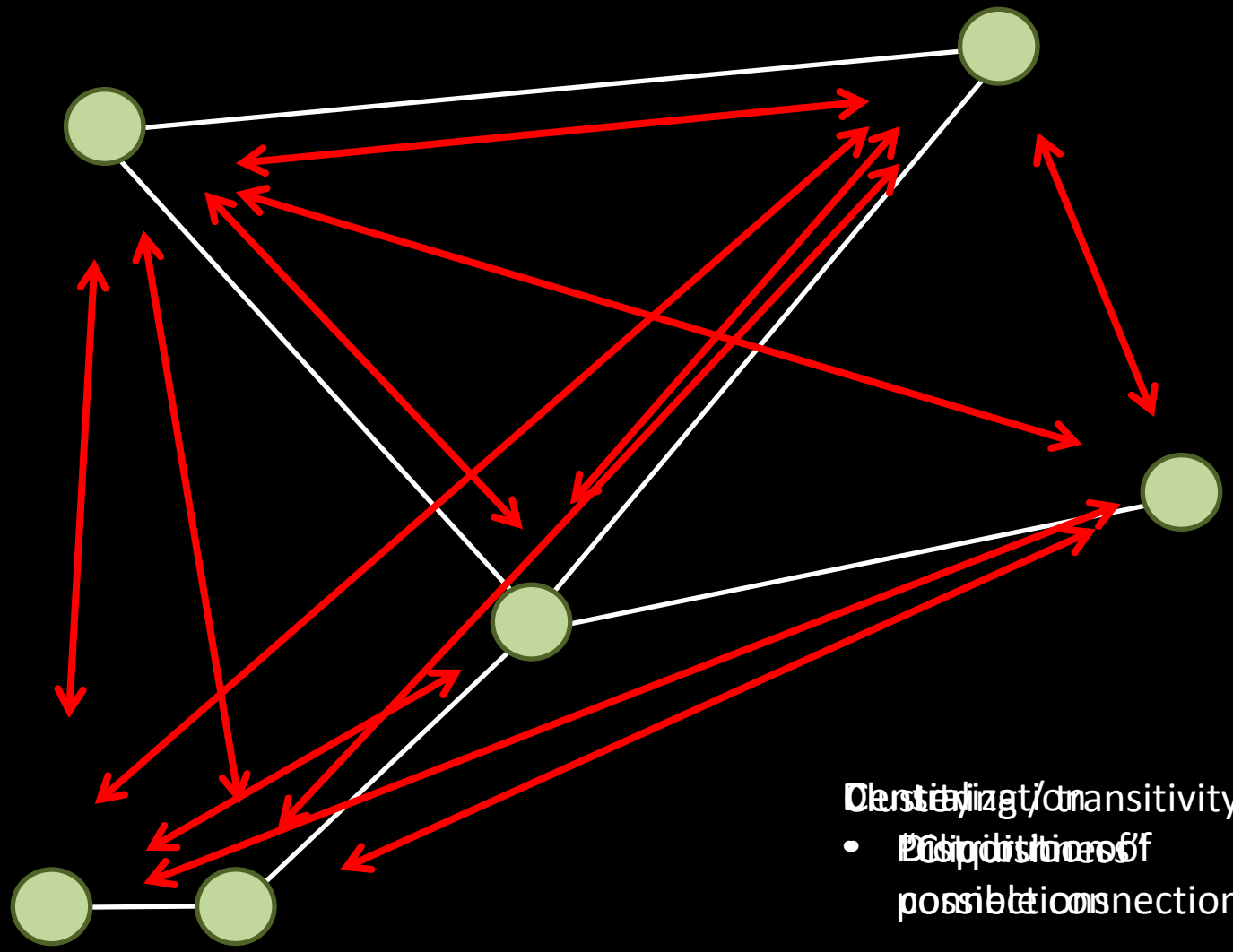


- 225 female radio-tagged and tracked
- Roost selection
- Social structure
- 538 relocation events
- Colony home range
- 221 roosts
- Movement patterns
- 7 roost cavities examined
- Effects of roost removal
- Characteristics of roost cavities



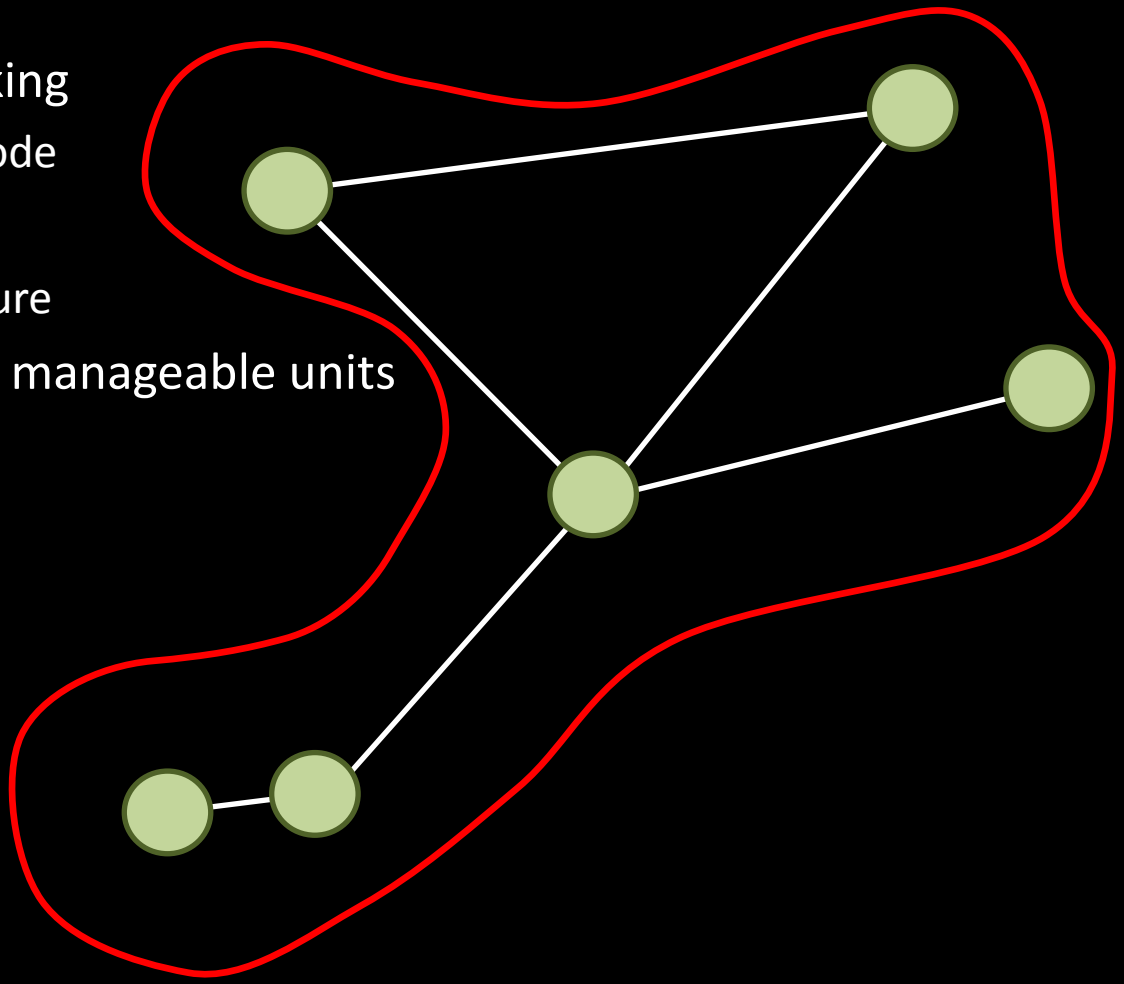



Reach
Strength
Motif
Closeness
Betweenness centralization
Degree centralization
Clustering/transitivity
Spectra
Community
Density
Diameter
Reach
Closeness centralization
Path length
Homophily/assortativity
Degree distribution


Density/connectivity
Proportion of possible connections

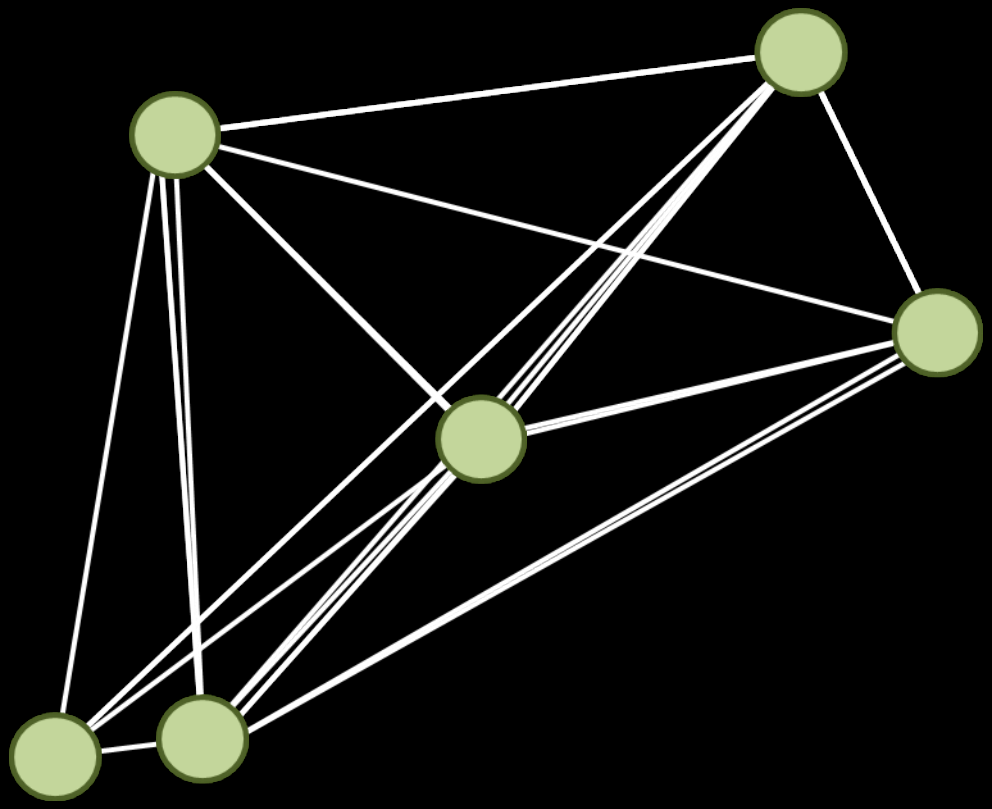
Network applications in bat conservation

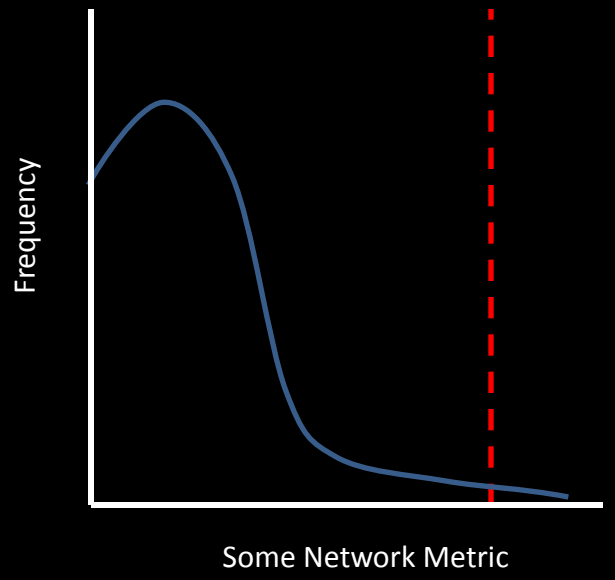
- Day-roost conservation ranking
  - Relative importance per node
- Robustness to disturbance
  - Changes in network structure
- Identification of individually manageable units
  - Colony identification
  - Area delineation



Network characteristics are relative to the number of nodes and links

- Significance of network metrics can only be assessed through comparisons to equivalent random networks

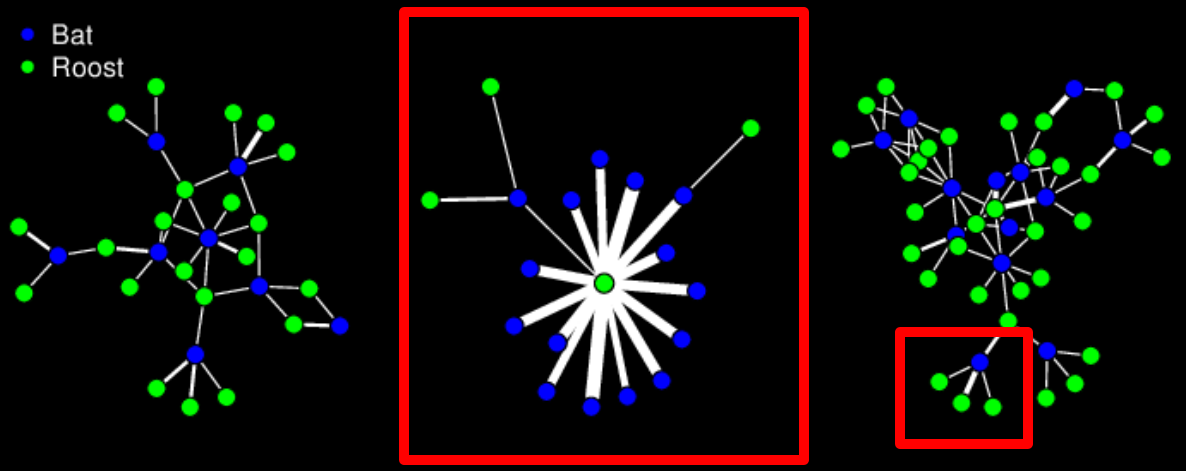




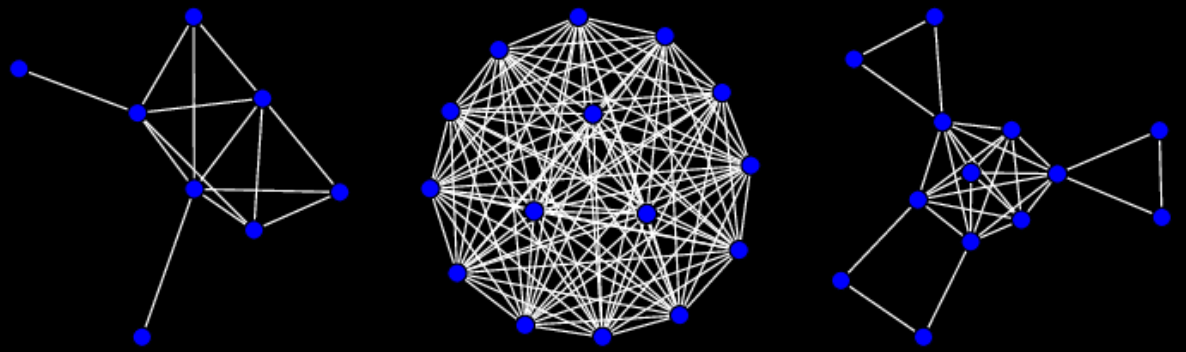
Primary results

Colony social structure displayed a mix of random and non-random characteristics, and differed from one another

- Roost networks
  - Centralized
  - Transitive

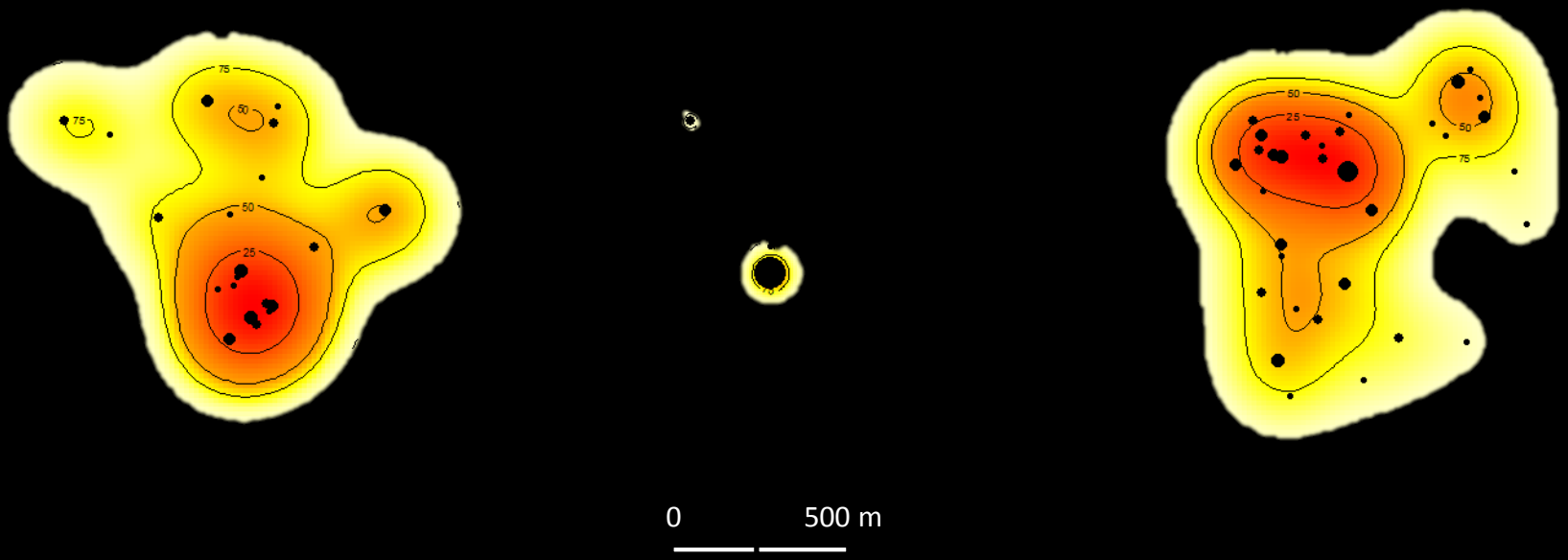


- Social networks
  - De-centralized
  - Transitive



Colony roosting areas centralized, but dispersed

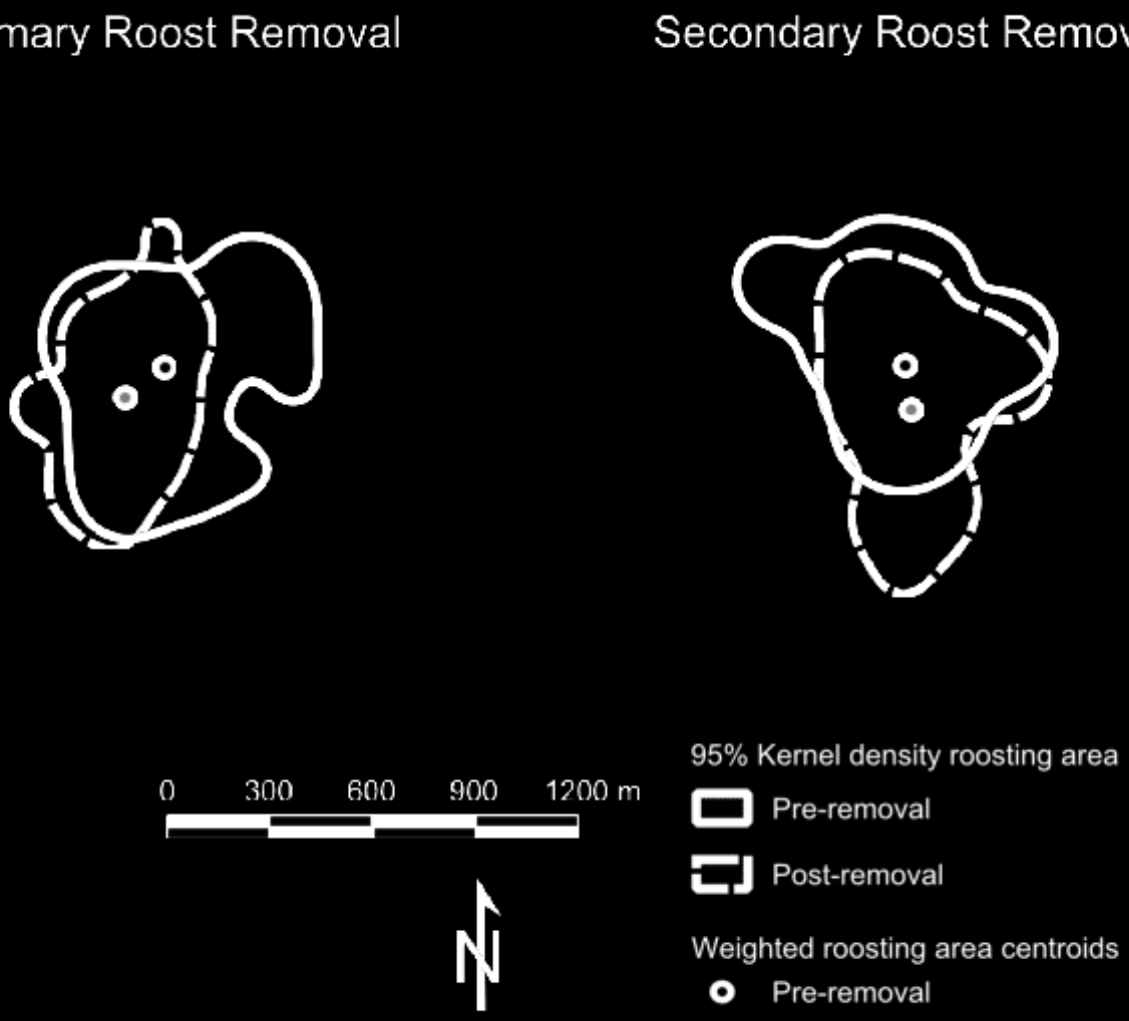
- Core use area reflects centralization of roosting network
- Areas used by adjacent colonies do not appear to overlap



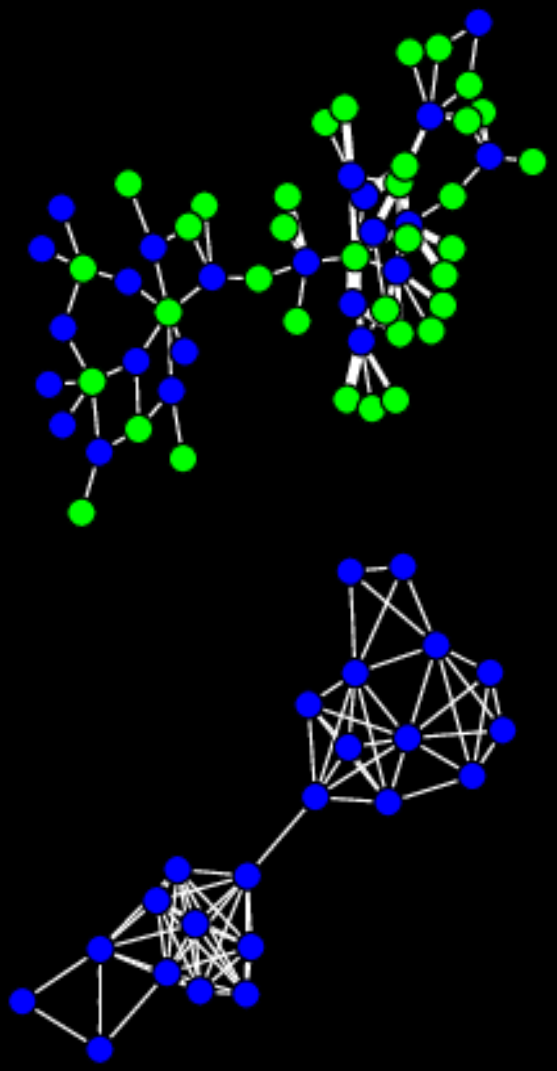
Colonies randomly assigned to treatment groups

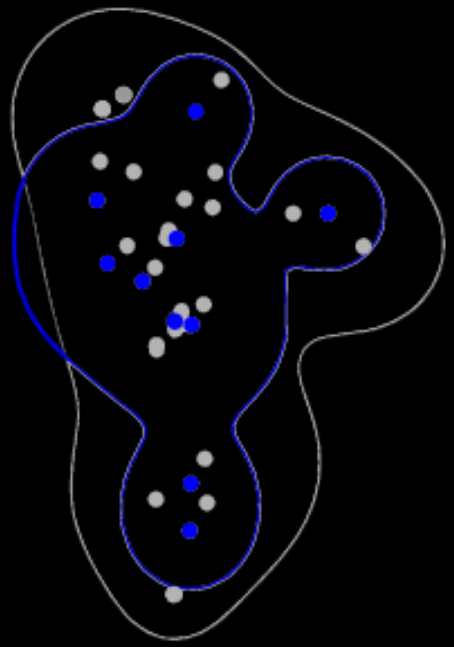
- Control colony (N = 0)
- Primary roost removal colony (N = 1)
- Secondary roost removal colony (N = 5; 24% of roosts)

Roost removal did not significantly alter roosting area location when accounting for distribution of use



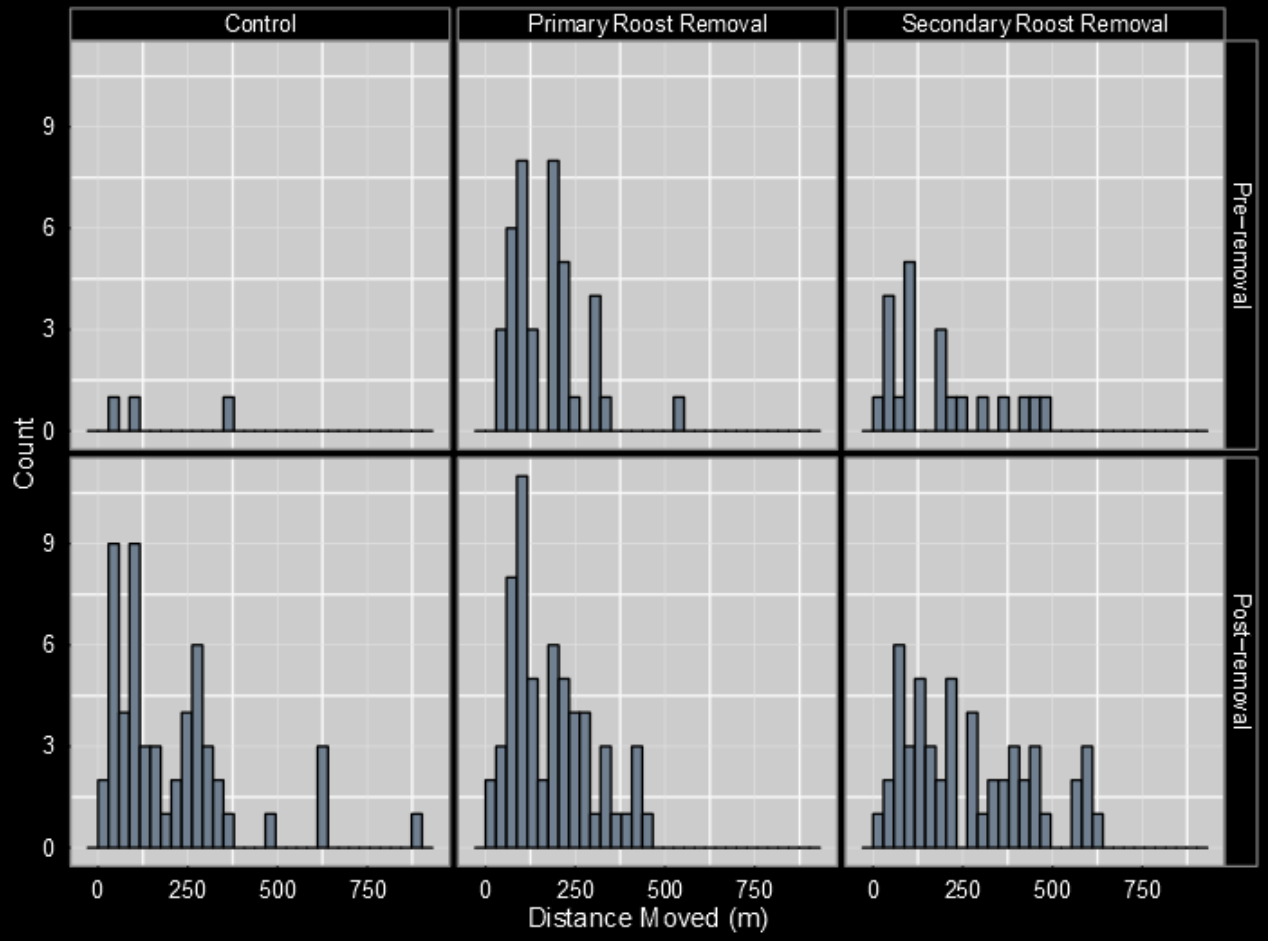
Removal of secondary roosts may have begun a colony fission event



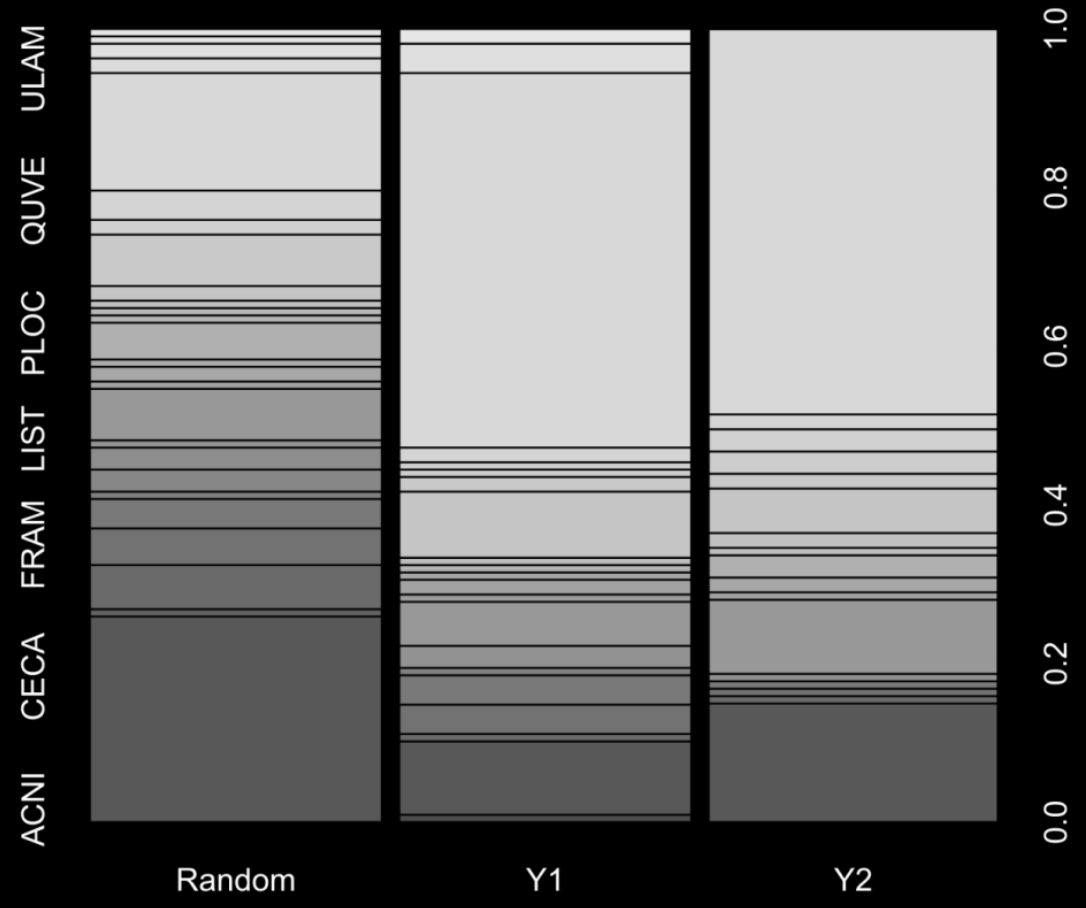


Distances moved between sequentially used roosts differed for the secondary removal colony

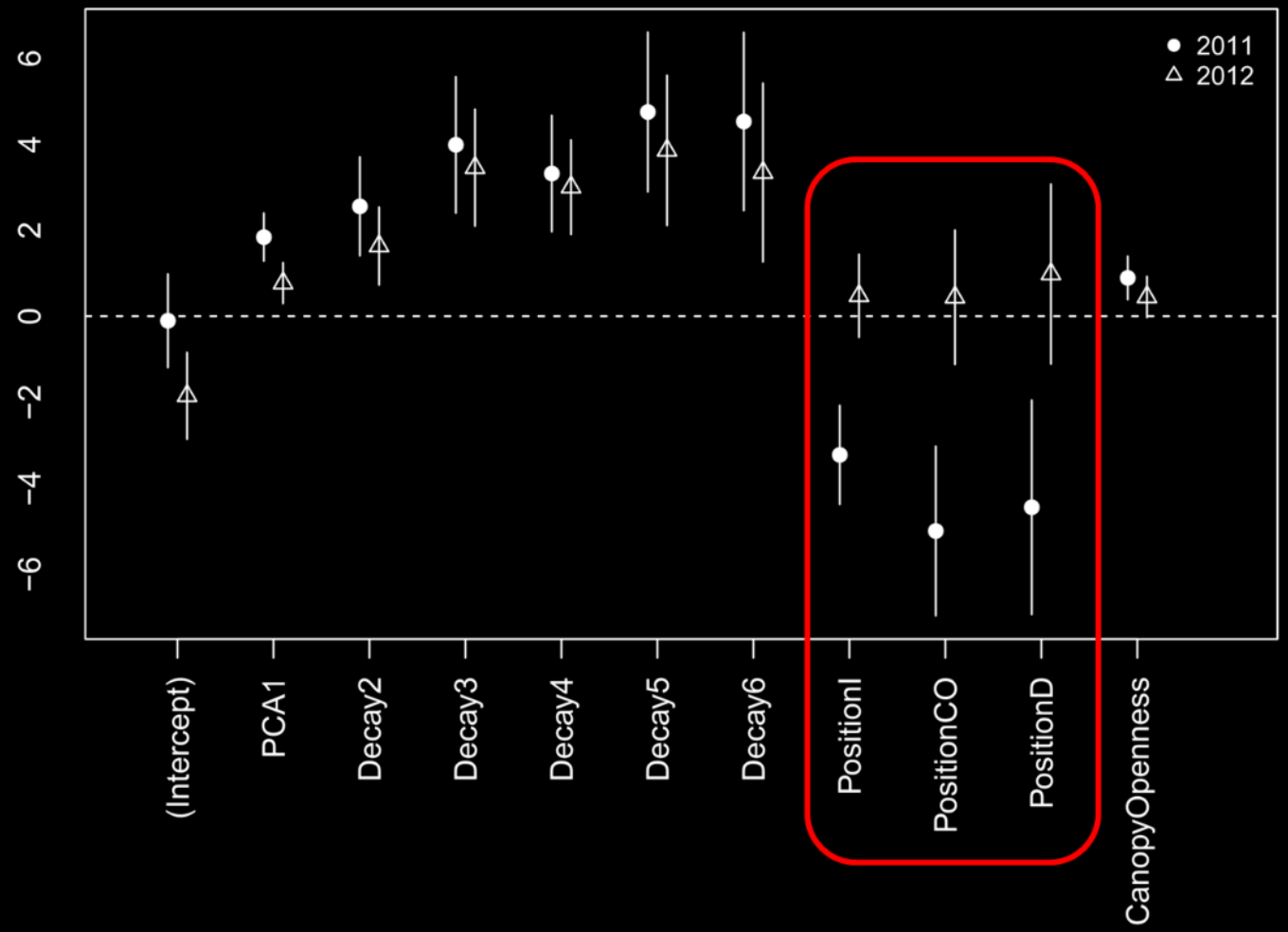
Number of roosts used did not differ between treatments



Day-roost characteristics and species selection similar between treatments and pre-post roost removal

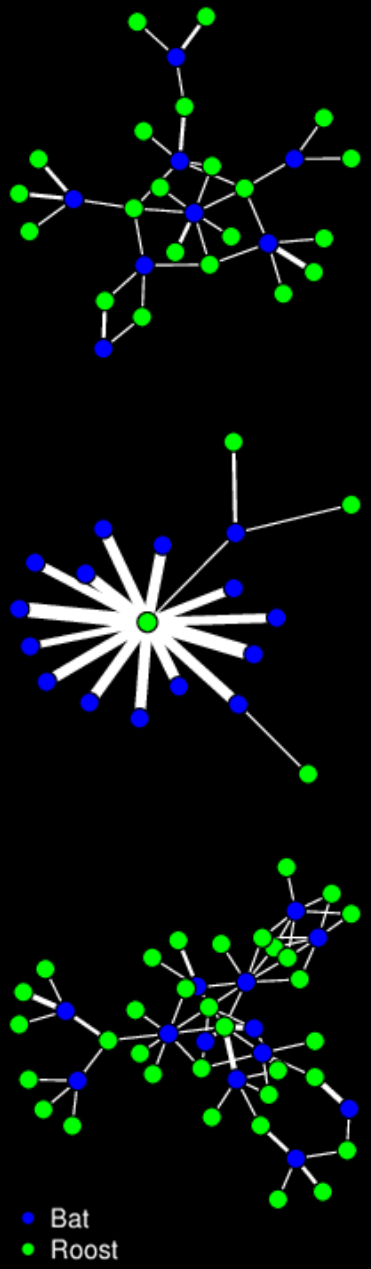


Across roost removal groups and the control, divergence in roost canopy position between years



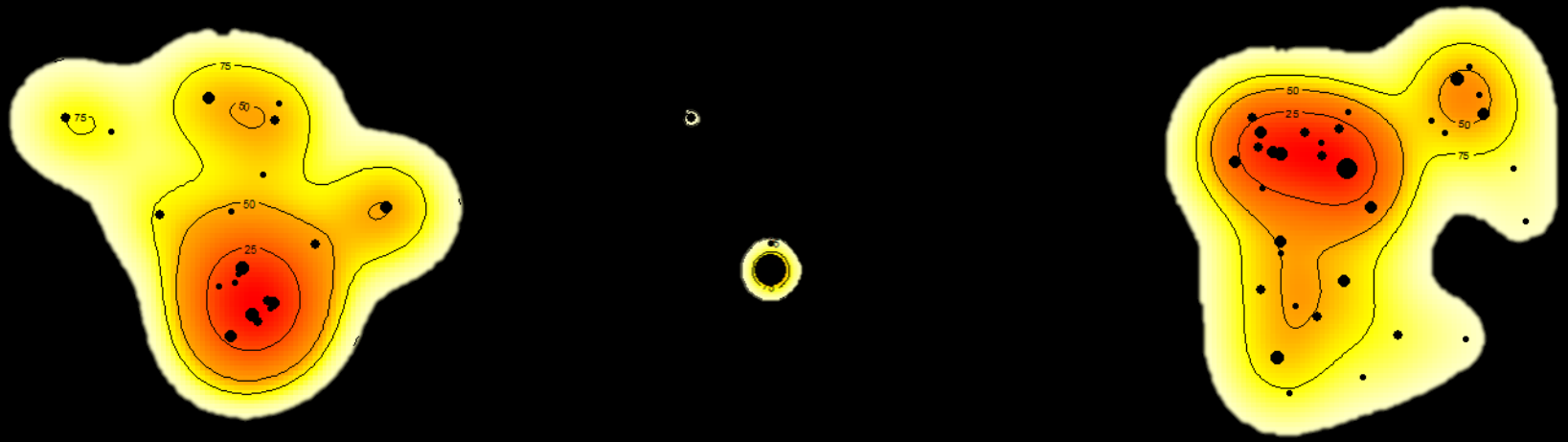
What does this mean for management?

- Result: Colonies have defined social structures
  - Implication: Sub-landscape scale management should focus on groups
- Result: Social structure varies
  - Implication: Management activities should consider differential impacts relative to reproductive condition
- Result: Confirms presence of “primary roosts”
  - Question: What defines a primary roost?
  - Implication: Management activities may be more effective if efforts prioritized



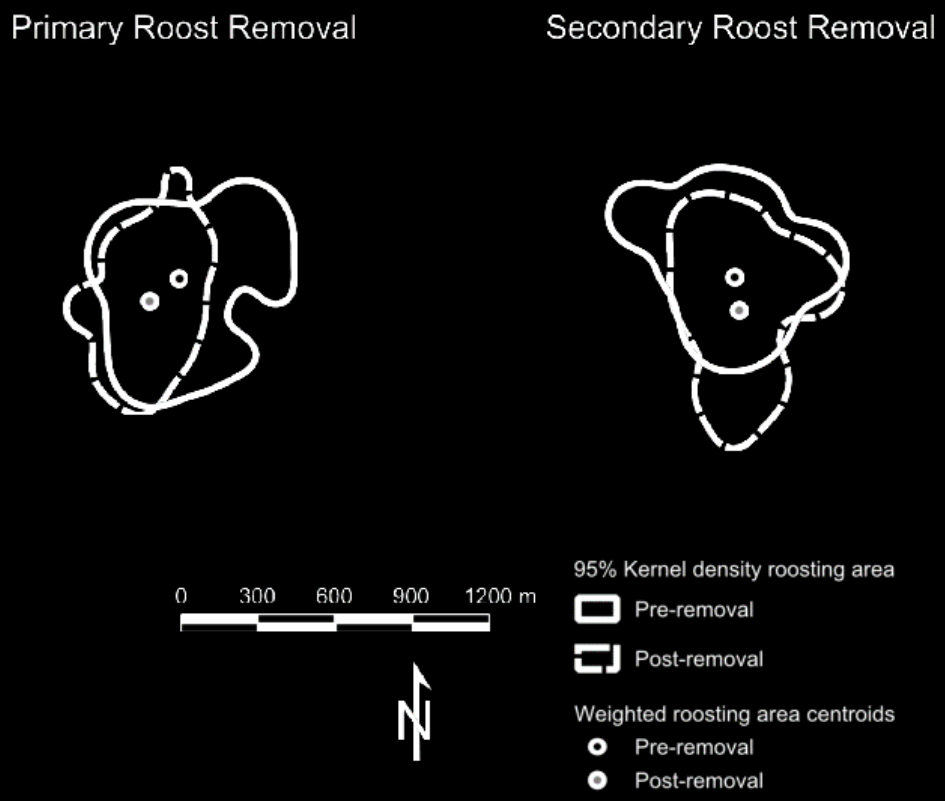
What does this mean for management?

- Result: Roosting areas centralized
  - Implications: Disturbances in periphery may be less harmful than those in the core. Monitoring more effective if targeted toward central roost area.
- Result: Colony roosting areas do not overlap
  - Implication: Need to consider individual colonies and whether should be managed jointly or separately.



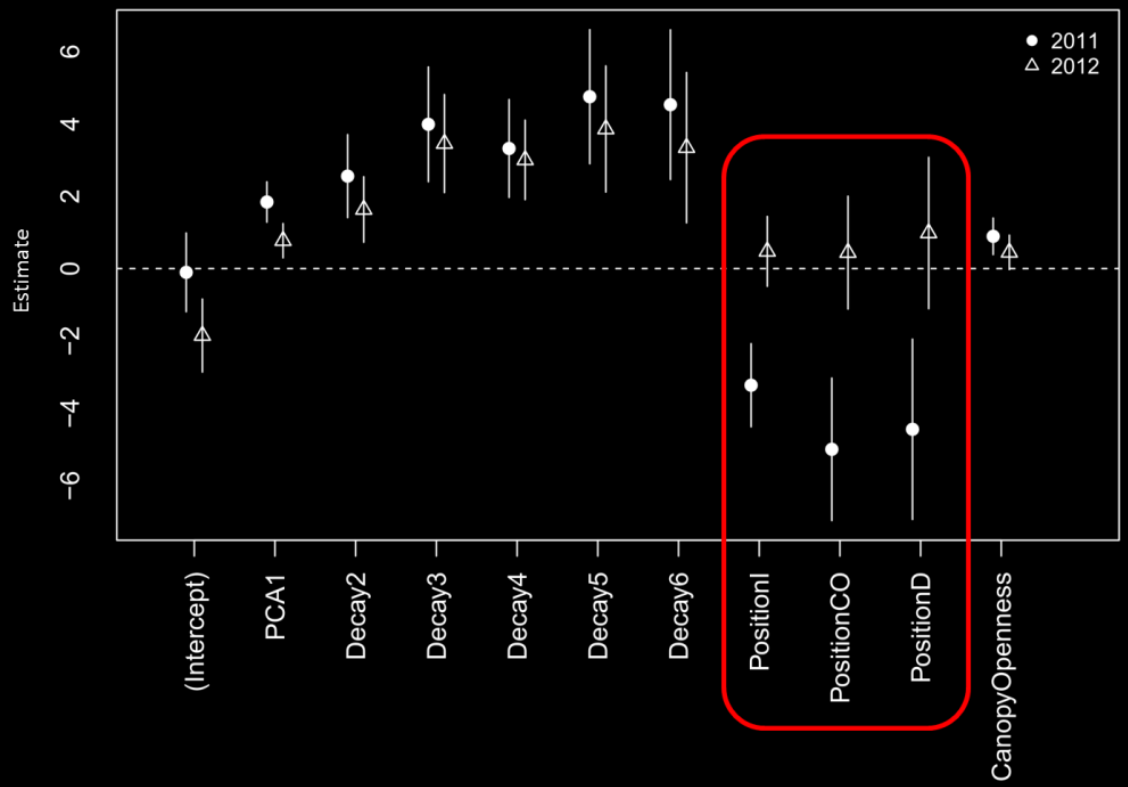
What does this mean for management?

- Result: Limited apparent impact of roost loss
  - Implication: May be able to take more flexible and less restrictive approaches to habitat conservation



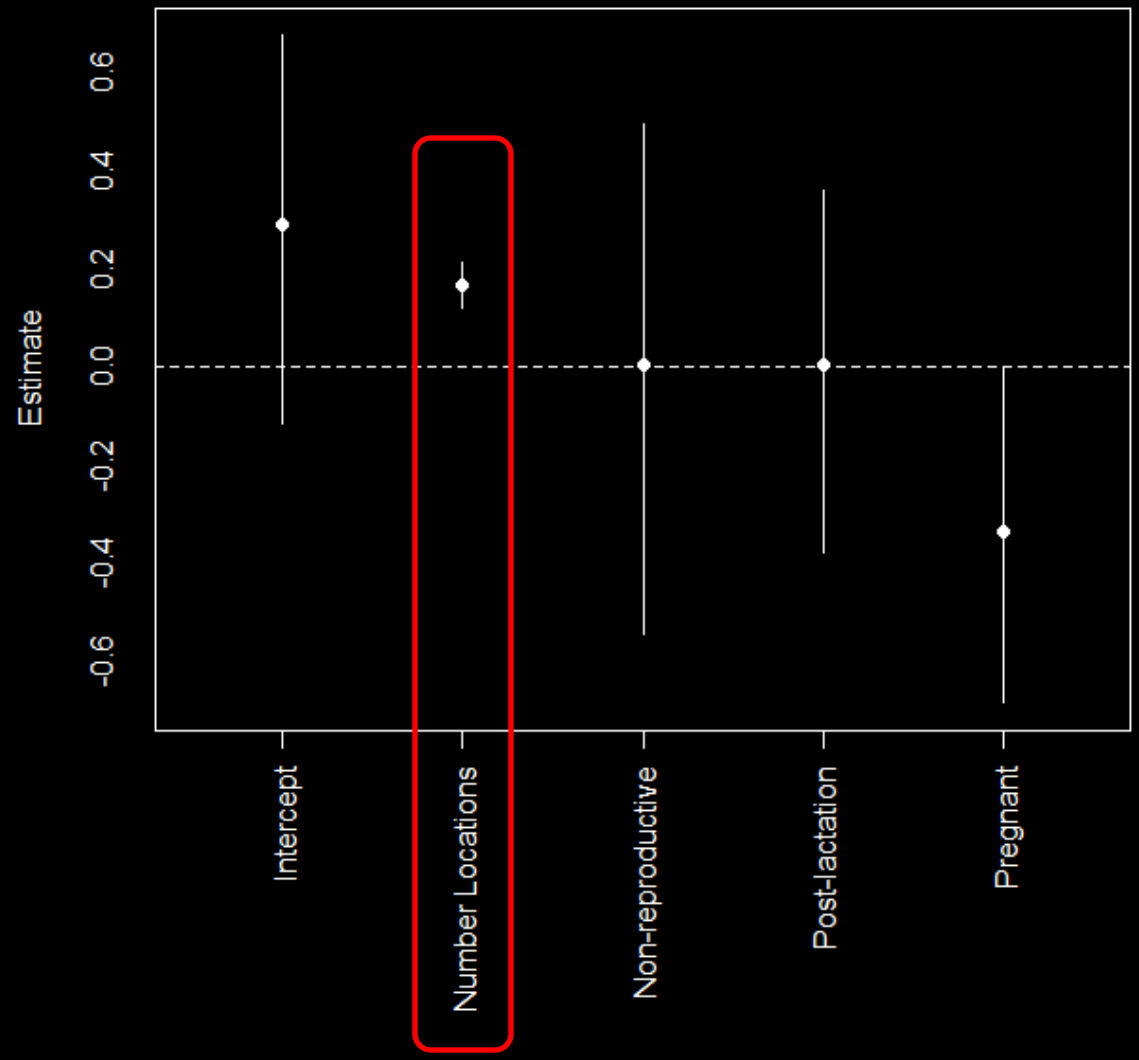
What does this mean for management?

- Result: Roost characteristics differed between years
  - Implication: Single-year roost selection data may yield inappropriate inference. Management decisions for roost conservation should try to incorporate multi-year data to account for variability in selection.

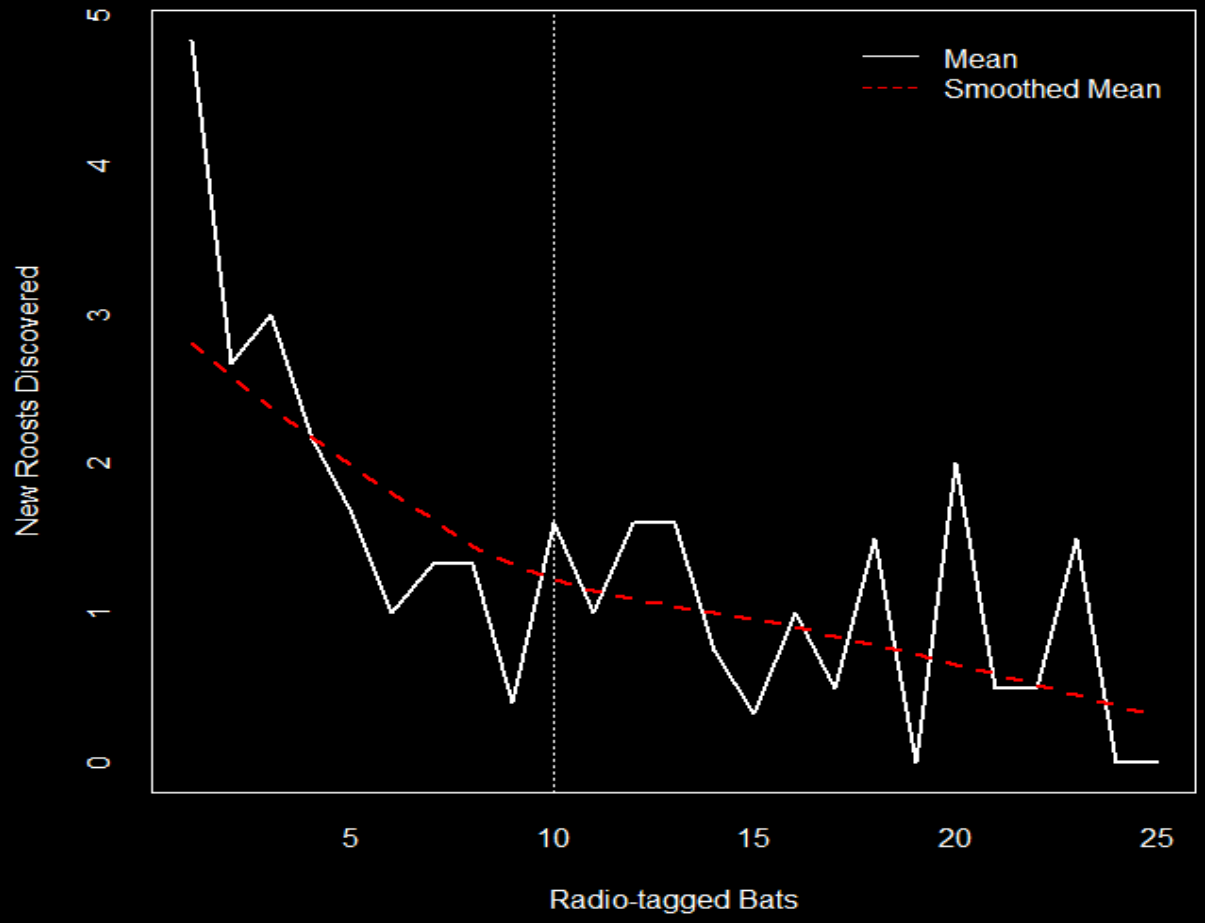


Secondary results

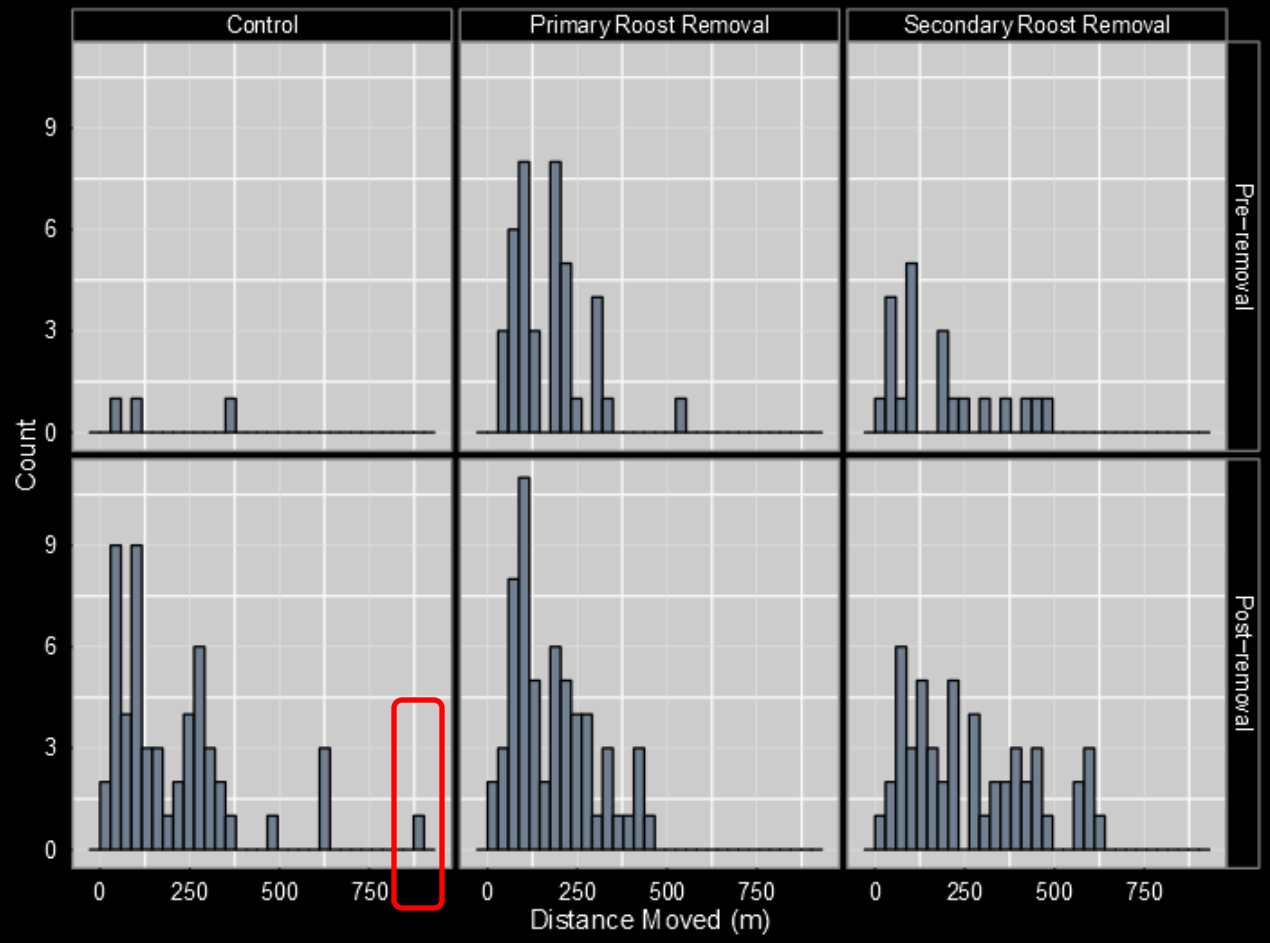
Number of roosts used by bats best predicted by number of relocations



Number of new roosts located declined with addition of each new bat



Inter-roost movement distances of up to 800 m

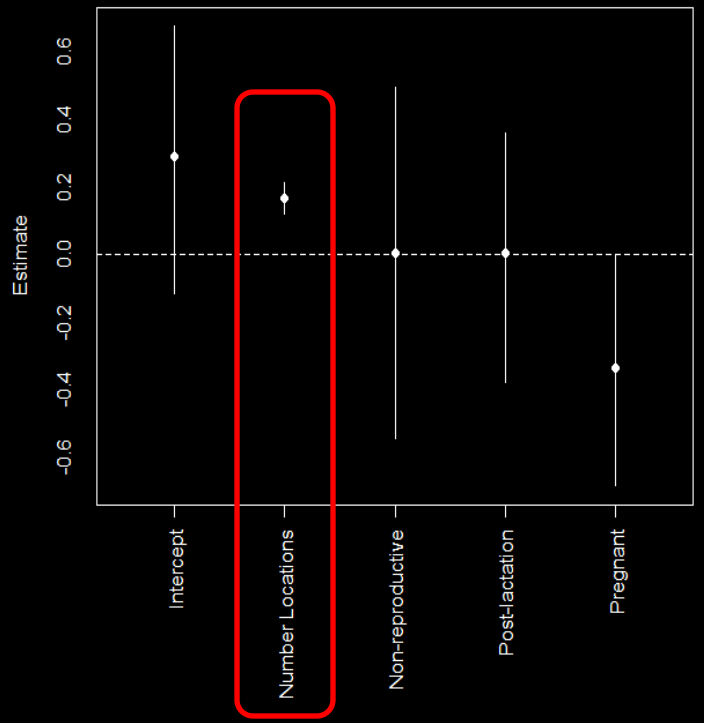


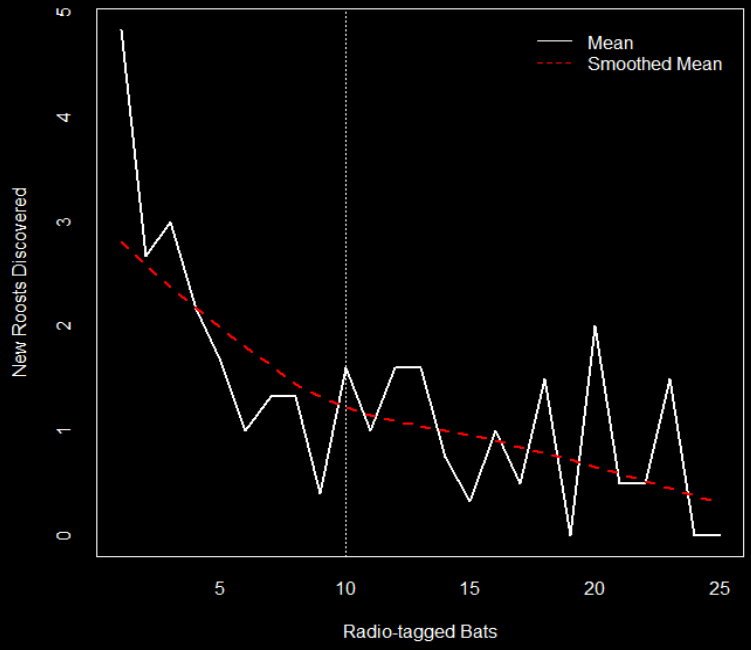
Roosts between 18 and 1,071 m from capture location, with a mean distance 358 m.

Cavities used were highly variable, but larger cavities generally more open than small cavities

What does this mean for management?

- Result: Number roosts used positively related to tracking period
- Result: Number new roosts located decreases with each additional bat tracked
  - Implication: Intensive tracking of few bats may be the most effect way to delineate colony roosting areas





What does this mean for management?

- Result: Inter-roost movement of 800 m
  - Implication: ¼ mile (= 402 m) buffer around roosts may be insufficient to protect all roosts
- Result: Roost location >1 km from capture site
  - Implication: May need substantial buffer to protect roosts

What does this mean for management?

- Result: Larger cavities more open, cavities variable
  - Implication: A variety of artificial roosts should be tested

Final recommendations

- Group based management
  - Spatial considerations
- Potential for liberal management
  - But buffer zones may need to be larger than currently proposed
- Multi-year monitoring
- Intensive monitoring of few individuals
- Potential for artificial roost creation

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RESEARCH ARTICLE

Effects of Hierarchical Roost Removal on Northern Long-Eared Bat (*Myotis septentrionalis*) Maternity Colonies

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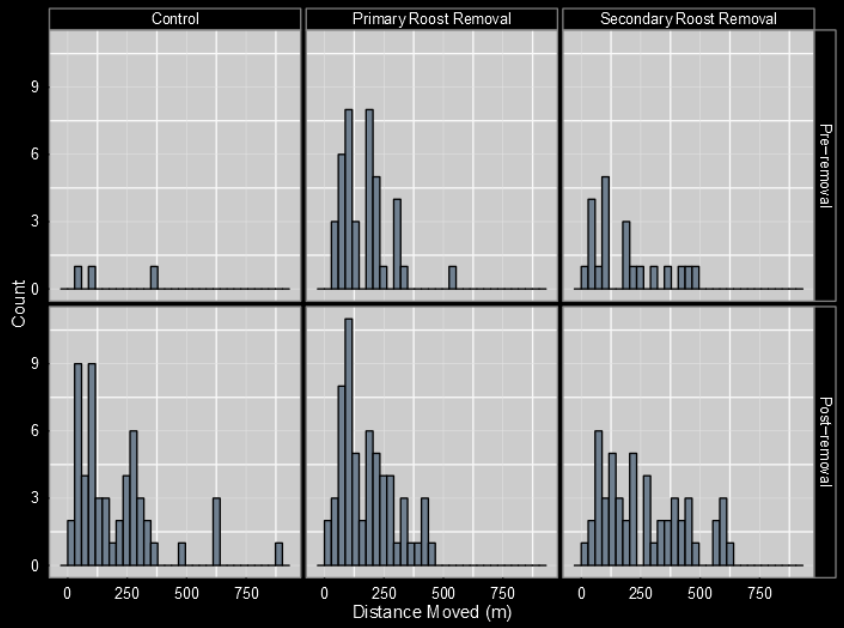
Abstract

Forest roosting bats use a variety of ephemeral roosts such as snags and declining live trees. Although conservation of summer maternity habitat is considered critical for forest-roosting bats, bat response to roost loss still is poorly understood. To address this, we monitored 3 northern long-eared bat (*Myotis septentrionalis*) maternity colonies on Fort Knox Military Reservation, Kentucky, USA, before and after targeted roost removal during the dormant season when bats were hibernating in caves. We used 2 treatments: removal of a single highly used (primary) roost and removal of 24% of less used (secondary) roosts, and an un-manipulated control. Neither treatment altered the number of roosts used by individual bats, but secondary roost removal doubled the distances moved between sequentially used roosts. However, overall space use by and location of colonies was similar pre- and post-treatment. Patterns of roost use before and after removal treatments also were similar but bats maintained closer social connections after our treatments. Roost height, diameter at breast height, percent canopy openness, and roost species composition were similar pre- and post-treatment. We detected differences in the distribution of roosts among decay stages and crown classes pre- and post-roost removal, but this may have been a result of temperature differences between treatment years. Our results suggest that loss of a primary roost or $\leq$ 20% of secondary roosts in the dormant season may not cause northern long-eared bats to abandon roosting areas or substantially alter some roosting behaviors in the following active season when tree-roosts are used. Critically, tolerance limits to roost loss may be dependent upon local forest conditions, and continued research on this topic will be necessary for conservation of the northern long-eared bat across its range.

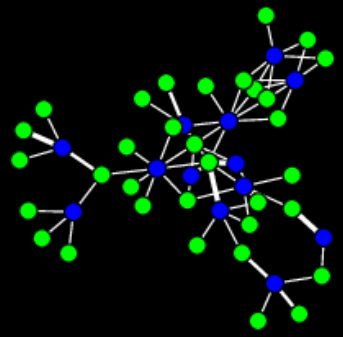
Introduction

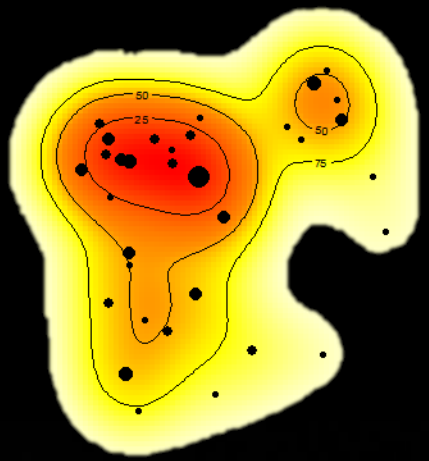
Roosts provide bats with sites for day-time sheltering as protection from weather and predators, mating, and social interaction. For species in temperate areas that form maternity groups



Primary Roost Removal

Secondary Roost Removal





Questions?