Response of Northern Long-eared Bats (Myotis septentrionalis) to Prescribed Fires in Eastern Kentucky Forests

Michael J. Lacki¹, Daniel R. Cox, Luke E. Dodd¹, and Matthew B. Dickinson²

¹University of Kentucky, Lexington, KY
²Northern Research Station, USDA Forest Service, Delaware, OH
Fire In Eastern North America

- Disturbance regime that alters successional pattern
  - Composition
  - Structure
  - Forest function

- Use of prescribed fire is increasing in frequency
  - Recreation of historic stand conditions
  - Control of insect pests
  - Fuel reduction
Introduction

- Habitat modification
  - Data on fire effects on bat habitat and behavior lacking

- Response of bats to fire
  - Red bats arouse during winter burns
  - Evening bats roosted in snags within a prescribe burn treatment area (Boyles and Aubrey 2006)
  - No difference in use between stands that were prescribe burned, thinned and burned, and control (Loeb and Waldrop 2008)

Foraging behavior? Prey base?
Fire Effects on Insect Populations

- Long term effects are variable
  - Orthopterans, dipterans and coleopterans show increased abundance
  - Some moth species attracted to fire causing mortality
- Could alter abundance of prey base
- More studies needed
Northern Long-eared Bat

Ecology

- Formerly ubiquitous in eastern NA forests
- Forms maternity colonies in dead and living trees
- Likely forages in forested habitat associated with roosting sites
  - Coleopterans and Dipterans are common in the diet
  - Attracted to burned areas
Purpose

Fire effects?

- Foraging behavior
- Habitat selection
- Roosting behavior

Insect abundance before and after fires

- Diet
- Foraging patterns
- Habitat choices
Methods: Study Area

Red River Gorge Geological Area, Daniel Boone National Forest, Kentucky

Burn units

- Powder Mill
  - 435 ha
  - Burned 10 April 2007

- Bear Waller
  - 185 ha
  - Burned 30 April 2007
Methods: Home Range & Habitat Use

- Adult female northern bats (n = 15)
  - Tracked while foraging and to roost trees
- 95% home ranges & 50% core areas
  - Pre- and post-burn
- Kruskal-Wallis tests
Methods: Home Range & Habitat Use

Habitat Use

- Euclidian Distance Analysis
  - 2\textsuperscript{nd} order landscape
  - 3\textsuperscript{rd} order home range

- Extended burn unit boundaries
  - Powder Mill - 1.3 km
  - Bear Waller - 0.7 km

- Merged the burn units – 2,670 ha

- Pre-burn and post-burn groupings
Methods: Habitat Types

- Aspect
- Stand type
- Slope position
- Burned vs. Unburned
Methods: Habitat Types

- **Aspect**
  - North (315 – 45°)
  - East (45 – 135°)
  - South (135 – 225°)
  - West (225 – 315°)

- Stand type
- Slope position
- Burned vs. Unburned
Methods: Habitat Types

- Aspect
- Stand type
  - Pine (≥ 70% softwoods)
  - Pine/hardwood (51 – 69% dominant and co-dominant basal area softwoods)
  - Hardwood (≥ 70% hardwoods)
  - Hardwood/pine (51 – 69% dominant and co-dominant basal area hardwoods)
- Slope position
- Burned vs. Unburned
Methods: Habitat Types

- Aspect
- Stand type
- **Slope position**
  - Ridge
  - Mid-slope
  - Lower-slope
- Burned vs. Unburned
Methods: Habitat Types

- Aspect
- Stand type
- Slope position
- Burned vs. Unburned
  - Restricted to post-burn bat grouping
Observed vs. Random

- **2\text{nd}** order selection
  - 5,000 random locations within study area

- **3\text{rd}** order selection
  - 1,000 random locations within 95% home range

- $H_0$: Habitat use should be random and ratio of bat locations to random distances should equal 1.0.
  - MANOVA  Distance ratios to available habitat
  - $t$ tests ranked habitats closest to farthest
Methods: Tree Characteristics

All roost trees and random snags

- 20-m radius plot
- Habitat characteristics
  - Species
  - dbh (cm)
  - Decay class
  - Cavity openings
  - Tree height (m)

- Canopy coverage (%)
- Bark coverage (%)
- Exfoliating bark coverage (%)
- Number of snags and live trees ≥ 16 cm dbh
- Canopy height (m)
All roost trees

- Roost height (m)
- Diameter at roost height (cm)
- Roost position (above, below, within canopy)
- Roost structure (cavity, crevice, bark)
- Exit counts
Methods: Insect Sampling & Food Habits

Black-light traps

- 2006 & 2007
- 4 traps per burn unit
  - 2 traps each on north and south facing slopes
- Sampled all trap locations on the same night within a burn unit
- ~10 day sampling interval
- Insects $\geq 10$ mm identified to ordinal level
Methods: Insect Sampling & Food Habits

Black-light trap analyses

- 2-factor ANOVA’s
  - Main effects
    - Aspect
    - Burn condition (pre-burn vs. post-burn)
  - Response variables
    - Total abundance of insects
    - Abundance of Lepidoptera, Coleoptera, and Diptera
Methods: Insect Sampling & Food Habits

Fecal samples

- Pellets from transmittered female bats
- Identified to Order
- Frequency of occurrence
- Percent volume
Results

- Capture and radio-tagged
  - Pre-burn ($n = 4$)
    - Lacatating ($n = 2$)
    - Post-lactating ($n = 2$)
  - Post-burn ($n = 11$)
    - Pregnant ($n = 4$)
    - Non-reproductive ($n = 7$)

- Primary roosts (> 15 bats exiting roost)
  - $N = 18$
  - Largest exit counts of 56 and 52
  - Large, tall tulip poplar snags
  - Frequent roost switching ($3.8 \pm 0.42 \text{ roosts}^{-1}$)
Results: Foraging Behavior

- Mean home range size
  - Pre-burn: 60.2 ha 14.1
  - Post-burn: **72.3 ha** 6.2

- Mean core area size
  - Pre-burn: 11.4 ha 6.1
  - Post-burn: **13.5 ha** 0.8

- Largest home range: 117 ha
  - Pregnant female captured on 20 May 2007

- Smallest home range: 18.6 ha
  - Lactating female captured on 22 June 2006
### Results: Foraging Behavior

<table>
<thead>
<tr>
<th>Stand Type</th>
<th>Closest</th>
<th>Farthest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-burn, 3(^{rd}) order</td>
<td>Pine(^A)</td>
<td>Hardwood(^{A,B})</td>
</tr>
<tr>
<td>Post-burn, 2(^{nd}) order</td>
<td>Pine(^A)</td>
<td>Pine/Hardwood(^{A,B})</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Slope Position</th>
<th>Closest</th>
<th>Farthest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-burn, 2(^{nd}) order</td>
<td>Mid-slope(^A)</td>
<td>Ridge(^A)</td>
</tr>
<tr>
<td>Post-burn, 2(^{nd}) order</td>
<td>Mid-slope(^A)</td>
<td>Ridge(^B)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Burn Condition</th>
<th>Closest</th>
<th>Farthest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post-burn, 2(^{nd}) order</td>
<td>Burned(^A)</td>
<td>Unburned(^B)</td>
</tr>
</tbody>
</table>
**Results: Foraging Behavior & Diet**

Means ± SE for abundance of insects (>10 mm) captured per trap night in Black-light traps before and after prescribed burning.

<table>
<thead>
<tr>
<th></th>
<th>Total Abundance</th>
<th>Coleoptera</th>
<th>Lepidoptera</th>
<th>Diptera</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-burn (n = 43)</td>
<td>140 ± 14.0</td>
<td>8.0 ± 1.47</td>
<td>126 ± 13.0</td>
<td>1.0 ± 0.25</td>
</tr>
<tr>
<td>Post-burn (n = 84)</td>
<td>188 ± 14.0</td>
<td>24.3 ± 3.24</td>
<td>154 ± 13.0</td>
<td>2.36 ± 0.34</td>
</tr>
<tr>
<td>F-statistic (P-value)</td>
<td>4.09 (0.04)</td>
<td>20.3 (&lt;0.0001)</td>
<td>0.27 (0.60)</td>
<td>12.2 (0.0007)</td>
</tr>
</tbody>
</table>
Results: Foraging Behavior & Diet

Mean percent volume ± SE and frequency of occurrence of insect prey in fecal samples of radio-tagged female northern bats (n = 13).

<table>
<thead>
<tr>
<th>Taxon</th>
<th>Percent Volume</th>
<th>Frequency of Occurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coleoptera</td>
<td>34.0 4.5</td>
<td>100</td>
</tr>
<tr>
<td>Diptera</td>
<td>9.0 2.8</td>
<td>69</td>
</tr>
<tr>
<td>Hemiptera</td>
<td>7.0 2.4</td>
<td>69</td>
</tr>
<tr>
<td>Hymenoptera</td>
<td>1.0 0.7</td>
<td>15</td>
</tr>
<tr>
<td>Lepidoptera</td>
<td>46.0 5.6</td>
<td>100</td>
</tr>
<tr>
<td>Neuroptera</td>
<td>0.0 0.1</td>
<td>8</td>
</tr>
<tr>
<td>Trichoptera</td>
<td>0.0 0.2</td>
<td>8</td>
</tr>
<tr>
<td>Other</td>
<td>4.0 0.3</td>
<td>69</td>
</tr>
</tbody>
</table>
Results: Roosting Behavior

- Located 54 roost trees
  - 30% before fire
  - 70% after fire
- Roosted in 12 species of trees and 3 additional genera
- Predominantly roosted in hardwood stands
- Post-burn
  - 74% of roost trees in burned habitat
  - 26% of roost trees in unburned habitat
  - Roost position switched from mostly south-west facing to south-east facing slopes
- Roosts typically found on ridges and mid-slopes regardless of burn condition
Results: Roosting Behavior

Roost trees vs. Random snags

- **Pre-burn**
  - Roost trees taller in height and in earlier stages of decay

- **Post-burn**
  - Roost trees
    - Earlier stage of decay
    - Greater number of cavities
    - Greater bark coverage
    - Greater exfoliating bark coverage

- No difference in stand characteristics
Results: Roost Characteristics

- Pre-burn vs. Post-burn
  - Majority of roosts located below the canopy with none above the canopy
  - Increased selection of cavities post-burn
    - Consistent with comparisons to random snags
Discussion

- Home ranges and core areas were unaffected by prescribed fire
  - Suggests insect prey remained available
- Higher abundance of total insects, coleopterans, and dipterans supports this prediction
- Home ranges were comparable to other *Myotis* species
Discussion

- Foraged at forested mid-slope positions
  - Consistent with being clutter-adapted foragers
- Preferred to forage in or near pine-dominated stands and burned habitats
  - Sought out less cluttered spaces within forests and habitats supporting abundant prey
Discussion

- Used a range of tree species within the study area
- Majority of roosts in hardwood species (93%) compared to pines (7%)
  - Contrasts with previous studies in Kentucky where pines were used most frequently (Lacki and Schwierjohann 2001)
- Chose roost trees in burned habitats
  - Consistent with finding for evening bats (Boyles and Aubrey 2006)
Discussion

- Roosts were situated on ridge and mid-slope positions
  - Known to roost on upper slopes in Kentucky (Lacki and Schwierjohann 2001)
- Roost locations changed from south-west to south-east aspects after prescribed fire
  - Likely due to burning on east facing slopes
- Chose roost trees in earlier stages of decay than random snags
Discussion

- Roost tree selection
  - Pre-burn ➡ tree height
  - Post-burn ➡ bole condition

- Roost site selection
  - Pre-burn ➡ exfoliating bark
  - Post-burn ➡ cavities

- Importance of bole condition after fire was unexpected
  - Possible that a wider range of roosting structures could provide more long-term roosting opportunities
Discussion

Fire-adapted species

- Roosted and foraged extensively in burned habitat after prescribed burning
  - Results suggest that populations of northern bats will not likely be harmed

- Behavioral plasticity
  - Uses live trees and snags for roosting
  - Uses range of roosting structures
  - Awaken and move during fires (Dickinson et al. 2008)
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Literature Cited