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

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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

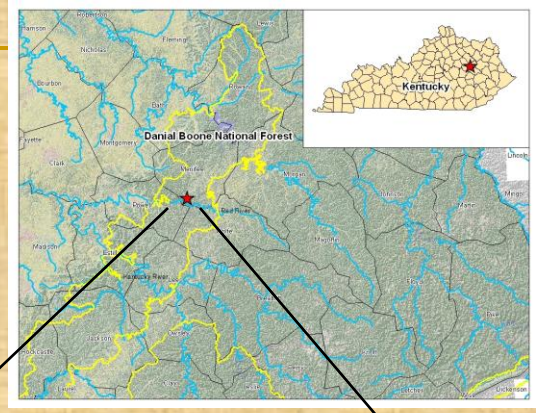
- **Diet**
- **Foraging patterns**
- **Habitat choices**

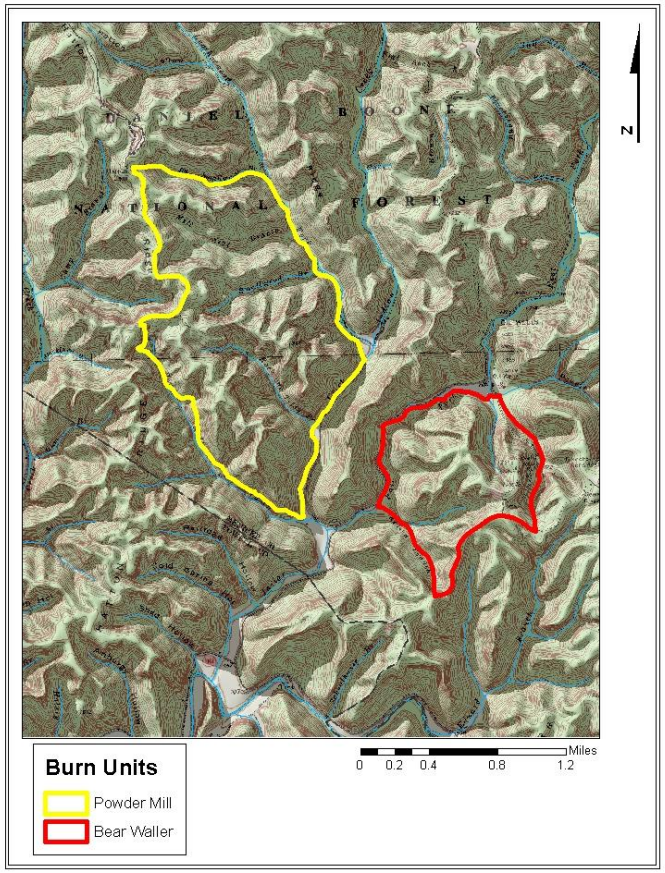
Methods: Study Area

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
  - 2nd order → landscape
  - 3rd 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**

Methods: Home Range & Habitat Use

Observed vs. Random

- 2nd order selection
  - 5,000 random locations within study area
- 3rd order selection
  - 1,000 random locations within 95% home range

- H_o: 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)

Methods: Roost Tree Characteristics

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 ≥ 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

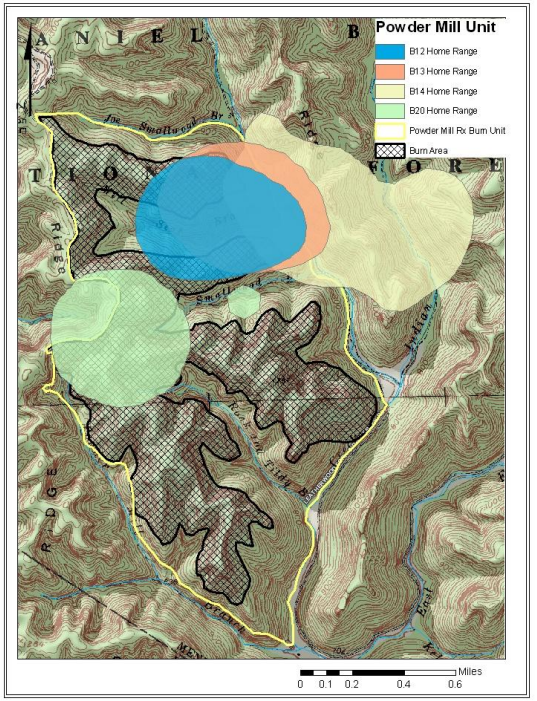



Results

- 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 0.42 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

Closest → Farthest

Stand Type

Pre-burn, 3rd order	Pine^{A}	Hardwood^{A,B}	Hardwood /Pine^{A,B}	Pine/ Hardwood^{B}
Post-burn, 2nd order	Pine^{A}	Pine/ Hardwood^{A,B}	Hardwood^{B,C}	Hardwood/ Pine^{C}

Slope Position

Pre-burn, 2nd order	Mid-slope^{A}	Ridge^{A}	Lower-slope^{B}
Post-burn, 2nd order	Mid-slope^{A}	Ridge^{B}	Lower-slope^{C}

Burn Condition

Post-burn, 2nd order	Burned^{A}	Unburned^{B}

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.

	Total Abundance	Coleoptera	Lepidoptera	Diptera
Pre-burn (*n* = 43)	140 14.0	8.0 1.47	126 13.0	1.0 0.25
Post-burn (*n* = 84)	188 14.0	24.3 3.24	154 13.0	2.36 0.34
F-statistic (*P*-value)	**4.09 (0.04)**	**20.3 (<0.0001)**	0.27 (0.60)	**12.2 (0.0007)**

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).

Taxon	Percent Volume	Frequency of Occurence
Coleoptera	**34.0 4.5**	**100**
Diptera	**9.0 2.8**	**69**
Hemiptera	7.0 2.4	69
Hymenoptera	1.0 0.7	15
Lepidoptera	**46.0 5.6**	**100**
Neuroptera	0.0 0.1	8
Trichoptera	0.0 0.2	8
Other	4.0 0.3	69

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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