Response of *Peromyscus* mice to the effects of timber harvesting in Ozark oak-hickory forests in southeast Missouri

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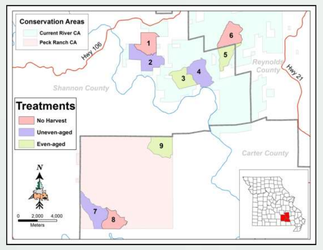
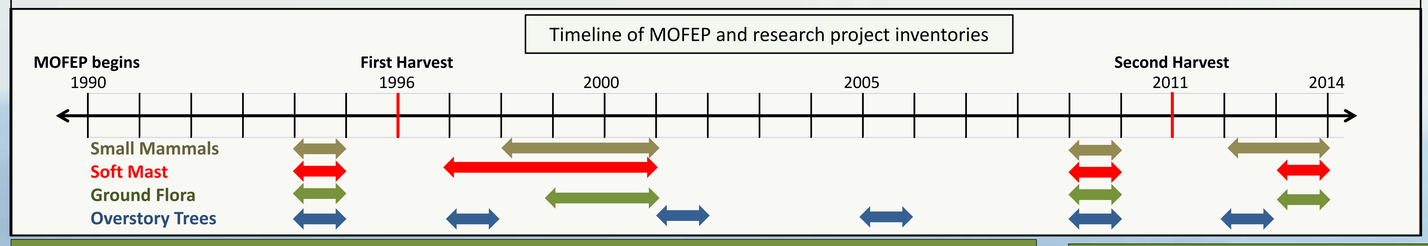
Missouri Ozark Forest Ecosystem Project (MOFEP)

Description: a landscape-scale experiment to determine the effects of common forest management practices on multiple ecosystem components of Ozark forests, using an adaptive management approach to implement timber harvest techniques.

- Planned 100 years in duration
- Randomized complete-block design
- 3 treatments, or management practices:
  - even-aged management
  - uneven-aged management
  - no harvest management
- 3 replicate sites per treatment (range 772-1271 acres)
- Harvests occur every 15 years



- Core studies:
  - Overstory trees
  - Ground flora
  - Small mammals
  - Herpetofauna
  - Birds
- Other studies include hard- and soft-mast, soil and nutrients, snags and tree cavities, and carbon flux



Objectives and Hypotheses

Objectives

- Understand how changes to the forest ecosystem after timber harvesting affect *Peromyscus* mice abundance
- Integrate data from multiple research projects on MOFEP to better explain mouse population dynamics

Hypotheses

- Mice abundance is positively affected by increases of soft mast berry production
- Soft mast vegetative cover and harvest intensity positively influence mice abundance
- Mice abundance is negatively associated with increases in canopy cover, stand density and basal area
- Mice abundance is positively associated with cover of down dead wood and leaf litter

Challenges

- Different research studies conducted at various spatial scales
- Limited overlap of inventory years
- Due to these considerations, variable selection was limited to data collected in the same timeframe
- Harvest intensity is represented in the model by harvest type (categorical), thus limiting interpretative ability of results ; model procedure investigated the pairwise differences between each harvest type vs. no harvesting.

Small Mammal Project

Objective: Determine the effects of even-aged, uneven-aged, and no-harvest forest management on the species composition and relative abundance of small mammals.

Methods

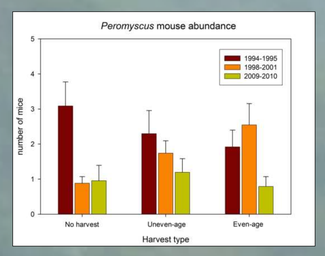
- 2 trap grids per site; placed on northeast slopes
- Trap grids consist of 144 Sherman live traps (12 x 12), spaced at 25m
- Trapping occurs from April – May
- Individuals were marked with unique ID

Peromyscus mouse being marked with ear tag

Results

- Following the 1996 harvest, apparent region-wide natural declines in Peromyscus mice abundance was dampened on harvested sites
- Short-term effects of harvests had dissipated by 2010
- No species have been lost on any MOFEP site since 1994

Sherman live trap

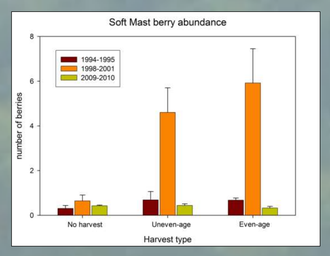


Soft Mast Project

Objective: Investigate the response of soft mast (berry) producing species to forest management

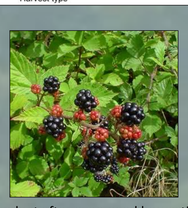
Methods

- Data collection occurs from June – September
- 16 1-meter^2 quadrats are nested within each of the 70-76 1/2-acre vegetation plots per site; >10,000 quadrats!
- Record vegetative cover of soft mast producing species
- Count number of reproductive structures (bud, flower, fruit, or empty fruit stalk)



Results

- Timber harvesting significantly increased soft mast production
- Species of *Rubus* (raspberry) and *Vitis* (grape) increased cover and production the most under even-aged management
- Increases were short-lived; 13 years after harvest, berry abundances had sharply declined



Rubus (raspberry and blackberry) species are abundant after even-aged harvesting

Analytical Methods and Results

Multiple Linear Regression (Figures 1-4)

Parameters (all data was averaged to the site-level)

- Independent covariates in model:
  - Average number of berries per quadrat in previous year (fig 1)
  - Soft mast vegetative cover (0-1 meter height) in previous year (fig 2)
  - Number of *Peromyscus* mice in previous year (fig 3)
  - Harvest type (fig 4)
- Dependent variable: number of *Peromyscus* mice

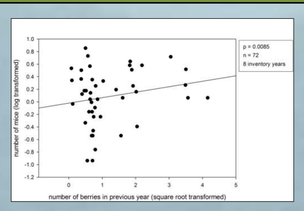


Figure 1. Regression of soft mast berries on mice

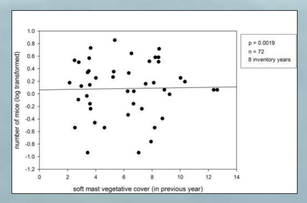


Figure 2. Regression of soft mast plant cover on mice

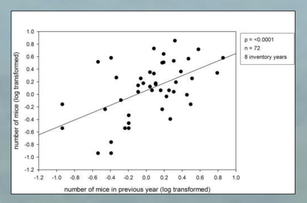


Figure 3. Regression of mice on mice in next year

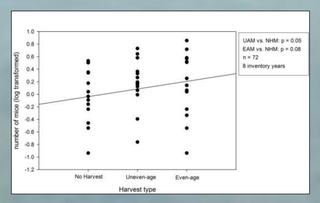


Figure 4. Regression of harvest type on mice

Results

- $R^2 = 0.47$; $p = 0.0001$; DF = 5; F = 7.01
- Berry count has a positive effect on the following year's mouse population: increased food resource may contribute to greater survival and reproduction
- Mice abundance is influenced by mice abundance in previous year: support for auto-correlative effect; mice beget more mice

R^2	MSE	SSE	Variables in model	# of variables
0.47	0.787	24.16	uneven-age harvest, even-age harvest, # berries, # mice, softmast veg cover	5
0.41	0.811	26.95	# berries, # mice, softmast veg cover	3
0.32	0.865	31.43	# berries, # mice	2
0.28	0.879	33.23	# mice	1
0.32	0.881	31.05	uneven-age harvest, even-age harvest, # berries, # mice	4

A

B

C

D

E

F

A. B. C. Changes in stand density and basal area after harvest. D. E. F. Canopy cover development after harvest.

Simple Linear Regressions (Figures 5 and 6)

- Basal area and canopy cover of overstory trees are important indicators of stand conditions
- Both are negatively correlated with mice abundance
- As forest stands develop, less sunlight penetrates to the understory, soft mast plants flower less, and therefore fewer food resources are available

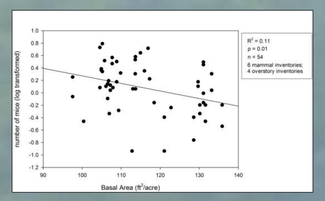


Figure 5. Regression of basal area on mice

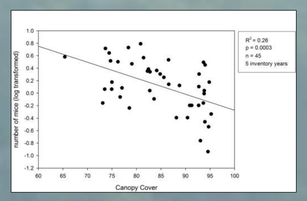


Figure 6. Regression of canopy cover on mice

Future Directions

- The second harvest in 2011 substantially increased the amount of the study area affected by active forest management; this data will contribute to further understanding of *Peromyscus* population dynamics.
- Addition of acorn production from the MOFEP hard mast project as an important food resource of *Peromyscus.*
- Addition of climate data (precipitation and temperature) from local weather stations as an environmental filter on *Peromyscus* abundance.

Acknowledgements

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- Hundreds of dedicated biologists and seasonal technicians have contributed to the successful data collection at MOFEP.