

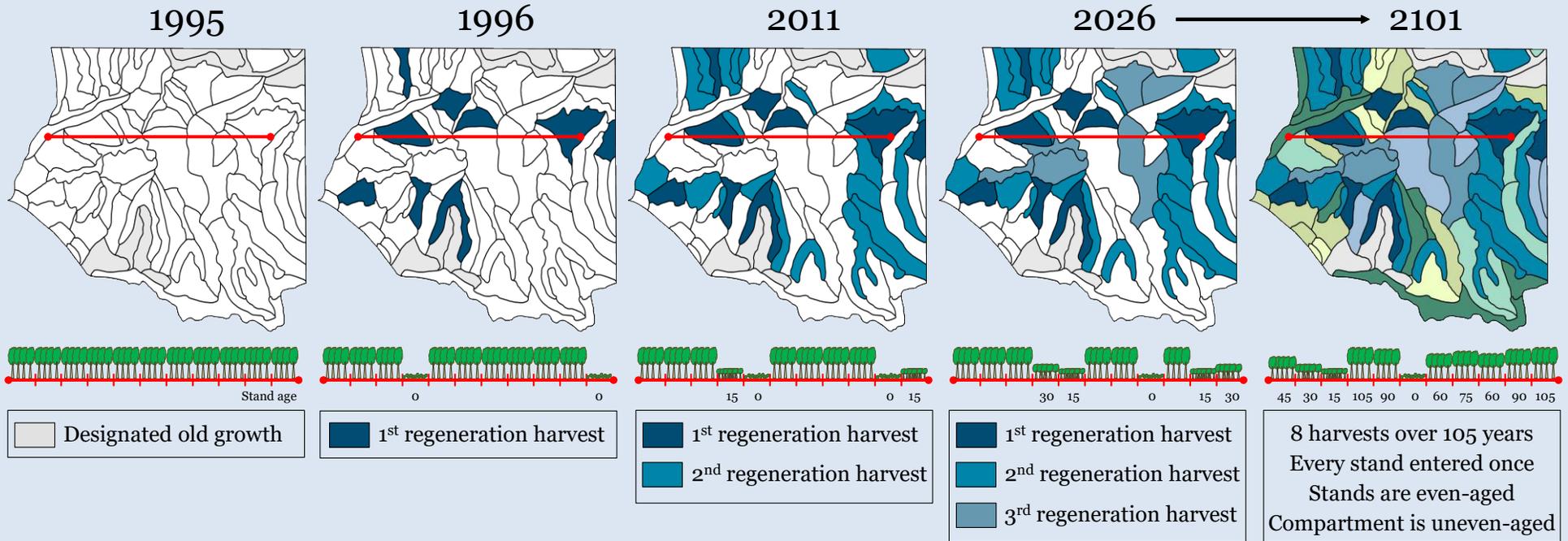


# Missouri Ozark Forest Ecosystem Project MOFEP

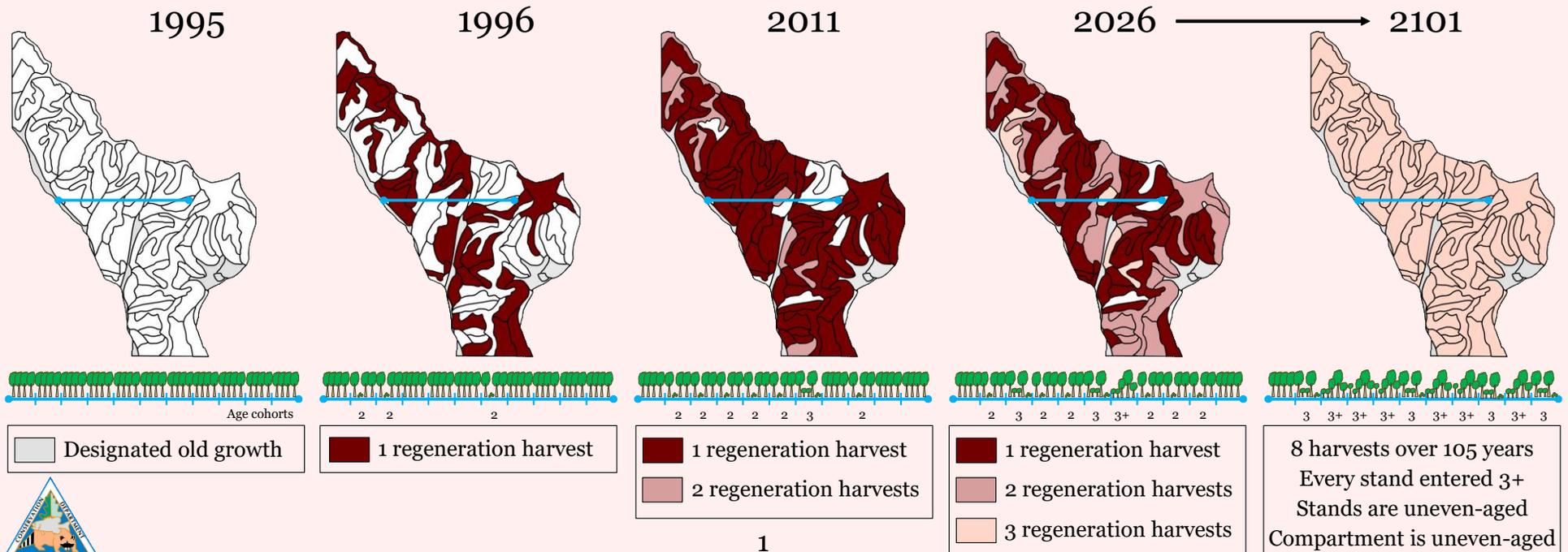


# MOFEP Forest Management Systems

## Even-aged Management



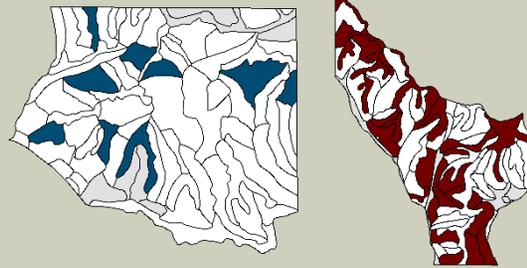
## Uneven-aged Management



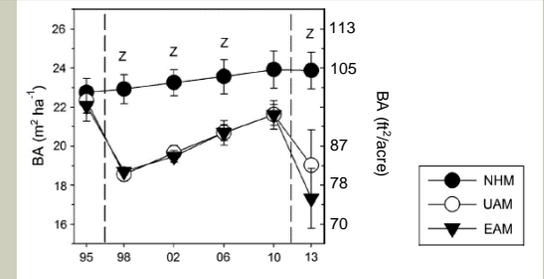
# MOFEP Silvicultural Treatments

## Scale

- Treatments are applied at the stand-scale
- Even-aged management is intensive
  - 10 – 12% of compartment treated
- Uneven-aged management is extensive
  - 20 – 60% of compartment treated
- Approximately the same amount of timber is removed per entry under each management system



Stands entered in 1996 even-aged harvest on site 9 (blue) and 1996 uneven-aged harvest on site 7 (red).



Basal area on all MOFEP sites through time. Vertical dashed lines represent harvest years.

## Regeneration Harvests

- Even-aged regeneration harvests
  - Clearcut with reserves
    - Residual basal area (RBA) < 10 ft²/acre
  - Shelterwood
    - Overwood RBA ca. 30 ft²/acre
- Uneven-aged regeneration harvests
  - Single-tree selection
    - RBA ca. 60 – 70 ft²/acre (B-level stocking)
  - Group selection (only used in 1996 harvest)
    - RBA ca. 60 – 70 ft²/acre (B-level stocking)
    - Group opening size dependent on aspect



2011 clearcut with reserves (left) and 1996 clearcut with reserves (right).



2011 shelterwood after the establishment cut.

## Intermediate Treatments

- Intermediate treatments
  - Selection and free thinning
  - Timber stand improvements
- Stands in even-aged sites receive intermediate treatments in an entry prior to the regeneration harvest
- Stands in uneven-aged sites receive intermediate treatments at the same time as the regeneration harvest



2011 free thinning on an even-aged site.



1996 single tree selection.



1996 group openings on a ridge.



# Woody Vegetation

Project Summary

2019

## Management Suggestions:

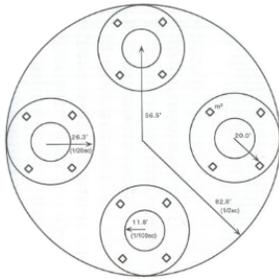
- To promote red and white oak regeneration, reduce stand basal area to at least ca. 25 ft<sup>2</sup>/acre & 45 ft<sup>2</sup>/acre, respectively.
- Red oak regeneration will be most successful on poorer quality sites and when advance regeneration density exceeds roughly 450 stems/acre.
- If relying on UAM methods, group-selection harvests will result in higher densities of total regeneration and of white oak regeneration than will single-tree selection harvests.
- To promote shortleaf pine regeneration, additional treatments will be required to prepare the seedbed and to control competing hardwood vegetation.
- Monitor red maples during the seedling-to-sapling transition; on higher quality sites the species may maintain a competitive advantage.



## Objectives

Evaluate the impacts of forest management on the composition and structure of woody tree, sapling, and seedling species

## Project Design

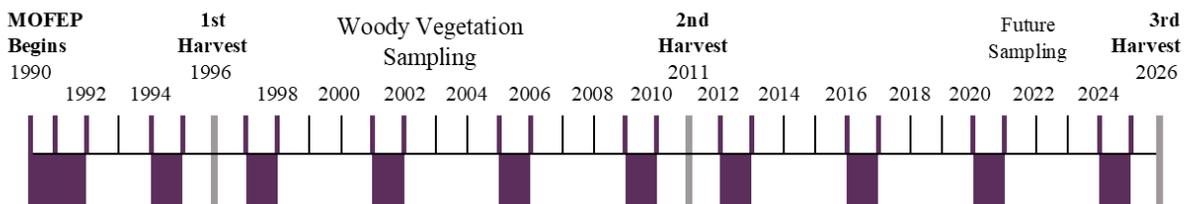
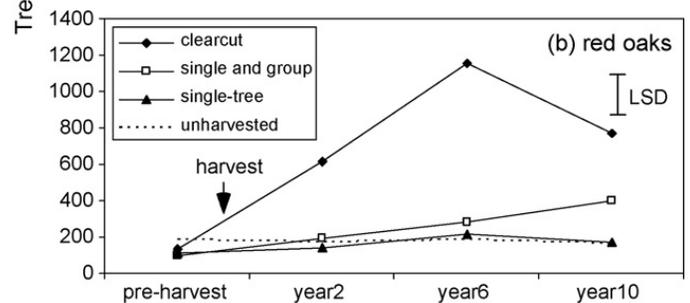
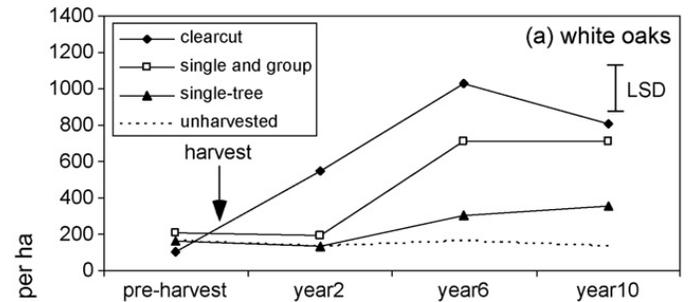


- Total of 648 half-acre woody vegetation plots across the 9 sites.
  - Between 70 and 76 plots per site across all ELTS.
- Trees, saplings, and woody regeneration are sampled in successively smaller nested subplots.
- Sampling occurs in the dormant season every four years and in the years pre- and post-harvest.



## What we have learned so far:

- In the 15-year interval between the first two harvests, tree basal area on EAM and UAM sites rebounded to nearly the level of untreated NHM sites.
- In the overstory of all sites, black oak and scarlet oak decreased while white oaks increased, indicating a potential compositional shift.
- Recruitment of red oaks into larger size classes is occurring only on EAM sites, mostly localized to clearcuts.
- Recruitment of white oaks and hickories has occurred on both EAM and UAM sites, with white oak recruitment being highest in combination group- and single-tree selection areas and in clearcuts.
- The density of red maple seedlings increased on all sites.
- Harvesting on both EAM and UAM sites accelerated the replacement of declining older trees by more vigorous young trees, which should enhance forest health.



# Ground Flora & Soft Mast

Project Summary

2019



## Management Suggestions:

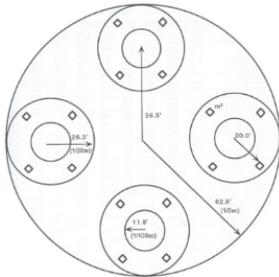
- Prevent introduction of new invasive plant seeds via logging equipment
- Vigilant monitoring and removal of invasive plants
- Watch for decreases in high quality species
- Clearcut areas should remain small and scattered on the landscape
- Devote resources to glade management to increase flora diversity



## Objectives

Evaluate the impacts of forest management on the richness, diversity, abundance, and composition of ground flora plant species and soft mast abundance.

## Project Design

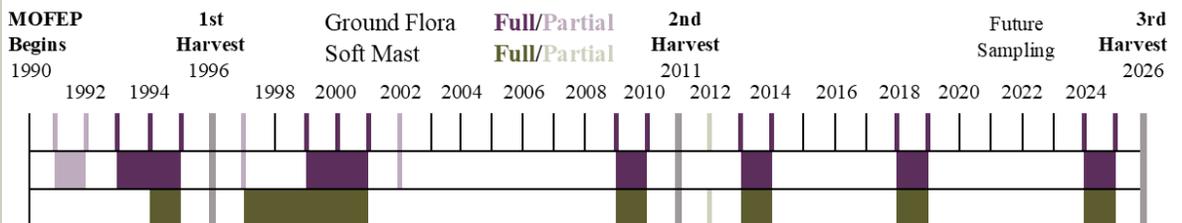
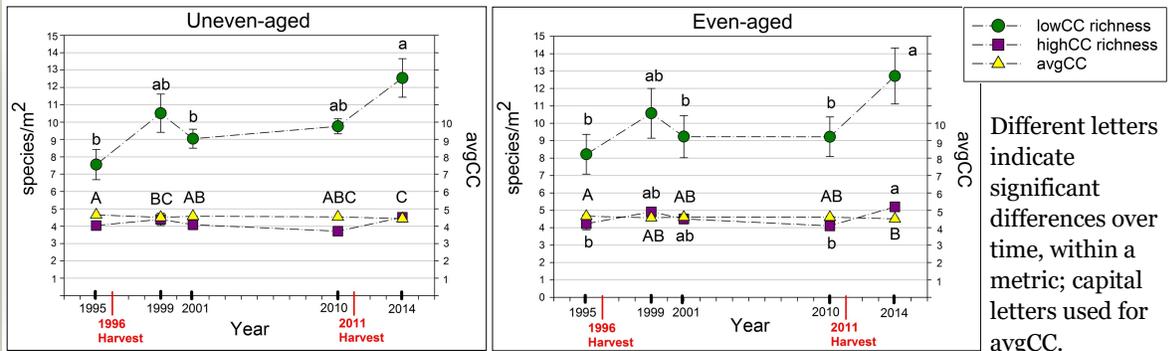


- Inventories are on 648 half-acre vegetation plots, randomly placed across nine sites.
- Data recorded on 16 1-square-meter quadrats, systematically nested within the half-acre plot.
- Sampling occurs from June through early September.
- Every vascular plant identified to species level; abundance assessed using percent cover; soft mast structures counted.



## What we have learned so far:

- There were no significant changes in the No Harvest sites; species richness, diversity, and abundance of flora and soft mast berries remained low.
- Increases in richness, diversity, and abundance occurred in Even-age and Uneven-age sites 3-5 years after harvest, especially native woodland species.
- Soft mast berries increased dramatically in clearcut stands in EAM.
- These metrics later declined as the new stand developed, especially as clearcut stands entered stem exclusion, shading out the ground layer.
- Community quality assessed using Coefficients of Conservatism (CC) values; high quality species increased, but average floral quality (avgCC) declined slightly due to a greater increase of low quality native species.
- Non-native species did not increase on plots, but we found new occurrences of aggressive non-native invasive species, especially on logging landings and skid trails.





# Breeding Songbirds

Project Summary

2019

## Management Suggestions:

- Larger areas (>400 ha) of uncut forest would provide the highest densities of mature forest birds.
- Reducing the number of stands harvested per entry and harvesting adjacent stands could reduce negative direct and indirect effects on mature forest species.
- A shorter re-entry period of 7-10 years would provide a more sustained population of early succession shrub land bird species.
- Changes in the surrounding landscape, such as exurban development, increase in food opportunities for generalist predators, increase in short-grass pasture/lawn, or an increase in grazing herbivores and associated land management should be monitored because these could change the interaction of forest management and avian reproductive success.



## Objectives

Evaluate the effects of forest management on territory abundance and reproductive success of breeding bird populations.

## Project Design

- Spot-mapping to count the number of breeding territories/area.
- Point-counting to measure relative abundance from rate of song detection.
- Nest searching and monitoring to estimate reproductive success and brood parasitism by Brown-headed Cowbirds.
- Mist-netting and banding to study bird use of regenerating clearcuts during the post-fledgling period.



**Focal Mature Forest Species:** Acadian Flycatcher, Kentucky Warbler, Ovenbird, Wood Thrush and Worm-eating Warbler.

**Focal Early Succession Species:** Blue-winged Warbler, Hooded Warbler, Indigo Bunting, Prairie Warbler, White-eyed Vireo & Yellow-breasted Chat.

## What we have learned so far:

### Mature forest bird species

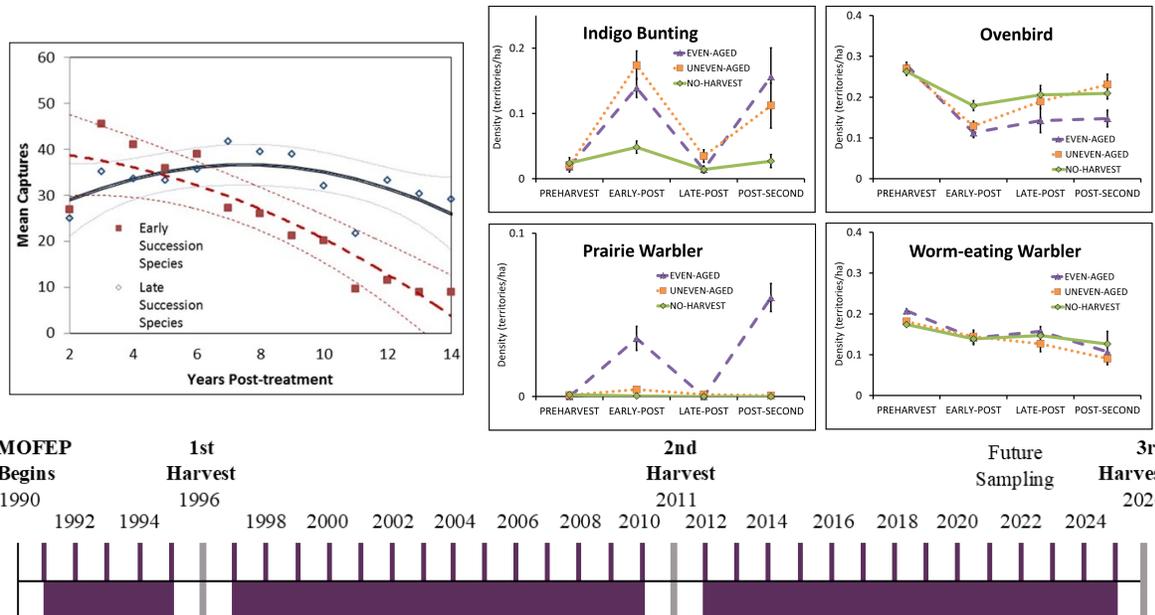
- Forest management reduces territory abundance, but forest birds continue to occupy and reproduce on sites managed with all three silviculture alternatives.
- Reductions in abundance on the no-harvest sites suggest the possibility that silviculture may have impacts on forest birds that occur over a distance of several kilometers and last for up to 14 years.

### Early succession shrub land bird species

- Both harvest practices provided habitat that was not present prior to harvest, but some species responded most positively to even-aged management.
- Current management tends to produce a recurring pulse where abundance of shrub land bird species peaks in year 7-8 and declines to near zero by 12 years after harvest.

### Reproductive Success

- Forest management does not appear to increase populations of avian nest predators or Brown-headed Cowbirds and does not significantly affect nest success or brood parasitism, but future changes in the landscape may interact with effects of forest management.
- Both groups of bird species use the dense vegetation of regenerating clearcuts as potentially important habitat during the post-fledgling period of juvenile development.





# Herpetofauna

Project Summary

2019

## Management Suggestions:

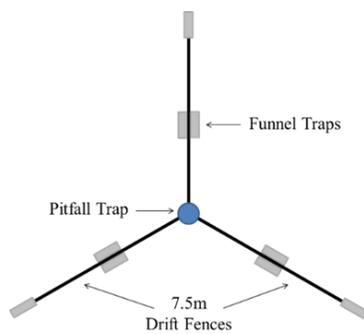
- Keep clearcut acreage small.
- Minimize soil disturbance and compaction.
- Leave down and dead wood and snags to provide refugia in disturbed areas.
- Maintain or exceed BMPs around ponds and streams.
- Balance needs of mature forest species and early successional species.
- Consider availability of surrounding habitat. Is their potential for species immigration or emigration?
- Do not allow intentional snake killing. Give venomous snakes their space to reduce chance of envenomation.



## Objectives

Evaluate the impacts of forest management on abundance and species composition of amphibian and reptile populations.

## Project Design

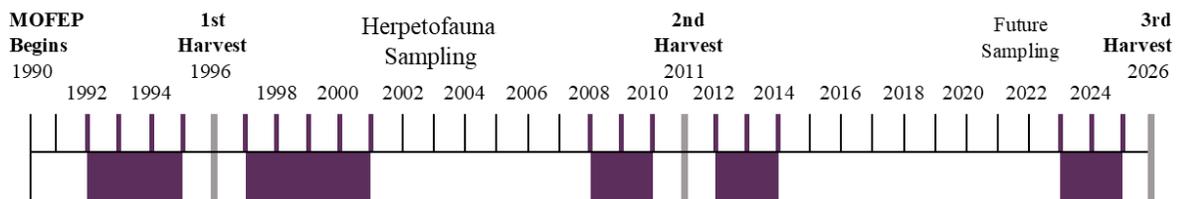
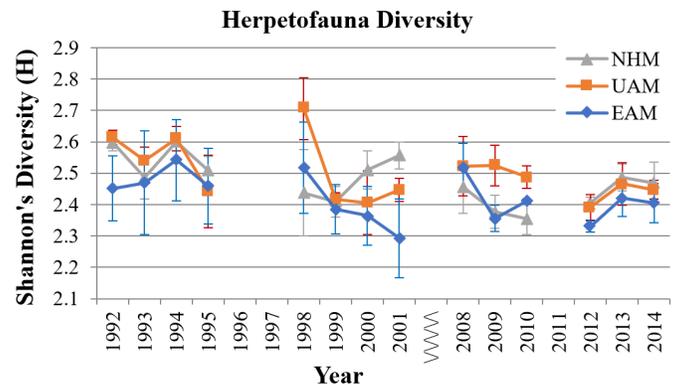


Western Ratsnake

- Total of 108 arrays across the 9 compartments  
-12 arrays per compartment
- Arrays randomly placed using a split-plot design based on Ecological Land Type (ELT)  
-6 arrays on S- and W- facing aspects  
-6 arrays on N- and E- facing aspects
- Sampling occurs in spring and fall

## What we have learned so far:

- Minimal compartment-level effects.
- Environmental factors lead to natural population fluctuations, supporting the need for a long-term dataset.
- Numerous herpetofauna respond locally to harvest. Lizards increased following harvest, snakes showed mixed responses, salamanders showed declining trends, and frogs/toads had minimal changes.
- The mosaic of habitats created by forest management may increase herpetofauna diversity across the landscape.
- Although there is no current need to change MDC's forest management due to impacted herpetofauna populations, as more area within the compartments receive treatment we may see cumulative effects that impact the community.





# Small Mammals

Project Summary

2019

## Management Suggestions:

- Leave down and dead wood and snags to provide refugia in disturbed areas.
- Even-aged and uneven-aged management can increase expected abundance of *Peromyscus* by 50 to >100% compared to no-harvest management.
- Increased availability of soft mast and insects in early successional habitat influences *Peromyscus* populations.



## Objectives

Evaluate the impacts of forest management on small mammal composition, species richness, and relative abundance.

## Project Design



- Each compartment has two –12x12 station trapping grids (total area= 18.7 acres/grid). -144 stations per grid with a baited ground-based Sherman trap.
- Grids were placed on the north- and east-facing slopes.
- Traps are checked daily for 6 days, with trapping starting in April and ending in May.
- All mammal species captured are marked with an ear tag, toe-clip, or with a black marker.



## What we have learned so far:

- We have recorded 7135 captures of 14 species. The most predominate species are deer mouse (*Peromyscus maniculatus*) and white-footed mouse (*P. leucopus*).
- *Peromyscus* spp. increased on even-aged and uneven-aged compartments relative to controls following the first harvest entry. The increase persisted through the 18 post-treatment years.
- Environmental factors can lead to large fluctuations within the population, monitoring long-term allows the separation of the environmental impacts from management impacts.
- Most species move beyond the scale of the stand; thus, the persistence of a population is dependent on the dynamics across the landscape. As more of the MOFEP compartments are managed, cumulative effects will be monitored to further advise forest management.

