

# ***The Reproduction of Oak Trees***

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# ***Issues in Oak Reproduction***

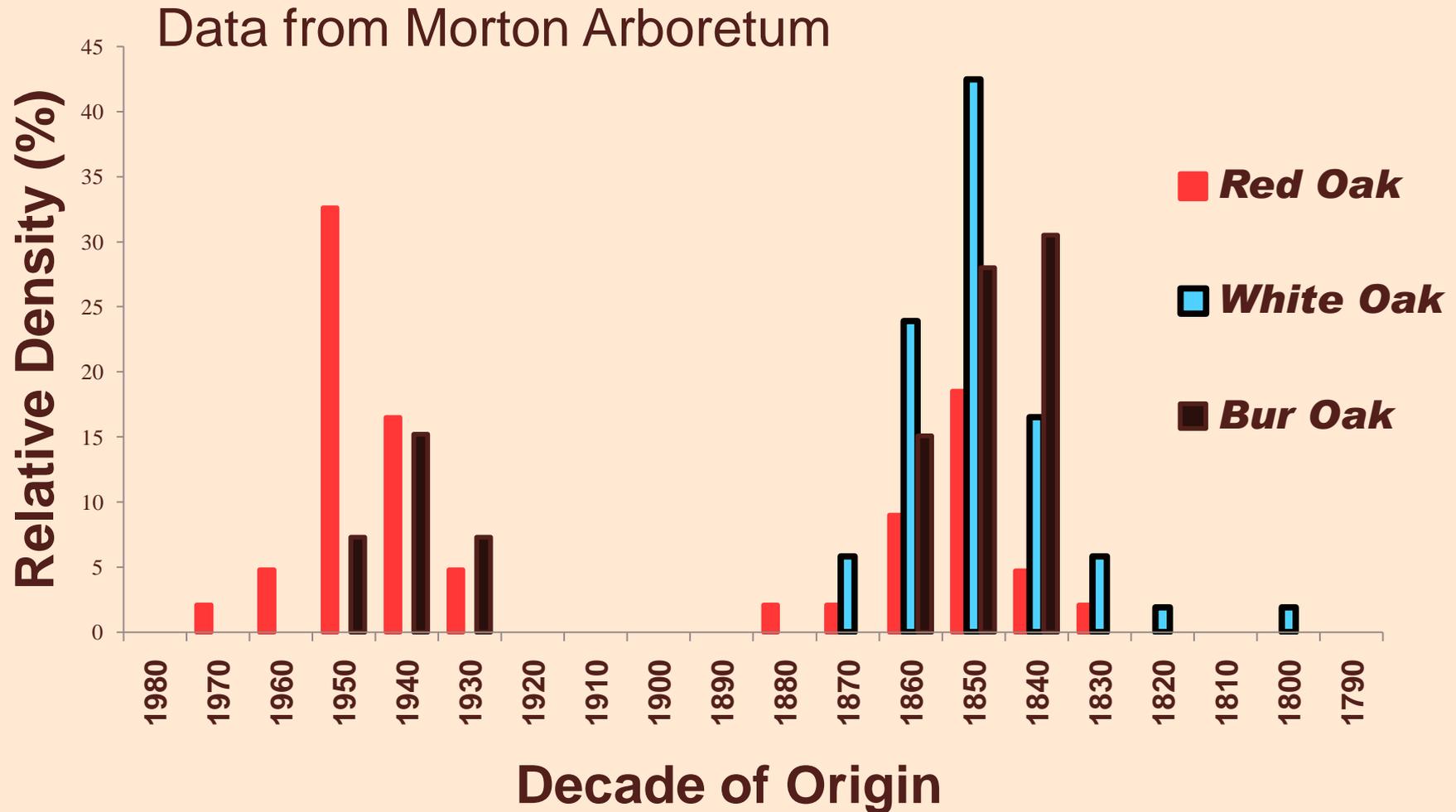
- 1. Much oak timber has little of no reproduction, and it seems unlikely that the trees will replace themselves.**
- 2. Where oak reproduction is happening or has happened, oak woods that are primarily white oak and bur oak will shift to Hill's oak (occasionally red oak).**
- 3. Recreating savanna structure has not stimulated oak reproduction in many places.**

***The Last 150 Years of  
Oak Reproduction***

# Explanation of the Next Figure

The next figure shows the results of a study of the age of oak trees in the Morton Arboretum East Woods, conducted using an increment coring tool. The study was performed in the early 1990s. The height of each bar reflects the relative density of trees of that age class, for that species, that is, the percentage of all trees of that species in that age class. Note two things: first that the oaks are of two cohorts. The first cohort established after Euro-settlement in the 19<sup>th</sup> century (late 1830s to 1870s), and the second cohort established at the end of the agricultural era and beginning of the Morton Arboretum (1920s to 1950s). There is a 40-50 year period between when no oak reproduction takes place, presumably the result of livestock grazing, and a modern period beginning in the 1960s when little or no reproduction happens, presumably the result of the rapid growth of shade-tolerant exotic and native trees and shrubs. Note also that the species composition of these two cohorts is dramatically different, with red oak being much more heavily represented in the post-agricultural cohort than in the settlement-age cohort. Likewise, white oak is absent from the post-agricultural cohort and heavily represented in the settlement-age cohort.

# ***Changes in Oak Reproduction Over Time***



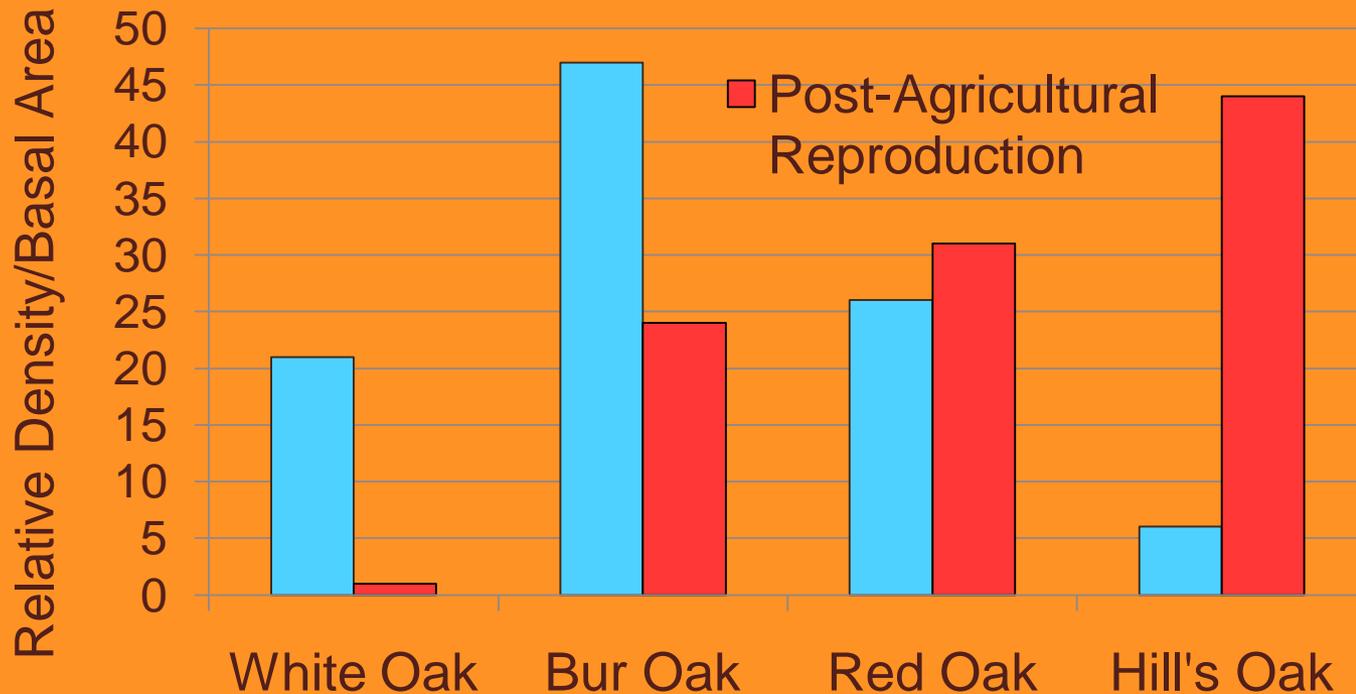
# Explanation of the Next Figure

The next figure represents the distribution of oak trees by species and age class for a privately owned woodland in northwestern McHenry County. Trees were separated into two age classes by diameter and growth form. Trees of settlement age and older were GPS located, identified to species, and the dbh measured. From this we calculated the relative basal area for each species. This corresponds roughly to the potential reproductive output of each species in that cohort. The post agricultural oaks were sampled using a point-quarter method, and from these data we calculated relative density of each species. This corresponds to the realized reproduction of each species. Note that Hill's oak dramatically increases in the post agricultural cohort, while white oak dramatically decreases.

# Compositional Changes Over Time

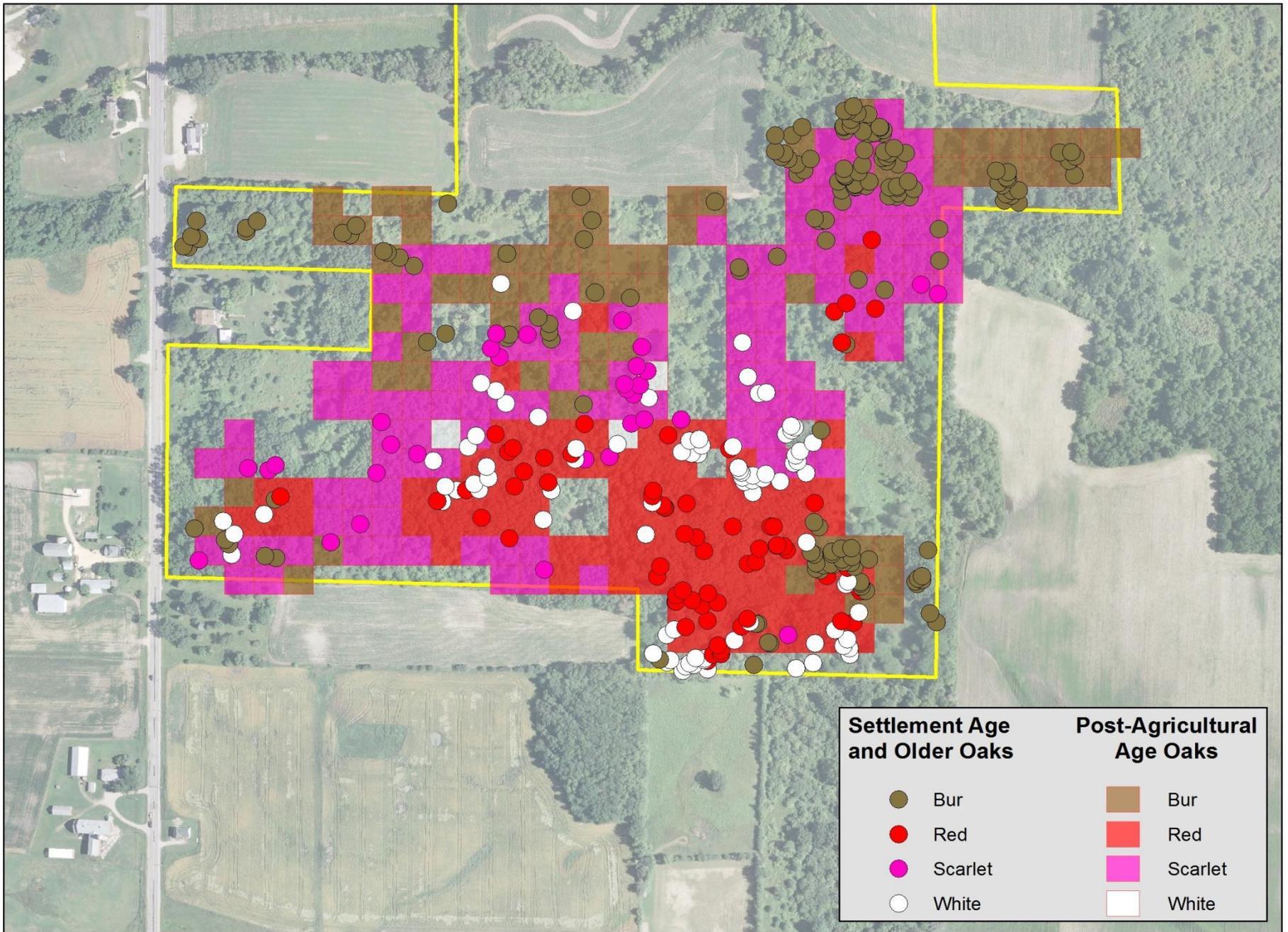
Data from a private holding near Bigfoot, IL

Oaks of Settlement Age and Older

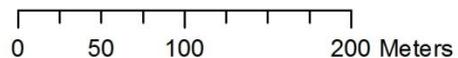


# Explanation of the Next Figure

The next figure shows a map representation of the two cohorts of oaks (same study location as previous graph). The settlement age oaks are represented as dots on the map. We represented the results of the point-quarter sample with a checker-board pattern, with each point-quarter sample located at the junction of four squares. For example, if for the northeastern quadrant, no oak was found in that age class, the square is blank. If a post-agricultural age oak was found, the color of the square indicates the species. Note that red oak dominates the post-agricultural cohort where red oaks of the older cohort are common. Note also that Hill's oak dominates the post-agricultural cohort wherever older trees are present, even in areas where bur oak is more common. Finally, note that white oak is almost absent in the post-agricultural cohort.



**Oak Distribution**  
Dig-East Woods



10-8-10 km  
MCCD-NRM



# ***The Oak Life Cycle***

**Growth**

**Flowering**

**Maturation**

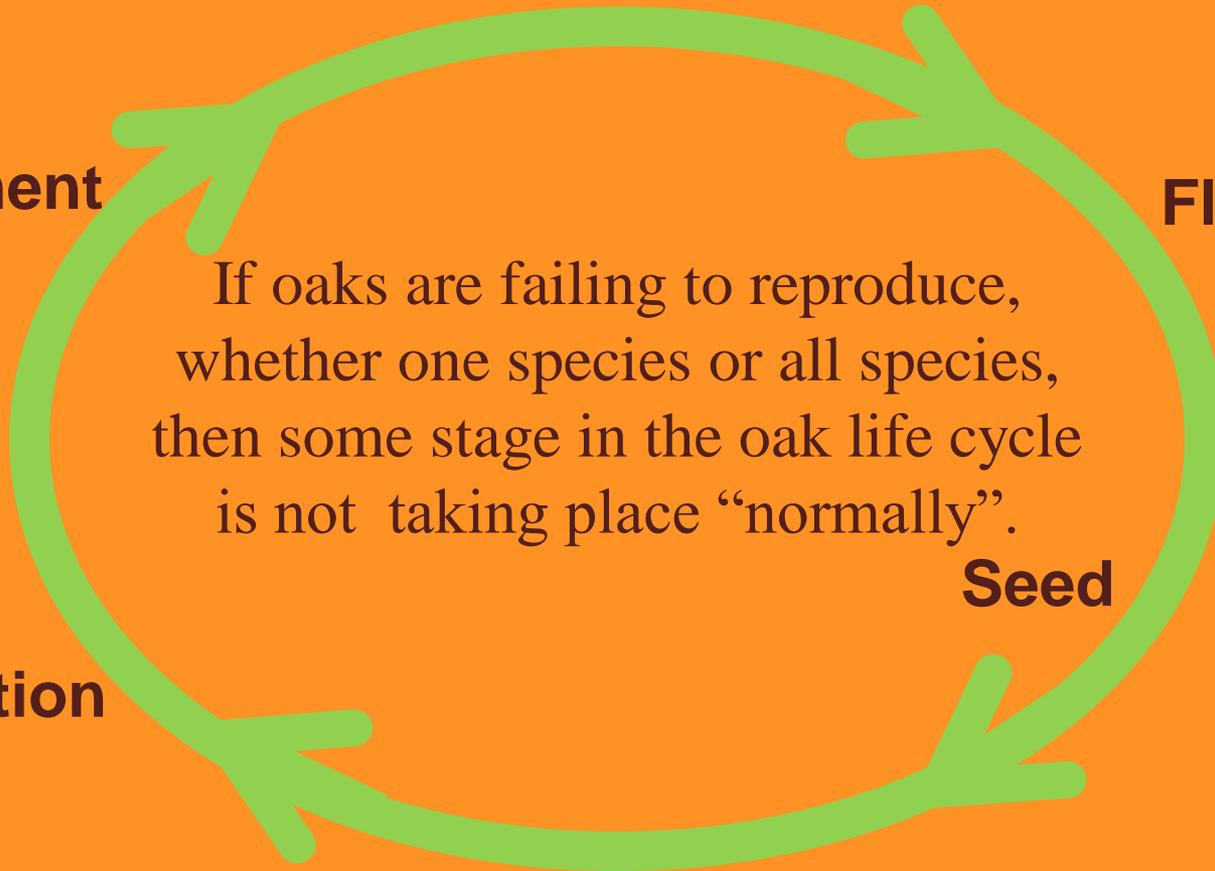
**Seed**

**Dispersal**

**Germination**

**Establishment**

If oaks are failing to reproduce,  
whether one species or all species,  
then some stage in the oak life cycle  
is not taking place “normally”.



# ***Oaks as “Forest” Trees***

Oaks in our region are not “forest” trees, and there is no evidence that they have reproduced effectively in heavily shaded forest situations in the last 150 years. Even the most shade-tolerant oaks species, red oak, seems to have reproduced in large numbers only during periods of high light availability.

The remainder of this presentation addresses the character of oak reproduction in and adjacent to restored oak savannas, where sunlight, water, nutrients, and seed would appear to be adequate to support abundant reproduction.

# ***What isn't a problem?***

1. One can plant any of the common oak species and a high percentage of the seedlings or saplings survive and grow, meaning that **there is no widespread malady of soil or changing climate that prevents growth**.
2. Oak trees periodically produce viable acorns in large numbers. There is no reason to believe that too few acorns are produced, which means that **flowering and seed maturation occur “normally” or at least adequately**.

**The problem must lie within  
the dispersal, germination,  
and establishment phases  
of the life cycle.**

***GERMINATION AND  
ESTABLISHMENT:  
Post-Dispersal Survival of  
Acorns***

**Question:** What happens to the thousands of acorns that fall from an oak tree in autumn?

In mid-November we surveyed 196 1-meter square quadrats beneath oak trees in Glacial Park and counted the number of sound acorns.

# ***Results***

1. We found an average of .07 acorns per meter square across all oak species. Hill's oak = 0.0 ac/m<sup>2</sup> Bur oak = 0.2 ac/m<sup>2</sup> White oak = 0.02 ac/m<sup>2</sup>
2. This represents approximately 0.1 % to 1% of the acorn crop.
3. **Few acorns survive even short periods of time on the ground beneath oaks.**

# ***GERMINATION AND ESTABLISHMENT: Post-Dispersal Survival of Acorns***

1. On October 15, we placed 252 bur oak acorns along transects divided among three oak savannas in Glacial Park: caches of 4 acorns were separated by 5 m
2. Half of the acorns were placed beneath tree leaves but on top of the mineral soil; the other half were buried about 1 cm below the mineral soil surface.

# ***Results***

1. 3 weeks later, no surface acorns survived, and 4 buried acorns survived (3%)
2. **Short-term survival following dispersal in oak savannas is very low.**

# ***GERMINATION AND ESTABLISHMENT:***

## ***Experiment 2: Germination & Establishment of White Oak***

**Question:** What is the effect on acorn survival and germination of excluding predators?

In 2009 we planted 72 white oak acorns in grassland adjacent to oak woods and protected them from predation with a ½ inch metal screen, and another 72 without protection.

# ***Layout***



# ***Results***

- 1. 60% of the screen-protected acorns produced seedlings the next summer.**
- 2. 22% of those not protected by screen produced seedlings the next summer.**

## **Why 78% predation and not 97%?**

Two possible explanations, the first being that the difference represents random variation, the second being that chopping the vegetation to ground level, necessary for installing the screen, affected acorn predator behavior.

# ***ESTABLISHMENT:***

## ***Experiment 3:***

### ***Fire Effects on Bur Oak Seedlings***

**Question:** Are the fires commonly use in oak savanna restoration responsible for the lack of oak seedlings?

1. In the spring of 2009 we planted 24 1-year old bur oak seedlings in a tall-grass prairie.
2. Seedlings were given no water or protection from predators.
3. The prairie was burned in May of 2010. Coverage of the fire was 100% and the intensity very high.

# ***Results***

1. In the spring of 2010, pre-burn, the survival was 42% (27% cut by rodents, 31% dug by rodents)
2. By summer 2010, post-fire, the survival rate was 33%
3. Fire killed 21% of seedlings that were alive immediately pre-fire.

# ***Fire Effects***

1. Fire restricts oak seedling survival but does not eliminate it.
2. Even annual fires with mortality rates of 20-50% coupled with low rates of recruitment (10 s/ha/yr = 4 s/ac/yr) **should produce oak seedlings at a density of 20-50 s/ha (8-20 s/ac).**
3. **Much of the restored savannas at Glacial Park and adjacent grassland have seedling densities much less than this.**

# ***DISPERSAL:***

## ***Populations of Gray and Fox Squirrels***

**Observation:** Large areas of restored oak savanna apparently have low populations of gray and fox squirrels relative to brushy oak woods.

**Question:** Are there differences in squirrel populations between restored oak savanna and unrestored (brushy) woods?

We surveyed oak woods both with and without a brushy understory to determine the spatial density of squirrel nests.

# ***Density of Squirrel Nests by Site (nests/ha)***

<b>Brushy Oak Woods</b>	<b>ha</b>	<b>N</b>	<b>ND</b>	<b>Cleared Savanna</b>	<b>ha</b>	<b>N</b>	<b>ND</b>
Harrison Benwall	19.5	63	<b>3.2</b>	Silver Creek	9.0	6	<b>0.7</b>
DeCarlo	10.8	31	<b>2.9</b>	Prairie View	3.9	3	<b>0.8</b>
Nippersink C.B.	10.1	29	<b>2.9</b>	Nippersink C.B.	10.1	6	<b>0.6</b>
Rush Creek	31.5	54	<b>1.7</b>	Glacial Park	18.5	5	<b>0.3</b>
<b>Average Nest Density n/ha</b>			<b>2.7</b>	<b>Average Nest Density n/ha</b>			<b>0.6</b>

# ***Why are Squirrel Populations Low in Oak Savanna?***

1. Increased predation by raptors and coyotes in cleared savanna.
2. Decreased summer food supply (berries)  
Today's brush savannas have abundant honeysuckle and buckthorn, while pre-Euro-settlement savannas may have had abundant viburnum/chokecherry etc.
3. Increased competition for winter food supplies.
  - a. increased white-footed mice populations
  - b. interference with scatter hoarding of acorns

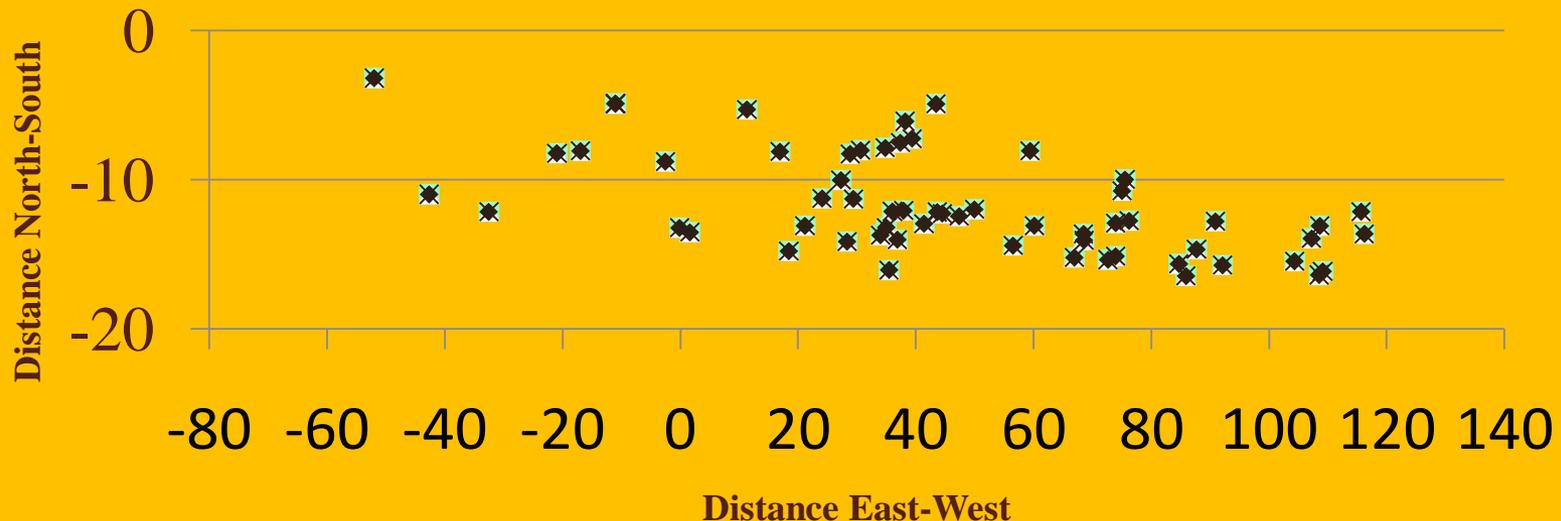
***Future Research:  
Observing Germination  
and Establishment***

*Locate newly germinated seedlings and record species, vegetation, distance to parent tree, buried or not?*

# ***Future Research: Monitor Oak Recruitment in Time***

1<sup>st</sup> year of study to track oak recruitment over time

Map Location of Oak Seedlings  
High Point Prairie: Summer 2010

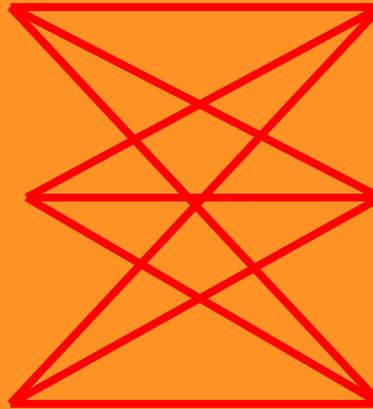


# ***Future Research: Acorn Preferences Among Rodents***

***white-footed mice***

***gray squirrels***

***chipmunks***



***white oak***

***bur oak***

**Hill's oak**

# ***Future Research: Effect of Mice Removal***

***What is the effect of removing white-footed mice on the post-dispersal survival of acorns?***



***Future Research:  
Effect of Habitat  
Alteration on WF Mice  
Foraging***

***What is the effect of mowing and burning  
prior to acorn dispersal on the post-  
dispersal survival of acorns?***

***Questions and comments?***