If our goal is to create functioning oak woods that are as similar as possible to their historical counterparts, then fostering natural reproduction should be the first choice. Alternatively, if our goal is to create an oak woodland with ten mature oaks per hectare, we could plant ten three-inch caliper balled-and-burlaped oak trees, deciding not only how many trees, but where precisely to put them. We would need to protect each tree throughout its early life and replace individuals if they die.

The two models for restoring oaks may look much the same to an untrained eye 75 years later, but through careful observation, the oak woodland relying on natural reproduction will teach us a great deal about the functioning of historical oak ecosystems—the second option, less so. Planting oak seedlings and saplings is a quick and direct way to return oaks to areas where they may have been absent for a century or more. Planting trees can be a positive communal activity that engenders support for the larger restoration cause. We have planted thousands of oak trees in Glacial Park over the last 10 years for these and other reasons. Nevertheless, if we claim to be restoring oak savannas and woodlands, it behooves us to address the process that maintained oaks in the landscape for thousands of years. Otherwise, we will never know what a functioning oak woodland is like until we get this right.

This booklet presents a series of research projects and observations that produce a working model of oak reproduction in oak savannas and woodlands under ecological restoration. I then suggest strategies to foster the natural reproduction of oaks.

Common Answers to the Problem of Oak Reproduction

I present here five commonly mentioned solutions to the problem of the lack of oak reproduction in modern oak woodlands:

The Gap Hypothesis: Oaks need abundant sunlight to grow and will reproduce when canopy gaps of the appropriate size appear. Prior to restoration activities, almost all modern-day oak woodlands have closed canopies and shady understories, and when gaps occur they are quickly filled by other tree species. Therefore, the way to stimulate oak reproduction is to create gaps and control the invasion and growth of other tree and shrub species...

Prescribed Fire: Frequent prescribed fires could eliminate oak seedlings and may be a principal cause for the lack of oak reproduction in oak woods under restoration management...

Deer Browse: Browse by large populations of white-tailed deer may eliminate oak reproduction in the modern landscape...

Soil Incompatibility: Human activities have so greatly modified the soils of our area that these soils may no longer support the growth of oaks. Oaks are not especially demanding of nutrients and water relative to other tree species, but they do have an obligate relationship with mycorrhizal fungi in the soil...

Acorn Weevils: Weevils consume a significant percentage of acorns every year and may interfere with oak reproduction...

Passenger Pigeons: Now extinct, the passenger pigeon once numbered in the billions as recently as the mid 19th century. Acorns were their principal food source and this close association may have fostered oak reproduction...
A Working Hypothesis Concerning Oak Reproduction

Caching of acorns by squirrels and blue jays is essential to oak reproduction.

Squirrels and jays preferentially cache acorns in areas of bare ground or short herbaceous vegetation to avoid the risk of mice and vole predation on their (the squirrel’s or jay’s) food supply. They avoid caching acorns in areas of tall herbaceous vegetation in order to avoid predation of those acorns by mice and voles.

In order to encourage acorn caching in and adjacent to restored oak savannas and woodlands, we need to create bare ground or short vegetation around the time of acorn dispersal and caching.

Our work on the feeding behavior and habitat preferences for mice, voles, and squirrels provided some support for the first two parts of the hypothesis. What remained was to show that creating short-structured vegetation or bare ground would indeed cause squirrels and jays to cache acorns in those places. ...

Observations & Experiments in Oak Reproduction

...Based on experiments, the failure of oak reproduction in restored oak woodlands and adjacent grasslands would seem to be due, at least in part, to the manner in which the structure of herbaceous vegetation mediates the competition between acorn-caching animals and acorn predators. Clearing invasive brush as a part of oak woodland restoration increases light availability, which stimulates rapid growth of the herbaceous vegetation. The increased height and density of this layer leads to higher populations of white-footed mice (Larsen 2012). Squirrels and jays then avoid the area as a site for caching acorns. The story is much the same in adjacent grassland, where thick herbaceous vegetation supports a large meadow vole population, which in turn discourages acorn caching by squirrels and jays.

Whether squirrels and jays respond directly to vegetation structure or to the presence and abundance of mice and voles, we do not know. Nevertheless, when we experimentally produced bare ground patches, squirrels and/or jays responded by caching acorns and other nuts.

This avoidance of tall grass for nut caching by both squirrels and jays is peculiar because it subjects the animals to an increased risk of predation while they are in these bare, open areas. For evolution by natural selection to produce such a risk-taking behavior, mice and voles must have presented an important threat to jay and squirrel survival over very long periods of time. Further, it implies that both bare-short herbaceous vegetation and dense-tall vegetation and corresponding low and high mouse populations were a part of the world in which these behaviors evolved.

Early in this research project, we entertained the idea that mice and vole populations in modern times are simply much larger overall than those of the pre-European settlement past, and that the large mice populations simply overwhelm and outcompete squirrels and jays for acorns. Oaks thus lose their seed dispersal agents.

Given the rodent population numbers of today, bare ground or short-grass vegetation causes vole and mice feeding to drop to negligible levels. Squirrels and jays respond to the same situation by caching acorns. Short-term fluctuations in mice and vole populations, however, may lessen or increase effects of spatial variation in acorn-caching. We can imagine a model in which mice populations rise in the months following a large acorn crop and fall after poor crops. If a small acorn crop preceeds a large crop, then the mouse population will be low (in response to the poor crop) at the time of the large crop. If we introduce into this model a mechanism to create patches of bare ground and short-grass vegetation, the result will be a prime opportunity for oak seedling establishment. Whether meadow vole populations respond similarly to fluctuations in acorn abundance is unknown.

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A Closer Look

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MANAGEMENT RECOMMENDATIONS

We suggest here a few management techniques that may stimulate the establishment of oak seedlings.

1.) The use of mowing and late-summer burning in and adjacent to stands of seed-bearing oaks may stimulate the caching behavior of squirrels and jays. For our mowing experiments, we used a tractor-mounted rotary woods mower, and the grass was 7.5–12.5 cm (3-5 inches) tall after mowing.

2.) Likewise grazing large numbers of livestock for short periods may produce opportunities for acorn caching. Whenever possible, one should apply fire or grazing treatments in the year of a heavy acorn crop and seasonally timed to produce maximum bare or short-grass habitat at the time of acorn dispersal.

3.) Timing the removal of invasive shrubbery and small trees to produce bare-ground conditions may also stimulate oak seedling establishment, if it is done in the year of an abundant acorn crop and immediately prior or during the period of acorn dispersal. Likewise if thinning overstory oaks is timed similarly, and one creates patches of bare ground or short vegetation, one may produce a crop of oak seedlings. In either case, the increase in sunlight intensity will enhance the survival and growth of the seedlings.

4.) Prairie restoration on ex-agricultural fields adjacent to stands of mature oaks often leads to a cohort of young oaks in the prairie border. This is due to squirrels and/or jays caching nuts in the bare ground of the adjacent field. Timing prairie-restoration activities to correspond to years of heavy acorn crops will allow the establishment of a large cohort of oaks, which will create a more natural transition between prairie and oak savanna/woodland. In prairies already established, late summer burning or mowing may stimulate oak recruitment. Also, moving away from sod-forming grasses, such as big bluestem and toward shorter-statured bunch grasses, such as little bluestem and prairie dropseed may encourage the creation of unvegetated gaps and openings suitable to attract acorn dispersers.

CONCLUSION:
The Case for Change

McHenry County lost half of its oak woods by 1872; by 1939, 81% were gone, and by 2005, 86% were missing (MCCD 2009 -The Oaks of McHenry County). Prairies disappeared under the plow as oak woods were either converted to woode pastures for domestic livestock or cleared and the ground put into crop production. Farmers not only grazed stock in remaining woods but seeded aggressive, exotic grasses to replace the rapidly disappearing native plants. The bare, often disturbed soil created by heavy grazing offered prime habitat for the rapid spread of weedy plants unpalatable to livestock. At the same time, acorns and young oaks were preferred food for cattle, and oak reproduction almost completely stopped during the agricultural era, extending roughly from the 1870s and 80s into the mid to late 20th century in most parts of the Chicago Region. With neither fire nor cow to slow their growth, invasive shrubs and trees rapidly invaded oak woods and transformed open savanna and woodland into dense forest...

Oaks in the modern landscape are under threat from diseases such as bur oak blight, oak wilt, shoestring fungus, and sudden oak death, and from insects such as gypsy moth.

Oak woodlands and prairies that survive today have suffered so many abuses over the last 200 years that we quite naturally think of disturbance as bad. It is not surprising that, when people began restoring oak woodlands in the late 1980s, they understood restoration as an activity that repaired the damage and disturbance of the past and then protected the land from further disturbance. A healthy oak woodland we believed was one with a thick and diverse growth of native sedges, forbs, and grasses. We had every reason to believe that removal of invasive brush and use of fire would restore both the ground flora and provide the necessary opportunities for oak reproduction. Many very talented and intelligent people have made enormous strides over the last 30 years in oak savanna and woodland restoration.

This model of a verdant oak savanna, lush with the grow of native herbaceous plants does not need replacement, but it does need revision based on an emerging understanding of the intricacies of oak reproduction. The oak woodlands of the Chicago Region and the Midwest were part of cultural landscapes for over 10,000 years, were burned frequently by the native inhabitants in the summer and fall, and were grazed by elk and bison. We do not know how the frequency and intensity of these and other events combined to present opportunities for acorn caching by squirrels and jays. If we manage to provide these opportunities, we may find other problems that prevent oak reproduction. Even so, without an abundant supply of seedlings, issues such as deer browse and fire, which effect height growth of seedlings and young trees, are of little importance.

In McHenry County more than 90% of witness trees recorded by the public land survey in 1840 were oaks. Oak and hazel were nearly ubiquitous in the shrub layer. Oak has dominated the arboreal pollen record across the Midwest for the last 11,000 years. Species that are often unable to reproduce in adequate numbers in modern landscapes were doing so over millions of acres and thousands of years.

The search for a solution or solutions to this problem must be a joint effort of scientists and land managers. The range of situations routinely confronted by restoration managers is far greater than that captured in a limited number of scientific experiments. For this reason, ecological restorationists should begin to work these ideas into their practice. When dozens to hundreds of practitioners are experimenting succeeding and failing together and talking to one another, the solutions will emerge. There is no reason to believe that if we continue to do restoration in the future only as we have done in the past that we will produce abundant oak reproduction.