chapter seven

Regenerating oak stands the "natural" way

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Contents

Disturbance happens

In forest stands, there is always a background of growth, senescence, and death of individual trees. There also is always some type of disturbance, from simple and constant events, such as wind, to more intensive and dynamic events, like a timber harvest. Hardwood stands are composed of multiple species, and these species respond differently to disturbance, depending on the age and size of each individual. So, when a stand is disturbed, you must consider not only the species but other factors as well. Every time a hardwood stand is disturbed (either via commercial harvest or other intermediate treatment, such as thinning or burning), there is an impact on the next stand (the regeneration). Disturbance must be coupled with what we know about regeneration response in order to accomplish a goal of regenerating oaks. AQ1

Two main characteristics drive the response of regeneration to disturbance—the species of regeneration and its shade tolerance (see Chapters 5 and 6). Some regeneration comes from new seedlings that develop after disturbance, typically light-seeded species, such as ash and yellow-poplar. These species thrive under open conditions with plenty of sunlight (they are not tolerant of shade).

Other species, such as oaks, are considered advance-growth dependent, which means they must persist through the disturbance. As mentioned in Chapters 5 and 6, oaks are considered intermediate in shade tolerance, an inference to their ability to hang around in the understory (in the shade) and then respond to an increase in sunlight (more open conditions following harvesting, for example). The ability of oaks to survive through disturbance depends on the size of the regeneration and its growth rate. The probability of a small oak stem surviving and thriving after a disturbance increases with its stem size. The more oak stems you have before disturbance, and the bigger those oak stems are, the greater chance you have of maintaining oaks in your stands.

Hardwood trees also sprout when they are cut. We know the probability of having a stump sprout that will be competitive after cutting depends on the size and age of the cut tree and site productivity. Smaller, younger trees on less productive sites produce more stump sprouts. Large saw timber-size trees will not produce stump sprouts that contribute significantly to oak regeneration in the next stand.

Can we control disturbance to get what we want?

If oak is in your stands and they are producing acorns, you do not have a regeneration problem. What you may have, however, is a problem developing those oak seedlings into a competitive position. Many mast years are followed by a flush of small oak seedlings. If you do nothing to increase light to those seedlings, they will remain in the understory for several years, attaining a height of about a foot. After 10 years or so, they will die. This cycle is common without disturbance. If shade is the culprit, then the amount of sunlight hitting those small seedlings needs to be increased to promote growth. The catch is, in multiple species stands, when light is increased, everything responds. The race for dominance under these conditions is often won by shade-intolerant species—exactly the species competing with oak. So, how do we allow enough light to promote oak into a competitive position, but not open the stand so much that competitors take off?

A management prescription is stand-specific. You must prescribe practices according to current conditions influenced by uncontrollable factors, such as past stand history and site conditions. Too often, we make broad assumptions about the condition of stands when prescribing management. For example, it is often assumed stands are essentially the same age, also referred to as even-aged, though most stands have had partial harvests in the relatively recent past that resulted in older trees being left, while younger trees established. In reality, most hardwood stands contain trees in several age classes.

The clearcut method

Clearcutting can be a successful regeneration method in upland hardwood forests. It involves removing all trees in one harvest treatment, providing full growing space for new trees to grow, whether planted or arising from seed or coppice (sprouts). This results in a new stand of trees essentially the same age, or even-aged. If implemented as such, this is correctly termed a "silvicultural" clearcut. In practice, loggers often leave small-diameter trees (not commercial), poor-formed trees (low grade), and/or nonselect species with no economic value and still call it a "clearcut." This use of the term is inaccurate and causes extreme confusion. It is also not aesthetically pleasing to most people (if in view of roads) and degrades the regenerating stand significantly, depending on how many trees are left standing, their age, and species. When undesirable and poor-formed trees are left standing after harvest, they compete with the regenerating trees and the regeneration method is no longer a "silvicultural" clearcut, but often called a "commercial" clearcut.

Prior to clearcutting, there must be adequate regeneration of desired species. If the stand is ready to regenerate, it may be economically and biologically sound to remove the current stand. On less productive sites *where competition from species such as red maple and yellow-poplar is restricted*, oak can successfully regenerate following clearcutting. On more productive sites, *if adequate oak regeneration exists*, clearcutting releases these trees; however, it also releases competition. On productive sites, clearcutting is not the best method for regenerating oaks. Techniques that allow a slight increase of sunlight into the forest floor to stimulate oak regeneration, but not "release" competitor species, are needed. Once the oak seedlings have reached a height of 4–6 feet, a harvest should be considered to release the advance oak regeneration.

Economics often dictate the regeneration method used. If you need as much income from the stand as possible immediately, you may maximize income by removing all trees in the stand, regardless of regeneration status. However, that decision comes with the risk of not regenerating species you favor, especially oaks on good sites. When clearcutting is conducted on productive sites, you must lower your expectations of having oak in the next stand. There may be a few oaks that survive the competition, but the proportion of oak will be reduced considerably. If you have concerns about losing value or merchantability by leaving a portion of the trees in the stand (as would be done with a shelterwood harvest, described later), AQ2
that risk is removed by clearcutting.

You can enhance the probability of releasing regenerating oak from competition on good sites by identifying young, understory oaks and treating adjacent competing stems with an herbicide treatment. This release must be done while the oak is still competitive, before it is overtopped by competing vegetation. The more oak seedlings you release and the larger those oaks are, the chance you will have oak in the next stand increases. It is important to realize this treatment comes at a cost, in both money (herbicide and labor) and time.

Clearcutting may be used to help meet objectives related to wildlife. When all trees in a stand are cut, maximum sunlight is allowed to reach the forest floor. This stimulates an immediate vegetation response, which temporarily provides habitat for a number of species that use early succession and young forests. Increased forage, browse, and soft mast are available for approximately seven years without further disturbance until regenerating stems reduce the amount of sunlight reaching the forest floor to preharvest levels. The wildlife species that use developing young stands change as the vegetation composition and structure change. Clearcutting a hardwood stand sets back succession, but the site is dominated once again by young trees within two years as seedlings and sprouts reclaim the site.

Obviously, when a stand is clearcut, mast production from trees is limited for 30–40 years until the regenerating trees begin producing mast. When wildlife is an objective, one way to ameliorate this situation is to implement a clearcut with "reserves." By leaving reserves, that is, five or six mature mast-bearing trees with good form in the stand, some mast production is retained while the new stand regenerates. These trees can be harvested when the regeneration reaches mast-bearing age or they can be left and harvested when the regenerating stand is harvested.

From an economic standpoint, clearcutting with reserves makes little sense, especially when you consider the risk of wind damage to the trees retained. From an oak regeneration perspective, because oak is advance-growth dependent, leaving a few scattered oak trees postharvest will not contribute to oak regeneration. Any germinated acorns from those trees will not compete with the young forest that is already developing. Clearcutting with reserves should be considered when it is desirable to provide mast within dense cover (regenerating trees). This can be especially important for species such as ruffed grouse, white-tailed deer, and black bear.

The shelterwood method

The shelterwood method involves harvesting the stand through a series of partial cuts over several years but maintains an even-aged stand. The intention is to manipulate light and growing space so desired species (e.g., oaks) are favored over others and increase the probability of desired species dominating the next stand. Shelterwood harvesting can be used to successfully regenerate oak. However, advance oak regeneration must be present and you must consider the overstory species and the economics driving the harvests. The goal is to open up the stand so small oak regeneration can grow into a more competitive position, while sheltered by the remaining or residual trees. Once the oak is in a competitive position, residual trees are removed.

Residual trees (the "shelterwood") provide shade and protection for the regenerating trees below. In conifer systems, the shelterwood also provide a source of seed. In oak systems, the seed (acorns) have already fallen and germinated before the first shelterwood cut is implemented. As the regeneration develops, the shelterwood is removed through stages, usually in two or three cuts.

When managing for oaks, the purpose of the first cut is different than when managing conifer systems. When managing for oaks, the first cut may actually be a *thinning from below*, which removes stems from the midstory as well as some lower crown-class trees from the overstory (this may be 15%–25% of the stand's total basal area). The most important consideration when managing oaks is that oak seedlings (regeneration) are already present in sufficient numbers when the first cut is implemented. This is critical. The first cut allows only a relatively small amount of light into the stand to stimulate the oak seedlings and allows them to grow into a more competitive position (usually 4–6 feet tall). In many situations, the first cut is not a harvest. Sometimes, it is not even a cut. On some sites, sufficient sunlight is allowed to enter the stand by treating undesirable midstory species with an herbicide treatment (e.g., hack-and-squirt). It is important to realize this process is labor-intensive, relatively expensive, and not conducive to all stands or landowners. You also must be aware of the shade tolerance of other species in the stand. If there are shade-tolerant species, such as sugar maple and American beech, treat these species accordingly, or they too will respond to the increased light and growing space created when the midstory dies.

The increased light allowed from the first cut is ephemeral. Not only will the oak regeneration respond, but so will other regenerating species, as well as any remaining midstory species. Once the oak regeneration is in an advance position, additional sunlight is allowed to enter from a second cut, which is a harvest, usually implemented 5–10 years after the first cut (depending on site). In some situations, the shelterwood can be completely removed in the second cut. However, according to the other species present and the vigor of the competition, it may be advisable to remove a portion of the shelterwood and still provide partial shade to allow the oak regeneration to continue to grow. This is especially important if species such as yellow-poplar and red maple are prevalent and vigorously competing with the oak regeneration. If a third cut is implemented, this is usually 5–10 years after the second cut.

Another approach that has been used with some success is using fire to help control competition after the shelterwood has been removed. If the shelterwood is removed in the second cut and competition is significant, prescribed fire implemented during the growing season two to three years following the second cut will top-kill a majority of the existing stems, including the oaks. However, because oaks typically develop a strong root system early in life, they are able to send up a strong sprout the following year, enabling them to better compete with other species, such as yellow-poplar and red maple, that do not have as strong root reserves.

The impacts of the shelterwood method on wildlife are considerable. Following the first cut, the understory is stimulated, providing nesting cover for many forest songbirds, brooding cover for wild turkeys and ruffed grouse, and increased forage and soft mast for other species, including white-tailed deer, black bear, and raccoons. Following the second harvest, stem density in the midstory increases substantially. This provides cover for another suite of species, such as chestnut-sided warbler, eastern towhee, brown thrasher, and ruffed grouse. If some of the shelterwood remains, an added benefit is the mast available from those overstory trees, all within the cover of the developing regeneration. Along with those species that require dense developing cover, other species that nest and forage in overstory trees, such as tanagers, red-eyed and yellow-throated vireo, and black-throated blue warbler, may still be found in these stands. Thus, a diversity of wildlife species is found in stands that contain diverse vegetation structure and species composition.

If you are trying to manage property for wildlife species that benefit from acorns and dense cover, an option is an irregular shelterwood. This method allows a certain amount of the overstory (usually 20–50 square feet of basal area per acre) to remain for an extended period while the regeneration develops. The residual trees can be removed for increased timber value several years later or they can retained in the stand until the next rotation, providing increased wildlife value by continuing to produce mast within the developing cover. Obviously, it is necessary to retain species with good mast value (e.g., oaks, persimmon, blackgum) and to not retain trees that may produce increased competition (such as yellow-poplar, maples, ashes).

The shelterwood method involves multiple entries into a stand. Anytime you increase the number of harvest entries, you increase risk and potential cost. One risk is damaging residual trees during the first or second harvest. A logging operation will impact residual trees; leaving fewer trees will decrease the number the logger has to dodge around, but you may not have enough volume for the final harvest. The residual trees must be able to sustain another harvest, so species composition and merchantable condition (size and grade) must be adequate. If it is not feasible to leave enough merchantable trees for the final harvest, it is best to allow the stand to grow and harvest at a later date.

Shelterwood harvesting that targets suppressed and overtopped trees may create conditions favorable for oak regeneration, but the amount of sheltering wood, or residual trees, varies with site productivity. On more productive sites, more trees must be retained because there is a greater probability for competitive species to take over. You also should harvest competitive species, such as yellow-poplar, ashes, and maples, and reduce some of the potential competitive seed source. There is a fine line between allowing enough light for oak while not encouraging competitors. Of course, a registered forester should help you with these decisions.

The influence of residual trees affects the growth rate and the species composition of the nearby reproduction. Reproduction of all species is taller with larger diameters the farther they are from residual trees. However, the rapid growth of intolerant species, such as yellow-poplar and red maple, allow them to dominate the regeneration. Some treatment to release desirable species to meet management objectives may be beneficial. The duration of sheltering is varied and depends on site and stand development. An assessment of the oak regeneration is required to drive the decision to conduct a release of favorable trees or the final harvest.

The initial disturbance, or harvest, and the resulting residual conditions, influences regeneration. All species will respond to an increase in light. The response depends on species present, site conditions, and stand conditions. On productive sites, the regeneration cohort soon starts to compete with itself and the effect from the residual stand is diminished. Removing the residual stand while oak is still competitive increases the chances of oak becoming dominant in the stand.

On highly productive sites, a midstory herbicide treatment is often recommended, as openings created by a timber harvest may accelerate growth of competing tree species beyond that of oak. However, the economics of this treatment my render it unfeasible. If the initial shelterwood treatment on productive sites is a partial harvest, it may be necessary to go into the resulting regeneration and use an herbicide treatment to release oak prior to the final harvest.

Do not confuse the shelterwood method with a diameter-limit harvest. What typically happens when using diameter limits to drive a harvest is the best trees are taken in the first harvest and only "junk" or marginally valuable trees remain. The residual stand is usually of much lower quality, includes a greater proportion of less desirable species, and has reduced merchantability. The final harvest is more difficult and often not accomplished. These retained low-quality trees influence the resultant stand until the next rotation. The regeneration is never truly released and is compromised. Diameter-limit cutting is not recommended for regenerating upland hardwood stands.

Foresters often assess the cubic volume of stemwood and stem density by measuring the cross-sectional area of trees 4.5 feet aboveground (see the sidebar on "DBH," Chapter 12). For example, a tree with a diameter of 13.5 inches has a cross-sectional area of 1 square foot; a tree with a diameter of 16.6 inches has 1.5 square feet; a tree with 19.5 inches diameter has 2 square feet. This cross-sectional area is referred to as *basal area*. By adding the basal area of each stem on any given acre, a measure of tree density can be determined. If there is 100 square feet of basal area on an acre (a reasonable figure for many mature oak forests in the eastern United States), that can be comprised of many small diameter stems, a smaller number of large diameter stems, or some combination of small and large diameter stems. Basal area is fairly well correlated with the cross-sectional area of the crown. Thus, in most closed-canopy stands, if 40% of the basal area is removed, you may expect to allow approximately 40% sunlight into the forest floor.

Uneven-aged management

Uneven-aged management for sustaining oak stands has been marginally successful and is again dependent on site and stand characteristics. The premise is to create three or more age classes within the stand with partial harvests over time. Each partial harvest results in a new regeneration age class. These harvests are meant to be sustainable over time. Problems include having enough merchantable trees to make repeated commercial harvests and creating conditions to allow regeneration of desirable species.

There are two common uneven-aged systems: single-tree selection and group selection. In single-tree selection, periodic harvesting of trees of all species in all diameter classes is performed. In reality, the infrastructure of maintaining roads and trails, and marking the timber is difficult. Desirable species (including oaks) do not regenerate or do not grow into competitive positions with single-tree selection. In hardwoods stands in the eastern United States, single-tree selection favors shade-tolerant species, such as sugar maple and American beech, not oaks.

The other uneven-aged system is group selection, where openings larger than the height of the largest trees in the stand (0.2–1.5 acres) are harvested, similar to small clearcuts, but within a given stand.

As with any other method, adequate advance oak regeneration must be present prior to creating these openings or oak will not be successful in the future stand. Conditions conducive to regenerating and recruiting oak into competitive positions are created in the perimeter of these gaps where sunlight is more intermediate. Again, consider the infrastructure, as well as maintaining and developing enough merchantable stems to sustain the harvests.

Group selection can provide diverse cover and food resources for wildlife. Not only are conditions improved for those species that would benefit from clearcutting and shelterwood harvesting, but also many forest interior birds, such as cerulean warblers, select these small openings for foraging. Group selection harvest units can be placed across a property in such a way that they provide "successional stepping stones" connecting larger units of young forested cover and/or areas of early succession.

Conclusion

The clearcut method of regenerating upland hardwood stands is appropriate where existing numbers of advance oak reproduction is adequate, which may occur on most xeric sites. The more common situation is a lack of advance oak reproduction, or numerous small seedlings. In this case, the shelterwood method is most useful, is flexible to tailor its application for existing stand conditions, and can be combined with measures to control tolerant midstory species.

The bottom line in regenerating oak is advance regeneration must be present before harvesting. Getting advance oak regeneration prior to harvest can be challenging, but can be accomplished through intensive methods, such as herbicide treatments or by treatments that are carefully timed, such as prescribed fire, and applied based on individual stand characteristics.

Not only must advance oak regeneration be present, it must also be of significant stature to be competitive; a common rule is greater than 0.25–0.5 inch basal diameter. It is important to release oak regeneration before you lose it. Lack of light limits the development of oak seedlings in forest understories. You can control light by reducing stand density. On high-quality sites, the recommendation is to do this gradually, over 10–20 years, first by removing the midstory, then by decreasing overstory density in one or more removal harvests. Control competing regeneration anytime it threatens to suppress oaks.

Think of regenerating a stand as a process of repeated disturbances to favor oak, not as a single event. Assessing the potential of a stand and delivering timely and adequate disturbances with patience can regenerate upland hardwood stands to favor oaks.

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Author Queries

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