# SILVICULTURAL METHODS FOR REGENERATING OAKS

*by* F. BRYAN CLARK *and* RICHARD F. WATT, *respectively Assistant Director and Research Plant Physiologist, North Central Forest Experiment Station, Forest Service, USDA, St. Paul, Minn., and Columbia, Mo.*

*ABSTRACT.* Advance reproduction is the key to forming the new oak stand. However, the size or strength of the advance stems is just as important as number. Most oak stands approaching maturity have enough advance reproduction, but many do not. In such cases, harvest cuttings must be delayed and overstory densities regulated to favor the establishment and development of new oaks in the understory.

TWO BASIC PRINCIPLES should be understood when we discuss natural regeneration of upland oak stands:

1. The new stand will contain oak in proportion to the advance oak reproduction on the area before the harvest cut.
2. Advance oak reproduction must have a well-established root system in order to compete successfully with other woody vegetation.

Although many details for obtaining oak reproduction are not clear, these two basic principles are supported by research and experience *(Clark 1970)*. A number of experimental cuttings – including seedtree, shelterwood, and clearcutting – have failed to establish significant amounts of oak where newly established seedlings were relied on to regenerate the stand.

Many oak stands at or near harvest age contain enough advance oak to form a new stand. But there are also areas that do not contain adequate reproduction. Parts of Minnesota, Wisconsin, Michigan, Missouri, Indiana, and New Jersey have been cited as problem areas. Concern about the inadequacy of advance reproduction is mounting. There is good reason to believe that a lack of oak reproduction may be related to less fire, less grazing, denser overstories, and successional trends toward more mesic species.

With the advent of even-aged management, our mistakes will catch up with us quickly. However, we are convinced that some of this concern is premature and that more time is needed to evaluate final results *(Sander and Clark, in press)*. Before silvicultural treatments to reproduce oak can be prescribed, we must first understand how silvical and environmental factors relate to establishment and growth of various types of oak reproduction.

## SILVICAL CHARACTERISTICS

Dependence upon advance reproduction is possible because oak seedlings and saplings are moderately tolerant. Of the five important commercial species, white oak is the most tolerant; chestnut, northern red, and black oaks are intermediate; and scarlet oak is least tolerant. However, the ability of oak seedlings to survive in the understory must not be interpreted to mean that oak can be grown in all-aged stands like sugar maple. Oak grows best in full sunlight, and oak silviculture should be even-aged. During regeneration, harvest cutting must provide full sunlight for oak to compete successfully with its associates regardless of area size.

Oak seed crops are periodic. Black oak is the most consistent, producing some seed every year and good crops every 2 to 3 years *(Fowells 1965)*. The other four species generally have a high probability of producing a good crop every 4 or 5 years. Chestnut and white oaks are said to be some what more irregular than species in the red oak group. A large proportion of the crop is often rendered useless by insect infestation; birds and mammals utilize much of the crop for food. Even so, some seed dispersal is due to animals. Despite heavy losses, enough viable seeds are produced in good seed years to establish seedlings in most stands more than 50 years old. The problem is to maintain and strengthen this reproduction so it may win the competitive struggle with other plants and form the new stand.

In most stands, seedbed conditions will not inhibit the establishment of oak. One inch of litter seems desirable for establishing seedlings *(Minckler and Jensen 1959)*, but thicker layers are not highly detrimental. Disturbing the surface by disking increased the seedling catch, but the increase did not warrant the additional cost *(Scholz 1955)*.

It is important to define the different types of advance reproduction and the roles they play in oak silviculture. First, seedlings are produced from acorns. Second, seedling sprouts arise from stumps less than 2 inches in diameter at the ground line. Third, stools or grubs are seedling sprouts that have died back several times over a period of years, producing a large surface callous and a well-developed root system. Liming and Johnston *(1944)* explained how this type of reproduction gradually builds up to a point where it is strong enough to compete in the new stand when the overstory is removed. Fourth, stump sprouts originate from stumps 2 inches or more in diameter.

Seedlings, stool sprouts, and stump sprouts grow at different rates (fig. 1). Stump sprouts are by far the fastest growers, followed closely by stool sprouts, and seedlings are a poor third.

Newly established seedlings obviously cannot grow fast enough to form a part of the new stand. A bumper catch of 1-year-old chestnut oaks released by clearcutting in southern Indiana in 1929 failed to comprise a significant part of the new stand 10

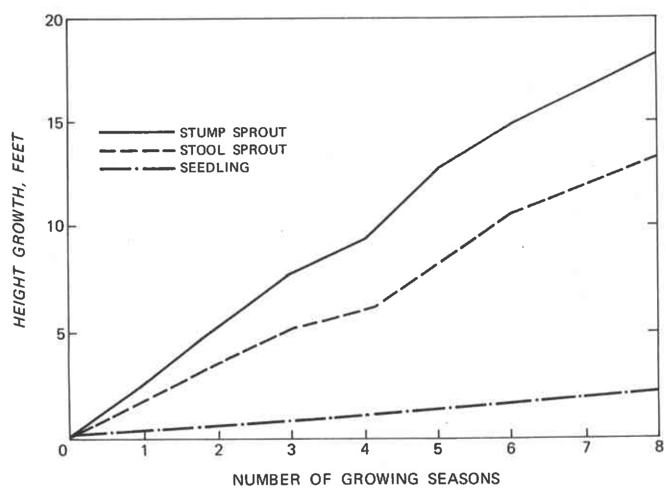



**Figure 1.—Height growth of white oak stump sprouts, stool sprouts, and seedlings after release.**

years later *(Kuenzel and McGuire 1942)*. After 36 years, the overstory was composed primarily of oak stump sprouts: the few surviving chestnut oak seedlings were only 5 feet tall.

Advance reproduction must be sturdy to have a good chance of becoming a part of the new stand (fig. 2). An Ohio-Kentucky study showed that unless the stem is at least ½ inch in diameter at ground level, or is at least 4 feet tall, it will probably be outgrown by competitors. On the best oak sites, even larger reproduction would be desirable for competing with the dense, vigorous brush. Much advance oak reproduction is either broken off during logging or dies back to the ground after the sudden exposure.

Figure 2.—The white oak held at left was small and spindly when the clearcutting was made 12 years ago. In contrast, the red oak at right was dominant in the understory before cutting.

## ECOLOGICAL FACTORS

Oak types are self-perpetuating and relatively easy to maintain on poor-to-medium sites. Oak species made up the highest percentage of advance understory on poor sites in two studies *(Arend and Gysel 1952, Weitzman and Trimble 1957)*. Carvell and Tryon *(1961)* showed that high light intensity and southern exposure are positively correlated with oak abundance on poor sites.

On the better sites, intense competition makes it difficult to reproduce oak stands. Arend and Scholz *(1969)* described problems in regenerating red oak on good sites in the Lake States. On good sites in southwestern Wisconsin, a current survey of clearcut areas being made by the North Central Forest Experiment Station shows that present management practices are not providing sufficient red oak reproduction. Curtis *(1959)* postulated that such stands arose after a history of severe fire and that succession is toward more mesic species.

Stand history plays a key role in the amount of advance oak reproduction present. In a West Virginia study, stands that had been thinned, grazed, or lightly burned during the past two decades generally had more oak reproduction than undisturbed stands *(Carvell and Tryon 1961)*. Disturbed stands had more light reaching the forest floor and consequently had more reproduction. Recent research in Missouri showed that all young oak reproduction died in a 70-year-old stand with an overstory density of 100 square feet of basal area per acre, but that a stocking of 80 square feet permitted the reproduction to survive and increase slowly in number.

Reducing competition undoubtedly influences establishment of oak seedlings. Elimination of understory brush with herbicides in an 80-year-old white oak stand in Iowa resulted in a much better reproduction catch from a bumper acorn crop than did no treatment. Untreated plots had only 2,100 oaks per acre, while treated plots had 7,900. Because fire has obviously played an important role in oak ecology, controlled burning may some day be a useful tool in improving oak regeneration. However, burning, mowing, and herbiciding have not yet been perfected as effective economic tools for oak regeneration.

Dense overstory stocking inhibits oak establishment in several ways. Acorn production is low in dense small-crowned stands. Dense overstories use most of the available moisture, nutrients, and light. During moist years oak seedlings may become established, but they remain small or die during dry or even normal years. Therefore, in the latter part of the rotation, overstory densities should be regulated to encourage the establishment and growth of understory trees.

Where site index is below 70, intermediate cuts to improve the growth and quality of the main stand will also improve reproduction. A series of light partial cuts during the last half or third of the rotation are probably much better than a heavy cut as the stands near maturity. The manager has better control of quality in the overstory, and the position of oak through a gradual buildup is more secure. Heavy cuts favor shrubs and other tree species to the detriment of oaks.

For purposes of reproduction, intermediate cuts should start 20 to 30 years before the harvest cut. Residual stocking should be about 70 percent or roughly 70 to 80 square feet of basal area per acre for small sawtimber-size stands. Some European oak culturists recommend similar stocking levels to encourage oak establishment. For example, in a Bulgarian reference *(Zelev and Dimitrov 1967)* a stocking of 70 to 80 percent was recommended for oak establishment. In Russia, Molcanov *(1962)* suggested 60 to 70 percent stocking for best acorn production.

## HARVEST CUTTING

Where advance oak reproduction is lacking and oak is wanted in the new stand, the rotation age must be prolonged. The area to be reproduced, no matter how large or small, must contain reproduction before the final cut is made. Estimates of what constitutes adequate advance oak reproduction have ranged from 400 stems per acre to 4,000. More important than number of stems is size of the reproduction and the number of stump sprouts expected. A thousand oaks per acre 2 feet or more in height should produce a new oak stand unless competition from other advance trees and shrubs is severe. If a large number of pole and small sawtimber-size oak trees are to be cut in the harvest area, there is no need to have a thousand oaks in the advance reproduction. In this case stump sprouts can be expected to augment the reproduction.

As early as 1927 Korstian *(1927)* recommended partial cutting to obtain oak reproduction. For uneven-aged stands with trees of all sizes, he recommended the selection system, in which reproduction would fill openings created by the removal of scattered large trees or groups of trees. He recommended the European shelterwood system for even-aged stands where natural reproduction is obtained through three cuttings. A gradual reduction of the overstory is preferred over a single cutting. However, Korstian agreed with other earlier American writers that in this country the seed cutting is probably unnecessary because of economic limitations and an abundance of advance growth. The pioneer American silviculturists advised the forest manager to take full advantage of advance reproduction. We cannot improve upon that recommendation even with nearly a half century of hindsight. The silvical principles remain the same.

As stated earlier, silvical characteristics call for even-aged silviculture to reproduce oaks. Fortunately, a variety of silvicultural methods can be applied to meet objectives of different owners or managers. For maximum timber production in the shortest time, clearcutting will give the best results. In contrast, long rotations with scattered irregular openings will be the best route for those who want to optimize a combination of values such as timber, wildlife, and esthetics. Both methods and their variants will produce timber, wildlife, and pleasant scenery throughout most of the rotation. Watershed protection values will be essentially the same, provided good logging practices are followed. The silvicultural methods that can be employed in oak management are summarized below.

### *Single-Tree Selection*

Although single-tree selection is not recommended as a final harvest for oak stands, selection thinning can be used for intermediate or light partial cuttings throughout a large part of the rotation. All oaks except scarlet oaks are long-lived, and the rotation age can be extended for many years by this means. When selection is generally made from below, the long rotation produces high-quality logs. Mast production is very good, and the large trees lend much to esthetic qualities of the stand. However, growth per acre per year is sacrificed during the latter part of the rotation.

### *Group Selection*

Sooner or later all stands must be regenerated. Group selection has less impact on a unit area than clearcutting. Cutting a group of trees provides the necessary room for the new stand to grow into the overstory.

The group or opening size will have little influence on the amount of reproduction. Sander and Clark *(in press)* found no difference in density of reproduction in openings ranging in size from 1/20 acre to 4 acres. However, reproduction grows slowly on the edges of openings, and the width of the area affected is the same regardless of opening size. Thus small openings have a relatively high proportion of their total area in ineffective edge (fig. 3). For best reproduction growth, circular openings should be at least ½ acre *(Sander and Clark, in press)* and 1 acre is even better. The 1-acre opening is also better for wildlife habitat.

The chief disadvantages of group selection are higher logging and administrative costs compared with the shelterwood or clearcutting methods. The group-selection method is easier to use on small to medium-size ownerships where identification of small areas for management is not an administrative problem.

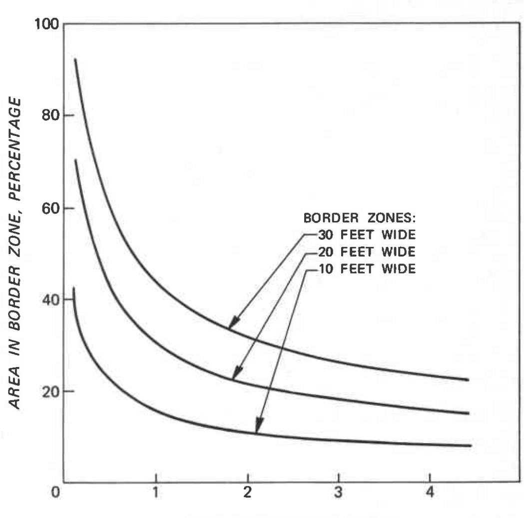
### *Shelterwood Method*

The shelterwood method is recommended by a number of authors, and a good technical review was given by Smith *(1962)*. Conceptually, it is a "safe" system because the final cut is not made until advance reproduction is established. The method has not been applied systematically on an operational basis in the United States, but a number of experimental cuttings have been made. The cuttings have generally failed to increase the amount of oak in the new stand. Perhaps the periods between preparatory cuts were simply not long enough, or the sites were too moist. In some places new seedlings were established but were unable to compete with the faster growing understory of other trees and shrubs.

After a study of advance oak reproduction in West Virginia, Tryon and Carvell *(1958)* suggested the one-cut shelterwood method for harvest cutting where there is abundant advance reproduction. In effect, such a system would be little different from technical clearcutting where there is advance reproduction.

The shelterwood idea is an excellent one for situations where an oak understory is lacking. But we must think of the preparatory cuttings and the seed cutting at least 20 years before the final harvest. The first cut or two must not be so heavy that it will release or establish fast-growing competing species.

**Figure 3.—Relation between total area of circular openings and percent of area in border zones 10 to 30 feet wide.**



The idealized shelterwood method provides one or more cuts that create optimum conditions for the establishment and development of advance reproduction before the final harvest cut. The first cut is made to encourage seed production and seedling establishment. The next cut or two strengthen the reproduction. The final overstory stand is made up of the best-formed and fastest-growing trees. It should contain about 40 to 50 percent of the original stand basal area. This final shelterwood stand is more open than a stand that has simply received a number of intermediate thinnings.

The advantage of the shelterwood cut is that a vigorous new stand occupies the site before the final harvest. The harvest is stretched over a number of years, and the stand is esthetically more pleasing than a clearcut stand. Mast and browse production should be near optimum for a relatively long period. Some disadvantages are the risk of degrade or windthrow of shelterwood trees, increased logging costs, and destruction of some advance reproduction during logging.

### Clearcutting Method

Many oak or mixed stands approaching maturity have enough advance reproduction to be regenerated by clearcutting. When we say clearcutting we mean technical clearcutting, in which the entire overstory stand, merchantable and unmerchantable, is removed at one time. The most important aspect of clearcutting for oak is the absolute requirement that well-developed advance reproduction be present in sufficient quantity to provide a fully stocked stand. This means at least 1,000 well-distributed oaks per acre, 2 to 4 feet in height. If other species can be depended upon to make up a part of a mixed stand, fewer oaks are needed.

Silviculturally, the size of the clearcut is limited only by the continuity of adequate reproduction. Other factors such as owner objectives and esthetics should determine the actual size of the clearcut areas. Some advantages of clearcutting are greater yields per acre, lower harvesting costs, simplified management, and the encouragement of the more valuable intolerant species. Disadvantages often cited, especially when large blocks are clearcut, are unpleasing looks, no mast production from the area for many years, and poor wildlife habitat in the dense sapling and pole stand. These and other disadvantages can be minimized by various management techniques that are entirely compatible silviculturally.

The combination of known and unknown hazards of oak silviculture demands that the forest manager be more than casual in his approach to oak regeneration. Unfortunately, we cannot at this time give exacting prescriptions for foolproof results. Even so, a few simple extensive treatments will greatly enhance the probability of establishing adequate advance reproduction. Most important, areas of deficient reproduction must be positively identified 20 to 30 years before the harvest cut. Remember, a harvest cut is made once in a rotation, and the timing of the cut is the most important single decision the forest manager makes. And the decision cannot be made upon timber values alone. Fortunately, in the oaks we are dealing with long-lived species, and harvests can be delayed for long periods.

Finally, classical cutting prescriptions are no panacea for oak silviculture. We rarely deal with a truly typical or classical situation. Stand conditions vary, and so must oak management. If the manager understands oak silvics, the silviculture will follow.

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