Selective Cutting and Reproduction of Cherrybark and Shumard Oaks

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Abstract. Red oak reproduction was surveyed in openings of two selectively cut bottomland hardwood stands. Seven years after a selection-cut only 3 percent of the seedlings were more than 12 inches tall. Regression analysis showed that distance, from sample trees, diameter of sample tree, diameter of sample tree squared, and length of opening transect had a significant effect upon number of red oak seedlings. Abundant reproduction is established but is not developing satisfactorily, and larger openings appear necessary if these species are to be managed under the selection method.

CHERRYBARK OAK (*Quercus falcata* var. *pagodaefolia* Ell.) and Shumard oak (*Q. shumardii* Buckl.) in bottomland hardwood forests of coastal South Carolina are capable of producing quality saw logs in 60 years and are desirable components of stands. Little is known, however, about regenerating these red oaks.[1]

Results from a selection cutting on the Santee Experimental Forest in mixed bottomland hardwoods during the winter of 1952-1953 showed red oak seedlings became established in abundance but did not develop in satisfactory quantities (Fig. 1).[2] Poor development prompted us to make a study in 1959 of the influence of several stand variables on red oak regeneration in openings made by the selection cut.

Study Area

Two mixed bottomland hardwood stands were treated by selection cutting in 1952-1953. Differences in species composition between the two stands (Table 1) were probably the result of variation in site conditions. Compartment 1 was largely creek bottomland, whereas compartment 2 included an appreciable amount of terrace site. Soils were Chastain silt loam along the stream bottoms and Bladen and Chastain fine sandy loams on the higher ground. Cherrybark and Shumard oak make excellent growth on these sites.

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[1]In this paper, red oak refers to either cherrybark oak or Shumard oak or both.

[2]Located in Berkeley County, near Charleston, S. C.

Methods

All openings having an adjoining dominant or codominant red oak were sampled. If several red oaks bordered the same opening, the most vigorous specimen was selected as the sample tree. A transect was extended from the sample tree to the center of the opening; both sample tree diameter and transect azimuth were recorded. Contiguous one-quarter milacre plots were established along the transect. Seedlings were tallied by size class (≤12 inches tall or >12 inches tall) and the nature of competition (whether free to grow or overtopped) for each plot.

Analysis and Results

Only 3 percent of the red oak seedling in the openings were more than one foot tall. Consequently, the analysis and findings refer only to red oak seedlings one foot or less in height. From preliminary plotting of the data it appeared that nature of competition had no discernible influence on seedling density, but that diameter of sample tree, distance from sample tree, and size of opening (length of opening transect) appeared to be correlated with the number of seedlings. The effect of these variables on seedling density was tested by the following multiple regression analysis:

D = distance from sample tree, in feet
D^2
D^3
d = dbh of sample tree, in inches
d^2

Table 1.—Species Composition in Each Stand by Number of Sawtimber Trees and Board-Foot Volume (1959)

Species	Compartment 1 Trees	Compartment 1 Volume	Compartment 2 Trees	Compartment 2 Volume
	Percent			
Cherrybark and Shumard oaks	27	46	20	26
Sweetgum	49	36	38	35
Loblolly pine	18	15	15	18
Swamp chestnut and white oaks	0	0	13	10
Miscellaneous species[1]	6	3	14	11
Total	100	100	100	100

[1]Includes white and green ash, American beech, black tupelo, eastern redcedar, baldcypress, American elm, hickories, black locust, red maple, black walnut, sugarberry, yellow-poplar, laurel oak, water oak, and willow oak.

Table 2.—Summary of Analysis of Variance for Significant Independent Variables

Source	d.f.	F value	Level of significance
Distance from sample tree (D)	1	22.22	0.005
Diameter of sample tree (d)	1	9.57	.005
(Diameter of sample tree)^2(d^2)	1	5.51	.025
Length of opening transect (L)	1	7.28	.025

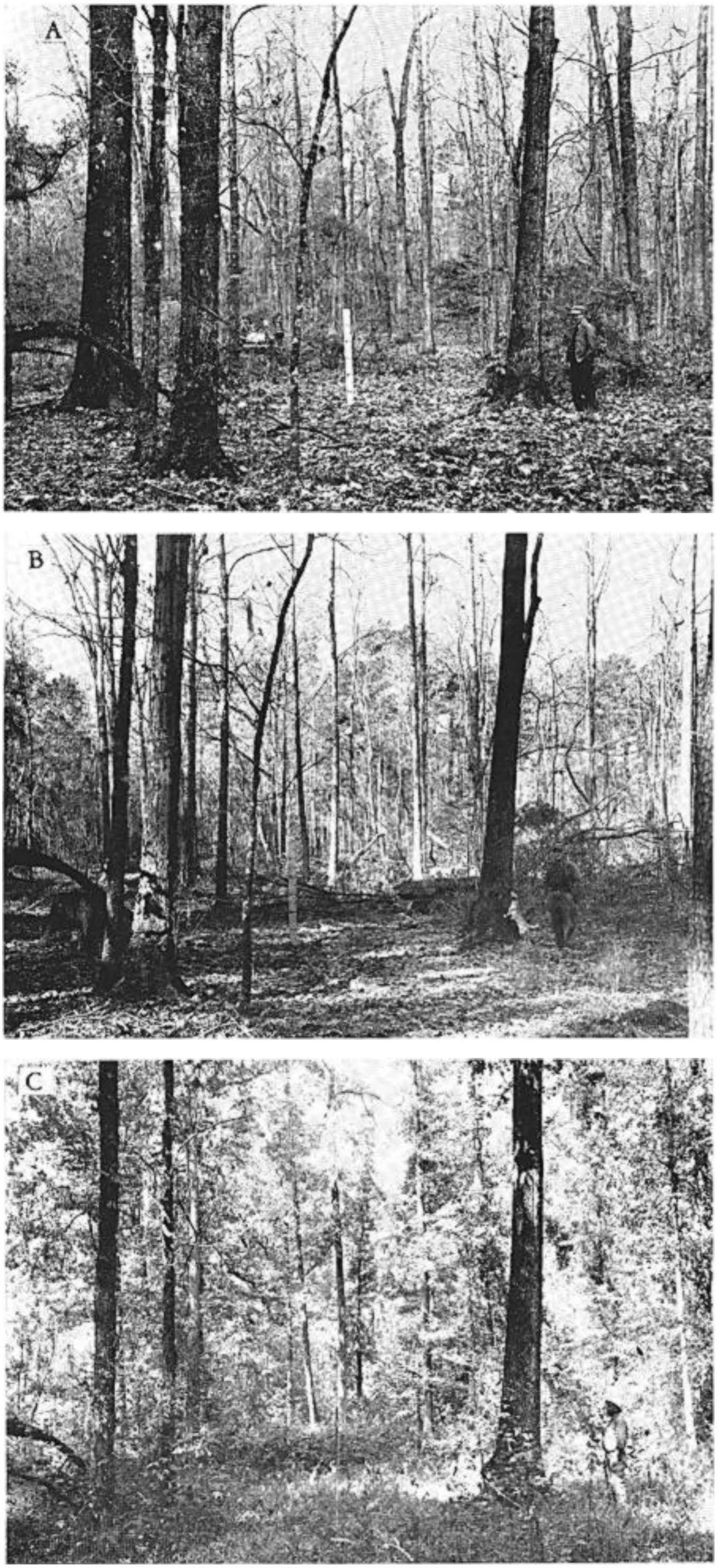

Fig. 1.—Typical stand conditions in compartment 1: (A) before selection cutting, (B) immediately after, and (C) ten years later. In the left foreground of (B) a large cherrybark oak was cut and a smaller tree girdled. Even with these two trees removed, reproduction has not developed after 10 years (C).

$D \times d$

L = length of transect, in feet

N = average number of red oak seedlings one foot or less in height per quadrat.

Distance from sample tree was tested up to 69 feet, diameter of sample tree from 14 to 48 inches, and length of opening transect from 18 to 129 feet. The regression analysis was based on 175 observations on 37 transects.

The equation, $N = -9.9046 - 0.1388(D) + 0.9439(d) - 0.0139(d^2) + 0.0689(L)$ accounted for only 22 percent of the total variation. Further tests of the data were made by plotting the regression residuals against the interaction of transect length squared and distance from the tree, but no correlation could be detected.

The analysis showed that several variables had a significant influence on the quantity of red oak seedlings established (Table 2). Number of seedlings per plot was directly correlated with sample tree diameter and length of opening transect, and negatively correlated with distance from the sample tree. Diameter also had a significant curvilinear effect (d^2); fewer seedlings were associated with the largest and smallest diameter sample trees as compared to those of median size. Basic data clearly show that this curvilinear effect does exist and that it is not an artifact of the quadratic curve form.

Discussion

Other researchers have had mixed success in relating the quantity of small oak regeneration to environmental and stand variables. Carvell and Tryon[3] found that a series of factors, including slope, percent sunlight, stand history, and exposure were more strongly correlated with number of oak seedlings greater than one foot tall than with the total number of oak seedlings. Hosner and Minckler[4] evaluated reproduction by broad forest types, density of overstory, size of canopy opening, density of ground cover, depth of litter, and available mois-

[3]Carvell, K. L., and E. H. Tryon. The effect of environmental factors on the abundance of oak regeneration beneath mature oak stands. Forest Sci. 7:98-105. 1961.

[4]Hosner, John F., and L. S. Minckler. Hardwood reproduction in the river bottoms of southern Illinois. Forest Sci. 6:67-77. 1960.

ture-holding capacity of the surface and subsoil. Although cottonwood and willow reproduction was strongly related to these factors, reproduction of other species, including the oaks, showed only a weak correlation.

These findings, coupled with the results of our opening survey, indicate that small oak regeneration is only weakly related to the factors we measured. An obvious question arises: What factor or factors do account for the levels of oak regeneration observed? No pat answer is available. However, the summation of available information gives some clues. Carvell and Tryon[5] stated that ". . . the ability of oak regeneration to persist on a specific site is more closely related to environmental conditions than is its ability to become established." Hosner and Minckler[6] observed that reproduction of oaks, hickory, pecan, and miscellaneous species was more abundant on heavier soils (higher water-holding capacity) than on sandy soils (lower water-holding capacity). They felt that one factor contributing to this condition was the preponderance of heavy-seeded species (a greater seed supply) in the overstory on the heavy soils.

Basic data from our survey fell roughly into two categories: transects with many seedlings, and transects with few or no seedlings. This division of data suggests that we may have sampled two populations: trees that produced an adequate number of acorns and those that did not. This is a common phenomenon in the seeding traits of trees and becomes particularly significant with heavy-seeded species because of limited seed dissemination distances.

The relationship of fewer seedling being associated with the very large diameter trees is not understood. Although competition could be important, there were no indications, judging by other vegetation under the trees, that there was a severe increase in competition above the median diameter range. Some difference in seed production might be associated with differences in tree height by size; i.e., very large diameter trees tend to have a wolf tree form, hence they may be shorter than trees with smaller diameters. However any difference in height would be small and certainly would not account for an appreciable trend. More subtle factors, such as seed production and seed quality, are conceivably involved.

Openings created by the selection cut in these stands varied in size from essentially zero to over 200 feet in diameter. Large numbers of red oak seedlings have become established but are not developing into sapling sizes in satisfactory quantities. More overhead release seems necessary but the optimum size opening, if any, is not defined.

In summary, it appears that the micro-climate, edaphic conditions, and several stand variables all have a definite influence on the quantity of small oak regeneration established, but their effect may be overshadowed or secondary to that of seed supply. Failure to elucidate this point has been due largely to inadequate knowledge of seed production. Although the results from this study are not conclusive, some implications are evident. Where oak regeneration is to be favored in uneven-aged management, large openings appear most desirable. In even-aged management, when a seed-tree cut is contemplated, extremely large or small diameter trees should be left as seed producers only as a last resort.

[5]Ibid.
[6]Ibid.

CLEPPER RECEIVES AFPI DISTINGUISHED SERVICE AWARD

Henry Clepper, SAF executive secretary, received the American Forest Products Industries, Inc., Distinguished Service Award on October 29.

The presentation at AFPI's annual meeting was made by President Bernard L. Orell.

"For his leadership in the forestry profession and for his scholarly additions to the knowledge of the nation's forests and other resources, American Forest Products Industries, Inc., presents to Henry Edward Clepper its national award for distinguished service to the forest products industries," the formal citation reads in part.