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Growth of four types of white oak reproduction after clearcutting in the Missouri Ozarks

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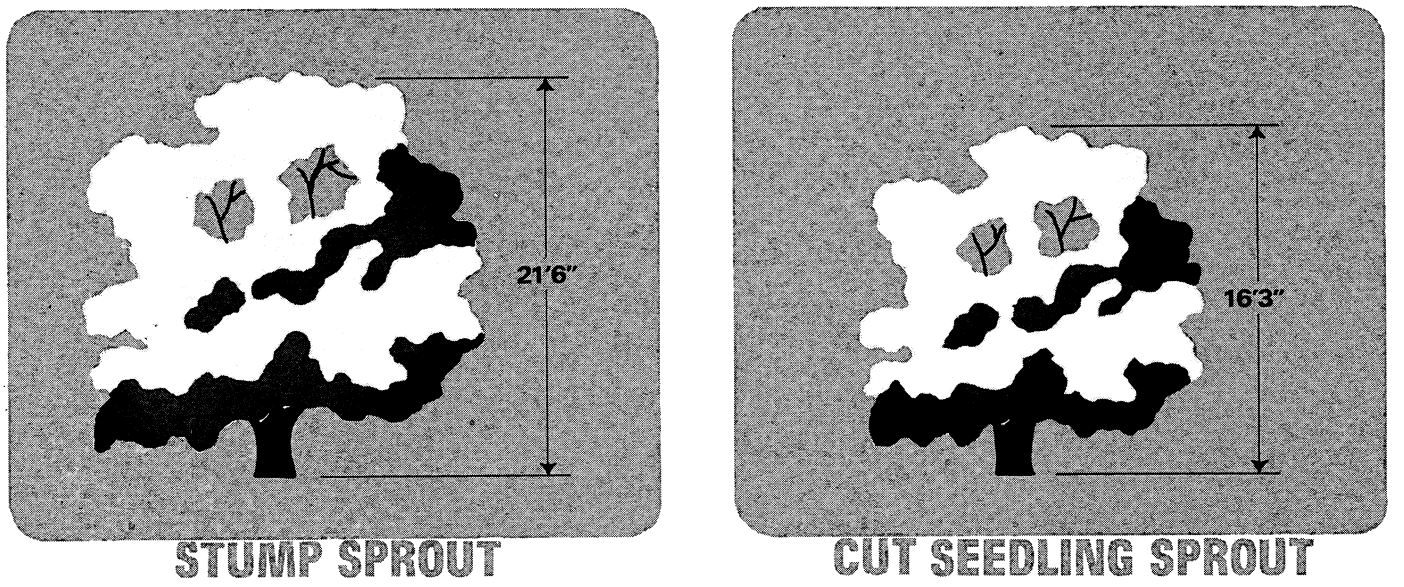

NORTH CENTRAL FOREST EXPERIMENT STATION
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GROWTH OF FOUR TYPES OF WHITE OAK REPRODUCTION AFTER CLEARCUTTING IN THE MISSOURI OZARKS

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Regeneration of oak stands after clearcutting depends on advance reproduction (seedlings and seedling sprouts present at the time of the cutting) and stump sprouts (Sander and Clark 1971). The study reported here corroborates that fact, and presents data on the survival and height growth of four types of white oak (*Quercus alba* L.) reproduction following clearcutting in even-aged white oak stands in the Missouri Ozarks.

METHODS

Sixteen 0.1-acre plots were established in even-aged oak stands on the Sinkin Experimental Forest in southeastern Missouri. The stands were composed primarily of white oak; black oak (*Q. velutina* Lam.) and scarlet oak (*Q. coccinea* Muenchh.) were minor stand components. Stand ages were between 41 and 58 years, and site indexes (McQuilkin 1974) ranged from 48 to 63 feet.

The plots were clearcut in April 1963. After the cutting, four types of white oak reproduction were established in a completely randomized design on the 16 plots; one reproduction type was established per plot, and each type was established on four randomly selected plots. Twenty-five individual plants were established or located on each plot to give a total of 100 plants of each reproduction type over the entire study.

The four types of reproduction were seedlings, seedling sprouts, new seedling sprouts, and stump sprouts.

Seedlings

Seedlings are young plants with tops and roots of the same age. In this study, seedlings were obtained by direct seeding after the clearcut and planting 1-0 nursery stock (from the same seed source) where the direct seeding failed to produce the necessary 25 seedlings per plot. On the 4 seedling plots, 48 direct-seeded seedlings were alive at the end of the first growing season, and 52 1-0 seedlings were planted as replacements.

Seedling sprouts

Sprouts with root systems several-to-many years older than the tops are seedling sprouts. These develop as a result of repeated top dieback and resprouting (Merz and Boyce 1956). To ensure that the roots were at least several years older than the tops, seedling sprouts were selected that had a root at least 1 inch in diameter at the ground line but had a top less than 0.5-inch d.b.h. The mean height of the 100 selected stems was 2.2 feet.

New seedling sprouts

New sprouts originating from the base of seedling sprouts (described above) are new seedling sprouts. In this study, these were created by cutting off the tops of seedling sprouts just above the root collar.

Stump sprouts

Sprouts originating from stumps of the overstory trees are stump sprouts. They were selected 4 months after the trees were cut, and only those stumps that had already produced at least one sprout were selected. One plot had only 24 sprouting stumps, so the stump sprout data for the whole study are based on a total of 99 stumps.

Immediately after the clearcut, understory stems down to 0.5-inch d.b.h. were cut on the seedling sprout plots, and all

understory vegetation (other than the study trees) was cut on the rest of the plots.

All study plants were released from competing vegetation after the first and second growing seasons. No further release was done after that.

The survival, height, and form of all study trees were measured each fall for 10 years. If more than one stem per plant was present, the height of the tallest stem was measured. Form was recorded as: *good*--single, straight, erect stem; *fair*--leaning stem or multiple stems of unequal height; or *poor*--multiple stems of about equal height, flat-topped crowns, excessive sweep or crook, or trees with stem decay.

RESULTS

Survival of the four reproduction types after 10 years was:

	Percent
Seedlings	79
Seedling sprouts	95
New seedling sprouts	93
Stump sprouts	97

As expected the stump sprouts grew the most; height growth of the seedling sprouts and the new seedling sprouts (which differed very little from each other) was about 75 percent of that of the stump sprouts; seedling growth was only 12 percent of that of the stump sprouts (fig. 1).

Often the range and distribution of heights can be more informative than just mean heights, so the data are presented in figure 2 as the percents of the total number of originally selected stems that attained various minimum heights after 10 years.[1] Mortality is represented by the difference on the vertical axis between the data line intercept and 100 percent.

Because only those stumps that had already produced at least one sprout were originally chosen for the study, the stump sprout percents of figure 2 were adjusted to reflect the percent of stumps that, at the time of cutting, would be expected to produce sprouts. Unpublished data on white oak stumps of 30- to 70-year-old trees from

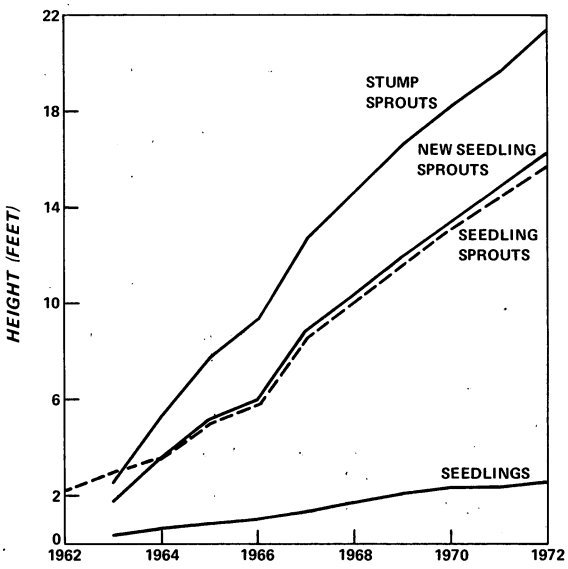

Figure 1.--*Mean heights of the four types of reproduction, by year. Heights were measured in the fall of the year indicated. A late spring frost in 1966 reduced height growth for that year.*

similar stands in the same area show this figure to be approximately 60 percent.

The survival and height data for seedling sprouts and new seedling sprouts were almost identical and were therefore combined in figure 2. The two categories were originally set up to see if new sprouts would outgrow existing stems, but 63 percent of the uncut seedling sprouts died back and resprouted at least once during the 10-year period, so at the end of that time the distinction between seedling sprouts and new seedling sprouts became almost meaningless. Moreover, the data indicated that new sprouts would grow at almost exactly the same rate as existing sprouts; the mean height of the uncut seedling sprouts that did not dieback and resprout was 15.7 feet at the end of the 10-year period, and the mean height of the seedling sprouts that did dieback and resprout was 16.0 feet.

There was a fairly strong correlation between height growth of the uncut seedling sprouts after release and size of the sprouts before release (fig. 3), which agrees with findings in Ohio and Illinois (Sander 1971, 1972). Figure 3 shows the relation between

[1] *Unpublished study summaries by Paul S. Johnson, on file at Columbia, Missouri.*

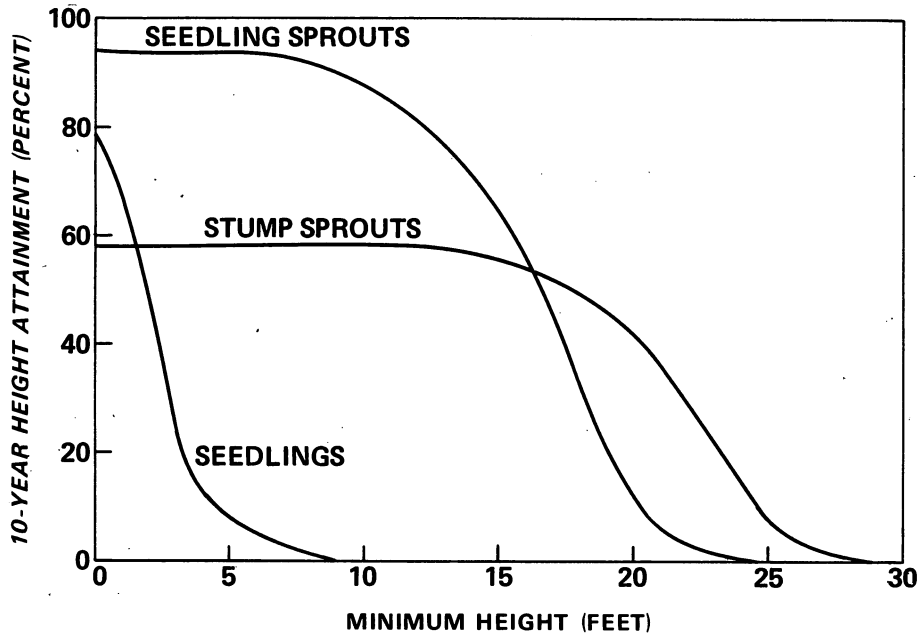

Figure 2.--*Seedlings, seedling sprouts, and stump sprouts attaining the indicated minimum heights 10 years after the clearcut.*

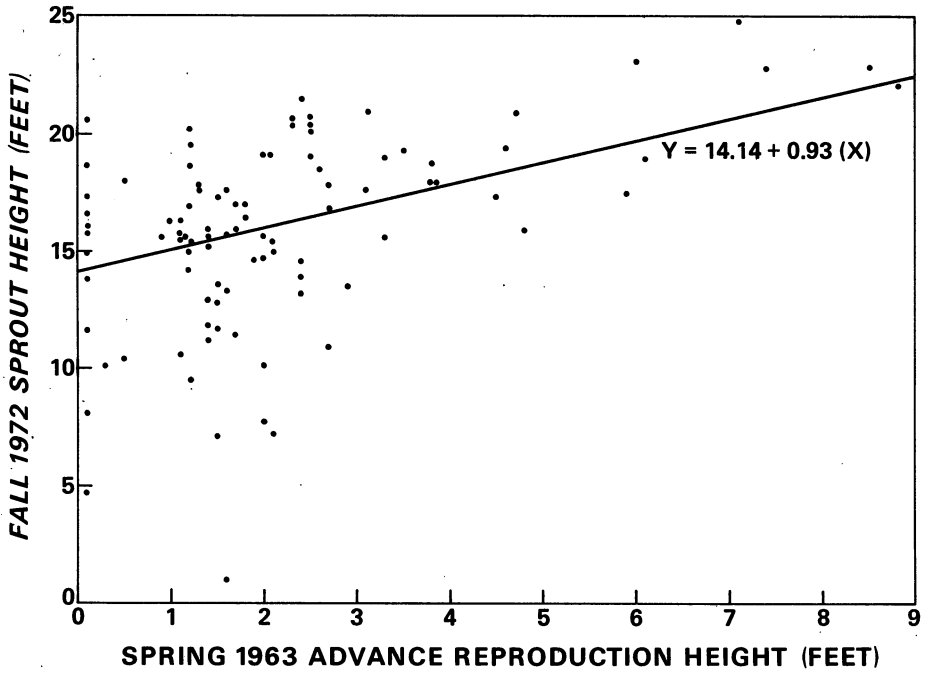

Figure 3.--*Fall 1972 sprout height vs. spring 1963 advance reproduction height.*

initial (preclearcut) and final (fall 1972) heights for the 95 surviving seedling sprouts. The regression in figure 3 was weighted ($w = 1.0/(9.0-X)^2$) to compensate for the greater variation in Y associated with the smaller values of X, and had a correlation coefficient of +0.83. The large amount of variation in final height among sprouts that were under 2 feet in height initially was presumably due to differences in vigor or size of the root systems.

The 10-year height attainment percents also varied for seedling sprouts of different original heights (fig. 4). In addition to their height advantage, stump sprouts and seedling sprouts also had much better form than the seedlings. More than 80 percent of the stump sprouts and seedling sprouts were in either the "good" or "fair" stem form categories in 1972, but less than 40 percent of the seedlings were in these categories.

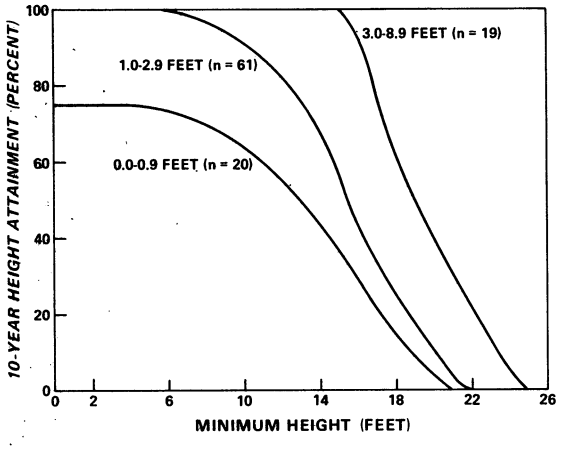

Figure 4.--*Seedling sprouts that attained the indicated minimum heights 10 years after the clearcut, by three height classes at the time of the clearcut.*

The stem form of uncut seedling sprouts improved after release, a trend also noted for oak seedling sprouts in West Virginia by Carvell (1967). Sixty-one percent of the surviving uncut seedling sprouts were in a higher form category at the end of the 10-year period that they were in the fall of the first year; 29 percent remained in the same category and 10 percent were in a lower category.

At the end of the 10-year period, the mean d.b.h. of the stump sprouts was 2.6 inches and that of the seedling sprouts and new seedling sprouts was 1.4 inches.

The mean number of live stump sprouts per stump at the end of the eighth year (the only year for which such data were available) was 2.2.

DISCUSSION AND SUMMARY

This study corroborates the findings of others (Beck 1970, Sander and Clark 1971, Sander 1972) that oak seedlings established at the time of clearcutting grow too slowly to be of value in stand reproduction, and that stump sprouts and the larger seedling sprouts are the most important sources of reproduction.

The similarity in height, survival, and form of the seedling sprouts and new seedling sprouts after 10 years leads to the conclusion that in regenerating white oak stands through clearcutting, it is not necessary to either protect seedling sprouts from logging damage or to deliberately knock back the existing tops to promote new sprouts.

Height attainment graphs (figs. 2 and 4) are particularly valuable in assessing oak reproduction because they combine measures of height distribution plus survival in a graph that can be used to make quantitative evaluations of the reproduction potential of stands before cutting. An example follows showing how height attainment percents can be used in evaluating stand reproduction.

Example

A 60-year-old white oak stand contains 300 overstory trees per acre; the understory contains 50 seedling sprouts $\geq$ 3.0 feet tall, 200 seedling sprouts 1.0 to 2.9 feet tall, 300 seedling sprouts $\leq$ 0.9 feet tall, and 100 new seedlings per acre. If the overstory is removed, the number of reproduction stems that will be present and at least 15 feet tall after 10 years can be computed by multiplying the 15-foot height-attainment percents (figs. 2 and 4) by the number of stumps, sprouts, or seedlings present at the time of the clearcutting (table 1).

The number of reproduction stems at any other minimum height 10 years after cutting can also be determined by substituting the appropriate height attainment percents from figures 2 and 4.

Table 1.--*Sample computation of number of reproduction stems at least 15 feet tall 10 years after cutting*

Reproduction type	15-foot height attainment	Sprouts or seedlings at time of cutting	Reproduction stems ≥15 feet tall 10 years after cutting
	Percent	*No./acre*	*No.*
Stump sprouts	[2] 0.56	300	168
Seedling sprouts			
≥3.0 feet	[1] 1.00	50	50
1.0 to 2.9 feet	[1] .57	200	114
≤0.9 feet	[1] .37	300	111
Seedlings	[2] .00	100	0
Total			443

[1] From figure 4.
[2] From figure 2.

The actual minimum heights that should be used in any particular case and the interpretation of the results cannot be determined from this study, but would depend on the site index, the type of competition anticipated, and the management objectives.

In using the results of this study, it should be remembered that these data are from white oak only, and caution should be exercised in extending this information to other species, to overstory stands of other ages or to other types of reproduction.

Similar information for other oak species, information on seedling sprouts with roots less than 1 inch in diameter, and a procedure to account for spatial distribution of the reproduction will be needed to make complete evaluations of reproduction in mixed oak stands.

LITERATURE CITED

Beck, D. F. 1970. Effect of competition on survival and height growth of red oak seedlings. USDA For. Serv. Res. Pap. SE-56, 7 p. Southeast. For. Exp. Stn., Asheville, N. C.

Carvell, K. L. 1967. The response of understory oak seedlings to release after partial cutting. W. Va. Univ. Agric. Exp. Stn. Bull. 553, 20 p.

McQuilkin, R. A. 1974. Site index prediction tables for black, scarlet, and white oaks in southeastern Missouri. USDA For. Serv. Res. Pap. NC-108, 8 p. North Cent. For. Exp. Stn., St. Paul, Minn.

Merz, R. W., and S. G. Boyce. 1956. Age of oak seedlings. J. For. 54:774-775.

Sander, I. L. 1971. Height growth of new oak sprouts depends on size of advance reproduction. J. For. 69:809-811.

Sander, I. L. 1972. Size of oak advance reproduction: key to growth following harvest cutting. USDA For. Serv. Res. Pap. NC-79, 6 p. North Cent. For. Exp. Stn., St. Paul, Minn.

Sander, I. L., and F. B. Clark. 1971. Reproduction of upland hardwood forests in the Central States. U.S. Dep. Agric., Agric. Handb. 405, 25 p.

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OXFORD: 181.51:232.324:176.1(778). *Quercus alba*.
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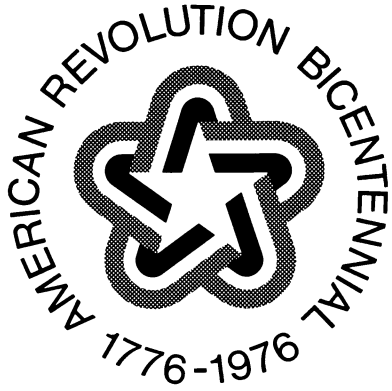
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