

**Reproduction 7 Years After
SEED-TREE HARVEST CUTTING
in Appalachian Hardwoods**



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Introduction

THIS IS A REPORT on the potential of young even-aged hardwood stands, based on measurements made when the stands were 7 years old. It was designed to provide forest managers with data that can aid them in deciding whether or not to do early cultural work. As a basis for this appraisal, we determined for the stands: (1) the number, size, and distribution of stems; (2) the species composition; (3) the stem quality; and (4) the effect of early cultural treatments.

Because we stratified our results by site-quality classes, we believe that these results should be generally applicable to hardwood forests in the central Appalachians. We recognize that our evaluation, made on stands this young, can only indicate and not blueprint development. However, the need for specific information about the results of regeneration cuttings in even-aged silviculture is so great that the outcome should be useful now.

This paper is a sequel to a previous publication that described reproduction on the same areas when the new stands were only 3 years old (*Wendel and Trimble 1968*).

Study Areas and Methods

The study was carried out on nine compartments that averaged about 12 acres each. Three of the compartments were on areas of site index 80, three on site index 70, and three on site index 60—based on 10-foot oak site-index classes (*Schnur 1937*). These indexes characterize sites that will be referred to as excellent, good, and fair.

The soils of the study area are of medium texture, well drained, probably average over 3 feet deep, and are derived mostly from sandstone and shale (with some limestone influence in places). The general area gets about 58 inches of well-distributed rainfall a year; the frost-free growing season is about 4½ months long.

The original stands were well stocked; they had not been disturbed by cutting or fire for at least 35 years. All of them contained considerable sawtimber volume. The most numerous species among sawtimber stems were hickories, sugar maple, red oak, white oak, and black cherry on the excellent sites; yellow-poplar, red oak, hickories, chestnut oak, and white oak on the good sites; and chestnut oak, red oak, black gum, and white oak on the fair sites. (Scientific names of species are given in the Appendix).

Most of the sawtimber trees on the three excellent-site areas and many on one good-site area and one fair-site area were old-growth trees 90 to 100 years old. The sawtimber trees on the other areas were mostly second growth, 55 to 60 years old, with a few old-growth residuals.

The same harvest-cutting procedure was used on all study areas: in the first cutting, all stems over 5 inches d.b.h. were logged except for designated seed trees. After three growing seasons, the seed trees were removed.

The number of seed trees varied by site quality. We reasoned that, on the lower site-quality areas, more seed trees were needed to obtain adequate distribution of seeds because of the greater proportion of the heavy-seeded oaks. By site-index class, we left the following numbers of seed trees per

Table 1.—Cultural treatments

Compartment	Oak site index	Seed trees	Treatment of residual 1-5 inch d.b.h. stems	Crop-tree release
<i>No.</i>	<i>Feet</i>	<i>No.</i>		
32	80	10	—	✓
33	80	10	—	—
43	80	10	✓	✓
36	70	20	✓	✓
37	70	20	—	—
39	70	20	—	✓
34	60	30	—	✓
35	60	30	—	—
38	60	30	✓	✓

acre: site index 80—10 trees, site index 70—20 trees, and site index 6—30 trees (table 1).

Two types of precommercial cultural operations were made in the new stands of reproduction (table 1). On three of the compartments—43, 36, and 38—the residual 1- to 5-inch stems still living after the seed-tree cutting were treated (in 43 they were cut; in 36 and 38 they were basal-sprayed). On six compartments, crop-tree releases were made at 7 to 9 years—compartments 43, 36, and 38 (this was the second cultural treatment for these three compartments); and compartments 32, 39, and 34 (this was the first cultural treatment on these compartments). And on three of the compartments—33, 37, and 35—no cultural work at all was done.

To measure the development of the new stand, we sampled reproduction at frequent intervals, beginning before the harvest cuttings. Tallies were made by species, size class, stem origin (seedlings or sprouts), and for the larger stems by stem quality class—good or poor. The seedling category included seedling sprouts, defined as stems arising from stumps less than 2 inches in diameter at ground line.

Two size classes of reproduction were recognized: *Small* (1 foot high to 1 inch d.b.h.) and *large* (1 inch to 5 inches d.b.h.). Small reproduction was sampled on milacre plots and

large reproduction on 1/100-acre plots. Both size classes of reproduction were tallied as seedlings or stump sprouts, and the large reproduction was also tallied as good or poor stems.

All reproduction tallies after the harvest cutting were made at 45 permanent sampling points in a 5-acre area in the center of each compartment.

Results

ABUNDANCE OF COMMERCIAL SPECIES

Only stems of commercial species were tallied. A commercial species is one that is merchantable in the area for any product: veneer, sawtimber, ties, posts, blocking, pallet stock, pulpwood, etc.

The number of *small stems* per acre at 7 years averaged 10,741 for the excellent site, 5,985 for the good site, and 8,181 for the fair sites (table 2). There were appreciably fewer stems of this size class than occupied the same areas 4 years earlier: 13,338 for the excellent site, 10,183 for the good sites, and 13,604 for the fair sites.

The number of *large stems* per acre at 7 years (excluding those residuals that were between 1 and 5 inches d.b.h. at the time the overstories were harvested) averaged 362 for the excellent sites, 874 for the good sites, and 774 for the fair sites (table 2). Four years earlier, only a small number of stems had reached this size.

Three factors may be partially responsible for the fewer large stems on the excellent sites: (1) two of the excellent-site areas were characterized by an unusually heavy ground cover of herbaceous vegetation that obviously slowed seedling growth (fig. 1); (2) all three excellent-site stands were older than most of the stands on the sites of lower quality, and thus stump sprouts (which are faster growing than young seedlings) were fewer; and (3) the original stands on the lower-quality sites had many more red maple, a species that stump sprouts prolifically (fig. 2).

Table 2.—Reproduction of commercial species after 7 growing seasons

Compartment number	Small reproduction				Large reproduction			
	Total stems/ acre	Sprout stems/ acre	Proportion of sprouts	Proportion of ¹ / ₁₀₀₀ -acre plots stocked	Total stems/ acre	Sprout stems/ acre	Proportion of sprouts	Proportion of ¹ / ₁₀₀ -acre plots stocked
	No.	No.	Pct.	Pct.	No.	No.	Pct.	Pct.
EXCELLENT SITE								
32	7,400	666	9	96	420	248	59	80
33	15,755	1,444	9	98	378	208	55	84
43	9,067	1,289	14	93	289	150	52	91
Ave.	10,741	1,133	11	96	362	202	56	85
GOOD SITE								
36	6,223	1,533	25	91	926	630	68	96
37	4,333	1,133	26	91	790	450	57	100
39	7,400	1,444	20	96	907	526	58	100
Ave.	5,985	1,370	23	93	874	535	61	99
FAIR SITE								
34	8,955	1,644	18	98	579	446	77	89
35	8,156	1,756	22	96	898	521	58	100
38	7,434	1,886	25	98	844	675	80	100
Ave.	8,181	1,762	22	97	774	547	71	96



Figure 1.—Heavy herbaceous ground cover on an excellent site.



Figure 2.—A clump of red maple stump sprouts.

As was to be expected, the total number of reproduction stems decreased as the new stand increased in age from 3 to 7 years. Mortality among small stems were high, and replacement from below was slight because, after 3 years, the ground was densely shaded.

DISTRIBUTION OF COMMERCIAL SPECIES

The percentages of sampled milacres that were stocked with at least one *small stem* of a commercial species were: excellent sites, 96 percent; good sites, 93 percent; and fair sites, 97 percent. Little difference in stocking existed either within or between site-quality classes (table 2). The stocking percentages at 7 years were almost identical to what they had been at 3 years.

The percentages of 1/100-acre plots that were stocked with at least one *large stem* of a commercial timber species were: excellent site, 85; good site, 99; and fair site, 96 (table 2).

SPECIES COMPOSITION

By sites, for *small stems*, the five leading species at 7 years did not differ much in ranking from the five leaders at 3 years. The first five at 7 years were:

Excellent site: (1) Sweet birch, (2) sugar maple, (3) yellow-poplar, (4) white ash, and (5) black cherry.

Good site: (1) Sugar maple, (2) yellow-poplar, (3) sassafras, (4) sweet birch, (5) red maple.

Fair site: (1) Sassafras, (2) sweet birch, (3) red maple, (4) chestnut oak, (5) red oak.

On all the areas, we found a large number of species. The three compartments on the excellent site had 13, 14, and 15 different commercial species; on the good site, the numbers of species were 13, 17, and 18; and on the fair site, they were 12, 13, and 14.

As was expected, site quality had a strong influence on species composition. Yellow-poplar, black cherry, and sugar maple were more abundant on the excellent sites; sassafras, red maple, and the oaks were more numerous on the fair sites. The good site was the transition zone for species composition and, perhaps for this reason, had a greater number of species than either the excellent or the fair sites. As we have noted, stems of sweet birch were numerous on all three sites. Sweet birch appears to be unusually tolerant of site quality differences. Moreover, because of its early fast growth rate, it gets a jump on many species that outgrow it later.

For *large stems* of commercial species, the five most numerous were (numbers in parenthesis are numbers of stems per acre):

Rank- ing	Excellent sites	Good sites	Fair sites
1	Sugar maple (91)	Black locust (124)	Red maple (186)
2	Basswood (49)	Sugar maple (111)	Sassafras (176)
3	Eastern hophorn- beam (43)	Red maple (107)	Chestnut oak (103)
4	Black locust (38)	Sassafras (97)	Red oak (84)
5	Black cherry (27)	Yellow-poplar (75)	Sourwood (49)

On all study areas, we found a large number of species in this stem-size class. The three compartments on the excellent site had 10, 12, and 12 different commercial species. For the good site, the numbers were 14, 17, and 17; and for the fair site they were 13, 13, and 16. As occurred with the small stems, the good site exhibited the greatest diversity of species.

Several factors have a pronounced influence on the species composition of the large reproduction at 7 years. One is site quality, the effect of which was discussed in the previous section dealing with "small stems". Shade tolerance, too, has an effect, in that the species that were abundant as advance reproduction under the old canopies, such as sugar maple, got a jump on the others. Sprouting vigor, as exemplified by red maple and basswood, put these species in the forefront. Another species-related characteristic that favors

early fast growth is the propensity to root suckering, as exhibited by black locust and sassafras.

We compared species composition of new reproduction to the species composition of the old stand and the seed trees. With some exceptions, the predominant reproduction in the new stand was correlated in general to the most numerous species in the old stand, although the numerical order was somewhat different. An outstanding exception concerns red oak on excellent sites. Red oak was one of the most numerous sawtimber-size trees in the old stand, but constituted only a very small proportion of the reproduction. Several species, because of their prolific seeding characteristics, light seed, or heavy reproduction by root suckers, were more prominent in the new stand than in the old. These were sweet birch, sassafras, hornbeam, black locust, and yellow-poplar. With the exception of yellow-poplar, these species are short-lived, and most of them can be expected to drop out before rotation age.

Although we have no measurement of this, we feel that the seed trees did not have an appreciable effect on either the species composition or the abundance of stems in the new stand. Many of the stems present in the new stand came from small stems that existed at the time the old stand was cut. No doubt many of the new stems came from dormant seed in the duff, and many of them resulted from the current year's seed crop at the time the stands were harvested. The concensus of silviculturists is that seed trees are not needed to reproduce new hardwood stands.

REPRODUCTION QUALITY

No observations were made on the stem quality of *small reproduction* other than to tally it by seedlings (including sprouts from stumps less than 2 inches in diameter and root suckers) and stump sprouts (from stumps 2 inches in diameter and larger). At 7 years, percentages of sprouts were: excellent sites—11; good sites—23; and fair sites—22 (table 2).

Large reproduction was tallied as: (1) seedlings or sprouts, and (2) good or poor stems (table 3, and figs. 3 and 4). Good stems were straight and free from rot and mechanical injury; the others were classified as poor.

The percentage of total large stems that were sprouts went up as site quality decreased. On the excellent sites, sprouts averaged 56 percent of total stems; on the good sites, 61 percent; and on the fair sites, 71 percent (table 2). The higher sprouting incidence on the lower sites could have occurred because the previous stands there were younger when cut, and because they contained many more red maples, a vigorously-sprouting species.

For each site-quality class, seedlings averaged better quality than sprouts (table 3). For all areas on all sites, using

Table 3.—Stem quality of large reproduction

Compartment number	Percent of total stems that were sprouts	Percent of stems that were classified as good quality	
		Seedlings	Sprouts
EXCELLENT SITE			
32	59	77	53
33	55	61	59
43	52	66	43
Average	56	68	52
GOOD SITE			
36	68	56	43
37	57	53	51
39	58	63	40
Average	61	57	45
FAIR SITE			
34	77	39	43
35	58	53	53
38	80	63	40
Average	71	52	45

Figure 3.—Well - formed stems of large reproduction.



the t-test for paired data, the difference was significant at the 5-percent level. Observations lead us to believe, however, that if we had used in the comparison only the best quality stems of each sprout clump, the differences between the two groups would have been much less pronounced or might not even have existed.



Figure 4.—A poorly-formed stem of large reproduction.

NONCOMMERCIAL SPECIES VALUABLE TO WILDLIFE

We tallied three noncommercial species that are important suppliers of wildlife food: pin cherry, flowering dogwood, and downy serviceberry. Strictly speaking, these species are not always noncommercial in all locations. When they grow large enough, they are included with pulpwood in this area.

At 7 years, and including both large and small stems (most stems were small), the average numbers per acre by site classes were:

Excellent sites: Pin cherry—59, dogwood—44, and serviceberry—7.

Good sites: Pin cherry—17, dogwood—452, and serviceberry—103.

Fair sites: Pin cherry—148, dogwood—208, and serviceberry—260.

The data seem to indicate that these species are more likely to form an appreciable component of new even-aged stands on sites below average quality. Serviceberry, in particular, appears to compete better in stands on lower-quality sites.

INDICATED POTENTIAL EFFECT OF EARLY CULTURAL TREATMENTS

On the Threat to the New Stand Posed by Large Advance Reproduction

Two kinds of observations gave us a measure of the potential threat to the development of the new stand posed by the 1- to 5-inch stems that remained after the seed trees were harvested. Most of these residual stems were too poorly formed or —after 7 years of growing in the open—too badly feathered out to make good crop trees themselves. The observations made were: (1) the number of these residuals, and (2) an estimate of the percentage of the total area dominated by their crowns (based on the percentage of milacres

receiving what we judged to be shade sufficiently dense to retard the growth of intolerant species).

Although they have had little apparent effect as yet on the number and development of the new stems, many of them will continue to grow, expanding their crowns and eventually becoming wolf trees. Because these stems were treated differently on different compartments, we also have a measure of the effect of treatment in reducing the threat they pose.

First, look at the number of 1- to 5-inch residuals on the four compartments on which they were tallied—32, 39, 36, and 43 (unfortunately they were not tallied on all compartments).

On compartments 32 and 39, where no treatments were made until the crop-tree release, the tallies showed 53 and 129 advance reproduction stems per acre present before crop-tree release and 33 and 62 left after crop-tree release (table

Table 4.—Advance reproduction stems (1- to 5-inch residuals) and the effects of treatment

Comp. No.	Residual stems per acre		Area dominated by residual stems	
	Before crop- tree release	After crop- tree release	Before crop- tree release	After crop- tree release
	No.	No.	Pct.	Pct.
EXCELLENT SITE				
32	53	33	18	11
33	(¹)	(¹)	13	² 13
43	0	0	0	0
GOOD SITE				
36	(¹)	22	29	13
37	(¹)	(¹)	58	² 58
39	129	62	47	18
FAIR SITE				
34	(¹)	(¹)	49	38
35	(¹)	(¹)	53	² 53
38	(¹)	(¹)	22	2

¹ Tallies not made.

² Same as before release because no crop-tree release was made.

4). On compartment 36, where they were basal-sprayed at 3 years, we did not count them before crop-tree release, but after crop-tree release we found 22 per acre. These had been reduced from an unknown number by a combination of early basal spraying and a later crop-tree release. On compartment 43, these stems were cut at 3 years when seed trees were removed, and all of them were eliminated (fig. 5). Obviously cutting the stems was more effective than basal spraying.

Partly because data were taken on all nine compartments, the percentage of area dominated by residuals (based on the percentage of milacres receiving what we judged to be shade sufficiently dense to retard the growth of intolerant species) may be the better measure of the influence of residuals (fig. 6). It may also be a better indicator of the improvement brought about by the elimination of 1- to 5-inch residual stems.

On the total of 6 compartments where no stem treatments were made before crop-tree release, shading at 7 years and before release affected an average of 40 percent of the area. This is a good indication of the shading effect we might



Figure 5.—All large residual advance reproduction stems were cut on this area.



Figure 6.—Residual large advance - reproduction stem casting shade on new stand.

expect if no precommercial cultural work is carried out in young stands.

On the three areas where the first treatment was a crop-tree release (32, 39, 34), the percent of areas shaded was 18, 47, and 49 percent before the release and 11, 18, and 38 percent after it. The crop-tree release brought about an average reduction in shading of 40 percent.

On compartment 43, where all the residual stems were cut at 3 years, none of the area was shaded at 7 years, either before or after crop-tree release. On compartments 36 and 38, where the residuals were basal-sprayed at 3 years, the percent of area shaded before crop-tree release was 29 and 22. The shading was reduced by crop-tree release to 13 and 2 percent.

On Future Species Composition of Stands

As a measure of the effect of early cultural work on species composition, we compared the composition of the stand of large reproduction before crop-tree release to the composition of the stand of released crop trees. The rationale for

using this comparison was an assumption that the unreleased stand would provide a species mix in the final crop proportional to what it was at 7 years, and that the released tree stand would do the same.

The yardstick used in this comparison was the proportion of favored species, which were: for the excellent and good sites—yellow-poplar, black cherry, white ash, basswood, red oak, and cucumbertree; for the fair site—the same species (most of them except red oak occur frequently on the fair sites) plus black, white, and chestnut oaks, and red maple.

A comparison of the proportion of stems of favored species shows clearly that crop-tree release has, at least temporarily, improved the species composition prospects for the future stand (table 5). For the six compartments where crop trees were released, the percentages of crop trees falling in the favored species group were 61, 92, 98, 100, 100, and 100. At 7 years, before crop-tree release, these same compartments

Table 5.—Percentage occurrence of favored species among the five most numerous species

Compartment number	Large reproduction at 7 years before crop-tree release	Among released crop trees
EXCELLENT SITE		
32	15	92
33	44	(¹)
43	29	98
GOOD SITE		
36	26	61
37	50	(¹)
39	28	100
FAIR SITE		
34	66(20) ²	100(40) ²
35	35(3) ²	(¹)
38	61(13) ²	100(52) ²

¹ No cultural work was done in these compartments.

² Percent of stems that are red oak, the most favored species on fair sites.

had the following percentages of large reproduction stems in favored tree species: 26, 15, 29, 28, 66, and 61.

For the fair site, a more precise way to evaluate the species upgrading effect of crop-tree release might be to look only at red oak, the most favored species. Red oak comprised 40 and 52 percent of the released crop trees, but only 20 and 13 percent of the unreleased large reproduction (table 5).

Until more time has passed, we cannot be sure that the crop-tree composition will be maintained to the end of the rotation, nor can we ignore the fact that the commercial thinnings that will be made later in the untreated compartments (33, 37, and 35) will, to some extent, upgrade the species composition of these stands. But it appears now that crop-tree release has improved the potential species composition of the final stand.

Conclusions

1. At 7 years, both small and large stems of commercial species were abundant and well-distributed.

2. Species composition of the small reproduction at 7 years differed little from what it was at 3 years. However, at 7 years this size class was no longer dominant reproduction.

3. Large reproduction was composed mostly of species that had at least one of the following characteristics: (1) great sprouting vigor (red maple and basswood); (2) shade tolerance, permitting a start under the old stand (sugar maple); (3) unusually fast early growth (black cherry); and a (4) tendency to root-sucker (black locust and sassafras).

4. Species composition was strongly influenced by site quality, but a wide variety of species was represented on all sites and all study areas.

5. Seedlings and seedlings sprouts had better stem form than sprouts. However, if we had used in the comparisons

only the best quality stems of each stump sprout clump, the difference between the two groups would have been much less pronounced or might not have existed at all.

6. Early indications are that residual stems (those that were 1- to 5-inches d.b.h. when the old stands were cut) have potential for adversely affecting the new stand through shading it. Cutting these stems was more effective in eliminating them than was basal spraying.

7. Comparing the percentages of favored species found in the unreleased large-stem population to the released crop-tree population showed that crop-tree release had potential to improve species composition on all sites.

LITERATURE CITED

Schnur, G. Luther.

1937. YIELD, STAND, AND VOLUME TABLES FOR EVEN-AGED UPLAND OAK FORESTS. USDA Tech. Bull. 560, 88 pp., illus.

Wendel, George W., and George R. Trimble, Jr.

1968. EARLY REPRODUCTION AFTER SEED-TREE HARVEST CUTTINGS IN APPLACHIAN HARDWOODS. USDA Forest Serv. Res. Paper NE-99, 16 pp., illus. NE. Forest Exp. Sta., Upper Darby, Pa.



Appendix

COMMON AND SCIENTIFIC NAMES

Hickory (*Carya* sp.)
Sugar maple (*Acer saccharum* Marsh.)
Red oak (*Quercus rubra* L.)
White oak (*Q. alba* L.)
Black cherry (*Prunus serotina* Ehrh.)
Yellow-poplar (*Liriodendron tulipifera* L.)
Chestnut oak (*Q. prinus* L.)
Black gum (*Nyssa sylvatica* Marsh.)
Red maple (*Acer rubrum* L.)
Sweet birch (*Betula lenta* L.)
White ash (*Fraxinus americana* L.)
Sassafras (*Sassafras albidum* (Nutt.) Nees)
Black locust (*Robinia pseudoacacia* L.)
Basswood (*Tilia* sp.)
Eastern hophornbeam (*Ostrya virginiana* (Mill.) K. Koch)
Sourwood (*Oxydendrum arboreum* (L.) DC.)
Pin cherry (*Prunus pensylvanica* L. f.)
Flowering dogwood (*Cornus florida* L.)
Downy serviceberry (*Amelanchier arborea* (Michx. f.) Fern.)
Black oak (*Quercus velutina* Lam.)
Cucumbertree (*Magnolia acuminata* L.)



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