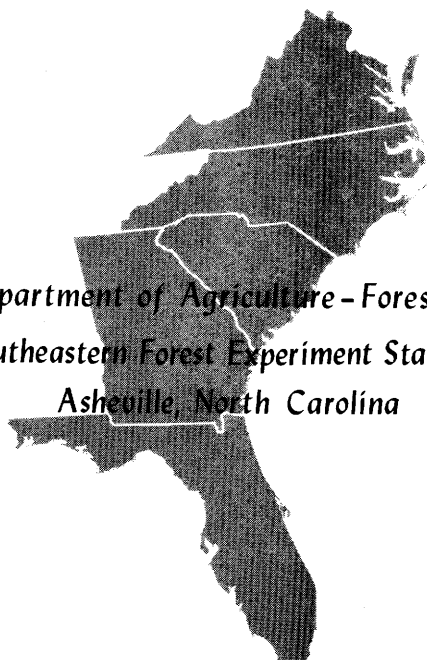


Regeneration after Clearcutting in the Southern Appalachians

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Even-aged silviculture with its associated heavy harvest cutting has tremendous potential for regenerating upland hardwoods. However, even-aged silviculture must involve much more than a heavy harvest cut, for a heavy cut alone does not necessarily solve all of the problems of upland hardwood regeneration. In this paper a careful look is taken at a 46-acre tract of timberland 5 years after a complete clearcut. Although some questions as to the future of the area are unanswered, the tremendous growth rate and rapid stand development allow a preview of things to come.

The Study Area

The study area is located on Bent Creek Experimental Forest 10 miles south of Asheville, North Carolina. It is bisected by a permanent north-south stream and has two major aspects. On the west side of the stream, the land has an eastern aspect and is typical of much of the better forest land in the mountains. Before the harvest, the west side contained excellent yellow-poplar and northern red oak and some good chestnut oak. The east side of the stream has a westerly aspect and is mostly typical of poorer mountain land, although some of the east-side coves are capable of growing high-quality hardwoods. Much of the land on the east side of the stream contained a dense understory of mountain-laurel and rhododendron before the area was cleared.

The study area has a research history dating back to 1936, when it was subdivided into fifty 1-acre plots as part of a harvest cutting study. At that time five treatments were replicated 10 times on the 1-acre plots. The treatments ranged from no cutting to a diameter cut in which all trees above 14 inches were removed. The original plot boundaries have been retained, and the plots are identified by number. Almost 35 years have passed since the cutting, however, and no effects of the relatively mild

treatments applied in 1936 have carried over to the regeneration on the area now. Four of the original plots have been deleted from this study because of road construction; therefore, results are now based on samples taken on 46 acres.

Methods

In 1963 and 1964, all commercial timber was cut by commercial loggers (fig. 1). The loggers removed an average of 24 sawtimber trees and 95 pulpwood trees per acre. The volume averaged 7,000 board feet of sawtimber and 10 cords of pulpwood per acre. Yellow-poplar, northern red oak, chestnut oak, and red maple made up most of the cut volume. The average stumpage price for sawtimber on this sale was relatively high for the period, indicating a large percentage of high-quality logs.

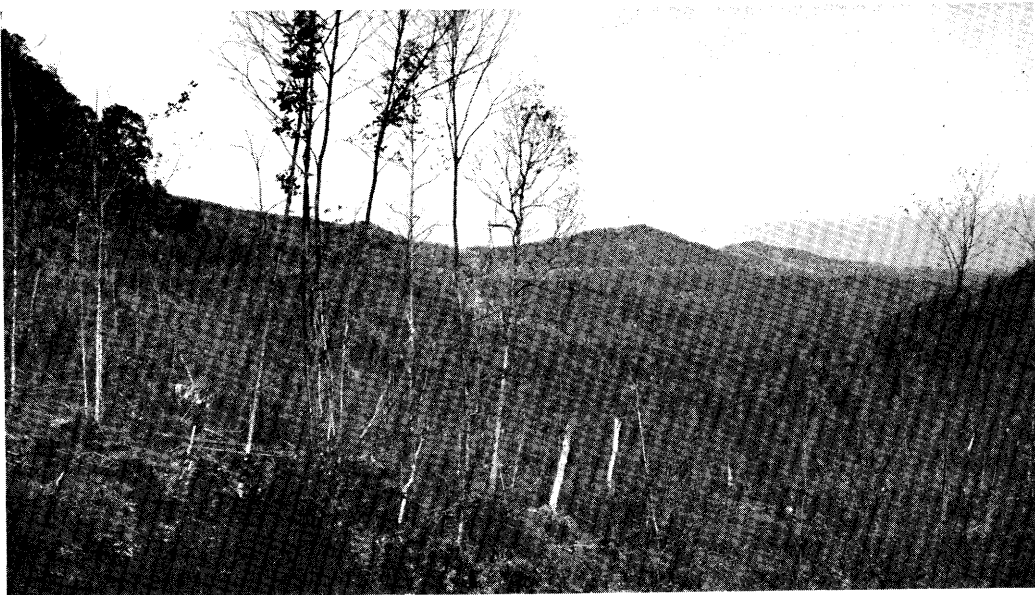


Figure 1.--A portion of the cutover area after commercial logging was completed but before any of the leftover material was removed.

After the commercial logging was completed, all leftover woody material over 4½ feet in height was cut by a contractor (fig. 2). Contract costs for this job were \$35 per acre. The relatively high cost was due in part to the very dense rhododendron understory present on eight of the plots.

Regeneration on the area has been sampled three times in recent years. In 1963, just prior to logging, the advance regeneration was examined. A tally was made when the new stand was 2 years old, and another examination was made in the fall of 1968 when the stand was 5. In the first two samples, observations were made on milacre subplots in each 1-acre plot. The fifth-year examination was made on a 1/40-acre

subplot in the center of each plot. Seedlings and sprouts less than $4\frac{1}{2}$ feet tall were not tallied because there was little likelihood that many would ever reach merchantable size. Seedlings and sprouts were judged to be either overtopped or free to grow and were listed accordingly. In the case of sprout clumps, no more than one stem in each clump was listed as free to grow.



Figure 2.--The study area immediately after felling of leftover stems.

Results

Prior to logging in 1963, a large quantity of advance regeneration was present. These seedlings, which averaged 18,000 per acre, were very small and most were 1 year old or less, though there were some seedling sprouts. The most abundant species, red maple, averaged 11,000 seedlings per acre and was found on almost all the 1-acre plots. Yellow-poplar seedlings were found on only 14 plots and averaged 1,500 seedlings per acre on these plots. Northern red oak seedlings were found on 28 plots and averaged about 2,500 seedlings per acre on these plots. Chestnut oak, white ash, hickory, and other seedlings were present on some plots, but in much smaller numbers.

When Southern Appalachian timberlands are clearcut, the relatively stable, mature forest is suddenly transformed into a rapidly growing tangle of seedlings, sprouts, weeds, and vines. Only those stems that

can endure the sudden exposure and take advantage of the increased supply of water, nutrients, and space can become a major complement of the new stand.

By 1965, 2 years after logging, the pattern of regeneration had changed considerably (fig. 3). The total number of seedlings present was still about 18,000 per acre, but the composition by species had little resemblance to that of the advance regeneration present 2 years earlier. Two species, yellow-poplar and sweet birch, the latter not even present in appreciable numbers in the 1963 sample, each totaled about 5,000 seedlings per acre and were found on almost all plots. Red maple seedlings were still abundant but averaged only 3,500 per acre. Northern red oak seedlings had also dropped in number and were found on only 12 plots. The presence of over 1,200 rapidly growing sprout clumps per acre was also changing the pattern of regeneration. Black locust, dogwood, and red maple clumps were present in the greatest number. Red maple and yellow-poplar sprout clumps were the tallest and occupied more space per clump than did other species.

In 1968 the stand was 5 years old. Though still a dense tangle, the new stand was beginning to show its true potential and also its problems (table 1). The stand contained an average of 370 desirable seedlings per



Figure 3.--Two-year-old regeneration. Note the large number of yellow-poplar and red maple sprouts.

Table 1. --Density of regeneration over 4½ feet tall after 5 years

Species	Free-to-grow seedlings	Free-to-grow sprouts	Suppressed seedlings	Suppressed seedling sprouts	Sprout clumps
----- Number per acre -----					
Yellow-poplar (<i>Liriodendron tulipifera</i> L.)	79	63	201	3	57
Sweet birch (<i>Betula lenta</i> L.)	226	35	740	2	41
Black locust (<i>Robinia pseudoacacia</i> L.)	0	247	0	122	23
Northern red oak (<i>Quercus rubra</i> L.)	20	12	40	0	17
Chestnut oak (<i>Quercus prinus</i> L.)	20	24	54	3	44
Black oak (<i>Quercus velutina</i> Lam.)	2	0	3	0	0
Other desirables ¹	23	34	43	6	41
Total desirables	370	415	1,081	136	223
Red maple (<i>Acer rubrum</i> L.)	4	58	24	3	65
Other undesirables ²	24	137	166	73	249
Total undesirables	28	195	190	76	314
Grand total	398	610	1,271	212	537

¹Other desirables include hemlock (*Tsuga canadensis* (L.) Carr.), white ash (*Fraxinus americana* L.), Fraser magnolia (*Magnolia fraseri* Walt.), black cherry (*Prunus serotina* Ehrh.), white oak (*Quercus alba* L.), and basswood (*Tilia americana* L.).

²Other undesirables include witch-hazel (*Hamamelis virginiana* L.), sourwood (*Oxydendrum arboreum* L. DC.), sassafras (*Sassafras albidum* (Nutt.) Nees), blackgum (*Nyssa sylvatica* Marsh.), dogwood (*Cornus florida* L.), and hickory (*Carya* spp.).

acre that were free to grow. These seedlings were sweet birch, yellow-poplar, white ash, and the oaks, and most of them have a reasonably good chance to survive and become a part of the future stand (figures 4 and 5). In addition to these free-to-grow seedlings, there were about 1,000 desirable seedlings per acre that were over 4½ feet tall but were not free to grow. The future of these overtopped or suppressed seedlings is in doubt. Some will persist, but many will drop out soon unless something happens to the overhead competition.

The desirable seedlings on the area added to the potential of the stand, but the 168 desirable sprouts per acre (not including black locust sprouts) were easily the most impressive group of plants on the area. Many of these free-to-grow sprouts were yellow-poplar, and these stems already 20 to 30 feet tall will probably make up a major portion of the future stand (fig. 6). In addition to the yellow-poplar sprouts, there were also a few white oak, chestnut oak, and red oak sprouts that will probably



Figure 4.--A fine 5-year-old white ash seedling. The seedling is free from overtopping competition and has a good chance of becoming a high-quality crop tree.

Figure 5.--One of the many bright spots in the future of this area is this mixture of yellow-poplar and sweet birch seedlings.



Figure 6.--An outstanding example of a yellow-poplar sprout. This 5-year-old individual is about 5 inches d.b.h. and 35 feet tall.



continue to hold a position in the new stand. Besides the desirable free-to-grow sprouts, there were some suppressed seedling sprouts and many stems in sprout clumps that were not free to grow. As in the case of the suppressed seedlings, these suppressed sprouts will not become a major factor in the new stand unless something happens to the overtopping or surrounding competition.

Distribution of desirable plant material is perhaps as important as the total numbers of individuals present on the study area (table 2). Only six of the 1/40-acre subplots did not have either free-to-grow yellow-poplar sprouts or seedlings on them, and 14 subplots did not have free-to-grow birch. Locust sprouts were widely distributed and were found on almost all plots. Northern red oak was a real puzzle. Much of the study area contained fine mature northern red oak, and 28 subplots contained numerous red oak seedlings prior to harvest. Consequently, red oak was expected to make up a considerable portion of the future timber crop. However, red oak seems to be waging a continually losing battle with other species. Only a few subplots contain high-quality red oak stems, and these stems are usually much shorter than the competing vegetation.

The more than 700 desirable seedlings and sprouts per acre that were free to grow provide the study area with an adequate source of regeneration. However, the presence of many undesirable sprout clumps may affect the species composition and distribution of the stand. At best, undesirable sprout clumps will continue to occupy considerable area and will provide competition to the desirable crop trees for some time to come.

There were over 500 sprout clumps over $4\frac{1}{2}$ feet tall per acre in the 5-year-old stand. Some of these clumps contain desirable stems, but over half are of undesirable species. One of the greatest threats to the favorable development of this area is the presence of red maple sprout clumps on 28 plots. These clumps often contain 30 or more stems and

Table 2. --Frequency of regeneration over 4½ feet tall after 5 years

Species	Free-to-grow seedlings	Free-to-grow sprouts	Suppressed seedlings	Suppressed seedling sprouts	Sprout clumps
-----Number of subplots ¹ -----					
Yellow-poplar	29	26	33	4	24
Sweet birch	30	19	32	1	21
Black locust	0	39	0	32	25
Northern red oak	9	12	18	0	14
Chestnut oak	5	13	12	3	15
Black oak	2	0	2	0	0
Other desirables	15	22	20	5	26
Red maple	4	29	8	3	28
Other undesirables	11	37	29	16	43

¹The entire sample is based on 46 subplots. Regeneration was recorded if at least one seedling or sprout of a species occurred on the subplot.

a single clump can completely occupy as much as 500 square feet of land (fig. 7). If these maple clumps continue to grow in height at a pace equal to or greater than the height growth of the desirable stems, much area can be lost to poor-quality red maple.

Locust sprouts and sprout clumps, though more numerous than red maple, do not offer as much competition. Few locust clumps completely occupy the site as the maple does; single locust sprouts do not interfere with the growth of other vegetation very much and are considered desirable. However, there are some plots on which locust has sprouted so prolifically that it has significantly affected the growth of other vegetation on the plot.

In the years immediately after the harvest cut, the presence of grape, rhododendron, laurel, fern, greenbrier, blackberry, and weeds played a significant role in the survival and growth of the woody stems. Now, after 5 years, these species continue to cover a considerable portion of the area. However, with the exception of grape and in a few cases laurel and rhododendron, these species will not affect the future of the stand.

Competition from grapevines has been a big factor in the development of the stand to date and will continue to influence both crop trees and the understory (table 3). In several places, grapevines have completely covered areas up to a quarter acre (fig. 8). As a result, these areas contain very few desirable stems and their future looks dim. Although the areas completely dominated by grapevines attract the most attention, the greatest overall damage has been and will be done by vines



Figure 7.--Red maple sprout clumps, such as this healthy specimen, occupy large amounts of valuable growing space and may continue to cause serious problems for some time.

that intertwine about desirable crop trees and grow up with the trees (fig. 9). Grapevines are present on at least 21 of the 46 subplots, and they will continue to damage crop trees unless treatment is imposed.

Rhododendron and laurel were present in considerable quantities on a number of the plots. If the rhododendron and laurel had not been lopped off after logging, very little woody regeneration could have occurred on these areas. The rhododendron and laurel sprouts have not managed to keep up with the growth of other woody vegetation, however, and they are not likely to significantly affect future stand development.

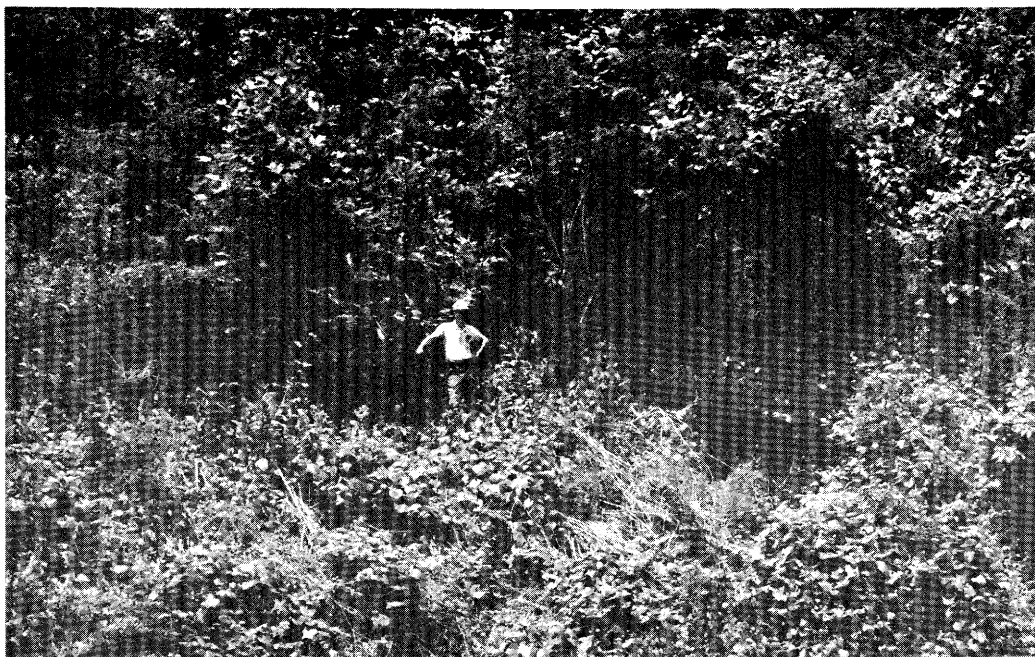


Figure 8. --Grapevines completely occupying an area to the exclusion of almost all woody vegetation.



Figure 9. --Grapevines riding down potential yellow-poplar crop trees.

Table 3.--Ground cover distribution on the 46-acre study area (excluding the dominant stand of trees)

Ground cover	Percent of ground covered	Number of subplots affected ¹
Seedlings under 4½ feet tall	14	30
Grapevine (<i>Vitis</i> spp.)	17	21
Greenbrier (<i>Smilax</i> spp.) and blackberry (<i>Rubus</i> spp.)	5	13
Ferns (<i>Polystichum</i> spp.)	16	27
Mountain-laurel (<i>Kalmia latifolia</i> L.) and rhododendron (<i>Rhododendron maximum</i> L.)	6	12
Weeds and grass	22	29
Open	20	36

¹ The entire sample is based on 46 subplots.

Discussion

The current condition of the study area is ample evidence that a complete clearcutting can be an effective means of regenerating upland hardwoods. The presence of many free-to-grow desirable stems is very encouraging. Also encouraging is the fact that after 5 years some seedlings are 10 to 15 feet tall and many sprouts are 30 feet tall.

The presence of undesirable sprout clumps and overtopped or suppressed seedlings will continue to cause some concern. Although the total number of desirable stems is adequate, distribution of crop trees in some places is not optimum with respect to spacing and species.

When faced with sprout clumps and overtopped or suppressed seedlings on similar areas, many forest managers will immediately propose an intense cleaning. We, on the basis of current information, do not recommend that such areas be cleaned. The cost of a properly applied cleaning will be high and the returns questionable. The results of a cleaning, particularly in a stand as young as this one, may be very unsatisfactory. Even though released by cleaning, some stems will not respond and will never make high-quality crop trees. Other stems would have made crop trees anyway and will benefit little from the cleaning. If it is done at all, cleaning should be reserved for 10- to 15-year-old stands without adequate free-to-grow regeneration on highly productive land. An important exception to this rule is the removal of grapevines from obvious crop trees.

Even-aged silviculture with complete clearcutting is obviously not a panacea. It is, however, the most effective technique that has been used in the Southern Appalachians for hardwood regeneration. There is a good chance that further modification could improve the reliability of the even-aged system and allow increased control over species composition. Modification is needed to develop techniques for increasing the percentage of

hard-to-regenerate species such as northern red oak. Further control of the early stand might also be accomplished through more effective use of intermediate cuts and preharvest treatments that would eliminate undesirable individuals or species.

One final point: A critical step in the procedure is the control of leftover material after commercial logging is complete. If the leftover material is not controlled, it will occupy the site and will accordingly reduce the productivity of the area for many years to come. If proper followup procedures are not feasible, then the harvest should be postponed.

McGee, Charles E., and Hooper, Ralph M.

1970. Regeneration after Clearcutting in the Southern Appalachians. Southeast. Forest Exp. Sta., USDA Forest Serv. Res. Pap. SE-70, 12 pp.

Remeasurements on a 50-acre area in the Southern Appalachians indicate that a complete clearcutting has tremendous potential for regenerating high-quality hardwoods. Five years after commercial logging and cutting of leftover material, over 500 desirable seedlings and sprouts per acre were free to grow. Yellow-poplar, sweet birch, northern red oak, chestnut oak, and white ash made up the bulk of the desirable stems. On the other hand, over 60 red maple sprout clumps per acre were present; these completely occupied large areas. Grapevines were present on many plots and will continue to impede growth and degrade the quality of some crop trees. Firm decisions as to the need for precommercial cultural measures cannot be made at this time. There is a good possibility, however, that no treatment will be needed except grapevine control on crop trees.

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