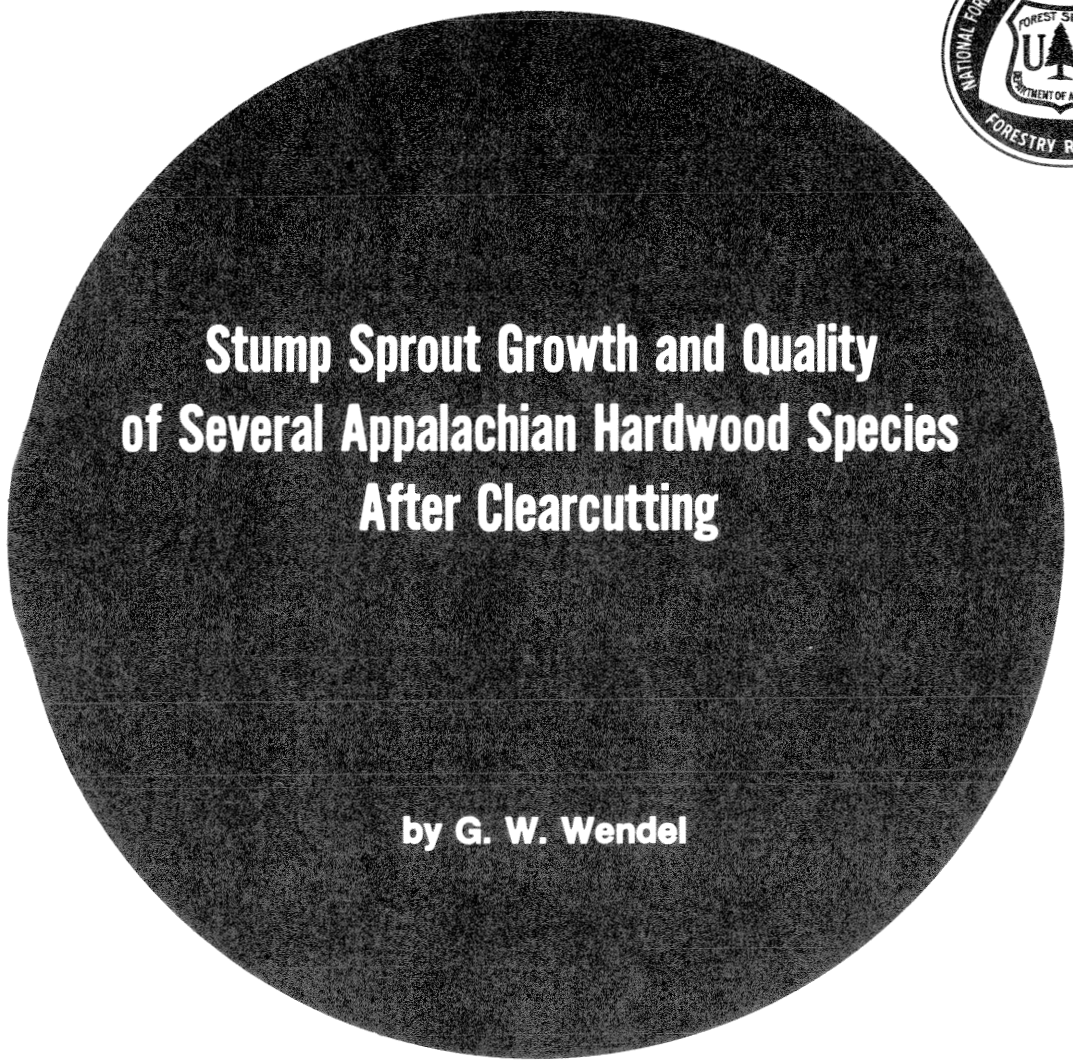

Stump Sprout Growth and Quality of Several Appalachian Hardwood Species After Clearcutting

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Common and scientific names of species referred to in this study:

Cherry, black ..... *Prunus serotina* Ehrh.
Maple, red ..... *Acer rubrum* L.
Maple, sugar ..... *Acer saccharum* Marsh.
Oak, chestnut ..... *Quercus prinus* L.
Oak, northern red ..... *Quercus rubra* L.
Oak, white ..... *Quercus alba* L.
Yellow-poplar ..... *Liriodendron tulipifera* L.

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Abstract

Results of a 10-year study showed that stumps from 50- to 60-year-old red oak, black cherry, yellow-poplar, white oak, and chestnut oak trees sprouted vigorously. A high percentage of the dominant sprouts had good stem form, and many had excellent height and diameter growth. For all species, we found that the proportion of stumps sprouting, number of sprouts per stump, and dominant-sprout height were not correlated with parent-tree vigor or parent-tree dbh. In red oak, sprouting was not related to season of cutting or site quality.

INTRODUCTION

THE INCREASED USE of clearcutting in second-growth central Appalachian hardwood stands has indicated the need for more information about the growth and development of sprouts.

In general, the greatest objection to sprout stands is the high incidence of butt rot that often occurs. However, most investigators have concluded that butt rot in sprouts can be reduced by cutting low stumps so that sprouts originate close to the ground.

In 1963, we began to study the growth and development of red oak stump sprouts on excellent and fair sites in West Virginia. One-half of the study stumps were from trees cut during the growing season, and the other half were from trees cut during the dormant season. The growth and development of some black cherry, yellow-poplar, white oak, and chestnut oak sprouts were also observed; but these species were confined to one site and, with the exception of black cherry, to one season of cutting.

This paper is a report on sprout growth over a 10-year period and an evaluation of dominant-sprout quality after 11 years.

METHODS

The study was set up on two sites on the Fernow Experimental Forest near Parsons, West Virginia. Red oak, yellow-poplar, and black cherry were the major species on the excellent site (S.I. [site index] 80 for oak); and red oak, chestnut oak, white oak, and red maple were most common on the fair site (S.I. 60 for oak) *(Schnur 1937)*.

Both stands were even-aged, about 55 years old, and vigorous at the time of cutting (figs. 1 and 2). Two 1-acre plots were established on each site. One plot was cut in February 1963

Figure 1.—Typical stand on the site index 80 area before cutting.

Figure 2.—Typical stand on the site index 60 area before cutting.

Table 1.—Summary of sprout data for all species, seasons of cut, and site index

Species	Site index	Season of cutting[a]	Number of stumps	Proportion of stumps with sprouts		Average number of sprouts per stump		Average height of dominant sprout[b]		Dominant sprout dbh
				1963	1972	1963	1972	1963	1972	1973
			No.	*Pct.*		*No.*		*Feet*		*Inches*
Red oak	80	D	50	98	94	34	7	3.1	25.6	2.6
Red oak	80	G	50	88	90	27	7	1.7	25.3	2.7
Red oak	60	D	50	98	100	38	7	3.9	26.2	2.8
Red oak	60	G	50	86	88	21	6	1.5	24.1	2.0
Black cherry	80	D	25	100	80	24	7	3.5	37.7	4.0
Black cherry	80	G	25	100	80	24	6	1.7	32.7	3.6
Yellow-poplar	80	D	36	97	89	42	5	4.0	32.4	4.1
White oak	60	D	26	85	85	35	4	2.4	19.6	2.4
Chestnut oak	60	G	47	81[c]	87	22	3	1.6	25.5	2.4

[a] D = Cut in dormant season; G = cut in growing season.
[b] Stumps with surviving sprouts.
[c] Some stumps produced sprouts the second year.

(dormant season), and the other plot was cut in June 1963 (growing season).

Sprout development was studied for 50 red oak stumps on each plot (table 1). On the excellent site, we also included for study 25 black cherry stumps on each plot and 36 yellow-poplar stumps on the dormant-season plot. On the fair site, we included 26 white oak stumps on the dormant-season plot and 47 chestnut oak stumps on the growing-season plot.

Dbh and vigor class of each tree were determined before cutting. Age was determined on the stump after the trees were felled. A 6-inch stump height was maintained, and stump wounding was avoided by careful felling and skidding.

There was a wide variation in parent tree dbh even though 97 percent of the red oak, 90 percent of the chestnut oak, 92 percent of the white oak, and all of the black cherry and yellow-poplar were between 50 and 55 years old. Parent tree dbh differed with each species: red oak ranged from 6 to 23 inches, white oak from 5 to 14 inches, chestnut oak from 5 to 18 inches, black cherry from 7 to 22 inches, and yellow-poplar from 6 to 22 inches.

The number of sprouts per stump and the height of the dominant sprout on each stump were recorded annually for the first 5 years, then at 7 years and again at 10 years. Dbh was recorded at the end of 7 and 10 years. Shifts in the dominant sprout from one measurement period to another were also recorded. Clear-stem length of the dominant sprout on each stump was measured at the end of 11 years.

The data were analyzed, using analysis of variance and regression techniques where applicable.

RESULTS

Proportion of Stumps Sprouting

By the end of the first growing season, more than 80 percent of all stumps had sprouted. At the end of 10 years, 80 percent or more of the study stumps still had sprouts (table 1).

There was no correlation between the proportion of stumps sprouting and site quality or season of cutting. However, a number of stumps, mostly from trees cut during the growing season, sprouted during the second growing season, which is why the 10-year data are higher than the 1-year data for some species (table 1).

Although there were only a few oak stumps in the 100-year-old class, most of the older stumps did not sprout.

For all species, there was an indication that a higher proportion of the stumps from trees smaller than 17.0 inches dbh produced sprouts,

although the small number of larger trees precludes a firm conclusion on this point.

Number of Sprouts per Stump

For all species, the number of sprouts per stump decreased with years since cutting. The average number of sprouts per stump ranged from 21 to 42 at the end of the first growing season and from 3 to 7 at the end of 10 years (table 1).

The number of red oak and black cherry sprouts per stump was not correlated with season of cutting, even though there were fewer red oak sprouts at the end of the first year on stumps of trees cut during the growing season. We also found that the number of sprouts per stump for red oak at the end of the 1st and 10th year was not correlated with site index.

Parent-tree vigor and dbh for all species was not significantly correlated with the number of sprouts per stump surviving after the 1st or 10th year.

A large number of sprouts died during the first 5 years of the study. Mortality from the 6th through the 10th year was much less. The relationship of the number of surviving sprouts per stump at 10 years to the number present at the end of the first year is shown in figure 3.

Figure 3.—Average number of sprouts per stump over years since cutting.

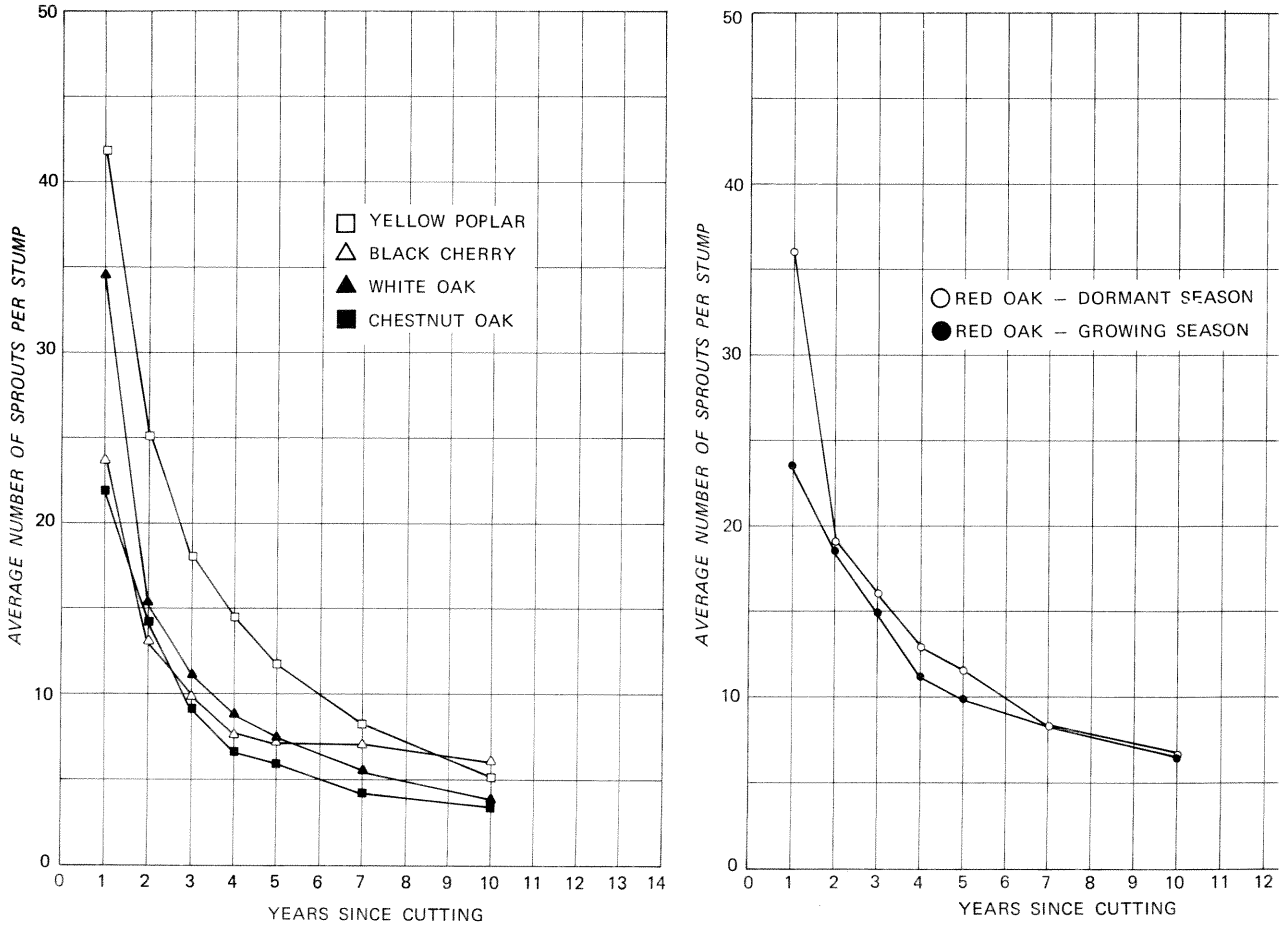
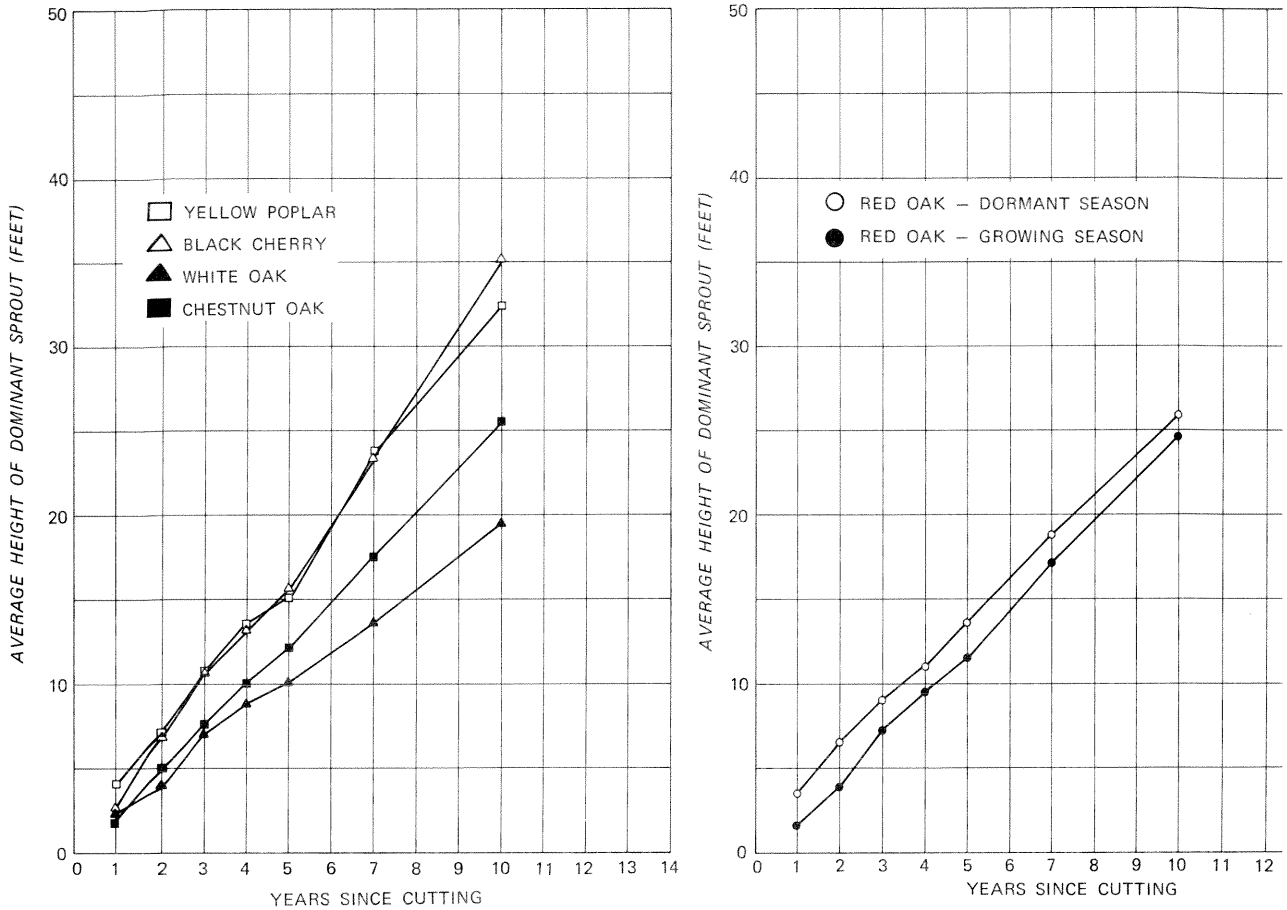


Figure 4.—Average height of dominant sprout over years since cutting.



Dominant-Sprout Height

For all species, dominant-sprout height at the end of 10 years was not correlated with parent-tree diameter or parent-tree vigor. For red oak, there was no correlation with site index or season of cutting; and for black cherry, dominant-sprout height was not correlated with season of cutting.

Ten-year average dominant sprout height ranged from 37.7 feet for black cherry to 19.6 feet for white oak (table 1 and fig. 4). Dominant sprouts on stumps of red oak and black cherry trees cut during the dormant season were about twice as tall as those cut during the growing season at the end of the first year; but 10 years later, there was no statistically significant difference.

Ten years after cutting, site index has not had an effect on dominant-sprout height of red oak.

On some stumps, the same sprout did not remain dominant from year to year. For red oak, shifts in sprout dominance occurred on about 50 percent of the stumps during the first 5 years (table 2). Even after 10 years, 12 percent of the red oak dominant sprouts were not the same ones that we had observed 3 years earlier. The number of shifts in dominant sprouts for the other species was frequent during the first 3 years but tended to taper off in later years.

Table 2.—Percentage of stumps having new sprout dominant since last observation

Species	Site index	Season of cutting[a]	Year of observation					
			1964	1965	1966	1967	1969	1972
Red oak	80	D	55	29	45	38	28	11
Red oak	80	G	58	76	47	18	9	11
Red oak	60	D	46	44	40	24	12	14
Red oak	60	G	60	53	48	24	14	12
Black cherry	80	D	52	54	0	14	5	25
Black cherry	80	G	78	65	38	10	25	15
Yellow-poplar	80	D	79	55	9	15	22	6
Chestnut oak	60	D	61	28	19	7	0	6
White oak	60	G	55	26	30	13	7	7

[a] D = cut in dormant season; G = cut in growing season.

Dominant-Sprout Dbh

Dominant-sprout dbh at 10 years ranged from 4.1 inches for yellow-poplar to 2.4 inches for white oak and chestnut oak (table 1). Red oak dominant sprouts on the fair site plot cut during the growing season tended to be smaller than those on the plot cut during the dormant season; but on the excellent site, there was no difference in dominant-sprout dbh between seasons of cutting.

The average dbh of black cherry sprouts from stumps cut during the dormant season was slightly larger than the average of those cut in the growing season, but this difference was not significant.

Dominant-Sprout Quality

Length of clear stem was used as the measure of stem quality. Small branches that we judged would drop off in natural pruning were disregarded. Large side branches and forks of about the same diameter as the main stem marked the upper limit of clear length. Because stem form changes rapidly at this age

Table 3.—Percentage of dominant sprouts by stem quality classes

[Based on number of stumps with surviving sprouts at 11 years]

Species	Site index	Season of cutting[a]	No. of stumps	Clear length of stem class (feet)[b]			
				12.0-17.0	17.1-21.0	21.1-25.0	25.1+
			No.	Percent			
Red oak	80	D	42	26	31	10	—
(good site)	80	G	44	20	41	20	5
Red oak	60	D	49	20	22	20	12
(fair site)	60	G	40	23	28	18	—
Total			175	22	30	17	5
Black cherry	80	D	20	—	10	15	65
(good site)	80	G	20	10	15	25	45
Total			40	5	13	20	55
Yellow-poplar (good site)	80	D	33	—	—	—	85
White oak (fair site)	60	D	22	55	9	9	—
Chestnut oak (fair site)	60	G	41	17	29	22	17

[a] D = cut in dormant season; G = cut in growing season.

[b] Small branches allowed but not major forks or large side branches that were judged to persist for a long time.

and usually for the better, we feel that this measure of quality was highly conservative.

About three-fourths of the red oak dominant sprouts had more than 12.0 feet of clear stem, and 52 percent had more than 17.0 feet (table 3). Only 5 percent of the red oaks had more than 25 feet of clear stem as compared to 85 percent of the yellow-poplars, 55 percent of the black cherry, and 17 percent of the chestnut oaks. None of the white oaks had more than 25 feet of clear stem.

DISCUSSION AND SUMMARY

For the species studied, we found that stumps from 50- to 55-year-old trees produced an abundance of sprouts the first year and that height and diameter growth of the dominant sprouts was very good during the 10-year period. In this study, stump size was not well correlated with tree age. Except for a few large red, white, and chestnut oaks that were 100 years old, all of the study stumps were from trees 50- to 55-years old. Large stumps sprouted as well as small stumps except for the few older and larger red oaks.

Previous studies have shown that the ability of oaks and sugar maple to sprout is inversely related to tree age and stump size *(Roth and Hepting 1943; Church 1960)*. Similarly Roth and Sleeth *(1939)* reported that low-origin oak sprouts were less likely to develop butt rot in later years than those that originated higher on the stump. True and Tryon *(1966)* reported that there was less butt rot in low-origin yellow-poplar sprouts and also less in sprouts from small stumps.

There tended to be more red oak sprouts at the end of the first year on stumps cut during the dormant season than on those cut in the growing season; but 10 years later, there was no effect of season of cutting.

Red oak and black cherry sprouts on the dormant-season cut plots were taller at the end of the first year than those on growing-season cut plots. After 10 years, there was no statistically significant difference, although dominant black cherry sprouts arising on stumps cut during the dormant season averaged about 5 feet taller.

We found that during the 10 years of the study, site quality was not a factor in red oak sprout height growth: sprouts on the fair site grew at about the same rate as those on the excellent site.

Between 75 and 90 percent of the sprouts died or were broken off in the first 10 years. This would suggest that thinning operations in sprout clumps might best be delayed for at least 10 years. Another factor in favor of waiting is that sprout dominance changes frequently in the early years, and it would be better to wait until dominance is more permanently expressed.

Our data show that there is usually one sprout that will develop into a good or excellent quality tree in the new stand (figs. 5, 6, 7, 8). For example, more than half of the dominant red, white, and chestnut oak sprouts have more than 17.0 feet of clear length after 11 years, ensuring at least one good log. For the black cherry and yellow-poplar, the potential is much greater. More than half of the cherry and 85 percent of the yellow-poplar have more than 25.0 feet of clear stem. In both species, the stems are well anchored, the crowns are well developed, and the trees are vigorous.

It does not seem likely that much butt rot will form in the sprouts. All trees were cut to a 6-inch stump height; and most of the surviving sprouts have low origins, thus greatly reducing the chance of butt rot.

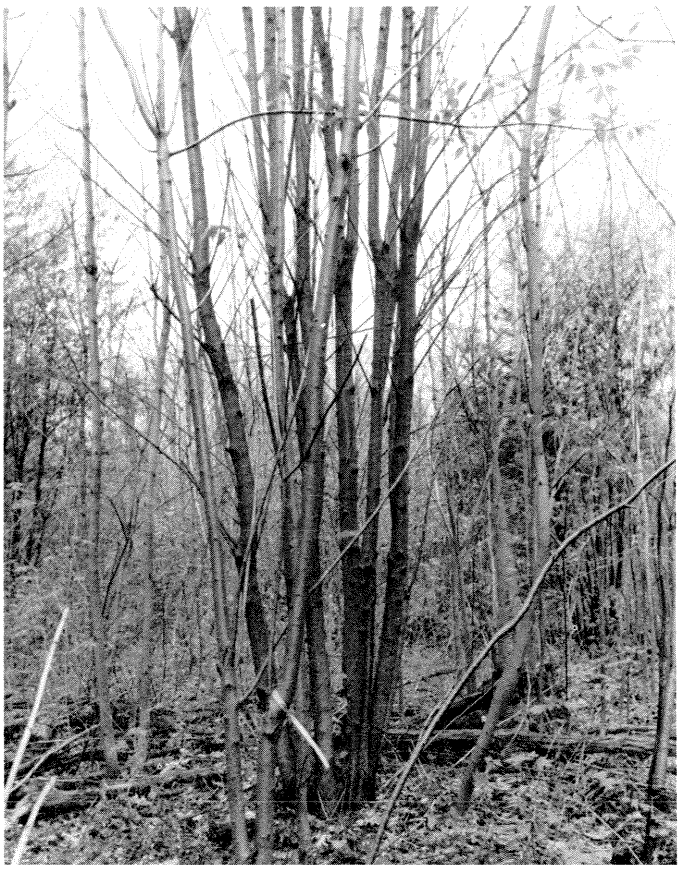
In general, we can conclude from this study that if we are going to clearcut 50- to 60-year-old central Appalachian hardwood stands on sites similar to those in this study, a high proportion of the natural reproduction will be stump sprouts, which will overtop and suppress most seedling-origin reproduction in the first few years. About the only practical way to reduce sprouting at this age is to chemically treat the cut stumps. An alternative might be to postpone cutting until the trees are older, at which time the ability to sprout is reduced for many species. In our opinion, it would be difficult and costly to eliminate sprouts and attempt to increase the proportion of seedling origin stems after cutting middle-aged stands.

Figure 5.—A red oak sprout clump at 10 years.

Figure 6.—A yellow-poplar sprout clump at 10 years.

Figure 7.—A chestnut oak sprout clump at 10 years.

Figure 8.—A black cherry sprout clump at 10 years.



On the other hand, many of the sprouts have good form, are well anchored, and are potential for crop trees. If we wait until dominance within the clump is more permanently expressed and the weaker sprouts have died, there seems to be no reason why the best one or two sprouts per stump cannot be selected and treated as crop trees in the new stand.

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