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Stand Development 25 Years after a 9.0-inch Diameter-Limit First Cutting in Appalachian Hardwoods

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ABSTRACT

This report is a case history of stand development 25 years after a 9.0-inch diameter-limit cutting in a primarily second growth 40- to 45-year-old Appalachian hardwood stand. Some old residual trees from the early 1900 logging era were scattered throughout the stand. In 1950, a 9.0-inch diameter-limit cutting removed 8,650 board feet per acre and reduced the basal area from 97 to 24 square feet per acre. Twenty-five years after this 1950 cutting, the total sawlog volume was 7,425 board feet per acre with a basal area of 98 square feet per acre. Oaks accounted for 42 percent of the sawlog-size trees and 45 percent of the sawlog stand volume.

THROUGHOUT THE Appalachian hardwood region, it is a common practice to harvest timber larger than a chosen diameter limit. Many foresters do not advocate this type of cutting because the larger trees are removed, so the stand is high-graded. Also trees below the diameter limit are not treated, so good and poor trees alike continue to grow. Hutnik (1958) indicated that foresters could recommend a diameter-limit cut as the initial cut, but that another type of cutting should be used thereafter.

We believe certain types of diameter-limit cutting or modifications of it have potential in Appalachian hardwood management, especially with the current concern for esthetics and environmental protection on forest lands. Such modifications could include a diameter-limit cut with a flexible cutting cycle, or a diameter-limit cut accompanied by improvement cutting or cultural treatment for trees below the minimum cutting diameter. No doubt there are others.

The purpose of this paper is to report a case history study of stand development 25 years after a 9.0-inch diameter-limit cut on a 40- to 45-year-old second growth Appalachian hardwood stand. Some old growth stems, residuals from the early 1900 logging period, were scattered throughout the stand.

We were also interested in the response of hardwood stems, particularly oaks, after partial cutting. (Scientific names of species are listed in the Appendix.) Scholz (1948) reported that 85- to 100-year-old sawtimber-size red oaks had a favorable diameter growth response after cutting. Likewise Minckler (1957) found that many 35- to 100-year-old pole-size white oak trees responded after release. Carvell (1969) reported similar results with diameter growth response for 40-year-old red oak on excellent sites; however, no response was evident on medium or low quality sites.

STUDY AREA

The study area is a 52-acre Appalachian hardwood stand located on the Fernow Experimental Forest near Parsons, West Virginia.

Annual precipitation averages about 58 inches with about 135 frost-free days. The red oak site index of the study area is 70, and the soils are Calvin channery silt loam about 30 inches deep.

The study area was cut (high-graded) between 1905 and 1910. In 1950, the area supported a sawtimber stand averaging 8,650 board feet per acre (International 1/4-inch rule, trees 11 inches dbh and greater); 1,725 board feet per acre of this volume was cull material, while old residuals totalled 3,000 board feet per acre. The basal area averaged 97 square feet per acre for all material 5.0 inches diameter at breast height (dbh) and larger.

METHODS

From May 1950 to March 1951, the study area was logged to a 9-inch diameter limit. All merchantable trees 9.0 inches dbh and larger were cut, and cull trees 9.0 inches dbh and larger were chemically frilled. The merchantable sawtimber removed amounted to 6,925 board feet per acre including about 3,000 from old-growth residual trees, plus 1,725 board feet per acre of cull. No cultural treatment was applied to cull trees less than 9.0 inches dbh. The residual stand consisted of trees that had previously been in the intermediate or overtopped crown class (fig. 1). About 31 percent of the total stems in the residual stand (5.0 inches or more dbh) were red, white, chestnut, or scarlet oaks (table

1). Residual basal area averaged 24 square feet per acre for trees 5.0 inches dbh and larger.

RESULTS

Twenty-five years later, the sawlog volume averaged 7,425 board feet per acre for trees 11.0 inches dbh and larger, including 100 board feet per acre of cull material. The merchantable volume was about 400 board feet per acre more than when the stand was cut in 1950 (table 2). The average volume growth was about 300 board feet per acre per year. Total stand basal area averaged 98 square feet per acre, which was similar to that in 1950 before cutting (table 2).

Figure 1.—Left: stand immediately after logging; right: stand development 25 years after logging.

Table 1.—*Stand structure before and after 9-inch diameter-limit cutting*

Original stand - May 1950						Residual stand - March 1951		
Stems 5.0 to 10.9 inches dbh			Stems 11.0 plus inches dbh			Stems 5.0 to 9.0 inches dbh		
	Stem/acre	*Percent*		*Stem/acre*	*Percent*		*Stem/acre*	*Percent*
Red oak	21.4	15.1	Red oak	6.5	18.2	Red oak	15.5	14.1
Chestnut oak	17.7	12.5	Yellow-poplar	5.6	15.7	Chestnut oak	13.8	12.5
Black locust	16.4	11.6	Chestnut oak	4.1	11.5	Black locust	11.3	10.3
Sassafras	11.5	8.2	Sugar maple	3.8	10.7	Sassafras	10.1	9.2
Red maple	10.2	7.2	Hickory	2.6	7.3	Red maple	8.9	8.1
Yellow-poplar	9.8	6.9	Black cherry	2.6	7.3	Sweet birch	8.7	7.9
Sweet birch	9.7	6.9	Black locust	1.8	5.0	Yellow-poplar	6.3	5.7
White ash	6.0	4.2	Beech	1.7	4.8	Cucumbertree	4.7	4.3
Hickory	5.8	4.1	Scarlet oak	1.4	3.9	White ash	4.6	4.2
Cucumbertree	5.7	4.1	White oak	1.2	3.4	Hickory	4.6	4.2
Sugar maple	5.0	3.8	Black gum	1.0	2.8	Sugar maple	4.3	3.9
Black cherry	4.9	3.5	—	—	—	Black cherry	3.3	3.0
White oak	3.4	2.4	—	—	—	White oak	2.5	2.3
Scarlet oak	3.2	2.2	—	—	—	Scarlet oak	2.4	2.2
Beech	2.2	1.5	—	—	—	—	—	—
Others	8.4	5.8	Others	3.4	9.4	Others	8.9	8.1
Total	141.3			35.7			109.9	

Table 2.—*Initial, residual, and 1975 volume-basal area data*

Time period	Volume per acre [a]				Basal area per acre	
	Merch-antable	Cull	Merch-antable	Cull	Merch-antable	Cull
	Board feet		*Cubic feet*		*Square feet*	
Initial: before cutting (1950)	6,925	1,725	1,890	330	84	13
Residual: after cutting	0	0	385	0	24	0
25 years after cutting	7,325	100	2,230	40	96	2

[a] Board-foot volumes using International 1/4-inch log rule for trees 11.0 inches dbh to an 8.0 inch top dib. Cubic foot volumes for trees 5.0 inches dbh to a 4.0 inch top dib.

Table 3.—*Commercial reproduction in sapling-size stems 1.0 to 4.9 inches dbh before and after 25 years after cutting*

Before cutting			25 years after cutting		
Species	Stems per acre		Species	Stems per acre	
	Number	*Percent*		*Number*	*Percent*
Beech	198	37.0	Sugar maple	201	49.0
Sugar maple	121	22.6	Beech	61	14.8
Red maple	50	9.4	Sweet birch	34	8.3
Hickory	42	7.9	Red maple	24	5.8
Sweet birch	37	6.9	Yellow-poplar	20	4.9
Red oak	21	3.9	Red oak	12	2.9
White ash	14	2.6	Black cherry	10	2.4
Chestnut oak	13	2.4	Black locust	8	1.9
Others	39	7.3	Others	41	10.0
Total	535			411	

Table 4.—*Summary of pole-size and sawtimber stand structure 25 years after a 9-inch diameter-limit cutting (in number of stems per acre)*

Pole-size				Sawtimber-size					
Species	Dbh class (inches)			Species	Dbh class (inches)				
	5-8	9-10	Total		11-14	15-18	19-22	Over 22	Total
Black locust	11.8	3.0	14.8	Red oak	6.6	5.0	1.0	0.04	12.6
Red maple	9.9	4.0	13.9	Chestnut oak	6.2	.5			6.7
Sugar maple	10.1	3.0	13.1	Red maple	4.8	.6	.1		5.5
Yellow-poplar	10.0	2.6	12.6	Yellow-poplar	3.1	1.3	.1		4.5
Beech	9.2	1.3	10.5	Sugar maple	2.8	1.0	.1		3.9
Chestnut oak	6.0	4.0	10.0	Black locust	2.6	.2			2.8
Red oak	5.4	2.7	8.1	Black cherry	1.8	.7			2.5
Sweet birch	5.3	2.0	7.3	Cucumbertree	2.0	.3			2.3
Sassafras	3.9	2.3	6.2	Sweet birch	1.5				1.5
Hickory	4.4	1.6	6.0	White ash	1.2	.2			1.4
Cucumbertree	3.6	1.4	5.0	White oak	1.0	.3			1.3
Black cherry	3.1	1.4	4.5	Sassafras	1.2				1.2
White ash	3.0	1.2	4.2	Hickory	1.1				1.1
White oak	2.2	.9	3.1	Beech	.7				.7
Others	10.5	1.6	12.1	Others	.9				.9
Total	98.4	33.0	131.4	Total	37.5	10.1	1.3	0.04	48.9

The present stand is a vigorous young sawtimber-size stand with little defect. Approximately 42 percent of the sawtimber volume consists of red, white, and chestnut oaks. Details of the current structure are summarized in table 4.

Sapling-size reproduction in stems 1.0 to 4.9 inches dbh was tallied before cutting and 25 years later (table 3). Before cutting, beech and sugar maple dominated the reproduction, totaling about 60 percent of the commercial saplings. After 25 years, about 64 percent of the commercial saplings were sugar maple and beech. Before cutting, beech was the more prominent species, but 25 years after cutting sugar maple was more abundant.

DISCUSSION AND CONCLUSIONS

In 1975, the most striking aspect of the new stand was the abundance of well-formed, fast-growing oaks. Oaks accounted for 42 percent of the sawlog-size trees, and 45 percent of the sawlog stand volume. Most of the stems were free from superficial defect.

One cannot base general silvicultural recommendations on a single case study, but this area supported a well developed young sawtimber stand, most of which probably developed from the pole-size material left after the logging.

Perhaps the most significant point in this paper is the response of these residual pole-size stems and large saplings. Currently, many foresters recommend the cutting or killing of all woody stems 1.0 inch in diameter (dbh) and larger during clearcutting. In many cases, they are justified in making this recommendation because small stems can overtop certain young seedlings and seriously influence their stem development. However, there are situations where the landowner should use discretion in cutting all stems 1.0 inch dbh and larger.

In the future, we should be alert for situations where vigorous pole-size stems have a good chance to respond after the removal of the overstory. We do suggest caution, however, for some older stands may not respond as the stand in this study did, though oak stands seem to respond well (Scholz 1948, Minckler 1957). Documenting of other situations is necessary to establish better guidelines.

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APPENDIX

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

Ash, white	*Fraxinus americana* L.
Beech, American	*Fagus grandifolia* Ehrh.
Birch, sweet	*Betula lenta* L.
Cherry, black	*Prunus serotina* Ehrh.
Cucumbertree	*Magnolia acuminata* L.
Gum, black	*Nyssa sylvatica* Marsh.
Hickory	*Carya* spp.
Locust, black	*Robinia pseudoacacia* L.
Maple, red	*Acer rubrum* L.
Maple, sugar	*Acer saccharum* Marsh.
Oak, chestnut	*Quercus prinus* L.
Oak, northern red	*Quercus rubra* L.
Oak, scarlet	*Quercus coccinea* Muenchh.
Oak, white	*Quercus alba* L.
Sassafras	*Sassafras albidum* (Nutt.) Nees.
Yellow-poplar	*Liriodendron tulipifera* L.