United States
Department of
Agriculture

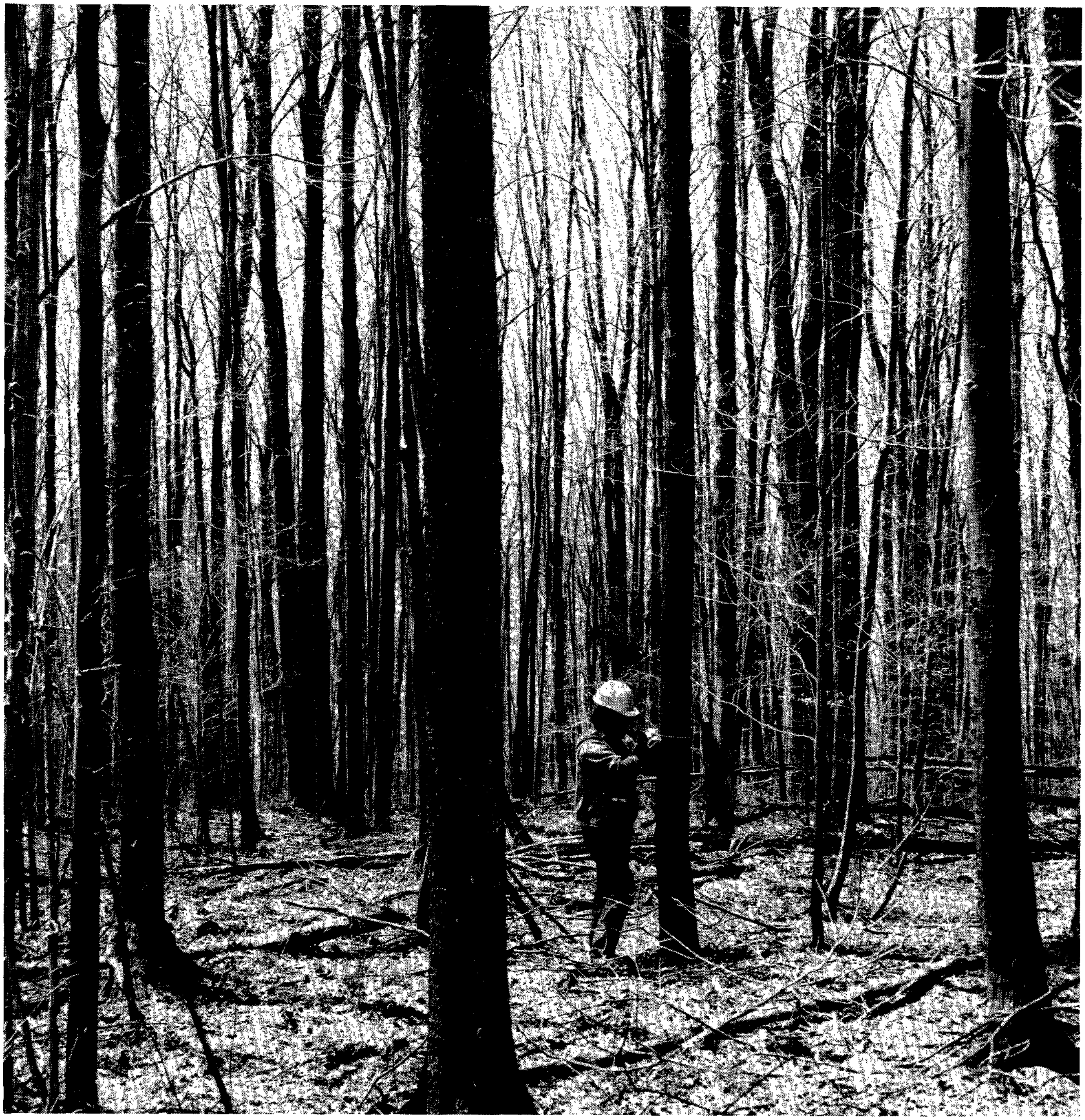
Forest Service

Northeastern Forest Experiment Station

Research Paper NE-615

Thinning Cherry-Maple Stands in West Virginia: 5-Year Results

Neil I. Lamson
H. Clay Smith



Abstract

In northern West Virginia, 60-year-old cherry-maple stands were thinned to 75, 60, and 45 percent relative stand density. Analysis of 5-year growth data showed that basal-area growth was not reduced by thinning. Cubic-foot and board-foot volume growth decreased slightly. Individual-tree growth of all trees, dominant/codominant trees, and the 50 largest diameter trees per acre was significantly increased by thinning. Dominant/codominant trees in the 45 percent plots grew about 0.42 inch more in 5 years than those in the control plots. Optimum stand density probably is less than 60 percent relative stand density.

The Authors

NEIL I. LAMSON, research forester, received B.S. and M.S. degrees in silviculture and forest soils from the State University of New York, College of Environmental Science and Forestry, Syracuse. He joined the USDA Forest Service, State and Private Forestry, in 1972. Currently he is engaged in timber management research at the Northeastern Forest Experiment Station's Timber and Watershed Laboratory at Parsons, West Virginia.

H. CLAY SMITH is Project Leader of timber management research at the Northeastern Station's Timber and Watershed Laboratory at Parsons. He received degrees from West Virginia University and Purdue University, and has been engaged in timber management research with the USDA Forest Service since 1962.

Manuscript received for publication 23 February 1988

Northeastern Forest Experiment Station
370 Reed Road, Broomall, PA 19008

May 1988

Introduction

Thinnings in even-aged hardwood stands usually are made to: a) increase the growth of the most valuable trees in the stand; b) increase yield by harvesting trees that would die; and c) reduce the rotation length and/or increase the size of trees at final harvest. In reference to thinning Allegheny hardwoods, Roach (1977) stated: "Ideally, to grow a full crop of wood products as quickly as possible, we should always have in our stand the minimum number of trees that will just use all of the light, moisture and nutrients that are available on the site each growing season. The problems have always been how to define this ideal and then how to achieve it." In this paper we report the 5-year results of a thinning study in cherry-maple stands in West Virginia. These preliminary results will help define the optimum stand conditions necessary to increase yields and monetary returns from managing similar stands.

Methods

In the fall of 1981, 16 plots, each 0.5 acre in size, were randomly located in a 60-year-old cherry-maple stand in northern West Virginia. Each plot was surrounded by a buffer strip that was 75 feet wide. Four treatments were randomly assigned to each of four plots. The four treatments were control and 75, 60, and 45 percent relative stand density (RSD) according to guidelines for managing Allegheny hardwoods (Marquis et al. 1984). Thinned plots and their buffer strips were marked according to guidelines in Marquis et al. (1984). The plot and buffer strips were thinned from below with about two-thirds of the basal area removed consisting of trees smaller than the average stand diameter. All trees at least 1.0 inch d.b.h. that were not marked for cutting were permanently identified using tree wires and numbered brass tags (Lamson and Rosier 1984).

The plots were thinned in the spring of 1982 by a three-man crew using chain saws and a rubber-tired skidder (Fig. 1). Each plot together with its buffer was logged as a separate unit. Trees were topped to a 4-inch d.i.b. and skidded full length. Trees less than 7 inches d.b.h. were not skidded. Stand data before and after cut are shown in Table 1.

A postlogging inventory conducted immediately after logging accounted for all residual trees. Crown class of residual trees was determined and logging damage was assessed. The logging damage was slight and concentrated in the sapling stems (Lamson et al. 1984).

In the fall of 1986, five growing seasons after thinning, diameters of the residual trees were remeasured. Ingrowth was tallied using a 1.0-inch threshold d.b.h. The 5-year growth data are summarized in this paper.

Before and 5-years after treatment, living epicormic branches were counted on the first two 16-foot logs (33 feet) of all trees at least 7.0 inches d.b.h.

Table 1.—Per-acre stand data by thinning treatment

	Stems 1.0+ inches d.b.h.		Stems 5.0+ inches d.b.h.		Stems 11.0+ inches d.b.h.		
Item	No. of trees	Basal area	No. of trees	Volume	No. of trees	Volume	RSD[a]
		Ft²/acre		*Ft³/acre*		*Bd. ft/acre*	*Percent*
			CONTROL				
	864	166	288	3,078	70	9,756	115
			75 PERCENT				
Initial	923	161	322	2,893	56	7,204	120
Cut	354	52	143	700	7	626	47
Residual	569	109	179	2,193	49	6,578	73
			60 PERCENT				
Initial	904	164	352	2,874	55	5,194	125
Cut	476	80	216	1,216	14	873	68
Residual	428	84	136	1,658	41	4,321	57
			45 PERCENT				
Initial	827	160	338	2,840	63	5,834	119
Cut	525	98	253	1,602	22	1,546	79
Residual	302	62	85	1,238	41	4,288	40

[a]Relative stand density of trees 1.0+ inches d.b.h.

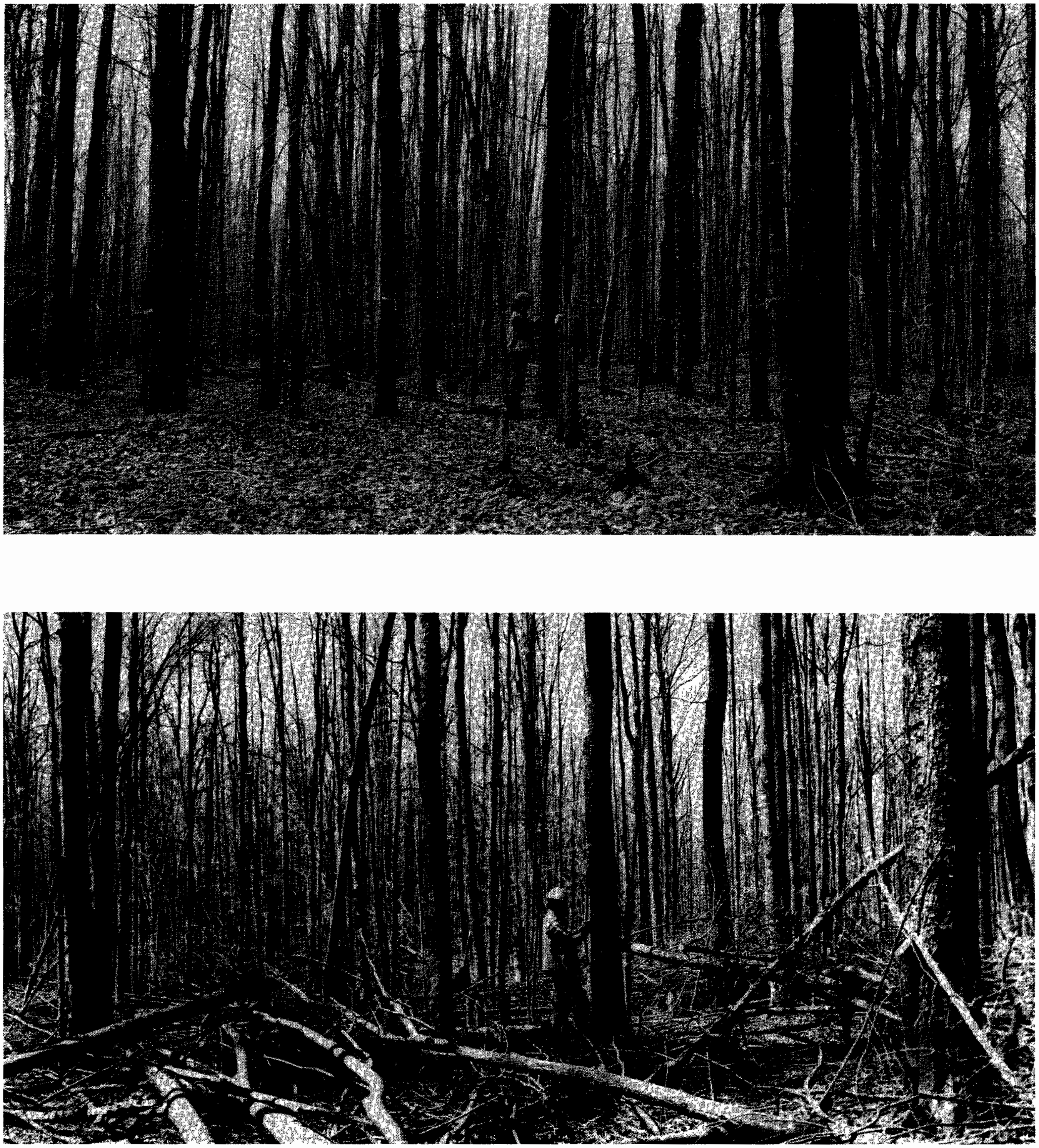


Figure 1. — A 60-year-old cherry-maple stand in northern West Virginia before thinning (top) and after thinning.

Results

Stand Growth and Mortality

Basal-area growth. Periodic net basal-area growth was increased by thinning (Table 2). The 75-percent plots averaged 19 ft²/acre of basal-area growth in the 5-year period, while the 60 percent, 45 percent, and control plots averaged 16, 15, and 10 ft²/acre, respectively. Thinning reduced periodic mortality from 9 ft²/acre in the control plots to about 1.4 ft²/acre in the thinned plots. Most of the dead trees in the thinned plots were those that had been damaged during logging. Ingrowth was directly related to the intensity of thinning, the heavier thinned plots having more ingrowth. Thinning also shifted the stand growth onto fewer, more valuable trees. For example, in the control plots, the net basal-area growth of 10 ft²/acre occurred on 746 stems/
acre, while in the 45 percent plots, 15 ft²/acre of growth occurred on only 335 stems/acre. Individual-tree net basal-area growth averaged 0.01, 0.03, 0.04, and 0.05 ft² for the control and 75, 60, and 45 percent plots, respectively.

Table 2.—Stand growth and mortality by thinning treatment

	No. of trees				5-year net growth[a]	
Treatment	Residual	Final	Ingrowth	Mortality	Per acre	Per tree
		BASAL AREA (Ft²/acre)				
Control	166	176	0.1 (8)[b]	9.0 (126)	10 (746)	0.01
75 percent	109	128	0.2 (33)	1.4 (48)	19 (554)	0.03
60 percent	84	100	0.3 (36)	1.6 (50)	16 (414)	0.04
45 percent	62	77	0.5 (64)	1.1 (31)	15 (335)	0.05
		VOLUME (Ft³/acre)				
Control	3,078	3,493	50 (17)	98 (19)	415 (286)	1.45
75 percent	2,193	2,636	0	9 (1)	443 (178)	2.49
60 percent	1,658	2,062	0	9 (1)	404 (135)	2.99
45 percent	1,238	1,609	0	9 (1)	371 (84)	4.42
		VOLUME (Board feet/acre)				
Control	9.756	12,847	889 (19)	124 (1)	3,091 (88)	35.1
75 percent	6,578	9,417	784 (14)	0	2,839 (63)	45.1
60 percent	4,321	7,259	1,077 (20)	0	2,938 (61)	48.2
45 percent	4,288	7,098	848 (15)	37 (1)	2,810 (55)	51.1
		RELATIVE STAND DENSITY (Percent)				
Control	115	115	—	—	0 (746)	0
75 percent	73	83	—	—	10 (554)	0.018
60 percent	57	67	—	—	10 (414)	0.024
45 percent	40	49	—	—	9 (335)	0.027

[a]Net growth = survivor growth + ingrowth - mortality.
[b]Numbers in parentheses are numbers of trees per acre.

Cubic-foot volume growth. Per-acre periodic net cubic-foot volume growth of all trees at least 5.0 inches d.b.h. was changed little by thinning (Table 2). Thinning to 75 percent increased cubic-foot volume net growth per acre from 415 to 443. The 45 percent plots averaged 371 ft³/acre periodic net growth. Mortality in the thinned plots averaged 9 ft³/acre compared with 98 ft³/acre in the control plots. Mortality in the thinned plots was the result of trees being severely damaged during logging.

Thinning redistributed the cubic-foot volume growth onto fewer stems and resulted in increased individual-tree growth. For control and 75, 60, and 45 percent plots, average per-tree cubic-foot volume growth averaged 1.45, 2.49, 2.99, and 4.42, respectively. There was no ingrowth of trees into the 5.0+ inches d.b.h. class in the thinned plots because all trees 3.6 to 4.9 inches d.b.h. were cut in 1981 to reduce the sapling basal area to the recommended level.

Board-foot volume growth. For all treatments, 5-year net board-foot volume growth averaged 2,920/acre of which about 900 board feet/acre was ingrowth (trees crossing the 11.0-inch threshold d.b.h. for board foot calculations). There was no mortality of sawlog-size trees in any of the thinned plots except for one tree per acre in 45 percent plots. This was a tree that had suffered severe logging damage. The number of sawlog-size trees in the control and 75, 60, and 45 percent plots was 88, 63, 61, and 55 per acre, respectively, while individual-tree growth averaged 35.1, 45.1, 48.2, and 51.1 board feet, respectively.

Relative stand density. The RSD for thinned plots increased by about 10 percent during the 5-year period. The control plots did not change, remaining overstocked at 115 percent.

Individual-Tree Growth

The data in Table 2 suggest that thinning increased individual-tree growth as per-acre volume growth decreased only slightly even though there were fewer trees in the thinned plots. Statistical comparisons of individual-tree growth are shown in Table 3.

For all trees at least 1.0 inch d.b.h., thinning significantly increased the average 5-year diameter growth of individual trees. All treatment means were significantly different from each other. Average 5-year diameter growth was 0.24, 0.48, 0.62, and 0.76 inch for control and 75, 60, and 45 percent plots, respectively. Trees in the 45 percent plots averaged 3 times as much diameter growth as those in the control plots. Five years after thinning, the average d.b.h. in the 75, 60, and 45 percent plots was 0.23, 0.36, and 0.52 inch larger, respectively, than in the control plots.

Thinning also significantly increased the growth of the dominant/codominant trees in 1981 (Table 3). All treatments were significantly different from each other. Average 5-year diameter growth was 0.69, 0.91, 1.03, and 1.11 inches for the control and 75, 60, and 45 percent plots, respectively.

Table 3.—Average individual-tree diameter growth by thinning treatment

Item	All trees	Dominant/ codominant trees (1981)	50 largest trees/acre
	CONTROL		
No./acre (1986)	742	138	50
1981 D.b.h. (inches)	4.90	11.38	14.15
1981-86 growth (inches)	0.24 a	0.69 a	0.82 a
	75 PERCENT		
No./acre (1986)	521	123	50
1981 D.b.h. (inches)	4.61	10.84	13.07
1981-86 growth (inches)	0.48 b	0.91 b	1.06 b
	60 PERCENT		
No./acre (1986)	379	109	50
1981 D.b.h. (inches)	4.84	10.60	12.15
1981-86 growth (inches)	0.62 c	1.03 c	1.17 c
	45 PERCENT		
No./acre (1986)	271	79	50
1981 D.b.h. (inches)	4.82	11.14	12.12
1981-86 growth (inches)	0.76 d	1.11 d	1.18 d

Note: Values in the same column followed by the same letter are not significantly different ($P < 0.01$).

Serious distortions can result in comparisons of individual-tree growth means if the number of trees in each treatment are not equal. In this study, the number of trees per acre ranged from 742 to 271 for all trees and from 138 to 79 for dominant/codominant trees. The sample size was equalized by selecting the 50 largest trees per acre in each plot. The 25 trees with the largest diameter in 1981 were selected from each ½-acre plot.

The 50 largest diameter trees per acre generally showed the same response to thinning as all trees and codominant trees (Table 3). Average 5-year diameter growth for control and 75, 60, and 45 percent plots was 0.82, 1.06, 1.17, and 1.18 inches, respectively. In the 60 and 45 percent thinning treatments, the 50 largest diameter trees per acre increased in diameter about 0.35 inch more than those in the controls in 5 years.

Tree Quality

Heavy thinning has been shown to increase the size and number of surface defects, particularly on white oak (Sonderman 1984). In this study, the number of live epicormic branches at least 1 foot long in the first two 16-foot logs (1 to 33 feet) were tallied on all trees at least 7.0 inches d.b.h. A total of 954 trees was examined. About two-thirds of the trees sampled were black cherry and about one-quarter were red maple. Other species sampled were sugar maple, cucumbertree and white ash (Table 4). Data were summarized by number of trees with fewer than three epicormic branches in each 16-foot log. It was assumed that only two epicormic branches in a 16-foot log would not reduce the grade of that log.

In general, thinning caused few epicormic branches to develop. For black cherry, the most numerous and highest value species in these plots, 97 percent of the trees in the plots thinned to 45 percent had fewer than three epicormic branches in the butt log (Table 4). In the second log, the percentage of trees with fewer than three epicormic branches in the second log was 98, 95, and 93 percent for the plots thinned to 75, 60, and 45 percent, respectively. Epicormic branching on red maple was slightly higher than on black cherry, especially at 45 percent RSD. Sugar maple, a very tolerant species, produced the most epicormic branches. However, since this species is a minor component of these stands, it is doubtful that stand value would be significantly decreased by the increase in epicormic branches on sugar maple.

Discussion

The basic concept of thinning even-aged stands is to leave just enough trees to fully occupy the site so that total production is not reduced. In this experiment, 5-year growth of total basal area, cubic-foot volume, and board-foot volume was not significantly reduced by any of the thinning treatments. It appears that thinning to as low as 40 percent RSD still leaves enough trees to fully occupy the site.

Table 4.—Percent of trees over 7.0 inches d.b.h. with fewer than three epicormic branches in the butt and second logs 5 years after thinning[a]

Treatment	Black cherry	Red maple	Sugar maple	Cucumber-tree	White ash	All species
	Percent					
			BUTT LOG			
75 percent	100 (307)	98 (96)	62 (8)	82 (11)	89 (8)	98 (403)
60 percent	97 (212)	99 (103)	86 (14)	100 (10)	100 (1)	97 (340)
45 percent	97 (147)	85 (33)	100 (2)	50 (2)	—	95 (184)
			SECOND LOG			
75 percent	98 (307)	88 (96)	50 (8)	27 (11)	100 (15)	97 (423)
60 percent	95 (212)	88 (103)	64 (14)	50 (10)	100 (1)	92 (340)
45 percent	93 (147)	76 (33)	50 (2)	—	—	87 (182)

[a]Numbers in parentheses are numbers of trees observed.

The RSD increased by about 2 percent annually in all thinned plots. This is another indication that the sites were fully occupied, even at 40 percent RSD. If the stands continue to grow at this rate, the 75 percent plots will reach about 93 percent RSD in 5 years. At that time, one could expect to see some mortality, which would mean the stands would be ready for another thinning. For the 60 percent plots, RSD probably will reach about 96 percent in 15 years. This would mean about a 20-year thinning cycle for stands thinned to 60 percent RSD. For the 45 percent plots, RSD will reach about 95 percent in 23 years. The stands will be about 90 years old at that time and probably will be ready for the harvest cut. However, the reader is cautioned that these estimates are based on 5-year growth data. The actual long-term growth of these stands may differ considerably from these estimates.

Thinning did not stimulate the production of epicormic branches on black cherry, the most valuable and most numerous codominant trees in these stands. It appears that individual-tree value of black cherry will not be reduced by reducing the RSD to as low as 40 percent. However, at 45 percent RSD, red maple tended to produce significant numbers of epicormic branches.

Another objective of thinning is to harvest trees before they die. Mortality was reduced by all thinning treatments. Mortality of trees 5.0+ inches d.b.h. in the thinned plots was only one tree per acre. In all cases, the mortality in the thinned plots was due to severe logging wounds, not stand competition. Thinning also increased yields because no trees were harvested from the control areas.

Individual-tree growth was increased by thinning. For the 50 largest diameter trees per acre, thinning to 60 and 45 percent increased the 5-year diameter growth by 0.35 inch per tree. For dominant/codominant trees, the 45 percent treatment increased individual-tree growth by 0.42 inch in 5 years. If these growth rates remain unchanged for the next 20 years, d.b.h. growth of dominant/codominant trees in the 45 percent plots will be about 2.1 inches more than that of codominant trees in the control plots. For the 50 largest diameter trees per acre, d.b.h. of trees in the 45 percent plots will be about 1.7 inches larger than those in the control plots. This could mean substantial gains in stand value because the codominant control trees will average about 15 inches d.b.h., while those in the 45 percent plots will average about 17 inches d.b.h. Trees must be at least 16 inches d.b.h. to produce a grade 1 butt log.

One cannot accurately predict long-term stand growth from these 5-year growth data. As the thinned stands continue to grow, competition will increase and diameter growth of individual trees will slow. However, it is clear that these previously unmanaged, 60-year-old cherry maple stands will respond to thinning. These data also show that the optimum thinning level may be less than 60 percent RSD as per-acre growth was not substantially reduced by thinning to 40 percent RSD.

Literature Cited

Lamson, Neil I.; Rosier, Robert L. 1984. **Wires for long-term identiification.** Journal of Forestry, 82(2): 110-111.

Lamson, Neil I.; Smith, H. Clay; Miller, Gary W. 1984. **Residual stocking not seriously reduced by logging damage from thinning of West Virginia cherry-maple stands.** Res. Pap. NE-541. Broomall, PA: U.S. Department of Agriculture, Forest Service. Northeastern Forest Experiment Station. 7 p.

Marquis, David A.; Ernst, Richard L.; Stout, Susan L. 1984. **Prescribing silvicultural treatments in hardwood stands of the Alleghenies.** Gen. Tech. Rep. NE-96. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 90 p.

Roach, Benjamin A. 1977. **A stocking guide for Allegheny hardwoods and its use in controlling intermediate cuttings.** Res. Pap. NE-373. Upper Darby, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 30 p.

Sonderman, David L. 1984. **Quality response of even-aged 80-year-old white oak trees after thinning.** Res. Pap. NE-543. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 6 p.

☆U. S. GOVERNMENT PRINTING OFFICE: 1988/548-066/60019

Lamson, Neil I.; Smith, H. Clay. 1988. **Thinning cherry-maple stands in West Virginia: 5-year results.** Res. Pap. NE-615. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 7 p.

In northern West Virginia, 60-year-old cherry-maple stands were thinned to 75, 60, and 45 percent relative stand density. Analysis of 5-year growth data showed that basal-area growth was not reduced by thinning. Cubic-foot and board-foot volume growth decreased slightly. Individual-tree growth of all trees, dominant/codominant trees, and the 50 largest diameter trees per acre was significantly increased by thinning. Dominant/codominant trees in the 45 percent plots grew about 0.42 inch more in 5 years than those in the control plots. Optimum stand density probably is less than 60 percent relative stand density.

ODC 242: 561: 562: 176.1

Keywords: Thinning, diameter increment, volume increment, Allegheny hardwoods.

Headquarters of the Northeastern Forest Experiment Station are in Broomall, Pa. Field laboratories are maintained at:

- Amherst, Massachusetts, in cooperation with the University of Massachusetts.
- Berea, Kentucky, in cooperation with Berea College.
- Burlington, Vermont, in cooperation with the University of Vermont.
- Delaware, Ohio.
- Durham, New Hampshire, in cooperation with the University of New Hampshire.
- Hamden, Connecticut, in cooperation with Yale University.
- Morgantown, West Virginia, in cooperation with West Virginia University, Morgantown.
- Orono, Maine, in cooperation with the University of Maine, Orono.
- Parsons, West Virginia.
- Princeton, West Virginia.
- Syracuse, New York, in cooperation with the State University of New York College of Environmental Sciences and Forestry at Syracuse University, Syracuse.
- University Park, Pennsylvania, in cooperation with the Pennsylvania State University.
- Warren, Pennsylvania.