United States
Department of
Agriculture

Forest Service

**Northeastern Forest
Experiment Station**

Research Paper
NE-571

1985

Thinning Increases Growth of 60-Year-Old Cherry-Maple Stands in West Virginia

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Abstract

In north-central West Virginia, previously unmanaged, 60-year-old cherry-maple stands were thinned to 60 percent relative stand density. Thinning reduced mortality, redistributed growth onto fewer, larger stems, and increased individual tree growth. Five-year periodic basal area growth per acre was 1.2 times greater in thinned stands than in unthinned stands. Periodic basal-area growth of individual trees was greater in thinned stands than in controls: 3.0 times for all stems and 1.3 times for dominants and codominants. Relative stand density in the thinned stands increased 1.6 percent annually.

Introduction

The Middle Mountain area on the Monongahela National Forest in north-central West Virginia supports well-stocked cherry-maple stands similar to those found in Allegheny hardwood forests of northwestern Pennsylvania. This area is approaching the southern limit of the most productive natural range of black cherry. There are about 125,000 acres of commercial forest in the Middle Mountain area, most of which is in even-aged cherry-maple stands 60 to 80 years old (Figure 1). Thinnings are now becoming economically feasible in many of these stands. An important question is "Will these unmanaged, even-aged stands respond to thinning at ages 60 years or greater?" In this paper, 5-year growth in thinned stands is compared with that of unthinned stands.

Figure 1.—Typical 60-year-old cherry-maple stand before thinning.

Study

Two tracts, each about 5 acres in size, were thinned to 60 percent relative stand density (Marquis et al. 1984) to determine the amount of wood products that could be produced from thinning 60-year-old cherry-maple stands on Middle Mountain. One tract was thinned in the fall of 1976 and the other was thinned in the spring and summer of 1977 (Figure 2). Detailed product yield data were collected, but no effort was made to document the residual stand growth.

In the spring of 1979, four study plots, each 1/4-acre in size, were established in each thinned tract. Two additional study plots, each one-quarter acre in size, were established in uncut areas close to each thinned tract. On each of the 12 plots, all trees at least 1.0 inch in d.b.h. were permanently marked with galvanized wires and brass tags (Lamson and Rosier 1984). Diameter at breast height (d.b.h.), species, and crown class of each tagged tree were recorded in April 1979 before that year's growth had commenced.

Figure 2.—Typical cherry-maple stand after thinning. Tree being measured is 9.0 inches d.b.h.

In the fall of 1983, 5 growing seasons later, the plots were again inventoried. The d.b.h. of each live tagged tree was measured at the same height that was used in 1979. Ingrowth and mortality were recorded, as well as the crown class of live trees over 1.0 inches d.b.h. If we assume that diameter growth had ceased by the time thinning was completed in the second area in the summer of 1977, these data represent growth for the 2nd through 6th and 3rd through 7th growing seasons after thinning. One control plot was vandalized and dropped from the study, leaving a total of 11 plots.

In April 1979, when the study plots were installed, the control areas averaged 735 stems per acre, 155.6 square feet per acre (1.0+ inch d.b.h.), 2,977 cubic feet per acre (5.0+ inch d.b.h.), 8,828 board feet per acre (11.0+ inch d.b.h.) and 105 percent relative stand density (1.0+ inch d.b.h.). The thinned stands averaged 407 stems per acre, 104.2 square feet per acre, 2,041 cubic feet per acre, 7,862 board feet per acre, and 66 percent relative stand density (Table 1).

Assuming that the control and thinned stands were similar before treatment, thinning removed mostly poletimber (5.0 to 10.9 inches d.b.h.). When this study was installed, basal area per acre of stems 1.0 to 4.9 inches d.b.h. and stems 11.0+ inches d.b.h. were similar for the control and thinned stands. However, basal area of poletimber in the thinned stands was only 32.9 square feet per acre, while in the control stands, poletimber basal area averaged 74.2 square feet per acre. This follows the guidelines for thinning Allegheny hardwood stands (Marquis et al. 1984), in which commercial thinnings concentrate the cut in trees of intermediate and weak codominant crown class to redistribute stand growth onto the best codominant trees.

Table 1. Stand data at the time study plots were installed and 5 growing seasons later.

	Thinned				Control			
	1.0–4.9	5.0–10.9	11.0+	Total	1.0–4.9	5.0–10.9	11.0+	Total
April 1979								
No./acre	258	92	57	407	444	229	62	735
BA/acre	13.4	32.9	57.9	104.2	17.4	74.2	64.0	155.6
Cu.ft./acre	—	613	1,428	2,041	—	1,349	1,628	2,977
Bd.ft./acre	—	—	7,862	7,862	—	—	8,828	8,828
RSD	15	25	26	66	20	56	29	105
September 1983								
No./acre	244	99	74	417	375	211	71	657
BA/acre	12.2	30.4	78.4	121.0	14.1	71.3	78	163.4
Cu.ft./acre	—	576	1,961	2,537	—	1,308	1,907	3,215
Bd.ft./acre	—	—	10,817	10,817	—	—	11,358	11,358
RSD	17	29	28	74	17	57	32	106

Basal area = Square feet of basal area of stems 1.0+ inch d.b.h.
Cu. ft. vol. = Cubic foot volume to 4 inches d.i.b. of stems 5.0+ inches d.b.h.
Bd. ft. vol. + International 1/4-inch board-foot volume to 8 inches d.i.b. of stems 11.0+ inches d.b.h.
RSD = Relative stand density, percent.

Results

Stand Growth

All trees. Thinning increased the per-acre growth (Table 2). Total basal area per acre of all trees at least 1.0 inch in d.b.h. was greater in the control stands than in the thinned stands. However, basal-area growth for the 5-year period averaged 16.8 square feet per acre in thinned stands and only 7.8 square feet per acre in the control stands; an increase of 2.2 times. Similarly, cubic-foot volume growth of trees at least 5.0 inches d.b.h. for the 5-year measurement period was 496 cubic feet per acre in the thinned stands and only 238 cubic feet per acre in the control stands; an increase of 2.1 times due to thinning.

Board-foot volume growth of those trees at least 11.0 inches in d.b.h. for the 5-year period averaged 2,955 board feet per acre in the thinned stands and 2,530 board feet per acre in the control stands, which is an increase of 1.2 times due to thinning.

Dominant and codominant trees. Dominant and codominant trees are the most important component of even-aged stands because these generate most of the revenue at harvest. Thinning also increased the per acre growth of trees that were dominant or codominant in 1983 (Table 2). It is interesting that the number of dominant and codominant stems per acre was about the same in thinned stands (109) and in the control stands (112). However, the 5-year basal area

Table 2. Five-year stand growth.

	Thinned			Control			5-Year Growth Ratio Thinned: Control
	4/79	9/83	5-Year Growth	4/79	9/83	5-Year Growth	
ALL TREES							
No./acre	407	417		735	657		
BA/acre	104.2	121.0	16.8 (407)	155.6	163.4	7.8 (735)	2.2
Cu.ft./acre	2,041	2,537	496 (173)	2,977	3,215	238 (282)	2.1
Bd.ft./acre	7,862	10,817	2,955 (74)	8,828	11,358	2,530 (71)	1.2
RSD	66	74		105	106		
DOMINANT AND CODOMINANT TREES							
No./acre	109	109		112	112		
BA/acre	80.6	93.2	12.6 (109)	85.6	95.8	10.2 (112)	1.2
Cu.ft./acre	1,858	2,258	400 (107)	2,027	2,246	219 (110)	1.8
Bd.ft./acre	7,767	10,648	2,881 (72)	8,436	10,740	2,304 (65)	1.3
RSD	43	48		44	48		
DOMINANT AND CODOMINANT CHERRY TREES							
No./acre	51	51		69	69		
BA/acre	48.1	54.7	6.6 (51)	61.0	67.9	6.9 (69)	1.0
Cu.ft./acre	1,157	1,369	212 (51)	1,482	1,622	140 (69)	1.5
Bd.ft./acre	5,892	7,740	1,848 (47)	6,997	8,691	1,694 (52)	1.1
RSD	20	22		25	27		

Note: Numbers in parentheses refer to number of trees used in calculations.
Number = Number of stems 1.0+ inches d.b.h.
BA = Square feet of basal area of stems 1.0+ inches d.b.h.
Cu.ft. = Cubic-foot volume to 4 inches d.i.b. of stems 5.0+ inches d.b.h.
Bd.ft. = International 1/4 inch board-foot volume to 8 inches d.i.b. of stems 11.0+ inches d.b.h.
RSD = Relative stand density, percent.

growth of dominant and codominant trees averaged 12.6 square feet per acre in the thinned stands and only 10.2 square feet per acre in the control stands. This represents a 20 percent increase due to thinning. In 1983 the total basal area of dominant and codominant stems averaged about the same for thinned and control stands, 93.2 and 95.8 square feet per acre, respectively.

Volume growth for the 5-year period averaged 400 cubic-feet per acre in the thinned stands, and 219 cubic feet per acre in the control stands; an 80 percent increase due to thinning. Sawlog volume growth of dominant and codominant trees averaged 2,881 board feet per acre in the thinned stands and 2,304 board feet per acre in the control stands. Like cubic-foot volume, total board-foot volume per acre was nearly the same for thinned and control stands at the end of the measurement period: 10,648 and 10,740 board feet per acre, respectively.

Dominant and Codominant Black Cherry Trees. The dominant and codominant trees in these stands are primarily a mixture of black cherry, red maple, and sugar maple. Of these species, black cherry is the most valuable. Basal-area growth per acre of dominant and codominant black cherry trees that were dominant or codominant in 1983 was about equal in the thinned and control stands, 6.6 and 6.9 square feet per acre, respectively. Although total basal-area growth per acre was not increased by thinning, the individual trees did respond to thinning. In the thinned stands, 51 dominant and codominant trees grew 6.6 square feet per acre, while in the control stands, 69 trees grew 6.9 square feet per acre.

Both cubic-foot and board-foot volume per acre of dominant and codominant black cherry trees were increased by thinning.

Mortality, Ingrowth and Survivor Growth

All Trees. Mortality was greater in the control than in the thinned stands (Table 3). In both stands, mortality occurred only in the intermediate and overtopped crown classes. When the stand growth from table 2 was adjusted for ingrowth and mortality, the survivor growth was greater in the thinned than in the control stands. Thinning increased per-acre survivor basal area growth 1.2 times, survivor cubic-foot volume growth 1.5 times, and survivor board-foot volume growth 1.1 times (Table 3).

Dominant and codominant trees. There was no mortality or ingrowth of dominant and codominant trees. In other words, no dominant or codominant trees died during the 5-year measurement period and no trees that crossed the 1.0-inch d.b.h. threshold were dominant or codominant. However, a portion of the cubic-foot volume present in 9/83 came from trees that crossed the 5.0-inch d.b.h. threshold, which is defined as cubic-foot volume ingrowth. Similarly, the 9/83 board-foot volume of trees that crossed the 11.0-inch d.b.h. threshold is defined as board-foot volume ingrowth. When stand growth from table 2 was adjusted for ingrowth, thinning increased the survivor growth of dominants and codominants (Table 3). Per-acre survivor basal-area growth was increased 1.2 times, survivor cubic-foot growth was increased 1.8 times, and survivor board-foot growth was increased 1.2 times.

Dominant and codominant black cherry trees. Survivor growth of dominant or codominant black cherry trees was increased by thinning (Table 3). Survivor basal-area growth in the thinned stands averaged 6.6 square feet per acre while in the control it averaged 6.9 square feet per acre. But because there were 69 trees per acre in the control stands and only 51 trees per acre in the thinned stands, individual tree growth was increased 1.3 times by thinning. Similarly, board foot volume growth per acre was only slightly increased by thinning, but individual tree growth was increased 1.4 times. Survivor basal-area growth per acre of thinned stands averaged 1.5 times more than that in the control stands.

Individual Tree Growth

All trees. Diameter growth of all individual trees was increased about 3 times by thinning (Table 4). During the 5-year measurement period, the average d.b.h. increased from 5.5 to 6.1 inches in the thinned stands, while in the control stands it increased from 5.1 to 5.3 inches.

Basal-area growth per tree was increased even more than d.b.h. growth per tree by thinning. In the thinned stands, basal area per tree increased from 23.7 to 29.2 square inches in the 5-year measurement period. Basal area per tree in the control stands increased from 20.4 to 22.1 square inches. This represents an increase due to thinning of 3.2 times. Analysis of variance indicated that individual trees in the thinned stands grew significantly faster than those in the control stands.

Dominant and codominant trees. For the 5-year period, d.b.h. and basal-area growth of individual trees that were dominant or codominant in 1983 was increased about 1.3 times by thinning (Table 4). In the thinned stands, average d.b.h. per tree increased only 0.9 inches, while in the control, average d.b.h. increased only 0.7 inches. Similarly, average basal area per tree increased by 16.5 square inches per tree in the thinned stands, but only 12.9 square inches per tree in the control stands. Analysis of variance indicated that dominant and codominant trees in the thinned stands grew significantly faster than those in the control stands.

Table 3. Mortality, ingrowth, and survivor growth of thinned and unthinned stands.

	Thinned				Control				Survivor growth ratio
	5-Year stand growth[1]	Mortality[2]	Ingrowth[3]	Survivor growth[4]	5-Year stand growth	Mortality	Ingrowth	Survivor growth	Thinned: Control
				ALL TREES					
No./acre	417	−9	19	389	657	−85	7	565	
BA/acre	16.8	−0.6	0.1	17.3	7.8	− 7.3	0.1	15.0	1.2
CF/acre	496	−3	65	434	238	−70	10	298	1.5
BF/acre	2,955	0	827	2,128	2,530	0	618	1,912	1.1
				DOMINANT AND CODOMINANT TREES					
No./acre	107	0	0	107	112	0	0	112	
BA/acre	12.6	0	0	12.6	10.2	0	0	10.2	1.2
CF/acre	400	0	0	402	219	0	0	219	1.8
BF/acre	2,881	0	783	2,098	2,304	0	506	1,798	1.2
				DOMINANT AND CODOMINANT BLACK CHERRY TREES					
No./acre	51	0	0	51	69	0	0	69	
BA/acre	6.6	0	0	6.6	6.9	0	0	6.9	1.0
CF/acre	212	0	0	212	140	0	0	140	1.5
BF/acre	1,848	0	388	1,460	1,694	0	300	1,394	1.0

[1] From table 2.
[2] Trees 1.0+ inches d.b.h.
[3] Ingrowth: Number and basal area threshold d.b.h. is 1.0 inch.
Cubic foot threshold d.b.h. is 5.0 inches.
Board foot threshold d.b.h. is 11.0 inches.
[4] Survivor growth = stand growth + mortality-ingrowth, i.e. growth of trees that were alive both in 4/79 and 9/83.

Table 4. Five-year individual tree growth based on plot means[a].

	Thinned			Control			5-Year Growth	
	4/79	9/83	5-Year Growth	4/79	9/83	5-Year Growth	Ratio Thinned: Control	Significance
				ALL TREES				
No. plots	8			3				
D.b.h./tree(in)	5.5	6.1	0.6	5.1	5.3	0.2	3.0	**
BA/tree(in^2)	23.7	29.2	5.5	20.4	22.1	1.7	3.2	**
				DOMINANT AND CODOMINANT TREES				
No. plots	8			3				
D.b.h./tree(in)	11.2	12.1	0.9	11.4	12.1	0.7	1.3	**
BA/tree(in^2)	98.5	115.0	16.5	102.1	115.0	12.9	1.3	**
				DOMINANT AND CODOMINANT BLACK CHERRY TREES				
No. plots	8			3				
D.b.h./tree(in)	13.0	13.8	0.8	12.4	13.1	0.7	1.1	*
BA/tree(in^2)	132.7	149.6	16.9	120.8	134.8	14.0	1.2	NS

[a] All data are arithmetic means, not quadratic means.
** = Significantly different at 0.01 level, * = significantly different at 0.05 level.
NS = not significantly different.

Dominant and codominant black cherry trees. During the 5-year measurement period, d.b.h. and basal-area growth of individual black cherry trees that were dominant or codominant in 1983 was also increased by thinning (Table 4). Average d.b.h. per tree increased from 13.0 to 13.8 inches in the thinned stands, but only from 12.4 to 13.1 inches in the control stands. Similarly, basal-area growth per tree averaged 16.9 square inches in the thinned stands but only 14.0 square inches in the control stands; an increase of 1.2 times due to thinning. Again, analysis of variance indicated that trees in the thinned stands grew significantly faster than those in the unthinned stands.

Discussion

It is not possible to predict long-term growth and yield of thinned and unthinned cherry-maple stands from the 5-year growth data of this study. However, these data show that trees in these 60-year-old stands did respond to thinning. Mortality was reduced, growth was redistributed onto fewer, larger stems, and individual trees grew faster.

Ingrowth was negligible in both the control and thinned stands during the 5-year measurement period. Table 1 indicates that the total number of stems per acre increased from 407 to 417 in thinned stands during the 5-year period. Ingrowth exceeded mortality by 10 stems per acre. However, in the control stands, the total number of stems per acre fell from 735 to 657—a decrease of 78 trees per acre—during the measurement period. In other words, thinning eliminated mortality during the 5-year measurement period.

Total basal area and cubic-foot volume growth was about 2 times greater in the thinned stands than in the control stands (Table 2) even though the thinned stands had only about two-thirds as many stems per acre as the control stands. At the beginning of the measurement period the average diameter of all trees was 5.5 inches in the thinned stands and 5.1 inches in the control stands (Table 4). This shows that thinning redistributed the total stand growth of the stems 1.0 inch d.b.h. and larger onto fewer, larger stems.

Table 4 shows that individual trees grew faster in the thinned stands than in the control stands. Not only was the absolute diameter and basal area growth greater, but analysis of variance indicated that individual tree growth was significantly greater in the thinned stands than in the control stands.

Relative stand density in the thinned stands increased 8 percent during the 5-year measurement period or 1.6 percent annually. At this rate, relative stand density will reach 90 percent in another 10 years. Current guidelines recommend thinning when the stands exceed 85 percent relative stand density. Therefore, it appears that these stands can be thinned at intervals of 10 to 15 years.

In conclusion, these data indicate that 60-year-old, previously unmanaged even-aged cherry-maple stands will respond to thinning.

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In north-central West Virginia, previously unmanaged 60-year-old cherry-maple stands were thinned to 60 percent relative stand density. Thinning reduced mortality, redistributed growth onto fewer, larger stems, and increased individual tree growth. Five-year periodic basal-area growth per acre was 1.2 times greater in thinned stands than in unthinned stands. Periodic basal-area growth of individual trees was greater in thinned stands than in controls: 3.0 times for all stems and 1.3 times for dominants and codominants. Relative stand density in the thinned stands increased 1.6 percent annually.

ODC: 242, 561, 562, 176.1

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

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