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Products Derived from Thinning Two Hardwood Timber Stands in the Appalachians

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Abstract

Two sample plots in poletimber-small sawtimber stands of Allegheny hardwoods were thinned to improve crop-tree spacing. Thinning produced nearly 35 tons per acre of wood fiber, including 13 tons of sawable boltwood, 3-1/2 tons of standard sawlogs, 18 tons of pulpwood, and 1 ton of fuelwood. Nearly 3,700 board feet of lumber and cants were produced from the sawbolts and sawlogs. An additional 34 tons suitable for wood chips or fuelwood or both were available but not harvested.

INTRODUCTION

A RECENT STUDY of forest management needs in the Northeast showed that more than one-half of the 42 million acres in the oak-hickory and beech-birch-maple types needed thinning or improvement cutting. In the Appalachian Region, a similar portion of timberland consists of overstocked poletimber-small sawtimber stands. For example, of 700,000 acres of timberland on the Monongahela National Forest, more than 300,000 acres need thinning. These stands are in the 40- to 60-year age class and most are located on the better sites. The dominant and codominate trees in these stands range from 6 to 14 inches in diameter at breast height (dbh); but due to overstocking, the stands are becoming stagnant, and there is a high rate of mortality. Timber managers on the Monongahela National Forest estimate that 200,000 cords of wood are lost annually.

Large-scale commercial thinning is limited because traditional logging and sawmill systems are desgined for harvesting and processing the larger, higher grade timber; small trees cannot be used efficiently. New or modified systems will be required for commercial harvesting from thinnings. To develop such systems, information is needed on the types and quantity of products that can be recovered from the small trees removed in thinnings.

STUDY AREA

We selected two sample plots on the Middle Mountain section of the Monongahela National Forest near Elkins, West Virginia. They represent approximately 100,000 acres of overstocked poletimber-small sawtimber stands of Allegheny hardwoods on Middle Mountain.

The first plot contains 5.9 acres and is located on a ridgetop at an elevation of 3,700 feet. The site index for black cherry is 80. Initial stocking was 147.9 square feet (ft^2) of basal area per acre, of which 8.9 ft^2 was in saplings, 65.7 ft^2 was in poletimber, and 73.3 ft^2 was in sawtimber. The initial distribution of basal area among species was: black cherry (*Prunus serotina* Ehrh.), 45.6 ft^2; sugar maple (*Acer saccharum* Marsh.), 40.0 ft^2; white ash (*Fraxinus americana* L.), 26.7 ft^2; red maple (*Acer rubrum* L.), 18.9 ft^2; beech (*Fagus grandifolia* Ehrh.), 6.7 ft^2; cucumbertree (*Magnolia accuminata* L.), 5.6 ft^2; other 4.4 ft^2.

The second plot contains 5.6 acres, and is located at an elevation of 3,400 feet. The site index is 90 for black cherry. Initial stocking was 151.2 ft^2 of basal area per acre, of which 12.5 ft^2 was in saplings, 53.7 ft^2 was in poletimber, and 85.0 ft^2 was in sawtimber. The distribution of basal area among species was: black cherry, 62.5 ft^2; red maple, 32.5 ft^2; cucumbertree, 32.5 ft^2; black birch (*Betula lenta* L.), 15.0 ft^2; white ash, 2.5 ft^2; (Tables 1 and 2).

Table 1.—Stocking by species for two study plots on Middle Mountain section of Monongahela National Forest

Species	Basal area			Number of trees/acre			Mean dbh (inches)		
	Initial	Designated removal	Residual	Initial	Designated removal	Residual	Initial	Designated removal	Residual
					PLOT 1				
Sugar maple	40.0	26.6	13.4	230	192	38	5.6	4.9	8.0
Red maple	18.9	11.1	7.8	90	72	18	6.2	5.3	8.9
Black cherry	45.6	13.3	32.3	62	31	31	11.6	8.9	13.8
Ash	26.7	10.0	16.7	62	31	31	8.9	7.7	9.9
Beech	6.7	3.4	3.3	19	10	9	8.0	7.8	8.2
Magnolia spp.	5.6	3.3	2.3	9	6	3	10.7	10.0	11.6
Miscellaneous	4.4	3.3	1.1	45	42	3	4.2	3.8	8.2
All species	147.9	71.0	76.9	517	384	133	7.2	5.8	10.3
					PLOT 2				
Sugar maple	6.2	5.0	1.2	44	40	4	5.1	4.8	7.4
Red maple	32.5	23.8	8.7	234	213	21	5.0	4.5	8.7
Black cherry	62.5	16.2	46.3	81	26	55	11.9	10.7	12.4
Ash	2.5	.0	2.5	4	0	4	10.7	—	10.7
Black birch	15.0	15.0	.0	44	44	0	7.9	7.9	—
Magnolia spp.	32.5	15.0	17.5	74	47	27	9.0	7.6	10.9
All species	151.2	75.0	76.2	481	370	111	7.6	6.1	11.3

Table 2.—Stocking by tree size class for two study plots

Item	Basal area (ft^2/acre)			Number of trees/acre		
	Initial	Designated cut	Residual	Initial	Designated cut	Residual
			PLOT 1			
Saplings	8.9	8.9	0	149	149	0
Poletimber	65.7	43.2	22.5	281	208	72
Sawtimber	73.3	18.9	54.4	87	27	61
Total	149.9	71.0	76.9	517	384	133
			PLOT 2			
Saplings	12.5	12.5	0	166	166	0
Poletimber	53.7	41.2	12.5	201	170	31
Sawtimber	85.0	21.2	63.7	114	34	80
Total	151.2	75.0	76.2	481	370	111

PROCEDURE

The residual crop trees were marked to provide the desired crop-tree spacing and stand density. The marking designated a residual stocking of 76.9 ft^2/acre on Plot 1 and 76.2 ft^2/acre on Plot 2.

The thinning on Plot 1 favored the faster growing, less tolerant, and more valuable cherry and ash. Thinning on Plot 2 eliminated the low-value, disease-prone birch, favoring the cherry and cucumbertree, which were dominant or codominate.

All trees designated for removal that were 5.5 inches in dbh or larger were felled, topped to a 4-inch minimum diameter inside bark (dib), and skidded, tree length, to a central landing for each plot.

Each stem was bucked into the longest straight or nearly straight pieces from 4 to 16 feet long as follows: **sawlogs:** pieces at least 8 inches in diameter by 8 feet long that would meet the U.S. Forest Service grade requirements for standard sawlogs (Rast et al. 1973); **sawbolts:** pieces at least 6 inches in diameter by 4 feet long, and straight enough to yield at least one sound square-edge 4- by 4-inch cant (National Hardwood Lumber Association 1974); **pulpwood:** pieces 4 to 5.6 inches in diameter by 5 feet long, and larger diameter pieces that were not straight or sound enough to yield a sawbolt; **firewood:** pieces too short for pulpwood or sawbolts.

Sawbolts were further divided as follows: **furniture round bolts:** pieces 4 feet long by 7.5 inches or larger in diameter and free of unsound defects; **pallet bolts:** all other 4-foot sawbolts; **furniture dimension bolts:** sound 6-foot-long bolts 7.5 inches or larger in diameter; **sawmill bolts:** all bolts 5 to 8 feet long exclusive of the furniture dimension bolts; **poles:** pieces 8 feet long or longer but less than 8 inches in diameter.

Sawlogs, sawbolts, pulpwood, and firewood were weighed and tallied separately. Cubic-foot volume and board-foot content were determined for each sawlog and sawbolt. All sawlogs and sawbolts were converted into the appropriate primary products for existing markets. Pulpwood and firewood were delivered to local markets.

YIELDS

Of the 71 ft^2/acre of basal area available for removal on Plot 1, 51 ft^2 were removed. Of the 75 ft^2/acre of basal area available on Plot 2, 55 ft^2 were removed. The remaining basal area on both the plots was in trees less than 5.5 inches in dbh; these trees did not meet current merchantability standards.

Biomass

The green weight of the above-ground portion of various stand components was estimated using whole-tree weight equations developed by Wartluft (1977). The results indicated that there were 69.2 tons of wood fiber available from each acre thinned; included were 17.9 tons of roundwood pulpwood, 16.5 tons of sawable logs and bolts, and 34.8 tons of fiber such as whole-tree chips or fuel-wood (Tables 3 and 4).

The available biomass that was not removed

Table 3.—Roundwood yields for two study plots, in board feet, cubic feet, and tons per acre

Item	Plot 1			Plot 2			Average		
	Weight (tons)	Volume fbm[a]	Volume ft³	Weight (tons)	Volume fbm[a]	Volume ft³	Weight (tons)	Volume fbm[a]	Volume ft³
Firewood	1.1	—	39.6	1.5	—	49.5	1.3	—	44.4
Pulpwood	15.4	—	572.5	20.6	—	686.7	17.9	—	628.1
Pallet bolts	6.1	804	201.9	5.9	857	187.1	6.0	830	194.7
Furniture round bolts	.4	97	16.4	.9	193	35.3	.6	144	25.6
Furniture dimension bolts	1.0	195	37.8	.8	141	26.2	.9	169	32.2
5- to 8-foot bolts	5.5	890	204.3	3.4	605	128.1	4.5	751	167.2
Poles	.8	120	30.1	1.0	170	37.3	1.0	144	33.6
Grade 2 sawlogs	.5	96	16.6	.6	131	20.4	.5	113	18.5
Grade 3 sawlogs	2.0	423	75.7	4.2	861	157.9	3.0	636	115.7
Total	32.8	2,625	1,194.9	38.9	2,958	1,328.5	35.7	2,787	1,260.0

[a] International 1/4-inch log scale.

Table 4.—Above ground green weight of individual stand components, tons per acre

Stand component	Plot 1	Plot 2	Average
Initial stand	153.3	158.8	156.0
Designated residual trees	86.4	87.1	86.7
Trees available for removal	66.9	71.7	69.2
Products actually removed	32.8	38.9	35.7
Remaining available biomass; trees <5.5 inches in dbh and residue from cut trees	34.1	32.8	33.5
Remaining material available for removal in pieces >3.0 inches in dob	18.0	16.4	17.2

consisted of trees less than 5.5 inches in dbh that were not harvested, and the tops and limbs of trees that were cut. We estimated that the remaining available biomass in pieces larger than 3 inches in diameter outside bark (dob) made up approximately 17 tons per acre. This material is suitable for solid fuelwood (Table 4).

Roundwood

The average combined per acre yield for the two plots was:

Item	*Tons*	*Cubic feet*
Pulpwood	17.9	628.1
Sawbolts (4 feet)	6.6	220.3
Sawbolts (5 to 8 feet)	5.4	199.4
Sawlogs and poles	4.5	167.8
Firewood	1.3	44.4
Total	35.7	1,260.0

See Table 3 for individual plot yields and subclassifications.

Bolts that were 4 feet long accounted for 41.3 percent of the sawable volume from Plot 1 and 37.5 percent on Plot 2. Nearly 90 percent of the bolt and log volume on both plots was in pieces with a scaling diameter of 10 inches or less (Table 5).

Sawed products

The yield of sawable wood averaged 2,787 board feet per acre (International 1/4-inch log scale), from which 3,695 board feet of sawn products was produced as follows: 1,344 board feet of pallet parts and 76 board feet of furniture rounds from the 4-foot bolts; 1,216 board feet of cants and lumber from the 4- to 8-foot sawmill bolts; and 1,059 board feet of cants and lumber from

Table 5.—Distribution of sawable cubic foot volume by diameter and length class, in percent

Length (feet)	Diameter (inches)													Total
	6	7	8	9	10	11	12	13	14	15	16	17	18	
						PLOT 1								
4	13.9	12.8	6.8	4.4	2.4	0.9	—	0.1	—	—	—	—	—	41.3
5	5.1	3.1	2.9	.8	1.2	—	.6	.3	—	—	—	.3	—	14.3
6	3.1	3.6	4.6	3.3	1.8	1.1	1.2	—	—	—	—	—	.4	19.0
7	1.0	1.3	1.0	.7	.3	—	.3	—	.3	—	—	—	—	4.9
8	2.2	2.7	3.5	2.1	2.5	1.7	.5	.3	1.5	1.0	—	1.4	1.0	20.5
Total	25.4	23.5	18.8	11.3	8.2	3.7	2.6	0.7	1.8	1.0	0.0	1.7	1.4	100.0
						PLOT 2								
4	5.3	10.6	9.1	6.2	4.4	1.4	.3	.1	.1	—	—	—	—	37.5
6	5.0	7.5	5.6	4.1	2.4	1.3	.2	.2	—	—	—	—	—	26.3
8	1.9	4.2	5.5	7.7	3.9	2.9	.4	—	—	—	—	—	—	26.5
10	.1	.8	.4	.5	.9	.6	.3	—	—	—	—	—	—	3.6
12	.5	1.1	1.1	1.1	.5	—	—	—	—	.5	0.6	—	.7	6.1
Total	12.8	24.2	21.7	19.6	12.1	6.2	1.2	0.3	0.1	0.5	0.6	0.0	0.7	100.0

Table 6.—Sawn-product yields, in board feet per acre

Item	Plot 1		Plot 2		Average	
	Input[a]	Yield[b]	Input[a]	Yield[b]	Input[a]	Yield[b]
Pallet bolts	804	1,402	857	1,284	830	1,344
Furniture round bolts	97	43	193	110	144	76
4- to 8-foot sawbolts	890	1,217	605	782	751	1,005
Furniture dimension bolts	195	249	141	172	169	211
Poles	120	181	170	211	144	196
Sawlogs	519	562	992	1,180	749	863
Total	2,625	3,654	2,957	3,739	2,787	3,695

[a] International 1/4-inch log scale.
[b] Lumber scale.

poles and sawlogs. Individual plot yields are given in Table 6.

Sawable yields and tree species

On both plots, most of the trees available for removal were red or sugar maple. However, the small average diameter of the maples on these plots limited the yield of sawable products. Few cherry and cucumbertrees were cut, but these species produced relatively high yields of sawable products because of their size. On Plot 1, black cherry yielded 30 percent of the sawable volume from 8 percent of the trees cut. On Plot 2, cucumbertree and cherry provided 73.8 percent of the sawable volume from 19.7 percent of the trees cut (Table 7).

Differences in diameter, sweep , and crook also affected the length of sawable pieces harvested from various tree species. Cucumbertree and sugar maple produced the lowest proportion of 4- and 5-foot bolts (13.2 percent and 32.4 percent of the sawable volumes, respectively). Ash and beech had the highest proportion of short pieces; more

Table 7.—Proportion of cubic foot volume in sawable logs and bolts, by species

Tree species	Plot 1	Plot 2	Plots 1 and 2 combined
		-Percent-	
Black cherry	30.0	54.7	40.0
Red maple	26.9	9.0	16.7
Sugar maple	26.0	4.6	20.5
Cucumber-tree	2.5	19.1	10.2
Magnolia	.6	2.3	1.4
Beech	7.7	—	3.5
Black birch	.7	9.0	4.6
White ash	5.0	1.3	2.9
Miscellaneous	.6	—	.2

Table 8.—Values per acre for roundwood products delivered to the nearest markets

Item	Amount	Value per unit	Total value
	PLOT 1	*-Dollars-*	
Firewood	0.4 cords	75.00	30.00
Pulpwood	15.4 tons	8.75	134.75
Pallet bolts	2.5 cords	35.00	87.50
Furniture rounds	0.060 M fbm Doyle	250.00	15.00
4- to 8-foot sawbolts	0.476 M fbm Doyle	50.00	23.80
Poles	0.042 M fbm Doyle	40.00	1.66
Grade 3 sawlogs	0.271 M fbm Doyle	50.00	13.55
Grade 2 sawlogs	0.076 M fbm Doyle	75.00	5.70
			311.96[a]
	PLOT 2		
Firewood	0.6 cords	75.00[c]	45.00
Pulpwood	20.6 tons	8.75	180.25
Pallet bolts	2.5 cords	35.00	87.50
Furniture rounds	0.128 M fbm Doyle	250.00	32.00
4- to 8-foot sawbolts	0.344 M fbm Doyle	50.00	17.20
Poles	0.068 M fbm Doyle	40.00	2.72
Grade 3 sawlogs	0.494 M fbm Doyle	50.00	24.70
Grade 2 sawlogs	0.097 M fbm Doyle	75.00	7.28
			396.65[b]

[a] Additional 34.1 tons fiber available @ $10/ton = $341.00/acre.

[b] Additional 32.8 tons fiber available @ $10/ton = $328.00/acre.

[c] Limited market available at this value ($25.00 per face cord for 16 inch wood).

than 75 percent of the sawable volume was in 4- and 5-foot bolts. Cucumbertree and black cherry yielded the highest proportion of sawable volume in bolts and logs 8 feet long or longer (61.4 percent and 31 percent, respectively).

VALUES

The product values represent the gross value of various products delivered as raw material to wood processors (Table 8). These values provide a realistic estimate of the value of the products actually obtained from the two thinned plots. The total value does not necessarily represent the maximum value that could have been obtained, because the stems were bucked into the longest straight or nearly straight pieces without regard for product value. For example, the Grade 3 sawlogs valued at $50 per thousand board feet would have been more valuable had they been bucked into 4-foot pallet bolts at $35 per cord, the equivalent of $70 per thousand board feet.

To harvest thinning material on a commercial basis, the delivered value of products must be more than the cost of logging and transportation. Although thinning cost data are limited, a recent study estimated the cost of producing whole-tree chips and sawlogs from thinnings in northern hardwood poletimber stands (Biltonen et al. 1976). Stands were thinned with a feller-buncher and a grapple skidder. Sawlogs were bucked out and the remaining material was chipped on the site with a whole-tree chipper; the total cost of logging, chipping, and transportation was $8.78 per ton. To buck out and sort a variety of products would require an extra chain saw operator as well as a small forklift to sort and pile bolts and logs. These additions would boost the cost per ton to approximately $9.50.

The average value of products obtained from the two plots was $9.85 per ton. If all available biomass, with the exception of the sawable logs and bolts, had been processed into whole-tree chips $10 per ton, the average value of products would equal $10.65 per ton. This amount exceeds the estimated cost of logging and transportation.

UTILIZATION

Because of current wood markets and prices, opportunities for commercial utilization of thinnings will depend primarily on the proportion of thinned wood that will yield products with higher values than pulpwood or chips. Although thinnings from the study plots yielded only 749 board feet per acre of sawlogs, the total yield of sawable wood averaged 2,787 board feet per acre (International 1/4-inch log scale). This figure represents 16.5 tons or 46.2 percent of the gross tonnage of wood removed.

Except for bolts suitable for furniture rounds (which comprised only 2.8 percent of sawable wood weight), the value per ton for pallet bolts exceeded that for all other roundwood products. So it seems that the opportunity to use thinnings from Middle Mountain would require the trees to be converted into two roundwood products: pulpwood and pallet bolts (except for a small percentage of pieces larger than 12 inches small end diameters). The approximate average value of roundwood would be $11.39 per ton or $406.96 per acre. Broken down by product, the average values would be:

Product	*Value per ton*	*Tons per acre*	*Value per acre*
Pulpwood	$ 8.75	17.9	$156.62
Pallet bolts	14.58	16.0	233.28
Other	9.48	1.8	17.06

CONCLUSION

Thinning two overstocked poletimber-small sawtimber stands of Allegheny hardwoods yielded nearly 3,700 board feet of sawn products, and more than 19 tons of pulpwood and fiber per acre. However, most of this material was derived from small logs and trees. Less than 25 percent of the sawn products came from sawlogs; most of it was produced from bolts 8 inches or less in diameter, and 6 feet or less in length.

If 5,000 acres of Middle Mountain poletimber stands were thinned each year over the next 10 years, 895,000 tons of pulpwood and approxi-

mately 140 million board feet (International 1/4-inch scale) of pallet bolts would be available from thinnings 5.5 inches in dbh or larger. An additional 1,705,000 tons of whole-tree chips could be manufactured from thinned trees less than 5.5 inches in dbh, and tops from trees greater than 5.5 inches in dbh.

We are now determining potential product yields from thinnings in northern hardwood, oak-hickory, and yellow-poplar stands to predict product potential (for a variety of products) for thinning the major timber types in the region.

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