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Residual Stocking not Seriously Reduced by Logging Damage from Thinning of West Virginia Cherry-Maple Stands

Neil I. Lamson
H. Clay Smith
Gary W. Miller

Abstract

In north-central West Virginia, unmanaged 60-year-old cherry-maple stands were thinned to 75, 60, and 45 percent residual stocking. Cut trees were skidded tree length by a rubber-tired skidder. Logging destroyed or severely bent over 22, 23, and 45 percent of the unmarked stems in the 75, 60, and 45 percent stocked plots. Because 99 percent of the destroyed and bent trees were less than 5.0 inches dbh, the effect on basal area and residual stocking was slight. Damage reduced the stocking by 5, 8, and 8 percent in the 75, 60, and 45 percent plots. For the 75, 60, and 45 percent plots, 18, 38, and 42 percent of the residual stems received wounds that exposed sapwood. Study results indicate that marking guidelines for trees larger than 5.0 inches dbh do not need to be adjusted to account for logging damage.

The Authors

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

H. Clay Smith is project leader in timber management research at the Northeastern Forest Experiment Station's laboratory at Parsons, West Virginia. He received a B.S. degree from West Virginia University and a M.S. degree from Purdue University. He has been working for the U.S. Forest Service since 1962.

Gary W. Miller, economist, attended the University of Pittsburgh and West Virginia University, where he received a B.S.F. and M.S.F. in forest resources management. Since 1981, he has conducted research in timber management at the Timber and Watershed Laboratory in Parsons, West Virginia.

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Introduction

Each time the forest is cut, some residual trees are damaged. Damage may include complete destruction of a potential crop tree, broken branches, or exposed sapwood. An important question in thinning even-aged stands is: Should an allowance be made in marking for logging damage to residual stems? This paper reports on damage to residual trees resulting from thinning even-aged cherry-maple (*Prunus serotina* Ehrh.-*Acer rubrum* L.) stands in West Virginia to three levels of residual stocking with a rubber-tired skidder.

The Study Area

The study area is located on Middle Mountain in the Monongahela National Forest in north central West Virginia. Treated stands were previously unmanaged even-aged cherry-maple stands about 60 years old. In trees at least 1.0 inch in dbh, the stands averaged 881 trees per acre, with a basal area of 165 ft^2 per acre, a cubic foot volume of 2,854 ft^3 per acre for trees at least 5.0 inches in dbh, and a board foot volume (International) of 7,314 fbm per acre for trees at least 11.0 inches in dbh. The study area is representative of about 125,000 acres of commercial forest land in the area and resembles the Allegheny hardwood forests of northwestern Pennsylvania. The terrain of the study area was nearly flat.

Data

As part of a large study to test the applicability of the Allegheny hardwoods stocking guide (Roach 1977) in this region, 2-acre plots were thinned to 75, 60, and 45 percent residual stocking. Twelve plots, 4 thinned to each level, were included in this portion of the study. Within each 2-acre plot, an observation plot of ½ acre was installed. After the 2-acre plots were marked for thinning, all residual trees at least 1.0 inch in dbh on the observation plots were permanently identified. Each tree was carefully examined for wounds resulting from natural causes before logging. Species, diameter, and crown class of each residual tree were also recorded before logging.

The plots were logged by a three-man crew using chain saws and a rubber-tired skidder. One man felled and topped trees to a 6-inch dib while the other two skidded tree-length logs to the decking area. Trees 3.6 inches dbh and larger were marked; however, those less than 7.0 inches dbh were cut but not skidded from the plots. Up to nine chokers were used per hitch with the skidder permitted to run throughout the plot. Trees from one 2-acre plot were not skidded through other plots. Felling and skidding started at the back of each plot and proceeded toward the main skid road or deck. Trees were directionally felled whenever possible, although the dense stands and level terrain made it impossible to fell all of the trees directionally.

Results

All logging operations were done in the spring of the year when the bark was slipping and logging damage to residual trees could be expected to be greatest. After logging, each residual tree on the observation plots was carefully examined for logging injuries. Four types of injuries were noted: 1) completely destroyed (Figures 1, 2, and 3); 2) bent over or severely leaning; 3) exposed sapwood; 4) broken tops. The length and width of each wound that exposed sapwood were measured.

Two types of damage, destroyed trees and bent or severely leaning trees, reduced the number of residual trees and lowered the residual stand stocking below the desired level. In the following discussions, these types of damage are expressed as a percentage of the unmarked portion of the stand. Conversely, damage involving exposed sapwood and broken tops affected only the quality of the residual trees and did not affect stand stocking. These types of damage are expressed as a percentage of the net residual stand—the unmarked stand minus destroyed and bent or severely leaning stems.

Figure 1.—Saplings destroyed during skidding.

Figure 2.—Saplings bent over during skidding.

Figure 3.—Exposed sapwood wound.

Destroyed

For the 75, 60, and 45 percent residual stocking plots, 11, 22, and 30 percent of the unmarked trees were destroyed by logging. Because most of the destroyed trees (99 percent) were less than 5.0 inches dbh, residual basal area was not seriously reduced. Only 2, 4, and 5 percent of the unmarked basal area was destroyed by logging in the 75, 60, and 45 percent stocked plots (Tables 1, 2, 3), resulting in plots with an actual stocking of 69, 53, and 37 percent after logging.

Bent Over or Leaning

For the 75, 60, and 45 percent stocking levels, a total of 72, 64, and 70 stems per acre were bent over or left leaning by logging. Ninety-nine percent of these trees were less than 5.0 inches dbh. This form of damage amounted to 12 percent of the unmarked stems and about 2 percent of the unmarked basal area (Tables 1, 2, and 3). Although these injuries did not kill the trees, such trees often die soon from snow and ice damage.

Exposed Sapwood

In the plots with 75 percent residual stocking, 18 percent of the residual stems comprising 25 percent of the residual basal area had damage that exposed sapwood (Table 1). In the plots with 60 percent residual stocking, 38 percent of the residual stems comprising 43 percent of the residual basal area had exposed sapwood (Table 2). Sapwood damage was most severe in the 45-percent-residual-stocking plots. Forty-two percent of the residual stems comprising 56 percent of the basal area had exposed sapwood in the heavy thinning treatment (Table 3). Thus, there was a direct relation between exposed sapwood and intensity of thinning: as the number of stems and basal area removed increased, sapwood was exposed on more trees.

Table 1.—Summary of logging damage in plots thinned to 75 percent residual stocking.

	Stems per acre, by dbh class				Basal area per acre (ft²), by dbh class				Percent stocking
	1.0–4.9 in	5.0–10.9 in	11+ in	Total	1.0–4.9 in	5.0–10.9 in	11+ in	Total	
Initial stand	602	266	55	923	22.0	87.2	54.0	163.2	111
Marked cut	120	135	7	262	11.9	35.8	5.7	53.4	
Unmarked stand[a]	482	131	48	661	10.1	51.4	48.3	109.8	74
Bent over or leaning	71	1	0	72	1.5	0.1	0	1.6	
Destroyed	74	1	0	75	1.5	0.3	0	1.8	
Net residual stand[b]	337	129	48	514	7.1	51.0	48.3	106.4	69
Exposed sapwood	47	30	14	91	1.3	12.4	12.4	26.1	
Broken top	15	0	0	15	0.3	0	0	0.3	

[a]Unmarked stand = initial stand − marked cut.
[b]Net residual stand = unmarked stand − (destroyed + bent over or leaning).

Table 2.—Summary of logging damage in plots thinned to 60 percent residual stocking.

	Stems per acre, by dbh class				Basal area per acre (ft²), by dbh class				Percent stocking
	1.0–4.9 in	5.0–10.9 in	11+ in	Total	1.0–4.9 in	5.0–10.9 in	11+ in	Total	
Initial stand	552	298	55	905	22.2	99.4	46.9	168.5	115
Marked cut	130	200	13	343	12.0	58.6	10.1	80.7	
Unmarked stand[a]	422	98	42	562	10.2	40.8	36.8	87.8	61
Bent over or leaning	63	1	0	64	1.4	0.2	0	1.6	
Destroyed	119	2	1	122	2.5	0.7	0.4	3.6	
Net residual stand[b]	240	95	41	376	6.3	39.9	36.4	82.6	53
Exposed sapwood	79	45	17	141	1.7	19.1	14.7	35.5	
Broken top	38	0	1	39	0.4	0	0.4	0.8	

[a]Unmarked stand = initial stand − marked cut.
[b]Net residual stand = unmarked stand − (destroyed + bent over or leaning).

Table 3.—Summary of logging damage in plots thinned to 45 percent residual stocking.

	Stems per acre, by dbh class				Basal area per acre (ft²), by dbh class				Percent stocking
	1.0–4.9 in	5.0–10.9 in	11+ in	Total	1.0–4.9 in	5.0–10.9 in	11+ in	Total	
Initial stand	489	275	63	826	19.5	93.0	53.4	166	107
Marked cut	106	229	22	357	10.2	72.3	17.2	99.7	
Unmarked stand[a]	383	46	41	469	9.3	20.7	36.2	66.3	45
Bent over or leaning	69	1	0	70	1.4	0.1	0	1.5	
Destroyed	140	1	0	141	3.2	0.4	0	3.6	
Net residual stand[b]	174	44	41	258	4.7	20.2	36.2	61.2	37
Exposed sapwood	61	21	27	109	1.9	10.0	22.3	34.2	
Broken top	21	1	1	23	0.5	0.4	1.3	2.2	

[a]Unmarked stand = initial stand − marked cut.
[b]Net residual stand = unmarked stand − (destroyed + bent over or leaning).

An important factor in sapwood damage is the size of the wounded tree. In this study, the percentage of residual trees with exposed sapwood increased with heavier thinning. The distribution of sapwood damage among size classes, however, remained about the same in each treatment. About 55 percent of the wounded trees were less than 5.0 inches dbh and 83 percent were less than 11.0 inches dbh.

Broken Tops

A few residual trees suffered broken tops during logging (Tables 1, 2, and 3). The most damage occurred in the heavily thinned plots (45 percent residual stocking), where 9 percent of the residual trees sustained broken tops. In the plots with 60 percent and 75 percent residual stocking, 10 percent and 3 percent of residual trees, respectively, sustained broken tops. Nearly all trees (96 percent) with this type of injury were less than 5.0 inches dbh, so a very small portion of the residual basal area was affected by top damage.

Effect on Residual Stand Stocking

The stands were marked according to the Allegheny hardwoods stocking guide (Roach 1977) with no allowance for logging damage to the residual stand. Trees that were bent over were included with destroyed trees in calculating the stocking of the residual stand (Tables 1, 2, and 3). Residual stand stocking was reduced 5, 8, and 8 percent by logging damage in the 75, 60, and 45 percent residual stocking areas, respectively (Tables 1, 2, and 3). About 99 percent of the destroyed or bent over trees were less than 5.0 inches dbh.

Discussion

The results of this study are about the same as those of other studies of logging damage in upland hardwood even-aged and uneven-aged stands. In partial cuts made with a rubber-tired skidder or crawler tractor with a rubber-tired arch skidding tree-length logs, seriously injured or destroyed trees amounted to less than 10 percent of the residual basal area in the stand. This damage was concentrated in the sapling size class (Weitzman and Holcomb 1952, Herrick and Deitschman 1956; Nyland and Gabriel 1972).

The thinning treatment currently recommended[1] for these stands is to reduce the residual stand stocking to about 60 percent. In stands with 20 or more square feet of basal area in trees 1 to 5 inches dbh, it is further recommended that sapling basal area be reduced to less than 10 ft^2 per acre. If thinned to 60 percent residual stocking, about 35 to 40 percent of the residual stems will receive injuries that result in exposed sapwood. Over half of the wounded trees will be less than 5.0 inches in dbh.

[1]Allegheny hardwoods silviculture training course. Northeastern Forest Experiment Station, Forestry Sciences Laboratory, Warren, PA.

Size of exposed sapwood wounds is an important factor. Research has shown that wounds with over 100 in^2 of exposed sapwood are likely to develop decay (Hesterberg 1957; Lavallee and Lortie 1968). Lamson and Miller (1983) found that in these same stands logged with the wheeled skidder, about 7, 13, and 22 percent of the residual dominant and codominant stems had exposed sapwood wounds of at least 100 in^2 in plots with 75, 60, and 45 percent residual stocking, respectively. In other words, it appears that most of the sapwood wounds on potential crop trees are small enough to heal with little danger of sapwood decay. Also, many of the trees with large sapwood wounds can be removed in future thinnings.

When trees bent over or leaning are combined with destroyed trees in the plots with 60 percent residual stocking, the total damage accounts for only about 6 percent of the basal area. Residual stand stocking was reduced 8 percent by this type of damage. Because most of the losses occurred in trees less than 5.0 inches in dbh, competition for light among dominant, codominant, and intermediate trees was not influenced by logging damage.

Conclusions

From this study, the following conclusions can be stated about thinning 60-year-old cherry-maple stands in northern West Virginia.

1. At three thinning levels, providing 75, 60, and 45 percent residual stocking, logging damage was concentrated in trees less than 5.0 inches dbh.
2. At 60 percent residual stocking:
   a. Logging injuries that result in exposed sapwood were found on 38 percent of the residual trees and about 88 percent of these injured trees were less than 11.0 inches dbh.
   b. Logging damage that resulted in destroyed or bent over trees reduced the stocking only about 8 percent.

Recommendations

1. In stands with less than 20 ft^2 of basal area per acre in trees less than 5.0 inches dbh, marking guidelines do not need to be adjusted to account for logging damage.
2. In stands with more than 20 ft^2 of basal area per acre in trees less than 5.0 inches dbh, reduce the marked cut in saplings by 5 to 10 stocking percentage points to account for logging damage.
3. Marking guidelines for trees over 5.0 inches dbh do not need to be adjusted to account for logging damage.

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