LOGGING DAMAGE TO DOMINANT AND CODOMINANT RESIDUAL STEMS IN THINNED WEST VIRGINIA CHERRY-MAPLE STANDS

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Abstract. Previously unmanaged 60-year-old, even-aged stands of cherry-maple in West Virginia were thinned using the Allegheny hardwoods stocking guide. A marked cut was computed for 75, 60, and 45 percent of full stocking; no trees smaller than 17.8 cm dbh were marked for commercial removal. Thinning was done with either a truck-mounted crane or a rubber-tired skidder. In stands thinned with the truck-mounted crane, 4, 2, and 5 percent of the residual dominant and codominant trees (17.8 cm dbh plus) were seriously abraded (with 650 cm^2 or more of exposed sapwood) in the 75, 60, and 45 percent treatments, respectively. In thinning with the skidder, 7, 13, and 22 percent of the residual dominant and codominant trees were seriously abraded in the 75, 60, and 45 percent treatments, respectively.

Keywords: Logging damage, thinning, *Prunus serotina* Ehrh., *Acer rubrum* L.

INTRODUCTION

Each time the forest is cut, some residual trees are usually damaged. Damage may be complete destruction of a potential crop tree or limited to broken branches or a small area of exposed sapwood. An important question in thinning even-aged stands is: Should an allowance be made for logging damage to dominant and codominant residual stems when marking the stand? This paper reports damage to dominant and codominant 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 using either a wheeled-skidder or truck-mounted crane.

Surface area of exposed sapwood seems to be a good indicator of the potential for decay. In a study of sugar maple (*Acer saccharum* Marsh.) in the Lake States 20 years after logging with a crawler tractor, Hesterberg (1975) found that sapwood-exposed wounds up to 10.2 cm wide resulted in minor decay. The amount of decay increased with increased width of the wound. In trees with wounds 25.4 cm or wider, he concluded that after 20 years defect deduction in large trees amounted to about 0.12 cubic meters, while small trees were often culled because of decay. Hesterberg also observed that about 50 percent of the trees with stem wounds exceeding 970 cm^2 of exposed sapwood developed decay within 10 years. In studying yellow birch (*Betula alleghaniensis* Britton) in the Lake States, Lavallee and Lortie (1968)

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usually found decay associated with 20-year-old wounds where at least 580 cm^2 of wood surface were exposed. Using tree length skidding data from Nyland et al. (1976), Wendel and Kochenderfer (1978) estimated that 20 to 30 percent of the residual trees larger than 15.2 to 20.3 cm were damaged when using wheeled-skidders. Kochenderfer and Wendel (1980) also evaluated a truck-mounted crane used to yard an average of 56 cubic meters per hectare from a second-growth, central Appalachian hardwood stand. About 3 percent of all stems over 12.7 cm dbh (total of 111 trees per hectare) had exposed sapwood.

THE STUDY AREA

The study area was located in the Middle Mountain area of the Monongahela National Forest in West Virginia. Treated stands were previously unmanaged, even-aged cherry-maple stands about 60 years old. The study area is representative of about 30,000 hectares of commercial forest in north central West Virginia and resembles the Allegheny hardwood forests of northwestern Pennsylvania.

DATA

Data for this study came from a large thinning study used to test the applicability of the Allegheny hardwoods stocking guide in these West Virginia cherry-maple stands (Roach 1977). In the main thinning study, 0.8-hectare treatment areas with 0.2-hectare measurement plots located within the individual treatment areas were evaluated. All trees 2.5 cm dbh and larger within the 0.2-hectare measurement plots were permanently tagged and measured. Before logging, each tree within the 0.2-hectare area that was not marked for cutting was examined closely. Species, dbh, crown class, and stem-condition remarks were recorded.

The marked cut for each 0.8-hectare treatment plot was calculated according to the Allegheny hardwoods stocking guide. Because 17.8 cm dbh is the commercial size limit in this locale, only trees at least 17.8 cm dbh were marked for commercial removal. Trees smaller than 17.8 cm dbh were not marked for removal even though they were used in computing the marked cut.

The Allegheny hardwoods stocking guide recommends thinning immature cherry-maple stands to the B-line or 60 percent residual stocking. To bracket this recommended level, the plots were randomly thinned to three levels of percent stocking--75, 60, and 45. A total of 12 plots, 4 in each thinning level were included in this study.

After logging, all plots were reinventoried. All unmarked residual trees were accounted for and carefully examined to disclose the extent of logging damage. The length and width of exposed sapwood were evaluated to determine damage. Other types of logging damage were minimal and will not be discussed here. Any tree that had exposed sapwood was tallied as an abraded tree. In this study, all abraded trees with more than 650 cm^2 of exposed sapwood were classed as high-risk, sapwood-exposed trees. Abraded trees with less than 650 cm^2 of exposed sapwood were classed as low-risk, sapwood-exposed trees.

In the fall of 1981, two plots at each of three levels of residual stocking were thinned using a truck-mounted crane. In the spring of 1982, again two plots at each of three thinning levels were thinned using a rubber-tired skidder. The plots thinned using the truck-mounted crane were on a 5 to 10 percent slope, while the skidder-thinned plots were on a relatively flat terrain. For the truck-mounted crane, 1.0 cm cable with two or three sliding chokers was used. With the skidder, a maximum of nine chokers was used for one load, and the skidder operator was permitted to run throughout a plot. For all plots, felling and skidding started in the back of each plot and worked toward the road or log deck. Log length was not limited and in most instances, trees were skidded tree length with trees topped for a minimum of 10.2 cm diameter inside bark. Our results refer to the logging damage to residual dominant and codominant trees on these 12 plots.

RESULTS

Trees Marked for Cut

Only trees at least 17.8 cm dbh were marked to be removed by logging. An average of 138, 259, and 324 stems per hectare were cut in the 75, 60, and 45 percent plots, respectively (Table 1). This represented 8, 12, and 17 percent of all stems at least 2.5 cm dbh, respectively. Basal area per hectare in trees marked for cut averaged 6, 12, and 16 m^2 for the 75, 60, and 45 percent plots. This was about 16, 33, and 43 percent of the basal area in trees at least 2.5 cm dbh, respectively.

Table 1. Stand characteristics of thinned plots at 75, 60, and 45 percent of residual stocking.

Logging equipment	Number stems per hectare			Basal area per hectare		
	Initial[1/]	Cut[2/]	Residual	Initial[1/]	Cut[2/]	Residual
				--------m^2---		
	75 PERCENT RESIDUAL STOCKING					
Truck crane	1,505	175	1,330	38.8	7.6	31.2
Skidder	1,945	101	1,844	37.2	5.1	32.1
All plots	1,725	138	1,587	38.0	6.3	31.7
Percent	100	8	92	100.0	16.0	84.0
	60 PERCENT RESIDUAL STOCKING					
Truck crane	1,804	257	1,547	34.9	13.3	21.6
Skidder	2,362	262	2,100	37.9	10.6	27.3
All plots	2,083	259	1,824	36.4	11.9	24.5
Percent	100	12	88	100.0	33.0	67.0
	45 PERCENT RESIDUAL STOCKING					
Truck crane	1,947	287	1,660	36.3	16.1	20.2
Skidder	1,947	361	1,586	38.3	16.1	22.2
All plots	1,947	324	1,623	37.3	16.1	21.2
Percent	100	17	83	100.0	43.0	57.0

1/ 2.5 cm dbh and larger.
2/ 17.0 cm dbh and larger.

Stand Damage

Destroyed trees

Before cutting, 9,350 trees at least 2.5 cm dbh were inventoried on the 12 measurement plots. Of these, only 946 (10 percent) were accidentally destroyed during the logging operations. All of these destroyed trees were smaller than 17.8 cm dbh and overtopped or intermediate in crown class. Although the loss of the destroyed trees reduced the residual stand stocking by about 2 percent, the loss probably will not significantly effect the growth of the residual dominant and codominant trees.

Abraded dominant and codominant trees

The dominant and codominant residual trees are the most important component of these thinned 60-year-old, even-aged stands. None of these trees were accidentally cut or destroyed during logging. However, felling and skidding wounded a number of the dominant and codominant residual stems resulting in exposed sapwood.

75 percent residual stocking. In the 75 percent residual stocking plots logged with a truck-mounted crane, 284 of 346 residual dominant and codominant stems per hectare were not abraded (Table 2). Of the 62 abraded trees per hectare, only 12 were classed as high-risk, sapwood-exposed trees.

Table 2. Number of dominant and codominant residual stems per hectare damaged using either a truck-mounted crane or skidder for three levels of thinning.

Stocking level	Residual	Damaged (sapwood exposed)	High-risk damage(≥650 cm sapwood exposed)	Percent of residuals high-risk
		TRUCK-MOUNTED CRANE		
75	346	62	12	4
60	250	64	5	2
45	156	77	7	5
		SKIDDER		
75	267	72	20	7
60	250	84	32	13
45	200	101	44	22

Of the 267 dominant and codominant residual trees per hectare, 72 (27 percent) were abraded during logging operations by the skidder (Table 2). Of these, only 20 per hectare (7 percent) were classed as high-risk, sapwood-exposed trees.

60 percent residual stocking. In the 60 percent residual stocking plots logged with the truck-mounted crane, 64 of 250 residual dominant and codominant trees per hectare were abraded (Table 2). Of these 64 per hectare, only 5 per hectare were classed as high-risk, sapwood-exposed trees.

For the same thinning level, logging with the skidder abraded 84 of the 250 residual dominant and codominant trees per hectare. Of these 84 abraded trees per hectare, 32 per hectare (13 percent) were classed as high-risk, sapwood-exposed trees.

45 percent residual stocking. In the 45 percent residual stocking plots, logging with the truck-mounted crane abraded 49 percent (77 of 156 per hectare) of the residual dominant and codominant trees (Table 2). However, only 7 per hectare (5 percent) were classed as high-risk, sapwood-exposed trees.

Logging with the skidder abraded 101 of 200 residual dominant and codominant trees per hectare (51 percent). Of these 101 abraded trees per hectare, 44 per hectare (22 percent) were classed as high-risk, sapwood-exposed trees.

DISCUSSION

The number of damaged residual dominant and codominant trees with sapwood exposed increased as thinning intensity increased. This was because more trees were cut and skidded in the more heavily thinned stands.

Thinning with a rubber-tired skidder damaged more residual dominant and codominant stems than thinning with a truck-mounted crane. Not only were more residual stems damaged by using the skidder, but the damage was more serious, that is, more trees were classed as high-risk residuals. Residual stand damage was much greater on plots logged with the skidder, and damage was directly related to intensity of cutting. Residual stand damage when using the truck crane, however, was not related to thinning levels.

In our opinion, the time of the year of the thinning also influenced these results, but this variable was not tested. The plots thinned with the truck-mounted crane were thinned in the fall, while those thinned with the skidder were thinned in the spring when the bark was slipping. Also, the stands thinned with the truck crane were on a 5 to 10 percent slope, which permitted directional felling, thus facilitating skidding. Those plots thinned using the skidder were on nearly level terrain where trees could not be directionally felled and no dozed skid roads were used.

In terms of reduced damage to residual stems, the truck crane would be more favorable than the skidder on even steeper terrain. If road spacing was 75 meters or less, both increased lift and operator control of logs would have improved (Kochenderfer and Wendel 1980), thus reducing residual stand damage. Also, on steeper ground, greater than 30 percent, skidders are restricted to roads which occupy 10 percent of the logged areas (Kochenderfer 1977). So, if the slopes had been steep, stand damage using the skidder would have been equal to the 10 percent loss due to roads, plus damage to residual stems.

Moreover, in using the skidder two or three well-defined nonbulldozed skid trails developed in each plot. Damage was concentrated along these skid trails. The truck-mounted crane was moved frequently along a truck haul road above the plots, thus skid trails did not develop.

In the truck-mounted crane operation, 4, 2, and 5 percent of the residual dominant and codominant trees were classed as high-risk for the respective 75, 60, and 45 percent thinning treatments. However, in the plots thinned using the skidder, the portion of residual dominant and codominant trees classed as high risk was about 7, 13, and 22 percent of the number of stems for the 75, 60, and 45 percent of full stocking treatments, respectively. The plots thinned using the skidder in the spring of the year resulted in the maximum amount of residual stand damage that could be expected from any thinning operations. In the 60 percent plots, there were 247 residual dominant and codominant trees per hectare. As mentioned, only 32 per hectare (13 percent) were classed as high-risk trees likely to develop significant decay. The normal thinning schedule for these stands recommends a second thinning in 15 to 20 years, and it is likely that 49 to 62 dominant and codominant trees per hectare will need to be removed at that time to thin the stand to 60 percent of full stocking. If all the 32 high-risk trees per hectare were alive at the second thinning, they would naturally be among those trees removed. Therefore, it appears that high-risk damaged trees amount to about 60 percent of the anticipated cut during the second thinning.

CONCLUSIONS

Postlogging data indicate that when thinning previously unmanaged cherry-maple stands in West Virginia to 60 percent of full stocking using the Allegheny hardwoods stocking guide, it is not necessary to allow for damage to residual dominant and codominant trees when marking the stand.

Residual stand damage was much greater on plots logged with a wheeled skidder than on plots logged with a truck crane.

Residual stand damage using the truck crane was not related to intensity of cutting; rubber-tired skidder damage was related to intensity of cut.

LITERATURE CITED

Hesterberg, G. A. 1957. Deterioration of sugar maple following logging damage. U.S. Dep. Agric., Lake States For. Exp. Stn. Pap. 51. 58 p.

Kochenderfer, James N. 1977. Area in skid roads, truck roads, and landings after logging in the central Appalachians. J. For. 75:507-508.

Kochenderfer, J. N., and G. W. Wendel. 1980. Costs and environmental impacts of harvesting timber in Appalachia with a truck-mounted crane. USDA For. Serv. Res. Pap. NE-456. 9 p.

Lavallee, A., and M. Lortie. 1968. Relationships between external features and trunk rot in living yellow birch. For. Chron. 44(2):5-10.

Nyland, Ralph D., P. J. Craul, D. F. Behrend, H. E. Echelberger, W. J. Gabriel, R. L. Nissen, R. Vebler, and J. Zarnetske. 1976. Logging and its effects in northern hardwoods. SUNY, College of Environ. Sci. For., AFRI Res. Rep. 31. p. 134.

Roach, Benjamin A. 1977. A stocking guide for Allegheny hardwoods and its use in controlling intermediate cuttings. USDA For. Serv. Res. Pap. NE-373. 30 p.

Wendel, G. W., and J. N. Kochenderfer. 1978. Damage to residual hardwood stands caused by cable yarding with a standing skyline. South. J. Appl. For. 2:121-125.

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