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DAMAGE FROM LOGGING AND PRESCRIBED BURNING IN PARTIALLY CUT DOUGLAS-FIR STANDS

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ABSTRACT

Damage from tractor logging and slash burning in a Douglas-fir stand on gentle terrain was measured for three different types of timber harvesting. Logging damage was light in the selection-cut and understory-removal cutting units. In the overstory-removal unit, about 11 percent of the leave trees were killed by logging. Little damage from burning was incurred in the selection-cut and understory-removal units, but in the overstory removal unit an additional 56 percent was killed by burning.

KEYWORDS: logging damage, prescribed burning, tree wound

Silvicultural needs and forest management objectives are sometimes best achieved by the partial cutting of timber stands. The success of partial harvesting depends in part on the extent of damage to residual or "leave" trees.

In a study begun recently at the Lubrecht Experimental Forest[2] east of Missoula, Mont., researchers are evaluating physical and biological effects of several harvesting methods and postharvest treatments. Objectives are to compare effect of harvesting techniques on populations of western spruce budworm (*Choristoneura occidentalis* Freeman) a common pest in the area, and to achieve more species diversity. This research note reports initial damage incurred to leave trees from logging operations and prescribed burning. Subsequent change from disease, insects, or wind may be assessed in future studies.

STAND CONDITIONS AND HARVESTING OPERATIONS

The study site is on a gently rolling area in a stand of primarily Douglas-fir (*Pseudotsuga menzeisii*), with some western larch (*Larix occidentalis*), ponderosa pine (*Pinus ponderosa*), and lodgepole pine (*Pinus contorta*) mixed in. The area had been cut over in the past, resulting in patches of large and small trees, with occasional two-storied stands of several ages. The area is primarily Douglas-fir/dwarf huckleberry habitat type (*Pseudotsuga menzeisii/Vaccinium caespitosum*), as classified by Pfister and others (1977).

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[2]This is a cooperative study between the Intermountain Forest and Range Experiment Station and the University of Montana School of Forestry. Complete plans of all phases of study are on file at the Forestry Sciences Laboratory, Missoula, Mont., and the School of Forestry.

Four cutting units were included in the overall study. One unit was clearcut and only the three units that were partially cut are discussed here. One unit was selection cut to remove suppressed and defective trees and achieve desirable spacing for the remaining trees, following the guidelines of the Montana Department of Natural Resources, Division of Forestry. In the other units, the objectives were to interrupt the spruce budworm life cycle. On one unit the overstory was cut to remove larger trees where the budworm overwinters and from which larvae are dispersed. On another unit the understory was cut to remove smaller trees on which dispersed larvae light and begin feeding. Where possible, ponderosa pine, western larch, and lodgepole pine were retained to improve species diversity.

The specific treatments were:

Selection cutting - About half the sawtimber and pole-size stems were harvested. Residue was tractor-piled for burning.

Understory removal - Vigorous young sawtimber and a few poles were marked for leave. Defective and older sawtimber trees were cut and all trees under 5 inches d.b.h. were cut.

Overstory removal - All trees over 9 inches d.b.h. were cut, and all Douglas-fir over 5 inches d.b.h. were cut to meet the objectives stated above. Remaining stems were thinned.

Trees were felled and bucked conventionally using chainsaws and were yarded with a crawler tractor. Where residues were removed from the site, small stems were bundled prior to yarding. Merchantable stems were skidded whole-tree to the landing for limbing. Harvesting began in July 1977 and was completed October 1977. The logger was thoroughly briefed on study objectives. Research personnel were usually present to provide advice and to insure close adherence to logging and utilization specifications. The number of stems before and after logging are summarized in table 1.

Burning was done in late summer of 1978 after 1 year of curing. The overstory removal unit was burned under moderate-to-hot burning conditions and the fire was highly successful in reducing fuel volumes. The understory removal unit was burned under more moist conditions; fine fuels were consumed, but larger fuels were reduced only by about one-third (Steele in press).

Table 1.--*Number of live green trees per acre, pre- and postharvest, by diameter class for each cutting and residue treatment, Lubrecht Experimental Forest, 1977*[1]

Cutting and residue treatment	Diameter class, live green trees									
	1.0-4.9 inches		5.0-8.9 inches		9.0+ inches		Total		Total	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
	Number per acre								*Number per hectare*	
Selection cut										
Residue piled and burned	319	46	134	48	87	54	540	148	1334	365
Overstory removal										
Residue left	354	141	83	73	55	7	492	221	1215	546
Residue burned	854	390	[2] 53	72	71	2	978	464	2516	1146
Residue removed	280	202	[2] 59	64	103	8	442	274	1092	677
Understory removal										
Residue left	800	0	138	38	49	25	987	63	2438	156
Residue burned	560	0	214	33	82	25	856	58	2114	143
Residue removed	220	0	42	19	104	45	366	64	904	158

[1]Green seedlings under 1 inch d.b.h. are not included because they are not involved in the damage analysis. Complete stand tables are on file at the Forestry Sciences Laboratory, Missoula, Mont.

[2]The apparent increase in trees per acre is due to preharvest sampling error.

DAMAGE FROM LOGGING

Logging damage was evaluated by measuring and visually estimating scars and crown breakage on marked leave trees tallied on 1/10th-acre fixed plots. Evaluation was begun following logging, but in some units was not completed until the following summer. The assessment included area and location of scars, and the number and stub-length of broken green branches. These injuries can influence the susceptibility of the tree to entrance of pathogens. No attempt was made to detect presence or absence of pathogens at this time. By the summer following logging, most scars were 80 to 90 percent covered with pitch, except for scars on small trees of low-vigor, particularly in the overstory removal unit.

The damage to marked leave trees is summarized in table 2. Additional trees in the overstory removal and selection units were not cut, but these were not included in the damage assessment because there was no intent to protect them.

Table 2.--*Logging damage to leave trees in partial cutting units, Lubrecht Forest, 1977*

Cutting and residue treatment	Number marked leave trees		Logging damage[1]				
			None	Broken branch or top	Bole[2] scar	Stump[2] scar	Killed
	Per acre	*Per ha*	*Percent*				
Selection							
Residue piled and burned	64	158	81	6	4	8	<1
Overstory removal							
Residue left	82	202	67	8	12	7	6
Residue burned	96	237	53	10	11	15	11
Residue removed	68	167	69	5	9	11	6
Understory removal							
Residue left	63	155	99	0	1	0	0
Residue burned	58	143	88	6	3	3	0
Residue removed	64	158	89	1	2	8	0

[1]A few trees had two types of damage. Damage shown here is most serious damage incurred.
[2]Scars 1 foot or less above ground were called stump scars; over 1 foot above ground, bole scars.

Trees Killed or Missing

In the overstory removal unit, from 6 to 11 percent of the marked leave trees were killed or were missing. These were virtually all uprooted or flattened. The understory removal unit had no dead or missing leave trees, and in the selection cut less than 1 percent were killed.

Bole Damage

Damage to the stump (1 foot or less above ground) or bole of the tree (over 1 foot above ground) was the most common injury in virtually all treatments (table 2). In general, the pattern was as might be expected; small-size leave trees sustained more frequent damage. In the understory removal unit, from 1 to 10 percent of the leave trees had bole or stump scars, and in the selection cut 12 percent had scars, but in the overstory removal unit bole or stump scar damage occurred on up to 26 percent of the leave trees.

The frequency of bole damage did not appear to be related to the type of residue treatment, even though the "residue removed" treatment required yarding of more stems. One possible reason is that most of the residue was small stems, less likely to cause damage in felling and skidding than larger residues such as snags or large down material. There was very little large dead or cull material on the site. Also, as mentioned earlier logging specifications were closely followed.

Large scars that occur close to the ground usually have the greatest potential for infection because of warmer and moister conditions. In all cutting units, half or more of the trees that were scarred had stump scars, and most of the bole scars were less than 2 feet above ground (table 3).

Table 3.--*Percentage of leave trees with stump or bole scars by height of scar above ground and size of scar, Lubrecht Experimental Forest, 1977*

Cutting method	Height of scar (ft)					
	<1	1-2	2-3	3-5	>5	Total
	Percentage of leave trees					
Selection cut	8.0	2.6	0.4	0.4	0.6	12.0
Overstory removal	11.2	4.7	2.5	1.9	1.6	21.9
Understory removal	3.7	1.9	0	0	0	5.6
	Size of scar (in^2)					
	1-10	11-30	31-50	51+	Total	
	Percentage of leave trees					
Selection cut	2.6	2.7	2.9	3.8	12.0	
Overstory removal	13.5	6.7	1.4	0.2	21.9	
Understory removal	2.1	2.5	0.8	0.2	5.6	

In the understory removal unit where only smaller trees remained, most of the scars were under 10 in^2 in size (table 3). In the understory removal unit where leave trees were larger, nearly half the damaged trees had scars 11 to 30 in^2 in size. In the selection unit nearly one-third of all the trees damaged had scars exceeding 50 in^2 in size. The larger scars in the selection cut were probably because slash was machine piled, which made large scars more likely; but no attempt was made to determine whether the damage was from yarding logs or piling slash.

Broken branches and broken tops do not usually seriously damage young trees, provided the damage is not extensive on any one tree. Most leave trees had no crown damage or only a few broken live branches (table 2). Leave trees in the overstory removal unit had the most crown damage, but not substantially greater than in the selection and understory removal units.

Stub length can be a factor in disease entry because long stubs do not heal rapidly, thus allowing greater time for access of pathogens. Stub length on all trees with broken branches was as follows:

Stub length	Percentage
1 inch or less	77
2-4 inches	17
5 inches or more	6
	100

In general, crown damage was less common than damage to the bole as shown in table 2, even in the overstory removal treatment where residue was removed.

Tree Size and Logging Damage

Generally smaller trees seem more susceptible to logging damage than larger trees, although comparisons in this study are limited because size of marked leave trees differed among the three cutting units.

All of the leave trees killed in logging were 1.0 to 5 inches d.b.h., except in the overstory removal unit where a small number of 5-inch to 9-inch leave trees were killed. In addition, bole and stump damage in the overstory removal unit was more frequent on smaller trees:

Residue treatment	Leave trees with stump and bole scars	
	1.0-4.9 inches	5.0+ inches
	Percent	
Residue left	26.1	12.1
Residue burned	36.4	6.4
Residue removed	33.9	12.8

Trees 1-5 inches d.b.h. in the overstory removal unit also suffered crown damage more frequently than larger trees. Crown damage averaged 20 percent of the leave trees 1-5 inches, but only 11 percent of the larger trees had crown damage.

DAMAGE FROM PRESCRIBED BURNING OF RESIDUES

Logging residues in the understory and overstory removal units were broadcast burned in 1978 after one season of curing. Some minor arrangement of fuels were made to protect leave trees and provide uniform fuel conditions, but otherwise fuels were left from the logging operation. Damage from burning the overstory and understory removal units was evaluated in 1979. No appraisal was made in the selection cut because piling fuels virtually eliminated damage to leave trees.

In the understory removal unit, there was relatively little damage from burning, but in the overstory removal unit 67 percent of the marked leave trees were dead or missing following burning; only 10.6 percent had been killed in the logging operation, so over half the leave trees were apparently killed by the burning. Damage from burning is summarized in table 4.

Table 4.--*Damage from prescribed broadcast burning in overstory removal and understory removal units, Lubrecht Experimental Forest, 1978*

Item	Overstory removal unit (96 leave trees per acre)	Understory removal unit (58 leave trees per acre)
	Percent of leave trees	
Killed in logging	10.6	0
Killed by burn	56.3	4.8
Live with bole scorched	7.6	15.5
Live with crown scorched	11.9	8.3
No damage from burn	13.6	72.4
	100.0	100.0

Most of the trees killed by burning had both crown scorch and bole char or scorching. In the understory removal unit, bole scorch was more frequent than crown scorch. In the overstory removal unit, crown scorch was somewhat more common, but there were so few live trees remaining the type of damage probably has little significance.

The extent of crown scorch, bole scorch, and char was also estimated, but again, so few trees were damaged in the understory removal unit, and so few live trees remained in the overstory removal unit, detailed breakdown of damage was not warranted.

The overstory removal unit was burned under conditions that were somewhat "hotter" than desired; in addition, the leave trees that remained in this unit were of poor quality and low vigor. This was due partly to their position in the crown canopy, and also because of heavy past budworm defoliation. Many of the crowns were very sparse, with a high proportion of dead flammable material.

DISCUSSION

Logging damage to marked leave trees in the selection-cut unit and in the understory removal unit was minor, with virtually no trees being killed, and only light crown breakage or scarring of the main stem. In the overstory removal unit, one-third to one-half the leave trees had some damage, but it did not appear that logging damage alone would severely impair future stand development.

This assessment was based on first-year assessment of physical injury only, and the susceptibility of the leave trees to insect, disease, or weather-related damage will not be known for several years.

Prescribed burning did have a severe impact in the overstory removal unit. Over half the leave trees were killed, and there was fire damage in addition to the initial logging damage. The trees remaining in the overstory removal unit were generally of poor vigor, and several years will be needed before survival of the leave trees in the burned treatment can be compared with those in the units with residue removed or residue left in place.

Based on initial observations, all three types of cutting can be done with an acceptable level of damage, even where residues are removed. However, treating slash by burning in the overstory removal unit, where mostly small trees remained, destroyed or damaged most of the leave trees. Different fuel arrangement, different burning conditions, or both are apparently needed when broadcast burning in this type of situation.

In the understory-removal and selection-cut units, both logging damage and burning damage were minor. Because the number of leave trees and their size is similar in both cutting units, future stand development can be compared among the four residue treatments.

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