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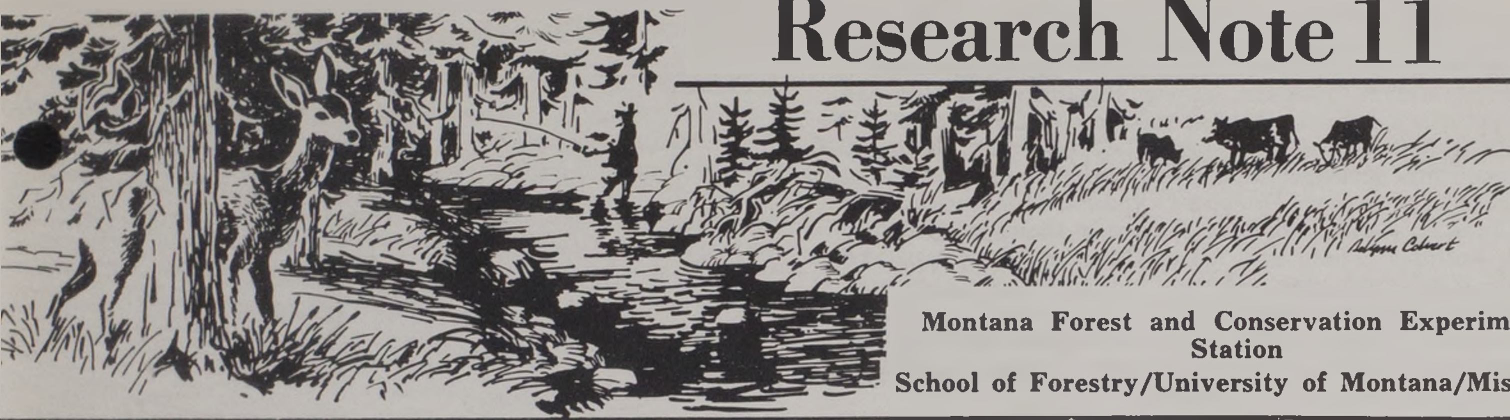

Research Note 11

Montana Forest and Conservation Experiment Station
School of Forestry/University of Montana/Missoula

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The Effect of Piling and Burning Versus Chopping of Logging Residues on Natural Regeneration of Serotinous Lodgepole Pine Forests

By Bernard Kovalchik, and George Blake

INTRODUCTION

Large amounts of seed stored in serotinous cones in typical stands of lodgepole (*Pinus contorta*) of south central Montana has resulted in overstocking following most harvest operations. Methods of site preparation such as piling and burning and broadcast burning have not met management objectives of desired seedling densities and distributions. The Forest Service is interested in the rolling brush chopper (Figure 1) as a method for obtaining these objectives in Montana.

FIGURE 1. Marden Brush Chopper

The purpose of this study was to compare pile and burning and rolling brush chopper methods of slash disposal to find out which results in regeneration at more favorable stocking levels.

DESCRIPTION OF STUDY AREA

We selected two clearcuts in an extensive lodgepole pine forest in the eastern foothills of the Gravelly Range of the northern Rocky Mountains. The cuts were units one and six of the Gazelle-Standard Creek Sale on the Beaverhead National Forest. Unit one contains 175 acres and unit six, 250 acres.

The topography of the units is similar. Both are located on flattened ridgetops, forming extensive butte-like benches. Their mean elevation is 7,000 feet, and the slopes of both are extremely gentle (Figures 2 and 3).

FIGURE 2. Unit 1

FIGURE 3. Unit 6

The soils on the two units are derived from a variety of parent materials. The main composition of their underlying rock is rhyolite, with occasional outcroppings of pumacite. In general, the soils are poorly developed having a high occurrence of rock in all horizons. Their moisture holding capacity is relatively high because of the presence of substantial amounts of silts and clays.

The climate in the study area is cool and moderately moist. The average annual precipitation for the past three years was 28 inches, most of which fell as snow. Records for the months of May through October show that 10.72 inches of rain fell during the six months critical to seedling establishment. Weather data collected on the two units showed that they are climatically similar and that their weather patterns closely parallel the averages for the region.

Pure stands of the lodgepole-pine type dominate the forests in the study area. The best stands are found on benches, in basins, and on gentle to moderate north- and east-facing slopes. Douglas-fir (*Pseudotsuga menziesii*) increases in importance,

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and old-growth stands can be found, on dry south- and west-facing slopes. Old-growth stands of Engelmann spruce (*Picea engelmannii*) and subalpine fir (*Abies lasiocarpa*) are found in sheltered stream bottoms. Young Engelmann spruce and subalpine fir are scattered in the subcanopy of lodgepole pine stands on benches and north-facing slopes. About 90 to 100 years ago fires destroyed much of the timber in the area except for the old, fire resistant Douglas-fir and some of the spruce and subalpine fir stands which are located in the more protected creek bottoms. These fires led to the establishment of vast stands of lodgepole pine which are now approaching maturity and are beginning to break up.

A survey of cone serotiny in 50 destructively-sampled trees located around the perimeter of each clearcut showed an average cone serotiny of 49 percent.

The study units are composed primarily of the *Alies lasiocarpa-Vaccinium scoparium* habitat type.[1] Both units also contain small areas of the *Pseudotsuga menziesii-Symphoricarpos albus* h.t. North slopes of the study area were occupied predominantly by *Vaccinium membranaceum* with subordinate amounts of *Vaccunium scoparium* and *Calamagrostis rubescens.*

PROCEDURES

The clearcut units were logged in 1967 and treated in 1968. Each unit was divided into northern and southern halves. In the southern half of each the slash was dozer piled, and in the northern halves the slash was chopped with the Marden Brush Chopper.

We located 50 plot centers at random on each of the two replicates per treatment and measured site preparation and competitive vegetation on each plot with a square, portable, milacre plot frame, consisting of an aluminum tube grid system having 10 vertical and 10 horizontal wires. We suspended the frame above the plot center and dropped a wire probe along each of the grid's 100 intercepts. The total number of hits on mineral soil, duff, slash, or vegetation represents the percent of each constituent present on the plot.

We evaluated seedling regeneration and mortality using a portable, circular, milacre plot frame and recorded the numbers and distribution of each species of seedling. We also noted seedling rooting substrates and probable causes of seedling mortality.

RESULTS

We used a simple "t" test to compare the proportionate amounts of duff, slash, competing vegetation, and exposed mineral soil left by piling and burning and by chopping and to compare the extent of natural regeneration following each procedure. We found that there was no difference between the two methods as regards regeneration but that there were great differences between them in respect to site preparation.

Data pooled from the two replicates of each treatment (see Table 1) show that in the piled-and-burned units exposed mineral soil constituted 36.9 percent of the area of the plots as opposed to 15.5 percent in the chopped units. On the other hand 25.1 percent of the area of the piled-and-burned plots were covered by slash, whereas 50.5 percent of the area of the chopped plots were so covered. This, of course, reflects the manner of manipulation of each treatment. Piling and burning disturbs large amounts of soil and destroys most of the slash. The Marden Chopper, by contrast, causes little soil disturbance and reduces slash volume only slightly.

Pooled duff and vegetational cover data for the two treatments showed little difference—37.6 percent duff and 32.6 percent vegetational cover on the pile-and-burned units as opposed to 33.6 percent and 33.3 percent on the chopped units.

The timing of timber harvests and site preparation which determines whether serotinous cones will be exposed to the summer temperatures required to break their resin seals, has a marked influence on the number of lodgepole pine seedlings which will emerge and on the time at which they will emerge. Each replicate in this study was exposed to different treatment application sequences. Seedlings that germinated in 1967 or earlier (three-year or older seedlings in Table 2) are a result of natural regeneration before logging.

TABLE 1

PERCENT PREPARATION & COMPETING VEGETATION

		SITE PREPARATION			
		MINERAL SOIL	DUFF	SLASH	VEGETATION
UNIT 1 Piled and Burned	$\bar{X}$	40.08*	35.72*	23.76*	26.36**
	Standard Deviation	27.47	22.39	14.69	19.15
UNIT 6 Piled and Burned	$\bar{X}$	33.80*	39.46*	26.36*	38.78*
	Standard Deviation	28.56	20.12	18.70	20.50
UNIT 1 Chopped	$\bar{X}$	11.32**	35.08*	53.00*	31.84*
	Standard Deviation	22.16	18.52	22.25	18.63
UNIT 6 Chopped	$\bar{X}$	19.68**	32.22*	47.94*	34.78*
	Standard Deviation	22.73	18.40	20.82	15.49

* The difference between this value and its counterpart in the other unit is not statistically significant at the .05 level.
** The difference between this value and its counterpart in the other unit is statistically significant at the .05 level.

TABLE 2

AGE, DISTRIBUTION AND SPECIES OF LODGEPOLE PINE SEEDLINGS BY TREATMENT

TREATMENT	AGE CLASSES			
	3 YRS +	2 YRS (1968)	1 YR (1969)	1970
UNIT 1 Piled and Burned	0	7	42	2
UNIT 1 Chopped	5	7	16	15
UNIT 6 Piled and Burned	1	5	11	12
UNIT 6 Chopped	6	4	14	38

Logging was completed on unit one in January and February of 1967. Serotinous cones were exposed to solar insolation during the summer and provided seed for germination in the spring of 1968. Seedlings that emerged on the unit one plots in 1968 (Table 2) are the result of logging.

The piled and burned plot of unit one was piled in July of

[1]Daubenmire, R. and Daubenmire, J. B. 1968. Forest vegetation of eastern Washington and northern Idaho. Wash. Agr. Exp. Sta. Tech. Bull. 60, 104 pp.

1968 and burned in October of the same year. Cones scattered over this plot during the piling operations were exposed to temperatures favorable to breakage of the resin seal during the months of July and August of 1968, and they provided the seed for 42 seedlings germinating in 1969 (Table 2). Only two seedlings emerged in 1970, and no new seedlings were recorded in 1971, indicating that regeneration is essentially complete on this piled and burned replicate.

The chopped section of unit one was treated in September of 1968, and serotinous cones did not open until the summer of 1969. The 15 seedlings germinating in 1970 (Table 2) are a result of the 1968 treatment; while the 16 seedlings that germinated in 1969 are probably a result of logging. Since many unopened cones still remain in the slash, regeneration could continue for several more years; however, no new seedlings were observed in 1971.

Unit six was logged in June and July of 1967, and again, the 1968 seedlings are the results of logging and not the treatments. The slash on unit six's piled and burned segment was piled in August of 1968 and burned in October of that year. Some cones scatterd about the unit during the piling process provided seed for 11 seedlings in 1969. However, many serotinous cones did not open until the following summer, and 12 seedlings germinated in the spring of 1970.

The slash on the other half of unit six was chopped with the Marden Brush Chopper in September of 1968, and cones did not begin to open until the summer of 1969. The 38 seedlings which germinated in 1970 are a result of the 1968 treatment while the 14 seedlings germinating in 1969 are primarily a result of the timber harvest. No new seedlings were observed on either half of unit six in 1971.

Table 3 presents information on the number of seedlings established per acre and seedling frequencies for the various treatments. As is indicated by the table, a 30 to 35 percent loss in seedlings and reduction of stocking occurred from 1970 to 1971.

TABLE 3

TOTAL LIVE SEEDLINGS PER ACRE AND

PERCENT MILACRE STOCKING

	1969		1970		1971	
	Seedlings/ Acre	Milacre Stocking	Seedlings/ Acre	Milacre Stocking	Seedlings/ Acre	Milacre Stocking
UNIT 1 Piled & Burned	820 (41)*	40% (20)**	760 (38)*	36% (18)**	380 (19)*	20% (10)**
UNIT 6 Piled & Burned	300 (15)*	14% (7)**	460 (23)*	20% (10)**	300 (15)*	12% (6)**
UNIT 1 Chopped	580 (29)*	30% (15)**	500 (25)*	32% (16)**	280 (14)*	26% (13)**
UNIT 6 Chopped	520 (26)*	24% (12)**	940 (47)*	34% (17)**	620 (31)*	18% (9)**

* Actual number of live seedlings/50 milacre plots

** Actual number of plots stocked

We applied a Chi^2, single classification test to the pooled regeneration and stocking data to determine if the differences between treatments were significant (Table 4). The Chi^2 value for regeneration was 1.5 and for stocking was .95, neither of which indicates a significant difference between treatments.

DISCUSSION

On all treatment replicates of this study the numbers of seedlings established per acre in 1971 ranged from 280 to 620, which, with even distribution over the plots, would not be too high. However, in all cases except on the chopped portion of unit 1, regeneration has occurred in dense scattered patches. This high density is reflected by low overall stocking percentages. Thinnings will be required within most of these patches of regeneration, and plantings will be needed in the understocked areas. Seedlings distribution on the chopped portion of unit 1 appears to be uniform with 280 seedlings per acre being distributed over 26 percent of the area.

The regeneration triangle expresses the three factors necessary for successful regeneration: seed source, seedbed, and conditions favorable to survival. Piling and burning exposes high amounts of mineral soil, providing ample seedbeds and a moisture regime suitable for seedling survival, and releases relatively low amounts of seed. The inverse is true with chopping which exposes little proper seedbed but provides immense quantities of seed from the serotinous cones contained on slash. The third element of the regeneration triangle, conditions favorable to survival, must also be considered. The results of this study show that the mineral and duff soils exposed by piling support considerably less vegetation than does the forest floor following chopping. However, there is no apparent difference between the treatments as to seedling mortality.

Consequently, there can be shown no statistical difference in established regeneration under the two methods. Different inputs into the regeneration triangle have resulted in similar overall effects on the study area.

TABLE 4

CHI^2 TEST

	Total Recorded Live Seedlings/ Treatments	Total Stocked Sample plots/ Treatments
Pile and Burn	34	16
Marden Brush Chopper	45	22
Chi^2	1.5	.95

$$Chi^2 = \sum \left(\frac{(obs. - expected)^2}{expected} \right)$$

CONCLUSIONS AND RECOMMENDATIONS

1. No statistical differences in regeneration could be demonstrated between the treatments.
2. Treatment differences were observed as they related to site preparation. Piling and burning resulted in the exposure of more mineral soil and in less slash than did chopping.
3. As of the summer of 1971, little if any additional regeneration is expected. The site has recovered and is completely occupied by understory vegetation except in sterile centers of the burn piles which are being invaded by spirea and fireweed.
4. The rolling chopper has application especially if fire is lost as a tool, but it is important to recognize its limitations; it is not a panacea.
5. Attention should be paid to the incidence of cone serotiny in the lodgepole pine stand before deciding what silvicultural method is to be used.
6. Stand composition has a marked effect on the efficiency of the brush chopper. Typically, a large volume of slash is generated by the harvest of natural timber stands in the western states. This is particularly true of lodgepole pine stands. When a heavy slash accumulation is chopped, the tractor and cutter may ride on top of several feet of the springy slash, reducing the cutting action of the blades. In

such cases additional treatment is required before satisfactory regeneration can be obtained (Figure 4). Consequently, other silvicultural methods should be used where heavy slash volumes exist.

FIGURE 4. Area of High Slash Accumulation

7. Since regeneration of lodgepole pine stands following chopping and piling and burning has been shown to be similar, other factors will determine which method should be used. These may include original stand composition, economics, fire hazard, air pollution, and aesthetics.