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FOREST RESEARCH REPORT

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AN EVALUATION OF 4 METHODS OF SITE PREPARATION

INTRODUCTION

During the past 5 years the majority of site preparation in Nova Scotia has been completed by using the brush raking and burning method. However, due to high costs and concern over the potential negative impact of removing slash from forest sites, research has been undertaken to evaluate alternative methods. This paper summarizes the results of a trial carried out by Scott Maritimes Ltd. and the Nova Scotia Department of Lands and Forests to compare the productivity and effectiveness of conventional brush raking to 3 alternate methods: corridor raking, dragging anchor chains and crushing with a Marden® Chopper.

METHODS

Each of the 3 trial locations was divided into 5, rectangular shaped, 2 hectare blocks with a 5 metre (m) buffer between blocks. Each site preparation treatment was randomly assigned to a block at each site. One block at each site was left untreated. Treatments consisted of brush-raking, corridor raking, dragging anchor chains and crushing with a Marden® Chopper.

® **Marden Chopper - Marden Manufacturing Co., Inc.**
® **Timberjack - Timberjack Inc.**
® **Raumfix - Hans Wahlers**
® **Ranger - Valmet Logging Inc.**

EQUIPMENT

Two prime movers were used for this trial (Table 1). The first was a Timberjack® 380 (135 hp) equipped with a 3.0 m, 5-tooth Raumfix® brush rake (the fourth tooth was missing) (Figure 1). This machine was used for corridor raking, brush raking and anchor chain treatments. The second prime mover was a Ranger® 67-F (180 hp), used for the crushing treatment.

The 7 metre long anchor chains consisted of a series of spiked links with tractor pads attached to their ends. The chains were attached to and spaced evenly along a 3 metre bar (Figure 2).

Canada

Nova Scotia

The Marden® Chopper consisted of a single-drum, measuring 3 m wide and 1.45 m in diameter with several blades attached to it. (Figure 3). The drum can be filled for added weight.

Table 1. Equipment and treatments used for site preparation.

	Treatment	Prime Mover	Attachment
*	Brush-rake	380 Timberjack	3.0 m Raumfix brush-rake
*	Corridor-rake	380 Timberjack	3.0 m Raumfix brush-rake
*	Anchor chains	380 Timberjack	4 rows; 7.0 m long with tractor pads
	Marden® Chopper	67 Ranger	3.0 m drum (filled)

* Same operator for these treatments.

SITE PREPARATION PROCEDURES

Corridor raking resulted in narrow rows (3-4 metres wide) created as the skidder driven rake pushed through the slash. When slash built up in front of the rake, the operator pushed off to the side, thereby creating a row of intermittent slash piles in the adjacent unraked strip. To limit the width of the non-site prepared strips, the operator pushed away from the previously raked corridors. To avoid forming a mound of slash at the ends of the rows, the operator was instructed to clear the rake before reaching the end of each corridor. This procedure results in approximately half of each area being raked, while the other half consists of intermittent slash piles. A report published by the Nova Scotia Department of Lands and Forests (1991) describes this treatment in further detail.

Figure 1. A five-tooth Raumfix brush rake with mechanical retracting teeth.

Conventional brush raking was completed by haystacking the slash into piles over the entire area. The number, width and height of the piles varied with slash conditions. The piles were to be burned at a later date.

The anchor chain treatment consisted of the 4 lengths of chain being dragged behind the skidder in a circular pattern starting at the outside edge of the area and working towards its centre. This treatment resulted in a swath approximately 3 metres wide with three 0.5 metre

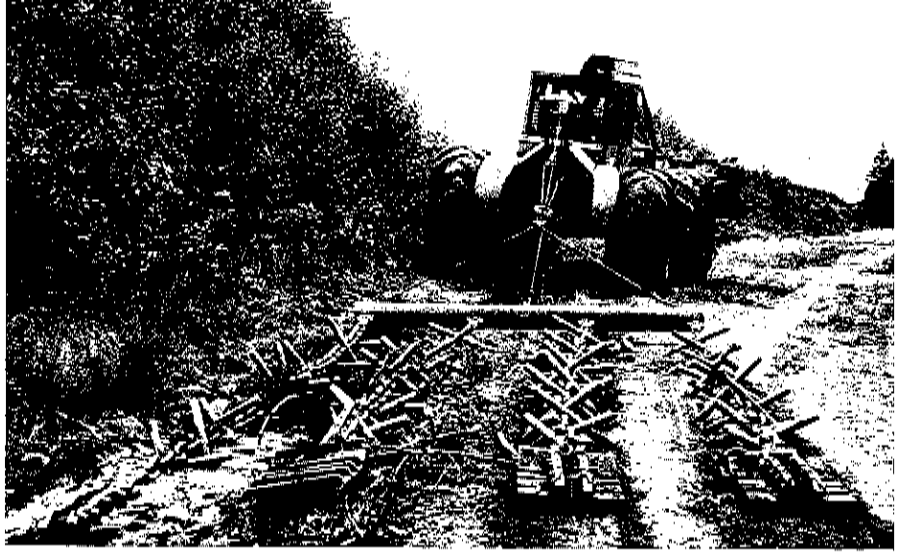

Figure 2. Anchor chains with tractor pads.

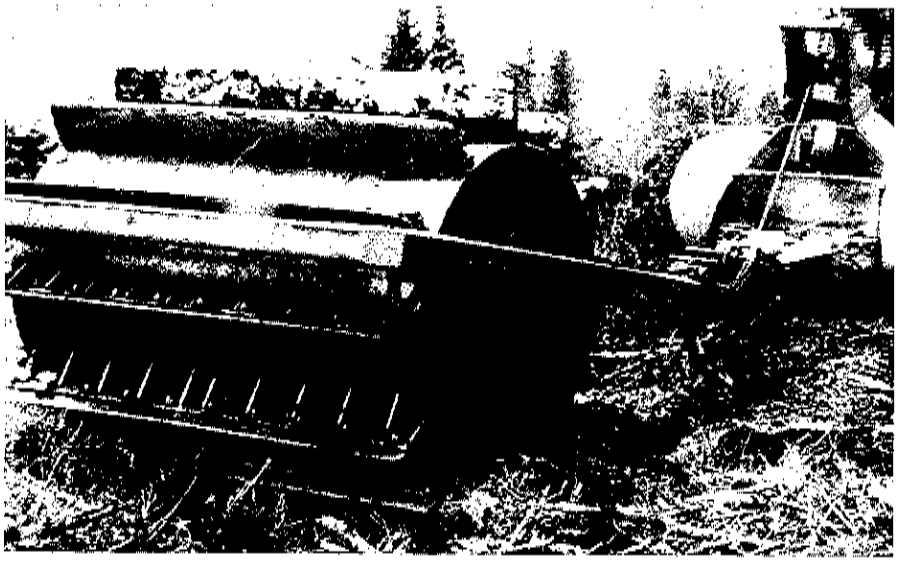

Figure 3. Single-drum Marden chopper.

wide non-site prepared sections within the swath over the entire area.

The chopping treatment was performed by pulling the Marden® Chopper over the entire area in a circular pattern starting at the outer edges and working towards the centre of the blocks.. The chopper was filled with fuel for this trial. There was no overlapping on successive passes.

DATA COLLECTION

Slash and site condition assessment

Slash and site conditions were assessed at each location prior to treatment. The assessment was conducted by establishing 20 plots, equally spaced within each block. Recorded at each plot was slash depth, average diameter, height and load as well as ground conditions (duff thickness, slope and moisture levels).

Time study

A time study was completed during each treatment. The study consisted of continuous timing of both total and productive time. Productive time was defined as the amount of time that the prime mover and implements were engaged in site preparation (Puttock and Smith, 1987). Productivity was determined by dividing

the area of each block by the productive work time.

Plantability assessment

Prior to site preparation, each of the blocks were assessed to determine the percentage of plantable area (opportunities for planting). The plantability survey was conducted by establishing two 100 metre lines within the block and assessing plantability at 1.8 metre intervals along these lines. Each assessment location was considered plantable providing a suitable microsite was found within 0.5 metres of the preselected spacing of 1.8 meters. Planting ease or the reason for a microsite being classified as not plantable were also recorded. The percent easy, moderate, and difficult to plant and not plantable due to slash were calculated as a proportion of the total number of microsites. Microsites considered not plantable for reasons other than slash were not included in the calculations (Appendix I). The basis for the calculations was:

$$\%\ \text{Easy} = \frac{\text{Easy}}{\text{Plantable} + \text{Not Plantable}} \times 100$$

$$\%\ \text{Moderate} = \frac{\text{Moderate}}{\text{Plantable} + \text{Not Plantable}} \times 100$$

$$\%\ \text{Difficult} = \frac{\text{Difficult}}{\text{Plantable} + \text{Not Plantable}} \times 100$$

$$\%\ \text{Plantable} = \frac{\text{Plantable}}{\text{Plantable} + \text{Not Plantable}} \times 100$$

$$\%\ \text{Not Plantable} = \frac{\text{Not Plantable}}{\text{Plantable} + \text{Not Plantable}} \times 100$$

Where,

Easy	=	the number of microsites rated easy to plant
Moderate	=	the number of microsites rated moderately difficult to plant
Difficult	=	the number of microsites rated difficult to plant
Plantable	=	total number of microsites rated plantable
	=	Easy + Moderate + Difficult
Not Plantable	=	the number of microsites not plantable due to slash

Post treatment assessments of plantability were conducted in each block following site preparation using the same methods as for the pre-assessment. However, in blocks that were corridor raked, plantability was determined by walking along the edge of a slash row and assessing the plantability of microsites at each 1.8 metre interval. At each of these points, a tape measure was extended out 3.6 metres (2 x 1.8 metres) perpendicular to the direction of travel, in order to assess planting spots in the middle of the corridor and in the adjacent slash row. In blocks that were conventionally brush raked, the slash piles were not burned before the post assessment. Therefore, when estimating plantability for these blocks, the area occupied by brush piles was excluded from the assessment.

A more direct estimate of plantability will be obtained when the trial sites are planted. At that time planting productivity will be determined by block.

SITE DESCRIPTION

The three sites chosen for the trial were situated on land managed by Scott Maritimes (Appendix II). Two of the locations (Maple Grove and Georgefield) were harvested 2 years before the trial, whereas the third site (Cooks Brook) was harvested 3 months prior to the trial.

At Maple Grove, the mixedwood stand (70% softwood and 30% hardwood) was clear-cut,

with the softwood processed tree-length and the hardwood by shortwood methods. The slash left on-site consisted of tops and branches of merchantable trees and unmerchantable trees. Overall, slash loading was categorized as light-moderate. Vegetation consisted of patches of ericaceous vegetation and hardwood sprouts and suckers, primarily red maple and trembling aspen, approximately 1.5 m in height.

At Georgefield, the mixedwood stand (30% softwood, 70% hardwood) was clearcut with the softwood processed full-tree and the hardwood tree-length. This resulted in a slash loading rated as light consisting of hardwood tops and branches, and unmerchantable trees. Vegetation consisted of a uniform cover of red maple sprouts and poplar suckers 1-2 m in height.

At Cooks Brook, the softwood stand was cut using a single-grip harvester which processed the trees at the stump. This method resulted in small piles of green slash approximately 1.0 m high scattered over the site. Due to the heavier slash conditions, overall slash loading was rated as moderate.

RESULTS & DISCUSSION

SITE PREPARATION EFFECTIVENESS

Brush raking

Brush raking and burning was the best site preparation treatment in terms of improvements to plantability (Table 2; Appendix I). At Maple Grove the percentage of microsites rated "easy to plant" increased by 56% following treatment as compared to an average of 14% for the other treatments. At Georgefield and Cooks Brook, the percentage of easily plantable microsites was increased by 15 and 22% respectively. However, brush-raking was the slowest method

Table 2. Pre and post assessment of plantability (opportunities for planting) by location and method.

Location	Treatment	Plantability[1] (%)											
		Pre Assessment				Post Assessment				% Difference (+/-)[2]			
		Notpl	Easy	Mod.	Diff.	Notpl	Easy	Mod.	Diff.	Notpl	Easy	Mod.	Diff.
Maple Grove	Brush rake	7	21	42	30	3	77	11	9	- 4	+56	-31	-21
	Corridor rake	7	44	38	11	16	42	23	19	+ 9	- 2	-15	+ 8
	Anchor chains	16	34	37	13	7	62	22	8	- 9	+28	-15	- 4
	Marden chopper	14	38	32	16	14	54	10	22	0	+16	-22	+ 5
	Average	11	34	37	17	10	59	16	14	- 1	+25	-21	- 3
Georgefield	Brush rake	0	73	21	6	0	88	20	7	0	+15	- 1	+ 1
	Corridor rake	1	49	33	18	7	58	18	16	+ 6	+10	-15	- 2
	Anchor chains	0	74	21	5	2	83	8	7	+ 2	+ 9	-13	+ 2
	Marden chopper	1	50	41	9	1	74	20	5	0	+25	-21	- 4
	Average	1	61	29	9	3	76	16	9	+ 2	+15	-13	- 1
Cooks Brook	Brush rake	14	55	15	16	2	77	13	8	-12	+22	- 2	- 9
	Corridor rake	18	40	23	19	18	58	15	9	0	+18	- 8	-10
	Anchor chains	31	30	28	12	24	54	10	12	- 7	+24	-18	0
	Marden chopper	22	45	12	21	15	60	13	13	- 7	+14	+ 1	- 8
	Average	21	43	19	17	15	62	13	10	- 6	+20	- 7	- 7
All	**Brush rake**	**7**	**50**	**26**	**17**	**2**	**81**	**14**	**8**	**- 5**	**+31**	**-11**	**- 9**
	Corridor rake	**9**	**44**	**31**	**16**	**14**	**53**	**18**	**15**	**+ 5**	**+ 9**	**-13**	**- 1**
	Anchor chains	**16**	**46**	**29**	**10**	**11**	**67**	**13**	**9**	**- 5**	**+20**	**-15**	**- 1**
	Marden chopper	**12**	**44**	**28**	**15**	**10**	**63**	**14**	**13**	**- 2**	**+18**	**-14**	**- 2**

1 Plantability is a subjective description based on the volume, distribution and depth of slash (Notpl: not plantable; easy; mod: moderate; diff: difficult).
2 Descrepencies between pre and post assessment columns and percent difference column due to rounding.

Table 3. Productivity and productive time by location and treatment.

Location	Treatment	Productivity (ha/hr)	Productive Time (%)
Maple Grove	Brush rake	0.5	71
	Corridor rake	1.5	64
	Anchor chains	1.4	78
	Marden chopper	1.2	94
Georgefield	Brush rake	1.1	97
	Corridor rake	1.2	98
	Anchor chains	1.4	89
	Marden chopper	1.0	76
Cooks Brook	Brush rake	0.8	83
	Corridor rake	1.1	88
	Anchor chains	1.3	92
	Marden chopper	1.2	87
All	**Brush rake**	**0.8**	**84**
	Corridor rake	**1.3**	**83**
	Anchor chains	**1.4**	**86**
	Marden chopper	**1.1**	**84**

of site preparation, averaging 0.8 ha/hr over the 3 sites (Table 3). Production varied from 0.5 ha/hr at Maple Grove to 1.1 ha/hr at Georgefield.

Corridor raking

Corridor raking was the least effective treatment in improving planting ease where the initial slash load was light, yet was as effective as the other treatments where initial slash load was heavier. For example, at Maple Grove, where the slash was light, dry and brittle, the number of microsites rated "easy to plant" actually decreased after treatment, whereas they were increased by 10 and 18% respectively at Georgefield (light-moderate) and Cooks Brook (moderate slash load).

Corridor raking was the second quickest method of preparing sites, averaging 1.3 ha/hr. Productivity ranged from 1.1 ha/hr in moderate slash (Cooks Brook) to 1.5 ha/hr in light slash conditions (Maple Grove). The high level of productivity, compared to conventional brush raking, is attributed to the fact that on average only 50% of the area is treated and that the prime mover was moving forward most of the time (Dunnigan and Cormier, 1988).

This treatment may not be appropriate where high rabbit populations exist. By leaving small slash piles throughout the site, rabbit habitat is being created and subsequent seedling browsing may occur (Murray, 1984).

Anchor chains

Anchor chains proved effective in all the blocks treated by this method. However, these blocks had initial slash loads no heavier than light-moderate (Appendix II). At these sites, the chains were able to redistribute the slash and provide some mixing of the duff layer. The type of anchor chains used in this study are not recommended for moderate or heavy slash conditions, as the chains may be ineffective in penetrating the slash, resulting in minimal site preparation.

In comparison to the other treatments, anchor chains were the quickest method of preparing sites, averaging 1.4 ha/hr. Productivity varied little between sites.

Marden Chopper

At Maple Grove and Georgefield, the crushing treatment produced good conditions for

planting. On both sites, the Marden Chopper easily crushed the dry, brittle slash resulting in a thorough mixing of slash and organic matter. At these locations the percentage of microsites classified as "easy to plant" increased by 16 and 25% respectively. The treatment was less effective on fresh green softwood slash (Cooks Brook). On these conditions the rolling reduced the height of the slash and resulted in a 14 % increase in the percent of microsites classified as "easy to plant".

Productivity for this method averaged 1.1 ha/hr, approximately 15 and 20% less than for corridor raking and anchor chains respectively. The productivity for this treatment varied by only 0.2 ha/hr between locations.

SUMMARY

The following are the results of a trial to compare the productivity and effectiveness of conventional brush raking to three alternative methods of site preparation.

1. Overall, each of the 3 treatments evaluated provided acceptable alternatives to brush-raking under certain conditions. Each alternative, generally improved planting ease over pre-treatment conditions, was higher in productivity, and left slash on-site.
2. Productivity was highest using anchor chains attached to a skidder, averaging 1.4 ha/hr over all sites. This treatment was most appropriate where initial slash conditions were light to light-moderate and dry, resulting in an increase in the percentage of "easy to plant" microsites of 19%. This treatment was not tested on moderate slash loads.
3. Productivity for corridor raking was almost equal to the anchor chains at 1.3 ha/hr, but ranked last in terms of increasing the percent of easy planting spots. This treatment was least effective when initial slash load was light and should be avoided in areas with high rabbit populations.
4. The marden chopper treatment was effective on older slash that was dry and brittle. The average increase in percentage of "easy" planting microsites at these sites was 21%. On the site with fresh green slash, the increase was less (14%). Its average productivity was 1.1 ha/hr.
5. Productivity was lowest for brush-raking (average 0.8 ha/hr). It also resulted in the most slash being removed from the site. However, this treatment resulted in the greatest increase in the percentage of microsites considered easy to plant (31%).

LITERATURE CITED

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APPENDIX I

THE PERCENTAGE OF AREA NOT PLANTABLE BY LOCATION, TREATMENT AND REASON: FOR PRE AND POST ASSESSMENTS

Location	Treatment	Not Plantable (%)									
		Pre Assessment					Post assessment				
		Total	Slash	Duff	Wet	Veg[1]	Total	Slash	Duff	Wet	Veg
Maple Grove	Brush rake	23	26	0	74	0	8	38	0	62	0
	Corridor	9	78	0	22	0	19	82	0	18	0
	Anchor chains	16	100	0	0	0	7	100	0	0	0
	Marden chopper	14	100	0	0	0	14	100	0	0	0
	Control	9	89	0	0	11	N/A			N/A[2]	
	Average	14	79	0	19	2	10	80	0	20	0
Georgefield	Brush rake	0	0	0	0	0	0	0	0	0	0
	Corridor	1	100	0	0	0	9	81	0	0	19
	Anchor chains	2	0	0	50	50	2	100	0	0	0
	Marden chopper	1	100	0	0	0	1	100	0	0	0
	Control	0	0	0	0	0	N/A			N/A	
	Average	1	67	0	16	17	3	72	0	0	28
Cooks Brook	Brush rake	14	100	0	0	0	2	100	0	0	0
	Corridor	18	100	0	0	0	21	85	6	9	0
	Anchor chains	30	100	0	0	0	24	100	0	0	0
	Marden chopper	22	100	0	0	0	15	100	0	0	0
	Control	29	100	0	0	0	N/A			N/A	
	Average	22	100	0	0	0	15	97	1	2	0

1 Vegetation.
2 Not applicable.

APPENDIX II

SITE CONDITIONS PRIOR TO SITE PREPARATION

Treatment	Block	Area (ha)	Slash Depth (cm)	Slash Type[1]	Slash Condition[2]	Slash Load[3]	Duff Depth (cm)	Drainage[4]	Slope[5]	Stump ht (cm)
MAPLE GROVE										
Brush rake	1	2.0	28	Mixed	Dry-Brittle	Light-Mod	11	Poor	Flat	22
Corridor	2	2.0	25	Mixed	Dry-Brittle	Light	12	Imperfect	Flat	29
Anchor chains	3	2.0	33	Hwd	Dry-Brittle	Light-Mod	11	Imperfect	Flat	30
Marden chopper	5	2.0	36	Swd	Dry-Brittle	Light-Mod	10	Imperfect	Flat	30
GEORGEFIELD										
Brush rake	4	2.0	15	Mixed	Dry-Brittle	Nil-Light	6	Imperfect	Flat	23
Corridor	3	2.0	27	Mixed	Dry-Brittle	Light-Mod	8	Imperfect	Flat	25
Anchor chains	1	2.0	23	Mixed	Dry-Brittle	Light	5	Imperfect	Flat	22
Marden chopper	2	2.0	21	Mixed	Dry-Brittle	Light-Mod	7	Imperfect	Flat	23
COOKS BROOK										
Brush rake	2	2.0	41	Mixed	Fresh-Green	Moderate	11	Imperfect	Roll	30
Corridor	3	2.0	32	Hwd	Fresh-Green	Moderate	7	Poor	Flat	23
Anchor chains	1	2.0	30	Swd	Fresh-Green	Light-Mod.	14	Poor	Roll	23
Marden chopper	4	2.0	41	Hwd	Fresh-Green	Moderate	10	Imperfect	Flat	26

1 Slash Type — composition of slash — (Mixed-mixewood, Hwd-hardwood, Swd-softwood)
2 Slash Condition — condition of slash
3 Slash Load — volume of slash — (Nil, Light, Mod-moderate)
4 Drainage — ground moisture
5 Slope — degree of slope — (Flat, Roll-rolling)