COMPARISON OF CLEARING-SAW CUTTING ATTACHMENTS FOR WEEDING YOUNG CONIFER PLANTATIONS

by

Sylvi D. Holmsen, R.P.F.*
Roger J. Whitehead**

FOREST ENGINEERING RESEARCH INSTITUTE OF CANADA
#201 - 2112 West Broadway
Vancouver, B.C. V6K 2C8

March 1988

FERIC Special Report No. SR-52

Also published as FRDA Report No. 028

KEYWORDS: Vegetation Control, Motor-Manual Method, Brush Saws, Cutting Attachments, Seedling Damage, Plantations, Softwoods, Evaluation, Productivity, Costs, Time Study, Husqvarna 244RX Clearing Saw.

*Researcher, Silvicultural Operations, FERIC, Western Division.
**Silviculturist, Forest Weed Control, Canadian Forestry Service, Pacific Forestry Centre, Victoria, B.C.

Canadian Cataloguing in Publication Data

Holmsen, Sylvi D. & R.J. Whitehead
Comparison of clearing-saw cutting attachments for weeding young conifer plantations

(FRDA report, ISSN 0835-0752: 028)

Issued under Forest Resource Development Agreement. Published by the Canadian Forestry Service. Also issued by Forest Engineering Research Institute of Canada as a FERIC special report.

On cover: Canada/BC Economic & Regional Development Agreement
Bibliography: p
ISBN 0-7718-8643-8

1. Conifers - manual weed control - British Columbia 2. Forest machinery - British Columbia - Redfish Creek Region (Central Kootenay) I Whitehead, R.J. II Canadian Forestry Service. III British Columbia. Ministry of Forests and Lands. IV Forest Resource Development Agreement (Canada). V. Canada/BC Economic & Regional Development Agreement. VI. Title. VII Series

SD397.C7H64 1988 634.9'53 C88-092099-8

ABSTRACT

In a study funded under FRDA, FERIC and CFS established research plots for the silvicultural assessment of a vegetation-management trial in Nelson. FERIC conducted productivity assessments of three cutting attachments for Husqvarna clearing saws: the MAXI 200, MULTI 300 and MULTI 255-4. Pretreatment vegetation and post-treatment seedling damage were examined by PFC researchers. This report summarizes the first-year results. Follow-up re-vegetation and crop growth response will be monitored and reported by PFC.

PREFACE

This study was funded by the Canadian Forestry Service (CFS) under the Canada/British Columbia Forest Resource Development Agreement (1985-1990) (FRDA). This report has been reviewed by the Canadian Forestry Service and approved for distribution. This approval does not necessarily signify that the contents reflect the views or policies of the Canadian Forestry Service.

The authors are grateful for the assistance provided by the Ministry of Forests and Lands personnel in the Nelson Forest Region Office and the Kootenay Lakes and Arrow Forest District Offices; for the operator training program and support provided by Pacific Equipment Co., Vancouver; for the cooperation of the contractors, Siltech Reforestation Ltd. and Kutenai Nature Investigations Ltd., Nelson; for assistance in field work, data analysis, and report preparation by FERIC personnel: D.J. Sudul, I.B. Hedin, J.R. Tan, K. Prochnau and K. Patton; and for assistance with experimental design and statistical analyses: Dr. C.S. Simmons of Pacfic Forestry Centre.

SUMMARY

In June 1987, the Forest Engineering Research Institute of Canada (FERIC) and the Canadian Forestry Service, Pacific Forestry Centre (PFC) established a trial in the West Kootenay Region of British Columbia for the evaluation of clearing-saw treatments for weeding young conifer plantations. The project was funded under the Canada/British Columbia Forest Resource Development Agreement. FERIC conducted productivity assessments of three cutting attachments for Husqvarna clearing saws: the MAXI 200/255, MULTI 300, and MULTI 255-4. Follow-up re-vegetation and crop growth response will be monitored and reported by the PFC researchers at the end of the study period.

Prior to treatment, vegetation on the site consisted of numerous shrub and herbaceous species varying in size and distribution. Beaked hazelnut, Douglas maple, ceanothus, ocean-spray, thimbleberry, and fireweed were some of the common species. Portions of the area had been planted one to five years previously with a variety of coniferous species. Forty percent of all sampled seedlings were overtopped by competing vegetation. Only 13% had leaders projecting above the competition.

The Husqvarna 244RX clearing saw was chosen for the study, based on the vegetation on the site. The MAXI 200/225 is the standard circular blade for woody vegetation, and the MULTI 300 and MULTI 255-4 blades are designed for herbaceous and shrub species. The overall productivity for the study was 0.025 ha/productive hour (PH), or 0.162 ha/manday. The MULTI 300 had the highest productivity on the study site; however in areas of woody vegetation its use is limited to diameters less than 2.5 cm. The productivity for this blade was 0.032 ha/PH. The costs for the study ranged from $600 to $850 per hectare for the contract crew.

Damage to the seedlings was assessed and summarized by PFC. Damage ranged from 9% of seedlings with leaders projecting above vegetation to 25% of seedlings that were overtopped. Overtopped seedlings or seedlings of the same height as the non-crop vegetation experienced the highest damage levels. Overall seedling damage was assessed at 19.5% of the seedlings examined. PFC will monitor the vegetation response on the site and undertake repeat treatments during the remainder of the study's three-year term.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

APPENDIX

INTRODUCTION

With increased emphasis on the rehabilitation of potentially productive forest sites which have been lost to non-commercial cover, and on the management of brush-prone current harvest sites, annual goals for brushing and weeding in British Columbia have increased substantially[1] (B.C. Ministry of Forests and Lands, 1987). This trend reflects growing recognition of the importance of early vegetation control in meeting long-term timber management goals and maintaining future employment potential in the forest sector.

Early plantation survival and growth are often compromised by physical damage or competitive stress from shrubs and forbs. Treatments which are both silviculturally effective and within acceptable cost limits must be identified and implemented. Options for chemical vegetation control have generally received more experimental attention than other alternatives (Sutton 1985, Conway-Brown 1984). However, motor-manual cutting treatments are considered important parts of vegetation management programs in British Columbia and therefore they warrant detailed evaluation.

In June 1987, the Forest Engineering Research Institute of Canada (FERIC) and the Canadian Forestry Service (CFS) initiated a study, under the Canada/British Columbia Forest Resource Development Agreement (FRDA), to evaluate clearing saws in a motor-manual vegetation management trial in the West Kootenay Region of British Columbia. The study has two phases: first, an evaluation of cost and productivity of clearing saws at time of treatment, including a comparison of three cutting attachments; and second, an evaluation of the effect of treatment on plantation growth dynamics. This report summarizes the results of Phase 1; Phase 2 will be reported separately upon completion in 1990.

Major objectives of the first phase of the study were:

1. To estimate the overall productivity, cost, and accidental crop damage levels which can be expected when weeding shrub-dominated coniferous plantations with clearing saws.

2. To compare the productivity and performance of three clearing-saw cutting attachments.

---

[1] Perry, J. 1987. An assessment of manual brush control in the Cariboo Forest Region. B.C. Ministry of Forests and Lands. Unpublished report.

DESCRIPTION OF SITE

The site chosen for this project is located near Redfish Creek, approximately 30 km east of Nelson, B.C. The site is on a moderate slope with a south to southwest aspect, and is classified as $ICHa_1(03)$[2] (after Utzig et al 1986). The soil is an ash-influenced silty loam cap, 10 to 30 cm in depth, over sandy gravel morainal materials of granitic origin.[3]

For the purpose of this study, the site was divided into three blocks accounting for differences in vegetation composition and size. Blocks 1 and 2 had been prepared for planting by a controlled burn in 1983; Block 3 was burned in 1985. Most fine fuels were consumed by both fires, and heavier debris dropped to ground level. However, portions of Blocks 1 and 2 had accumulations of slash which could impede movement of the clearing-saw operators.

Vegetation at time of treatment (Figure A and Table 1) was typical of burned sites in this ecosystem (Ketcheson, 1986). Most woody stems in the dominant shrub/forb layer were 0.75 to 2 cm in diameter in Blocks 1 and 2, with a higher frequency of stems in the smaller end of the range in Block 3. Clumps of stems from 2-4 cm in diameter were much more common in the tall shrub layer in Block 2 than in Block 1, and absent from Block 3 (Figures B and C).

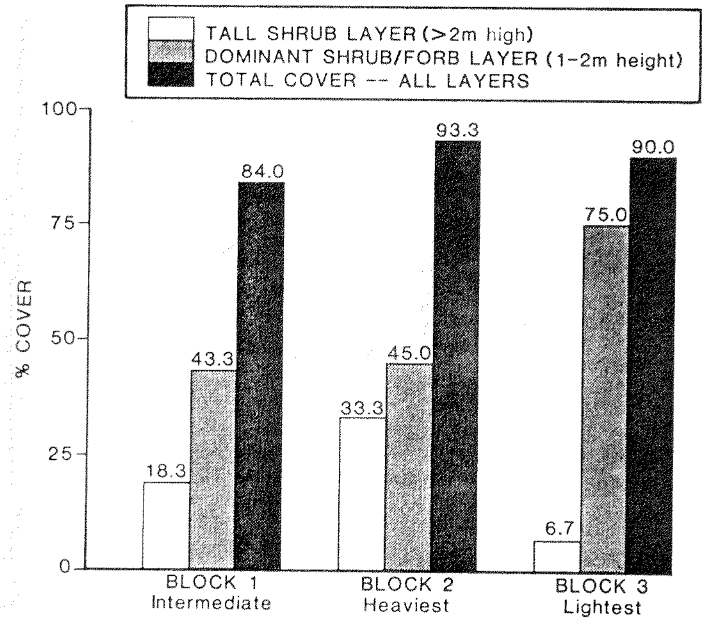


FIGURE A. Percent Cover of Plant Layers Within Blocks.

---

[2] $ICHa_1$ (03) is a sub-mesic association of the Lower Columbia-Kootenay Moist Southern Interior Cedar Hemlock climatic subzone.

[3] T.F. Braumandl, Regional Ecologist, Nelson Forest Region, B.C. Ministry of Forests and Lands, personal communication. August 1987.

TABLE 1. Pretreatment Assessment of Vegetation

Layer	Block	Description[a,b]
Tall shrub layer (>2.0 m height)	1	15-25% cover, as scattered clumps of beaked hazelnut or Douglas maple, 2.0 to 3.5 m height.
	2	30-40% cover, as scattered paper birch to 5 m height and clumps of hazelnut, maple and occasional redstem ceanothus and/or ocean-spray.
	3	5% cover as few scattered birch with small, infrequent patches of ceanothus and maple.
Dominant shrub and forb layer (1.0 m - 2.0 m height)	1	30-50% cover at 1.5 to 2.0 m height primarily as unevenly distributed clumps of ocean-spray and ceanothus with uniformly distributed fireweed and American vetch and less frequent patches of thimbleberry, maple, common snowberry, and roses.
	2	40-50% cover as hazelnut, birch, and thimbleberry in patches with uniformly distributed fireweed and vetch throughout.
	3	75% cover of ceanothus, thimbleberry and fireweed at 1.0-2.0 m height.
Total cover	1	80-95%
	2	90-100%
	3	90-100%

[a] Meidinger D. 1987. Recommended vernacular names for common plants of British Columbia. B.C. Ministry of Forests and Lands. Draft report.

[b] Latin names for plants are given in Appendix II.

FIGURE B. Variation in Vegetation Types and Sizes in Blocks 1 and 2.

FIGURE C. Vegetation Type in Block 3.

During the pretreatment assessment, conifer seedlings were also examined and classified by the extent to which they were being affected by the competing deciduous vegetation (Table 2). Few crop seedlings were above the height of the dominant shrub and forb cover. Most seedlings were either completely overtopped or of the same height as surrounding vegetation, which made them difficult for clearing-saw operators to see during the cutting treatment (Figures D and E). Conifer seedlings were tagged at ground level for re-examination during the post-treatment assessment.

TABLE 2. Distribution of Crop Trees by Overtopping Class Prior to Treatment

Species	Sample size	Mean height (m)	Frequency of occurence (%) by overtopping class		
			Overtopped	Same height	Leader projecting
Grand fir	79	0.54	53	41	6
Western larch	94	0.80	32	49	19
Douglas-fir	118	0.39	41	46	13
Ponderosa pine	17	0.20	18	76	6
Total for all seedlings	308		40	47	13

FIGURE D. Seedling with Leader Projecting Above Vegetation.

FIGURE E. Seedling Hidden in Vegetation.

DESCRIPTION OF CLEARING SAWS AND ATTACHMENTS

The Husqvarna 244RX clearing saw was selected for the study on the basis of the size and composition of the vegetation on the site as well as the cost and weight of the saw. According to the manufacturer's specifications and verbal communication with the dealership and distributor's representatives, this clearing-saw model was suitable for the vegetation conditions on the site. Conway-Brown (1985) presents a comprehensive review of specifications, maintenance requirements, and use of several clearing-saw models. The Husqvarna 165r was added later in the study when the 244RXs malfunctioned. These saws and the blades tested are described briefly in this section. More detailed descriptions and specifications are presented in Appendix I.

1. Husqvarna 244RX and 165r Clearing Saws

The Husqvarna 244RX and 165r clearing saws are the manufacturer's two professional models. A new 244RX and a 1986 model of the 165r were used in this study. The 244RX has a 44 cc engine and weighs 8.7 kg, whereas the 165r has a 66 cc engine and weighs 10.1 kg. Each saw is equipped with a load-equalizing harness, tool kit, and one blade with a blade guard (Figure F). Standard safety gear for the operator consists of a hard hat with face screen, hearing protection, and sturdy work boots (Figure G).

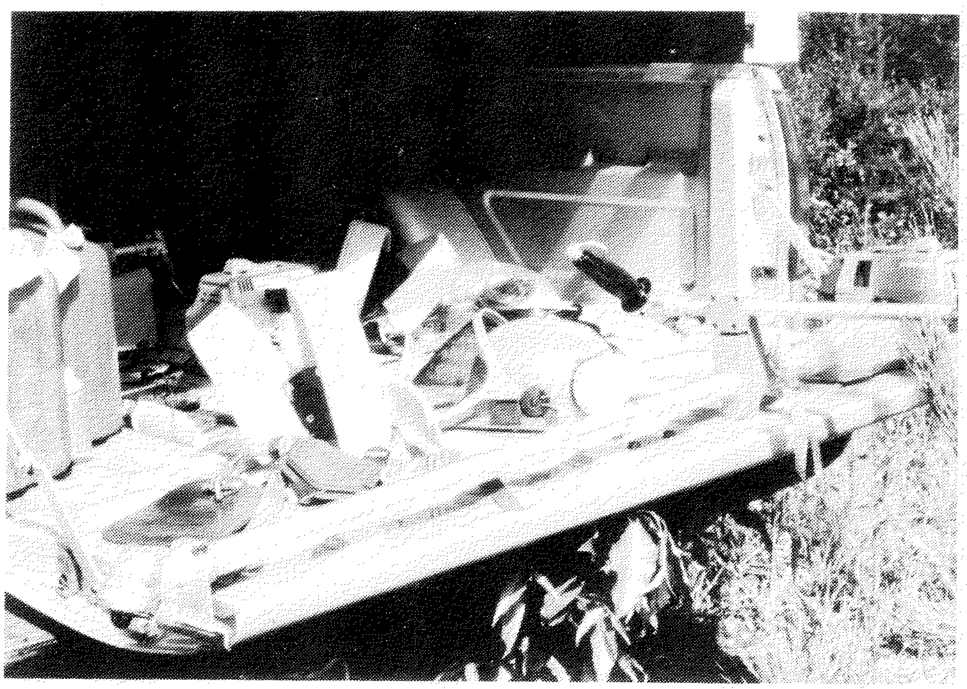


FIGURE F. Husqvarna 244RX Clearing Saw with Harness and Safety Equipment.

FIGURE G. Diagram of Operator with Harness and Saw Adjusted for Clearing.

2. Clearing-Saw Attachments

FERIC selected and purchased three blades and corresponding blade guards: the MAXI 200/225, the MULTI 255-4, and the MULTI 300. Figure H illustrates the blades tested.

a) MAXI 200/225 Blades

The MAXI 225 is a standard blade for the Husqvarna 165r clearing saw, and the MAXI 200 is standard on the Husqvarna 244RX. Both blades are of the same design for cutting a wide variety of woody vegetation but the 225 is 25 mm larger in diameter (225 mm). Maintenance of the blade consists of filing with a 7/32 inch round Oregon file and occasionally setting the teeth.

b) MULTI 255-4 Blade

The MULTI 255-4 is a circular blade with four flat cutting teeth extending from the circumference. This blade is recommended for smaller, less woody vegetation such as herbs and low shrubs. The teeth are filed with a flat file and the blade can be turned over providing the use of both cutting edges.

c) MULTI 300 Blade

The MULTI 300 is a triangular blade with sharpened cutting edges on the points. Like the MULTI 255-4, this blade is recommended by the manufacturer for smaller, less woody vegetation. A flat file can be used to sharpen this blade which can be reversed to make use of both cutting edges.

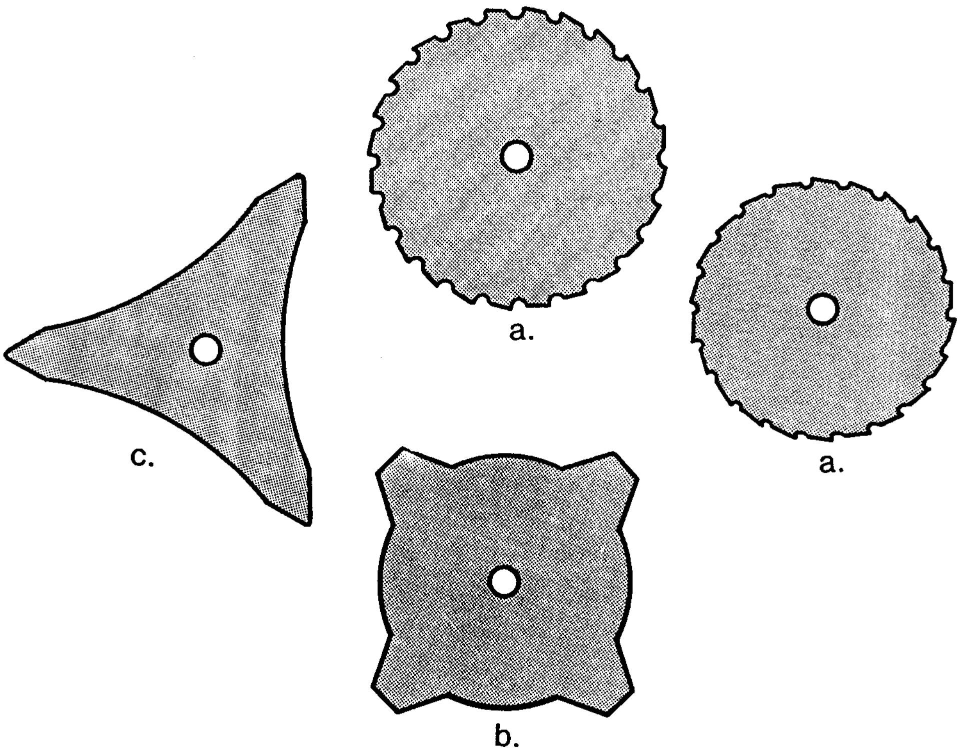


FIGURE H. Husqvarna Clearing-Saw Blades Used in Study. Clockwise from top: a. MAXI 225 and MAXI 200, b. MULTI 255-4, and c. MULTI 300.

OPERATOR TRAINING

Operator training has been recognized as a necessary step to ensure safe and efficient operation of the clearing saw; its importance has been detailed by Conway-Brown (1985). FERIC hired a local silvicultural contractor to provide two people to operate the clearing saws for the duration of the project. One operator had previous experience in thinning while the other had none. Neither operator had experience using and maintaining clearing saws and required training prior to the start of the project.

The two operators were trained for one week under the direct supervision of a qualified clearing-saw instructor provided by Pacific Equipment Co. of Vancouver. This training included:

- use and adjustment of the saw harness,
- balance and adjustment of the saw,
- maintenance of saw and blades,
- saw handling and cutting technique,
- adjustment of cutting technique to site factors, and
- safe work habits.

During the treatment, the operators were instructed to cut all non-crop vegetation within the treatment areas as low to the ground as was practical.

EXPERIMENT DESIGN AND BLOCK LAYOUT

Three 50-m x 50-m treatment plots were established in each of the three vegetation types or blocks. These nine treatment plots were further divided into six sub-plots (16.7 m x 25 m) for productivity measurements. The layout and design is presented in more detail in Appendix III.

Only three treatment levels, i.e. the three blade types mounted on the Husqvarna 244RX saw, were originally planned for the study. However, early mechanical problems with the Husqvarna 244RX saws made it necessary to add the Husqvarna 165r/MAXI 225 combination as a fourth treatment level. Table 3 illustrates the four blade-saw combinations used as treatments in this study. The resulting Analysis of Variance (ANOVA) design contains some missing cells; however, since all treatments occurred in all blocks, the analysis remained straightforward. Where significant differences in productivity were found, Student-Newman-Keul's multiple range test was applied.

TABLE 3. Clearing-Saw Blade/Saw Combinations

Clearing Saw	Blade			
	MAXI 200	MAXI 225	MULTI 300	MULTI 255-4
244RX	X		X	X
165r		X		

RESULTS AND DISCUSSION

1. Overall Productivity

Productivity for the study, averaged over all vegetation types and treatments, was 0.025 ha/Productive Hour (PH) based on the total productive time summarized in Table 4. Extrapolation to an 8-hour on-site working day, with 80% productive time, yields an estimate for average overall productivity of 0.16 ha/manday. This result is better than that obtained in projects undertaken in the Cariboo Forest Region where productivities of approximately 0.1 ha/manday were measured.[4]

---

[4] Perry. 1987.

TABLE 4. Summary of Time and Productivity Assessment by Block

Activity	Block 1		Block 2		Block 3		Total[b]	
	Time (hours)	% of total	Time (hours)	% of total	Time (hours)	% of total	Time (hours)	% of total
Productive time								
Clearing time								
Cutting time	23.8	77.2	23.9	73.6	18.8	75.6	66.6	75.5
Move within plot	0.1	0.4	0.1	0.2	0.2	0.6	0.3	0.4
Clear saw blade	0.1	0.2	0.0	0.1	0.0	0.0	0.1	0.1
Total clearing time	24.0	77.8	24.0	73.9	19.0	76.2	67.0	76.0
Delay time[a]								
Mechanical	1.3	4.1	1.9	5.9	0.7	2.8	3.9	4.4
Non-mechanical								
Refuelling	1.3	4.3	1.2	3.8	1.0	3.9	3.5	4.0
Saw and blade maintenance	1.8	5.7	1.9	5.9	1.4	5.6	5.1	5.7
Equipment	0.7	2.2	1.5	4.7	0.7	2.9	2.9	3.3
Breaks	1.1	3.6	1.6	4.7	2.0	8.0	4.7	5.3
Personal	0.2	0.5	0.0	0.1	0.1	0.4	0.3	0.3
Direction	0.5	1.8	0.3	1.0	0.1	0.2	0.9	1.0
Total delay time[b]	6.9	22.2	8.5	26.2	5.9	23.8	21.3	24.0
TOTAL PRODUCTIVE TIME (hours)	30.9	100.0	32.5	100.0	24.9	100.0	88.3	100.0
TOTAL AREA (ha)	0.75		0.75		0.75		2.24	
PRODUCTIVITY (ha/PH)	0.024		0.023		0.030		0.025	
ha/manday (based on 8-hr shift at 80% utilization)	0.16		0.15		0.19		0.16	

[a] Delays only include those between 0.05 min and 15 min. Delays less than 0.05 min are included in the element in which they occurred, while those over 15 min were not considered productive time and thus excluded from the sample.

[b] Differences due to rounding.

Delay time averaged 24% of the total productive time during the study. Major non-mechanical delays were caused by refuelling, saw and blade maintenance, equipment adjustments, and operator breaks. Minor mechanical delays accounted for less than 4% of the total productive time. More serious mechanical delays (described below) were encountered during the study but, to allow for the estimation of normal operating conditions, have not been included in the productivity calculations. Non-productive time was reduced because a spare 244RX saw was used when mechanical problems were encountered.

During the study, the Husqvarna 244RX clearing saws had several mechanical malfunctions that could not be resolved by the available mechanic. One problem was the seizure of engines in three of the four saws. This problem has also been noted in other clearing saws, the 244RX and the larger 165RX (Holmsen, 1988). The engine speed settings are critical and can result in early engine failure if done incorrectly. Maintenance of the correct carburetor settings can help prevent engine seizure from occurring, but this is a difficult task to perform without experience or the assistance of a tachometer.

Another mechanical problem FERIC encountered with the Husqvarna 244RX clearing saw was the seizure of bushings in the drive-shaft tube. This resulted in heating and scoring of the drive shaft and subsequent inoperability of two of the saws. This was a manufacturing defect which has since been corrected.[5]

Productivity was also affected by the weather on the site during the study. The high summer temperatures (30°C) combined with the southern exposure caused the operators to tire quickly. Dehydration of the operators was a major concern during the project. Each time the saws were refuelled, approximately every 45 minutes, the operators required a break so they could rest and replenish fluids. As the study progressed, it became necessary to operate split shifts to avoid the hottest part of the day; the operators also found this system fatiguing.

Wasp nests also presented a hazard on the site. This caused the operators to work more cautiously, possibly affecting their production.

Experience and operator attitude are important factors influencing the productivity of a clearing saw. Efficient operation of a clearing saw requires skill and a systematic work technique; both take time to develop and are affected by the operator's attitude. Though professionally trained, the operators used in this study were relatively inexperienced as are the majority of clearing-saw operators in British Columbia. Experienced crews may achieve higher productivity levels by improving elements within the clearing time, and possibly reducing some elements in delay time. However other factors, such as site conditions, will continue to limit overall productivity.

2. Detailed Costing

The calculation of owning and operating costs are presented in Appendix IV. The costs are based on the productivity achieved in the study, with a contract labour rate of $10.00/hr. Total cost for the saw and operator was $15.40/hr excluding interest and profit allowance. Major repair costs experienced during the study are not included as they were covered by warranty.

The costs of treatment ranged from $600 to $850 per hectare based on the 8-hour shift and productivities noted in Table 5. These costs are higher than those in the Cariboo Forest Region where costs ranged from $350 to $764 per hectare. Differences may be attributed to varying labour rates and cost factors. When considering these cost estimates, it should be noted that this was a short-term study.

---

[5] P. Watters, Pacific Equipment Co. Personal communication. March 1988.

3. Seedling Damage

During the post-treatment assessment, tagged seedlings were re-examined for damage. Nearly one in five seedlings assessed for injury showed some damage attributable to treatment (Table 5). Damage was more frequent on seedlings which had been overtopped completely, or surrounded by vegetation of the same height, than on the more visible seedlings with leaders projecting above competing vegetation. Half of the damaged seedlings were severed completely. The effects of other damage types on longer term crop performance will be assessed during Phase 2.

TABLE 5. Damage to Crop Trees by Overtopping Class

	Frequency of occurence by overtopping class			
	Overtopped	Same height	Leader projecting	Total
Total seedlings assessed	121	143	44	308
Damage type				
Leader cut or missing (stem undamaged)	5	4	0	9
Stem cut or missing	13	14	2	29
Stem with bark damaged	7	3	1	11
Stem bent or buried by cut vegetation	5	5	1	11
Total seedlings damaged	30	26	4	60
Damage % by overtopping class	24.8	18.2	9.1	
% of total assessed	9.7	8.4	1.3	19.5

COMPARISON OF VEGETATION EFFECTS AND CUTTING ATTACHMENTS

Average productivity on a per-hectare basis was greater on Block 3 (0.030 ha/PH) than on Blocks 1 and 2, which was 0.024 ha/PH and 0.023 ha/PH respectively (Table 4). Productivity for the MULTI 300 blade, including delay time, was 0.032 ha/PH (Table 6), which was much higher than any of the other treatments. However, this blade and the MULTI 255-4 are designed to be used only on vegetation up to 2.5 cm in diameter; any clumps of larger hazelnut and maple bushes had to be cut with the MAXI 200/225 (Figure I).

Delay time for each of the treatment levels varied from 21 to 26% of the productive time, with the MULTI 255-4 having the lowest proportion. Non-mechanical delays have the largest contribution ranging from 17 to 20%.

TABLE 6. Summary of Time and Productivity Assessment by Treatment

Activity	Treatment							
	MAXI 200		MULTI 300		MULTI 255-4		165r / MAXI 225	
	Time (hours)	% of total	Time (hours)	% of total	Time (hours)	% of total	Time (hours)	% of total
Productive time								
Clearing time								
Cutting time	21.6	73.8	11.6	75.1	17.5	78.2	15.8	75.1
Move within the plot	0.1	0.2	0.0	0.2	0.1	0.4	0.1	0.7
Clear saw blade	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.0
Total clearing time[a]	21.7	74.1	11.6	75.4	17.6	78.7	16.0	75.8
Delay time[b]								
Mechanical	2.0	6.9	0.6	4.0	0.4	1.9	0.8	3.8
Non-mechanical								
Refuelling	0.9	3.2	0.6	4.1	1.0	4.2	1.0	4.8
Saw and blade maintenance	2.1	7.2	1.2	7.5	0.9	4.0	0.9	4.3
Equipment	1.0	3.5	0.2	1.2	0.6	2.9	1.1	5.2
Breaks	1.0	3.4	0.9	5.9	1.5	6.9	1.2	5.8
Personal	0.2	0.7	0.0	0.2	0.0	0.0	0.0	0.0
Direction	0.3	1.0	0.3	1.7	0.3	1.4	0.1	0.3
Total delay time	7.6	25.9	3.8	24.6	4.8	21.3	5.1	24.2
TOTAL PRODUCTIVE TIME (hours)[b]	29.3	100.0	15.4	100.0	22.4	100.0	21.1	100.0
TOTAL AREA (ha)	0.67		0.50		0.57		0.50	
PRODUCTIVITY (ha/PH)	0.023		0.032		0.025		0.024	
ha/manday (based on 8 hr shift at 80% utilization)	0.15		0.21		0.16		0.15	

[a] Differences due to rounding.

[b] Only delays between 0.05 min and 15 min are included. Delays less than 0.05 min are included in the element in which they occurred, while those over 15 min were not considered productive time and thus excluded from the example.

FIGURE I. Cutting Large Vegetation with MAXI 200/225 Blade.

1. Statistical Analysis

Clearing-time productivities were used in the statistical analyses and comparisons of vegetation types and blades. Clearing time is the portion of productive time, excluding all delays, that pertains to the actual cutting of the vegetation; this reflects the cutting ability of the clearing-saw blade.

Analysis of Variance (ANOVA), using clearing-time productivities, showed significant differences in productivity between blocks (vegetation types), and between treatments (blade types) (Table 7). Within each block, there were also highly significant variations in productivity between the treatments. These results suggest that the prime reason for the difference in productivity was a result of interactions between the two main effects (vegetation type and blade type).

TABLE 7. Analysis of Variance

Source	df	Probability > F Value
Blocks B (Vegetation types)	2	.0106 *
Error a (R, R x B)	6	
Operators	1	.46 ns
(O x B)	2	.69 ns
Error b (RxP, RxOxB)	6	
Treatments T (Blade types)	3	.0011 **
(T x O)	3	.17 ns
(T x B)	6	.0040 **
Error c (Residual)	24	
Corrected Total	53	

* = significant, probability (of being due to chance) less than or equal to 5 percent.
** = highly significant, probability (of being due to chance) less than or equal to 1 percent.
ns = not significant, probability (of being due to chance) greater than 5 percent.

Student-Newman-Keul's Multiple Range Test was applied to the clearing-time data to identify where differences in productivity occurred. Block 3, with its lighter and more uniform vegetation, had significantly higher productivity (0.043 ha/PH) than Blocks 1 and 2, at 0.032 and 0.033 ha/PH respectively. Additional analysis (Table 8) showed that the 244RX/MULTI 300-blade combination had significantly higher productivity in Block 3 than any of the other three treatments. This combination had the greatest effect on overall block productivity.

TABLE 8. Student-Newman-Keul's Multiple Range Test of Clearing-Time Productivity (ha/manhour) Within Blocks

Block	Vegetation Type	Treatment			
		165r MAXI	244RX MAXI	244RX MULTI 255-4	244RX MULTI 300
1	Intermediate	.036	.033	.027	.038
2	Heaviest	.032	.027	.044	.041
3	Lightest	.032	.041	.038	.061
Mean for Treatments		.032	.033	.036	.047

Means underlined by the same line are not significantly different ($p < 0.05$). COMPARISONS ARE VALID ONLY WITHIN ROWS and are for the clearing time component.

Note: The treatment means are rounded least-squares means of the clearing time data. (The effects of unequal numbers in the various classes have been removed.)

Overall, the 244RX/MULTI 300 combination had the highest clearing-time productivity of the four treatments evaluated. This result was due to the combination's significantly higher productivity in Block 3. The multiple range test results also showed no significant differences between all of the treatments in Block 1, and no significant difference between the 244RX/MULTI 300 and 244RX/MULTI 255-4 combinations in Block 2.

However, there was a significant difference between the two MULTI combinations and the MAXIs in Block 2, contributing slightly to the treatment effect in the ANOVA. This difference cannot be explained by the vegetation and ground conditions in Block 2. Vegetation was the heaviest of the three blocks and had the highest frequency of larger stems. This would suggest that all blades would perform equally as in Block 1, or that the two MAXI blades would outperform the MULTIs.

Neither of the MULTI blades are recommended for cutting stems over 2.5 cm in diameter. Therefore, in all blocks, stems over 2.5 cm in diameter were left uncut in the sub-plots treated with the MULTI blades, and the area for productivity assessment reduced accordingly. The reported difference in productivity between the MULTI and MAXI blades in Blocks 1 and 2 reflects a difference in vegetation types cut by the blade types, rather than a difference in efficiency in cutting larger vegetation.

The rankings of the MULTI 255-4 in relation to the MULTI 300 in Blocks 2 and 3 may be related to the denser herbaceous vegetation (particularly vetch and fireweed) in Block 2, compared to the uniformly dense, small, woody stems present in Block 3 (ceanothus and thimbleberry). The 255-4 is designed to handle small woody and herbaceous vegetation, but its smaller cutting edge is evidently not as efficient as the larger cutting edge of the 300 when dealing with primarily woody stems.

The MAXI blades, most commonly supplied with the saws, are good general-purpose clearing blades, capable of cutting a wide diameter range of woody vegetation. They are not as efficient as the MULTIs for cutting dense small stems due to the less aggressive tooth design. The MAXI blades had some difficulty cutting the vinelike vetch, which wrapped around the saw shaft and operators' legs. This blade is also not as efficient when cutting herbaceous vegetation which tends to be pushed aside rather than severed. On sites with a similar mix of vegetation, it is possible to use the MULTI 300 to cut the smaller shrubs and herbaceous vegetation and then change to the MAXI blade to cut the larger stems.

SUMMARY AND CONCLUSIONS

The overall productivity measured by FERIC was 0.025 ha/PH, or 0.162 ha/manday based on eight hours per day at 80% utilization. These results are slightly higher than those obtained in projects undertaken in the Cariboo Forest Region where productivities of approximately 0.1 ha/manday were measured.[6]

Productivity of motor-manual clearing operations will always be site specific, depending largely on terrain, distribution of debris, and the nature of the vegetation complex. Factors influencing productivity in this study were site characteristics, weather, operator experience, and availability of spare saws.

Treatment costs for this project ranged from $600 to $850/ha based on an owning and operating cost of $15.40/hour.

Post-treatment assessment showed that the clearing saws were effective in removing the competing deciduous vegetation. An average of 19.5% of the conifer seedlings were damaged by the treatment, depending upon the visibility of the seedlings. The most common form of damage was the cutting of the seedling stems. Other stem damage such as injuries to the bark and bending or burying of the seedling by cut vegetation was also observed.

Treatment with the MULTI 300 blade showed the highest productivity (0.032 ha/PH). However, the blade's design limits its use to shrubs and woody vegetation less than 2.5 cm in diameter. Larger vegetation such as that found on portions of the study site must be cut with a MAXI-type blade which is less efficient in the smaller shrubs and herbaceous vegetation. Therefore, the choice of blade depends on the size and composition of vegetation to be cut.

---

[6] Perry. 1987.

LITERATURE CITED

British Columbia Ministry of Forests and Lands. 1987. Five year forest and range resource program 1987-1992.

Conway-Brown, M. 1985. Manual control of red alder with clearing saw: Operations report and equipment assessment. B.C. Ministry of Forests and Lands. Unpublished contract report.

__________. 1984. Alternatives to herbicides in forestry. Pages 183-216 in: Pesticide Policy--The Environmental Perspective. Friends of the Earth Canada, Ottawa, Ontario. (Page 210)

Holmsen, S.D. 1988. Stand cleaning with Husqvarna 165RX clearing saws in northern Alberta. FERIC Technical Note TN-116.

Ketcheson, M.V. 1986. Dynamics of target weed species in clearcuts of the $ICHa_1$, $ICHa_2$ and ESSFc as classified by potential climax ecosystem association. B.C. Ministry of Forests. File Report. Nelson Forest Region.

Sutton, R.F. 1985. Vegetation management in Canadian forestry. Canadian Forestry Service, Great Lakes Forest Research Centre, Int. Rep. O-X-369.

Utzig, G.F.; P.G. Comeau; D.L. MacDonald; et al. 1986. A field guide for identification and interpretation of ecosystems in the Nelson Forest Region. 2nd Revision. B.C. Ministry of Forests, Research Section, Nelson Forest Region. 82 p.

APPENDIX I

Specifications for Husqvarna Clearing Saws and Blades

	Husqvarna 244RX	Husqvarna 165r
Engine	Husqvarna Two-Stroke	Husqvarna Two-Stroke
Displacement	44cc	65cc
Bore	42mm	48mm
Stroke	32mm	36mm
Ignition System	electronic	electronic
Carburetor	Walbro WT 17	Tillotson HS 121 A
Fuel tank capacity	0.75 litres	1.0 litre
Fuel	50:1 mixture - premium unleaded gasoline and Husqvarna two-stroke oil.	50:1 mixture - premium unleaded gasoline and Husqvarna two-stroke oil.
Weight	8.7 kg - empty without harness and cutting equipment.	10.4 kg - empty without harness and cutting equipment.
Gearing	1.36	1.24
Idle speed	2 500 rpm	2 200 rpm
Engine speed at maximum power	9 000 rpm	8 400 rpm
List price	$779.95	$899.00 (1987 model 165RX)

Clearing-Saw Blades

Blades for Forest Clearing

Maxi 200 Clearing Blade

Diameter:	200 mm
Hole diameter:	20 mm
Thickness:	1.6 mm
Number of teeth:	22
Suitable clearing saw size:	at least 24 cc
Reference number:	5020413-02
List price:	$19.25

Maxi 225 Clearing Blade

Diameter:	225 mm
Hole diameter:	20 mm
Thickness:	1.8 mm
Number of teeth:	22
Suitable clearing saw size:	at least 35 cc
Reference number:	5020195-02
List price:	$20.10

Blades for Clearing Grass and Thicket

Multi 255-4 Thicket Blade

Diameter	255 mm
Hole diameter:	20 mm
Thickness:	1.8 mm
Number of teeth:	4
Suitable clearing saw size:	at least 24 cc
Reference number:	5019105-02
List price:	$20.70

Multi 300 Thicket Blade

Diameter:	300 mm
Hole diameter:	20 mm
Thickness:	2.4 mm
Number of teeth:	3
Suitable clearing saw size:	at least 35 cc
Reference number:	5020468-01
List price:	$34.00

Each blade requires a blade guard of a size specific to the blade being used. Blade guards range in cost from $12.00 to $16.00.

APPENDIX II

Species List[1]

Latin Name	Common Name
Tree Species:	
Abies grandis	grand fir
Larix occidentalis	western larch
Pinus ponderosa	ponderosa pine
Pseudotsuga menziesii	Douglas-fir
Shrub and Herbaceous Species:	
Acer glabrum	Douglas maple
Betula papyrifera	paper birch
Ceanothus sanguineus	redstem ceanothus
Corylus cornuta	beaked hazelnut
Epilobium angustifolium	fireweed
Holodiscus discolor	ocean-spray
Rosa spp.	rose
Rubus parviflorus	thimbleberry
Symphoricarpos albus	common snowberry
Vicia americana	American vetch

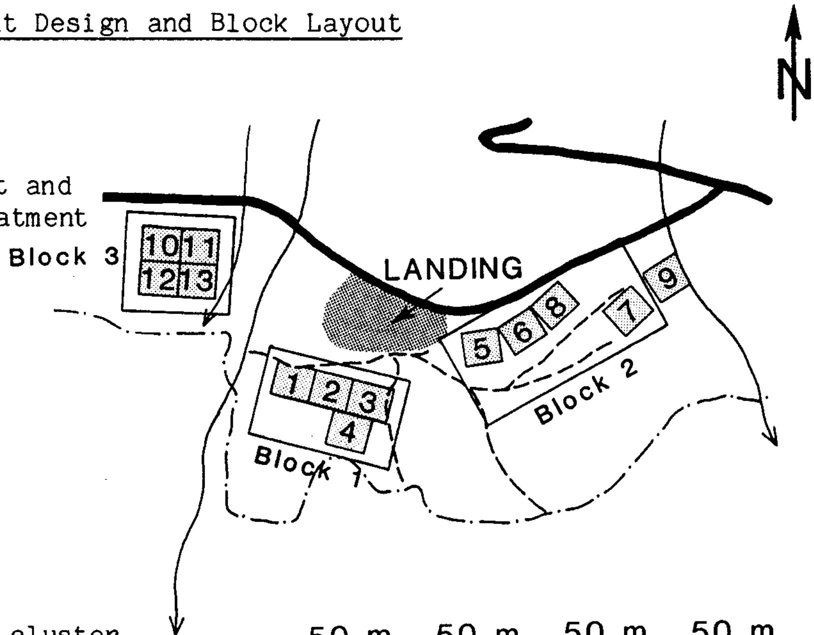
[1] Meidinger, D. 1987. Recommended vernacular names for common plants of British Columbia. B.C. Ministry of Forests and Lands. Draft report.

APPENDIX III

Experiment Design and Block Layout

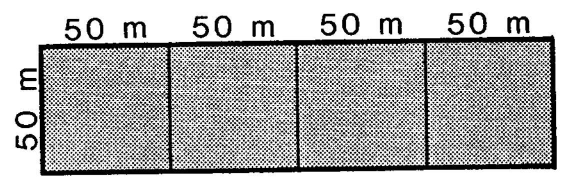
Level One

Three blocks were laid out and treated within the overall treatment area.



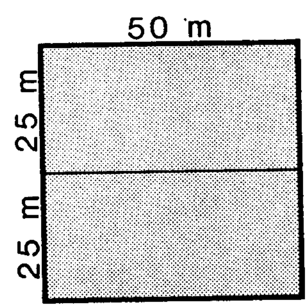
Level Two

Each block consisted of a cluster of four 50 m x 50 m plots. These plots were not necessarily contiguous, but were located closely within the area. The plots were assigned treatments randomly to obtain three treatment plots plus one control plot (for follow-up in Phase 2).



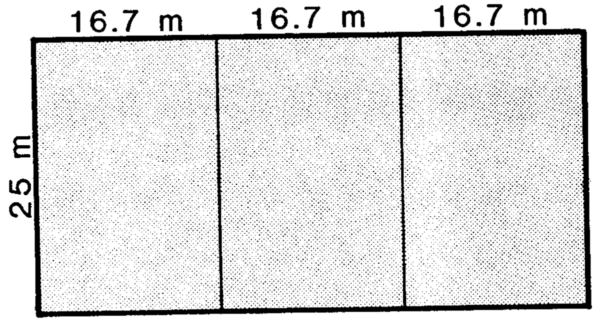
Level Three

The three treatment plots were each divided in half and one clearing-saw operator was randomly assigned to each half.



Level Four

Each clearing-saw operator was randomly assigned three saw blades (three subplots). And later, when clearing-saw model 165r was added to the study, treatments were randomly assigned to treatment areas or subplots.



APPENDIX IV

Machine Cost Analysis for the Husqvarna 244RX Clearing Saw

OWNERSHIP COSTS--INPUT		OWNERSHIP COSTS--RESULTS	
Purchase price (P)	$780.00	Average investment (AVI) = (P + S)/2	$468.00
Salvage value (S), (20% of P)	$156.00	Loss in resale value = (P - S)/h	$ 0.42/hr
Expected life (yr)	1	Interest = (Int*AVI)/(h/yr)	$ 0.03/hr
Expected life (h), (hr)	1,500	Insurance = (Ins*AVI)/(h/yr)	$ 0.01/hr
Interest rate (I), (%)	11		
Insurance rate (Ins), (%)	3		

OPERATING AND REPAIR COSTS--INPUT		OPERATING AND REPAIR COSTS--RESULTS	
Hourly fuel consumption (L/h)	0.75	Hourly fuel cost = (L)*($/L)	$0.56/hr
Fuel cost ($/L)	$0.75	Operating cost = O/(h/yr)	$0.38/hr
Annual operating cost (O)		Repair & maintenance cost = R/(h/yr)	$0.53/hr
Annual repair & maintenance cost (R)		Labour cost = (W)*[(WBL/100)]	$13.50/hr
Wages (W), ($/hr)	$10.00		
Wage benefit loading (WBL), (%)	35	TOTAL OPERATING AND REPAIR COSTS	$14.97/hr

TOTAL COSTS--RESULTS	
Loss in resale value	$0.42/hr
Insurance	$0.01/hr
Operating and repair costs	$14.97/hr
Total equipment cost (excluding interest)	$15.40/hr
Total equipment cost (including interest)	$15.43/hr