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Vol. 1 No. 10 May 2000

Contents

Evaluation of mechanical felling on a visually sensitive site

Abstract

In November 1998, the Forest Engineering Research Institute of Canada (FERIC), at the request of Spray Lake Sawmills (1980) Ltd., conducted operational and post-harvest monitoring on feathered block boundaries to determine productivities of mechanical felling and residual tree damage.

Keywords

Felling, Mechanical method, Productivity, Tree damage, Sensitive sites, Environmental aspects, Alberta.

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Introduction

Spray Lake Sawmills (1980) Ltd. holds long-term timber quota in the Kananaskis Country region of southwestern Alberta, which is a high profile recreational area due to its spectacular mountain vistas and proximity to Calgary. Kananaskis Country, zoned for multiple use by the Alberta Government, has 21% of its area defined as forest land base available for harvesting. In the fall of 1998, Spray Lake began harvesting operations in the McLean Creek area, for which it has developed a unique harvesting plan reflecting the recommendations of a special planning advisory committee of stakeholders.

Some areas designated for harvesting in this area had feathered block boundaries to reduce the visual prominence of the harvest and to stabilize the boundary against windthrow. As boundary feathering is a departure from Spray Lake's historic harvesting practice, Spray Lake requested that FERIC conduct operational and post-harvest monitoring on the cutblocks to provide feedback on phase productivities and residual tree damage. Because only the feller-buncher was affected by the feathered boundary treatment, it was the only equipment monitored.

Objectives

The objectives of the study were to:

- Compare the productivity of the feller-buncher within the block and within the feathered boundary region.
- Conduct post-harvest surveys to determine residual trees and tree wounding levels within the feathered boundary region.

Site and system descriptions

The feathering trial was conducted in two areas in the Lower Foothills Natural Subregion of Alberta. The first study block had an off-highway vehicle (OHV) trial passing through the length of the block, making aesthetics from the trail an item for consideration. One side of the OHV trail, the one with the feathered boundary, had slopes of 15 to 45%. The other side of the

trail was flat. The first study block had 750 m of feathered boundary. Activity sampling of conventional falling and boundary feathering was conducted in the first block. In a second block, activity sampling was only conducted in the feathered boundary region which was flat and 250 m long. Both blocks contained 80-year-old lodgepole pine with a minor component of white spruce in the understorey.

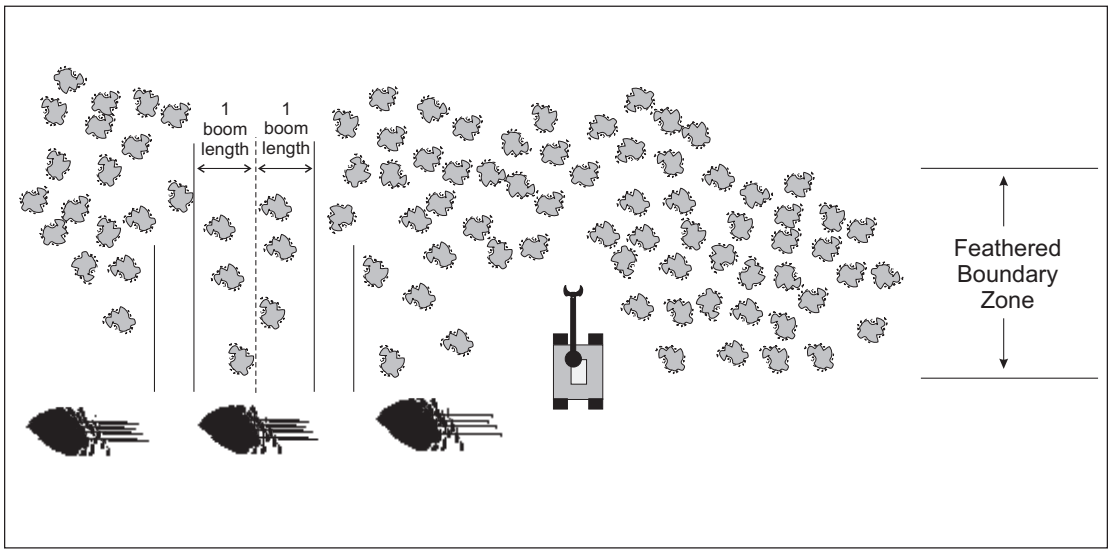
Figure 1. Feller-buncher operating within the block.

Soils in the sloped feathered boundary area were sandy loam in texture, of morainal origin, and well drained since they contained approximately 40% coarse fragments as gravel and cobbles.

Falling was completed by a Timbco T445-C feller-buncher equipped with a levelling cab and a Quadco head with a tree diameter capacity of 55 cm (Figure 1). While working on slopes, the operator travelled perpendicular to the road starting at roadside and working uphill. In areas with no slope, the operator walked the machine through the standing timber to the back of the block and then felled trees while working to roadside. In the second block, feathering was completed after the stand around the feathered boundary region had been felled. Strips were felled in the feathered area two boom lengths apart (Figure 2).

Spray Lake's feathering prescription was to remove 20% of the trees within one boom

Figure 2. Harvesting pattern of feller-buncher within the feathered boundary zone.



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ISSN 1493-3381

reach of the feller-buncher beyond the block boundary, and 80% of the trees within one boom reach inside the block boundary. The feller-buncher operator used his judgement to select the trees for removal. He decked the stems at the interior edge of the feathered boundary region for subsequent at-the-stump processing using a CAT 320B with a Waratah HTH dangle head. The processed stems were then skidded to roadside with grapple skidders. Only the feller-buncher productivity was affected by the feathered boundary treatment and therefore only its production was monitored.

Methods

FERIC conducted activity sampling on the falling operations in November 1998. Work cycle activities were described in Appendix I. Activities were recorded at intervals of thirty seconds. For analysis, percentages were first transformed using the arcsin percentage transformation, and means were compared using Tukey's multiple comparison.

Productivities were calculated based on the number of trees felled during timing periods. Volume harvested was obtained from company records, and was based on weigh scale values converted to volume.

Machine ownership and operating costs were calculated based on FERIC's standard costing methodology and are presented in Appendix II.

Post-harvest surveys were done using a randomized block sampling technique in the feathered boundary region. The entire treated boundary was divided into blocks 30 m long by the width of the treated area. Twenty percent of the blocks were selected at random for post-harvest cruising and tree wound surveying. The trees remaining within the feathered boundary region were not identified as being beyond, or within, the block boundary.

To determine pre- and post-harvest densities, all stumps and trees within the selected blocks were counted. As well, heights, diameters, widths, and lengths of wounds on all residual trees were measured and recorded. GPS positions of block corners were recorded and all residual trees were numbered so that subsequent surveys could be done to qualify windthrow or growth and yield.

Results and discussion

Feller-buncher productivities and costs

Normally with this logging method, the operator would feather the boundary during the same pass by combining the within-block operation and the feathered boundary treatment. However, for the purpose of the study, the operator felled the within-block area first and then feathered the boundary. This allowed activity sampling of the treatments to be carried out in two distinct operations. The results of the activity sampling are presented in Table 1.

Table 1. Feller-buncher activities by treatment

Activity	Within block (%)	Within feathered boundary region (%)
Fall and bunch	76 [a]	69 [b]
Fall to waste	7 [a]	2 [b]
Move	13 [a]	28 [b]
Delay	4 [a]	1 [a]
Total	100	100
Observations (no.)	1505	1065

Note: Rows with the same letter indicate the means are not significantly different at the 95% confidence interval (alpha=0.05).

The percentage of time spent falling and bunching was higher within the block because the operator was able to devote more time to these activities, since bunching locations were closer together than within the feathered boundary region.

productive machine hour (PMH) compared to 182 stems/PMH within the feathered boundary region (Table 2). The cost per cubic metre of the feller-buncher treatment was determined to be $4.18 within the block and $7.52 within the feathered boundary region.

Table 2. Productivities and costs of feller-buncher treatments

Activity	Productive time (PMH)	Productivity (stems/PMH)	Productivity (m^3/PMH)	Machine harvesting cost ($/PMH)	Machine harvesting cost ($/$m^3$)
Within block	12.54	326	45	187.97	4.18
Within feathered boundary region	8.88	182	25	187.97	7.52

The operator spent less time falling to waste within the feathered boundary region compared to within the block. This decrease occurred because the operator didn't have to fall dead trees within the feathered boundary region, and many of the dead trees were left standing since they could have only been accessed by falling living trees. Leaving the dead trees standing is a benefit to wildlife, and is therefore particularly important in this area since it is zoned for multiple use.

The percentage of time spent moving the feller-buncher was higher in the feathered boundary region compared to within the block because the operator spent more time moving between bunching locations. Also, after backing to the edge of the feathered boundary to deck stems, the operator had to drive back up the thinning trail to the next falling location.

During the study, the productivity of the feller-buncher within the block was 326 stems per

Post-treatment assessments

The width of the feathered boundary region ranged from 12.3 to 28.2 m and averaged 17.5 m. Approximately 50% of all trees were removed within the feathered boundary region. Of the trees remaining, 24% were dead and 17% of the live trees were damaged. Nine percent of the live trees had more than one scar (Table 3). All damage was caused by the feller-buncher as it was the only machine that accessed the feathered boundary region.

Table 3. Residual tree damage

Residual trees (no.)	583
Dead trees (no.)	142
Trees surveyed (no.)	441
Trees with scars (%)	16.6
Trees with more than one scar (%)	8.8
Size of damage	
Average width (cm)	3.5
Average length (cm)	10.4
Average area (cm^2)	39
Ave. height of damage from base of tree (cm)	110

Conclusions

On the visually sensitive slopes of the Kananaskis Country region in southwestern Alberta, Spray Lake Sawmills (1980) Ltd. is modifying both its harvest planning and harvest system selections to protect the high recreation and tourist values of these slopes.

Costs of the falling operations were calculated to be $4.18 and $7.52/$m^3$ within the block and within the feathered boundary region, respectively. Approximately 50% of all trees were removed within the feathered boundary region. Of the live trees remaining in the feathered edge region, 17% were damaged.

References

Meek, P. 1997. Mechanized selection cutting in hardwoods with a Timbco T-445. FERIC, Pointe-Clarie, Que. Technical Note TN-265. 12 pp.

Acknowledgements

The author would like to thank Ed Kulcsar of Spray Lake Sawmills (1980) Ltd., Vern Graham Jr. of Timber Pacific Forest Harvesting Ltd., and the crew of Victory Bar V Logging for their cooperation during the study. Peter Dyson of FERIC assisted with data collection.

Appendix I

Definitions

Detailed-timing studies

Productive time	When the machine does the type of work for which it is intended. Expressed in terms of productive machine hours (PMH), including all minor delays and machine movements, with durations less than 10 min/occurrence. The various activities performed by the machines during productive time are referred to as work elements.

Feller-buncher work elements

Fall and bunch	When the operator actively falls and bunches merchantable trees or snags. This includes all boom movements needed to fall and bunch trees (grab, fall, swing to bunch, bunch, and swing back). The number of trees accumulated in the felling head prior to bunching is referred to as trees/(falling) cycle.
Fall-to-waste	When the operator falls or knocks down (unmerchantable) trees with no intention to place them in bunches.
Move	When the operator moves the machine in the stand.
Minor delay	When the operator does not perform any work with the machine, or performs a machine activity that is not related to the objectives of the work cycle. Delays exceeding 10 min are classified as major delays, and not considered a time element in the productive time.

Appendix II

Machine costs [a]

	Timbco T445-C feller-buncher
OWNERSHIP COSTS	
Total purchase price (P) $	580 000
Expected life (Y) y	5
Expected life (H) h	10 000
Scheduled hours/year (h)=(H/Y) h	2 000
Salvage value as % of P (s) %	20
Interest rate (Int) %	7.0
Insurance rate (Ins) %	2.0
Salvage value (S)=(s•P/100) $	116 000
Average investment (AVI)=((P+s)/2) $	348 000
Loss in resale value ((P-S)/H) $/h	46.40
Interest=((Int•AVI)/h) $/h	12.18
Insurance=((Ins•AVI)/h) $/h	3.48
Total ownership costs (OW) $/h	62.06
OPERATING COSTS	
Fuel consumption (F) L/h	20.0
Fuel cost (fc) $/L	0.45
Lube and oil as % of fuel cost (fp) %	20
Track & undercarriage replacement (Tc) $	30 000
Track & undercarriage life (Th) h	3 000
Annual repair and maintenance (Rp) $	88 000
Shift length (sl) (h)	10.0
Operator wages (W) $/h	24.38
Wage benefit loading (WBL) %	35
Fuel cost (F•fc) $/h	9.00
Lube and oil cost ((fp/100)•(F•fc)) $/h	1.80
Track & undercarriage (Tc/Th) $/h	10.00
Repair and maintenance cost ((Rp/100)•P/h) $/h	44.00
Wages and benefits (W•(1+(WBL/100))) $/h	32.91
Total operating costs (OP) $/h	97.71
TOTAL OWNERSHIP AND OPERATING COSTS (OW+OP) $/SMH	159.77
TOTAL OWNERSHIP AND OPERATING COSTS ((OW+OP)/machine utilization) [b] $/SMH	187.97

[a] These costs are based on FERIC's standard costing methodology for determining machine ownership and operating costs. They do not include supervision, profit and overhead, and are not the actual costs for the contractor or company.

[b] Machine utilization used for the feller-buncher in the calculation was 85% (Meek 1997).