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Productivities and costs of harvesting small openings in the Cariboo Forest Region

Contents

Abstract

In cooperation with West Fraser Mills Ltd., Quesnel Division, the Forest Engineering Research Institute of Canada (FERIC) carried out a study to examine the effects of opening size, orientation, and retention level on harvesting productivity and visual quality in the Cariboo Forest Region in central British Columbia. FERIC monitored the harvesting phase on six openings during the winter of 1998. This report documents the productivities and costs of the harvesting operations and compares the operating practices for each opening.

Keywords

Harvesting, Felling, Manual method, Skidding, Productivity, Costs, Softwoods, Interior British Columbia.

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Introduction

In 1995 West Fraser Mills Ltd., Quesnel Division and FERIC initiated a study to investigate the effects of opening size, orientation, and retention level on visual quality in West Fraser's operating area north of Wells, B.C. The Barkerville Corridor portion of this operating area is in the Quesnel Highlands' Special Resource Development Zone of the Cariboo-Chilcotin Land-Use Plan (Province of British Columbia 1995). In this zone, timber harvesting, mining, or grazing can take place, but in a manner that respects the other values of fish, wildlife, ecosystem, backcountry recreation, and tourism.

Under contract to West Fraser, a consultant performed a digital terrain analysis and computer simulations for visual impact on a pilot block (harvested in January 1996) and on the study block (harvested in the winter of 1998). A second consultant completed a windthrow hazard assessment on the study block. The harvesting system for the study block and layout of the individual openings were determined following harvesting on the pilot block, after taking into account the recommendations by the consultants and concerns of the local community. FERIC monitored the harvesting phase on both the pilot and study blocks, with the results of the latter presented in this report.

Study objectives

FERIC's objectives, addressed in this report, were to:

- Determine the productivities and costs of the harvesting operations.
- Compare the productivities and costs of the harvesting phases in each opening.
- Evaluate the equipment and operating practices used for harvesting each opening and identify operating constraints.

West Fraser will determine the impacts of harvesting pattern on silviculture and visual quality, and the incidence of windthrow.

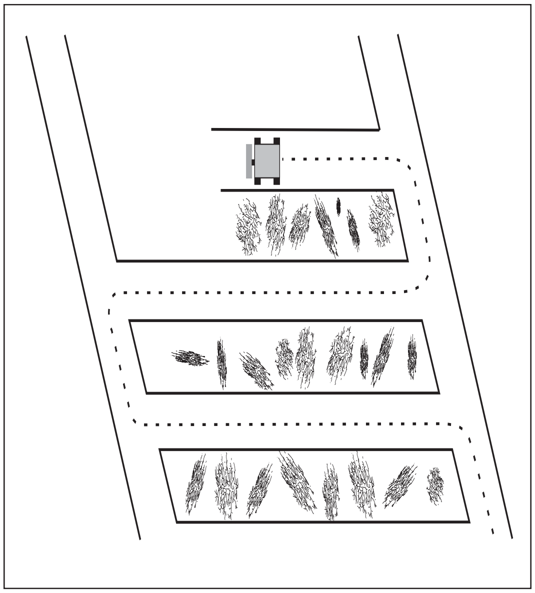

Figure 1. Location of the study site.

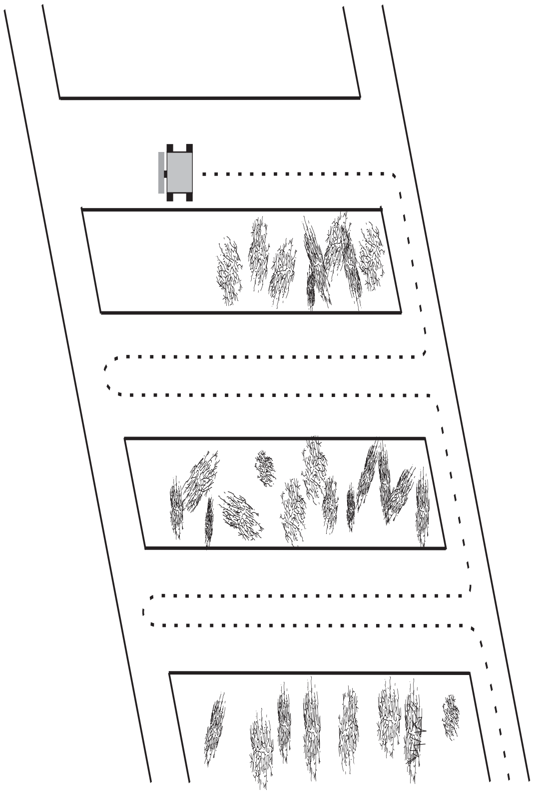

Figure 2. Locations of the openings studied.

Project and site descriptions

The study site is located on Cornish Mountain, which is 80 km east of Quesnel (Figure 1). The site is located in the Engelmann Spruce Subalpine Fir wet cool subzone (ESSFwk1) in the Cariboo Forest Region (B.C. Ministry of Forests 1997). The elevation ranges from 1190 to 1290 m and the terrain is broken with ground slopes up to 46%. The initial stand consisted of subalpine fir (*Abies lasiocarpa*), interior hybrid spruce (*Picea glauca* x *P. engelmannii*), Douglas-fir (*Pseudotsuga menziesii*), and lodgepole pine (*Pinus contorta* var. *latifolia*). The net merchantable volume for the stand ranged from 138 to 437 m^3/ha, and averaged 300 m^3/ha. The trees averaged 33 cm in diameter at breast height, 25 m in height, and 0.7 m^3 in merchantable volume.

Methods

The study block was divided into 13 openings ranging in size from 2.0 to 9.8 ha. Eleven openings were to be clear cut, one was to have a group selection for half of the opening and be clear cut for the other half, and one was to be commercially thinned with horses. Only six openings (five clearcuts and the group selection/clearcut) were completed during the 1998 winter season, and therefore only these are included in this report (Figure 2).

To obtain shift-level information for each opening, FERIC installed Servis recorders on the skidders and maintained daily crew records. To supplement the shift-level data, specific information on the falling, skidding and processing cycles was obtained by detailed timing. Harvested wood volumes for each opening were obtained from West Fraser's weigh-scale receipts.

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Harvesting costs were calculated using FERIC's standard costing methodology and assumptions (Appendix I).

Harvesting systems

Opening boundaries were marked with paint and flagging tape. Skid trails were located and constructed by the harvesting contractors. In five of the six openings studied, stems were processed and decked at roadside. In the sixth, a wide spot on the road was used for a landing.

Harvesting was completed by two of West Fraser's harvesting contractors using conventional ground-based harvesting systems. The first contractor completed five openings including the group selection/ clearcut (17 groups were removed) using a three-person crew: a hand faller, a John Deere 650G tracked line skidder operated by the contractor, and a John Deere 790 processor at roadside operated by a subcontractor.

The second contractor completed one opening with a two-person crew: a hand faller who divided his time between falling and bucking at the roadside, and the contractor who operated an International TD15 tracked line skidder. Both contractors used subcontractors with self-loading logging trucks to haul the wood to West Fraser's sawmill in Quesnel.

Only the falling and skidding phases were included in this study; the processing phase was not included because one contractor used a mechanical processor and the other used a chainsaw, so the results could not be compared.

Results

Productivity

Falling productivity ranged from 112 to 178 m^3/8-h shift (Table 1). The faller in Opening 1 spent approximately half of his time bucking, but was able to produce 106 m^3

Table 1. Falling productivity and costs by opening, based on shift-level timing

	Opening					
	1	2	3	4	5	6 [a]
Contractor	2	1	1	1	1	1
Productive falling hours (PWH) [b]	92.5	48.5	22.5	53.5	60.0	82.5
Productive bucking hours (PWH)	109.8	-	-	1.0	-	-
Non-mechanical delays						
Coffee/lunch (h)	12.3	4.0	1.5	3.5	4.0	4.5
Scheduled worker hours (SWH)	214.6	52.5	24.0	58.0	64.0	87.0
Volume harvested [v] (m^3)	2 610	1 165	335	984	1 016	1 447
Area harvested [a] (ha)	9.8	3.0	2.0	3.1	2.5	n.a.[a]
Volume harvested/area [v/a] (m^3/ha)	266	388	168	317	406	n.a.
Productivity						
m^3/PWH	28.2	24.0	14.9	18.4	16.9	17.5
m^3/SWH	26.5	22.2	14.0	17.3	15.9	16.6
m^3/8-h shift	106 [c]	178	112	138	127	133
Utilization (PWH/SWH) (%)	94 [c]	92	94	94	94	95
Falling cost (\$/m^3) [d]	1.81	2.17	3.44	2.83	3.02	2.89

[a] A portion of Opening 6 was clear cut; the remainder was harvested in 17 groups.
[b] Productive worker hours.
[c] The faller divided his time between falling and bucking; productivity is based on a 4-h shift.
[d] Hourly rate is based on June 15, 1996 IWA wage rates, with 35% for fringe benefits.

during his 4-h shift. Skidding productivity ranged from 72 to 138 m^3/8-h shift (Table 2). When the skidding distances are standardized at 100 m, productivity is highest for Opening 4, followed by Openings 5, 1, and 6 (Table 3). Openings 2 and 3 were harvested when FERIC was not onsite, so there is no detailed timing information for these.

Costs

Falling costs ranged from $1.81 to $3.44/$m^3$ (Table 1), while skidding costs ranged from $3.79 to $6.98/$m^3$ (Table 2). Opening 2 had the lowest overall cost from stump to landing, excluding processing, at $5.96/$m^3$. The remaining blocks ranged from $7.55 to $8.96/$m^3$ (Figure 3).

Table 2. Skidding productivity and costs by opening, based on shift-level timing

	Opening					
	1	2	3	4	5	6 [a]
Productive skidding hours (PMH)	259.1	59.7	23.6	56.1	79.1	106.4
Non-mechanical delays						
Coffee/lunch (h)	21.1	3.6	1.3	10.6	8.1	14.2
Mechanical delays (service, maintenance and repairs) (h)	11.2	4.2	1.7	4.3	5.1	4.6
Scheduled machine hours (SMH)	291.4	67.5	26.6	71.0	92.3	125.2
Total volume skidded (m^3)	2 610	1 165	335	984	1 016	1 447
Average skidding distance (m)	330	75	55	45	175	50
Productivity						
m^3/PMH	10.1	19.5	14.2	17.5	12.8	13.6
m^3/SMH	9.0	17.3	12.6	13.9	11.0	11.6
m^3/8-h shift	72	138	101	111	88	92
Utilization (PMH/SMH) (%)	89	88	89	79	86	85
Skidding cost ($/$m^3$)	6.98	3.79	5.19	4.72	5.94	5.65

[a] A portion of Opening 6 was clear cut; the remainder was harvested in 17 groups.

Table 3. Standardized skidding productivity, based on detailed timing

	Opening			
	1	4	5	6 [a]
Average pieces/cycle	12.8	5.4	6.3	3.3
Average piece size (m^3) [b]	0.54	1.28	0.71	0.84
Average skid distance (m)	330	45	175	50
Productivity (m^3/h)	9.1	19.5	12.3	17.8
Productivity at 100 m (m^3/h)	11.2	14.8	12.2	9.8

[a] A portion of Opening 6 was clear cut; the remainder was harvested in 17 groups.
[b] Based on the cruise summary.

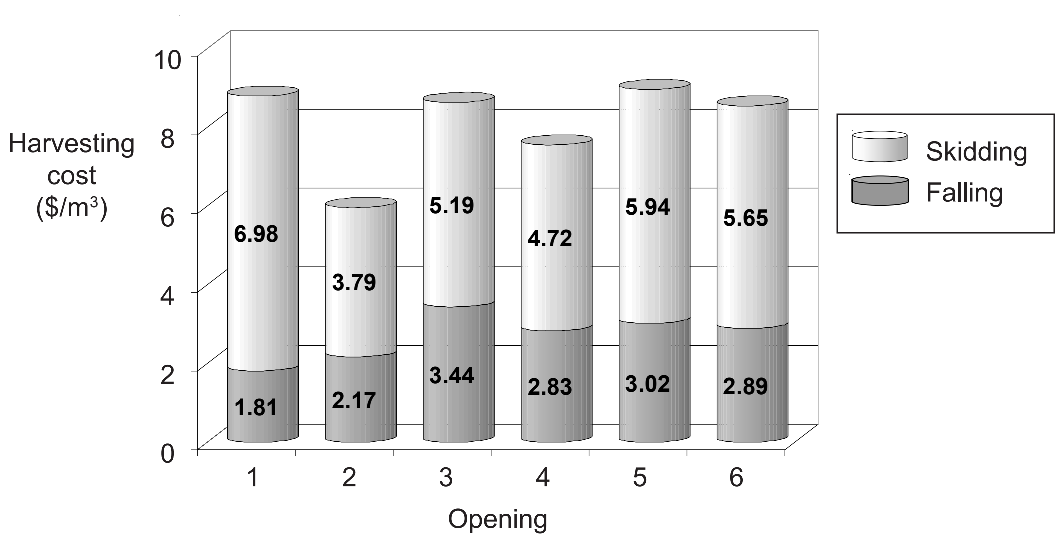

Figure 3. Falling and skidding costs.

Discussion

Harvesting with small openings or group selection requires more planning and field work during the development stage than conventional clearcut operations with larger opening sizes. The size and location of the access roads and landings will affect skidding distance, harvesting productivity, cost, and visual impact. Costs for planning and layout activities were not included in FERIC's study. However, Thibodeau et al. (1996) and Mitchell (1996) found that planning and layout costs for harvesting small patches were 1.9 to 2.3 times greater than for larger clearcuts due to more intensive planning and field work requirements.

The two harvesting contractors had experience in partial cutting and thinning. Because the operating procedures for partial cutting and thinning are similar to those for harvesting in small openings, the contractors were familiar with the procedures to be used in this study. West Fraser informed both contractors of the objectives and had frequent discussions with their crews, who were willing to try different things to achieve West Fraser's objective of minimizing visual impact with smaller, irregularly shaped openings.

During the study period, the temperatures on the site varied from –5° to –40° C. When the temperatures dropped below –30°C, the operators covered the equipment overnight and spent approximately one hour in the morning warming up the skidders before using them. At –40°C, the crew did not work.

Falling productivity was affected by the weather and operating procedure. The fallers found falling difficult on cold days, as the wood was frozen and harder to cut. The faller who divided his time between falling and bucking had the higher productivity, because he was not falling for the full 8-h shift. The faller had a "break" and could return to the falling refreshed. The faller on the group selection (Opening 6) was provided with daily instruction on how much to cut or leave, based on West Fraser's visual assessment from the town of Wells.

The skidding distance, slope, and weather affected skidding productivity. The block was developed to minimize the amount of road and landings required to access each opening and to minimize the visual impact of the harvesting, resulting in some irregularly shaped blocks and very long skidding distances. The skidder operators found skidding more difficult on warmer days, as the branches did not break off as easily as in cold weather.

The maximum skidding distance for the first contractor was in Opening 5, at approximately 350 m. Skidding productivity decreased when the skidder had to skid uphill (portions of Openings 1, 6, and 3). The shortest and most favourable average skidding distances for this contractor occurred in Openings 2 and 4 (approximately 50 m), the two openings with the lowest skidding costs.

The maximum skidding distance for the second contractor was 700 m. This contractor worked only in Opening 1, which was the largest of the openings (10 ha) and where all of the stems were skidded to one corner of the opening. Some of the skidding cycle times were close to one hour. Part of Opening 1 required adverse skidding, which increased the difficulty.

The skidder operator working in Opening 1 spent most of his time positioning the skidder, winching the stems to the skidder, and spreading and decking the stems at the landing. If he had used a mechanical processor, he could have reduced the decking time, as the stems would have been picked out of the pile by the processor rather than be spread out for the bucker.

The skidder operator working in the other openings had to balance short and long skidding distances to provide a continuous flow of stems to the processor without "plugging up" the decking space. The processor was unable to handle the large Douglas-fir stems in Openings 4 and 5, and set them aside until the faller or skidder operator could buck and delimb them so they could be decked. This process took time away from falling and skidding, but only occurred a few times and would not have warranted the extra cost involved in using a larger processor.

Falling and skidding productivities were not directly affected by opening size. Factors that have a greater effect include layout, weather, operating procedure, skidding distance, and decking space.

Conclusions and implementation

Falling productivity was influenced by weather conditions and the operating procedure, with cold weather negatively affecting the falling productivity. One faller divided his time between falling and bucking, and his falling productivity was higher than that of the full-time faller.

Opening layout, distance, slope, operating procedure, and weather affected skidding productivity. The openings with one landing at the end of the opening had the longest skid distances, as did the irregularly shaped openings. Skidding productivity was highest for short skid distances and those with favourable grade. The contractor who processed and decked the wood on the roadside had to maintain a consistent flow of stems to the processor, unlike the other contractor who stockpiled the stems for the faller/bucker. Cold weather made skidding easier as the branches broke off and created less resistance during skidding.

Mechanical processing was affected by the flow of stems to the roadside and by stem size. The long skid distances caused some idle time for the processor. The processor had a limited decking area while working at roadside without landings. When the stem was too large for the processor to handle, the processor had to wait for the processing to be done manually by the skidder operator or faller.

Harvesting costs (stump to landing excluding processing) ranged from \$5.96 to \$8.96/m^3. Piece size, opening layout, experience and skill level of labour, equipment selection, and weather conditions influence cost and productivity. Openings that are small or irregularly shaped will affect skidding productivity more than falling productivity. There is a trade-off between minimizing the number of landings and minimizing the skidding distance, and this should be considered in the planning and layout stages of block development. The increase in cost may be acceptable if a block has few roads and landings, and the visual impact is minimal.

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Appendix I

Machine costs [a]

	John Deere 650 tracked line skidder	International TD15 tracked line skidder
OWNERSHIP COSTS		
Total purchase price (P) $	120 000	100 000
Expected life (Y) y	6	6
Expected life (H) h	9 600	9 600
Scheduled hours per year (h)=(H/Y) h	1 600	1 600
Salvage value as % of P (s) %	30	30
Interest rate (Int) %	10	10
Insurance rate (Ins) %	3	3
Salvage value (S)=(s•P/100) $	36 000	30 000
Average investment (AVI)=((P+s)/2) $	78 000	65 000
Loss in resale value ((P-S)/H) $/h	8.75	7.29
Interest=((Int•AVI)/h) $/h	4.88	4.06
Insurance=((Ins•AVI)/h) $/h	1.46	1.22
Total ownership costs (OW) $/h	15.09	12.57
OPERATING COSTS		
Wire rope (wc) $	2 300	2 300
Wire rope life (wh) h	1 600	1 600
Fuel consumption (F) L/h	15	15
Fuel cost (fc) $/L	0.45	0.45
Lube and oil as % of fuel cost (fp) %	15	15
Track & undercarriage replacement (Tc) $	7 183	10 000
Track & undercarriage life (Th) h	4 000	3 000
Annual repair & maintenance (Rp) $	16 000	13 000
Shift length (sl) h	8	8
Total wages (W) $/h	21.68	21.68
Wage benefit loading (WBL) %	35	35
Wire rope (wc/wh) $/h	1.44	1.44
Fuel (F•fc) $/h	6.75	6.75
Lube & oil ((fp/100)•(F•fc)) $/h	1.01	1.01
Track & undercarriage (Tc/Th) $/h	1.80	3.33
Repair & maintenance (Rp/h) $/h	10.00	8.13
Wages & benefits (W•(1+WBL/100)) $/h	29.27	29.27
Total operating costs (OP) $/h	50.27	49.93
TOTAL OWNERSHIP AND OPERATING COSTS (OW+OP) $/h	65.35	62.50

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