Advantage

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Contents

Managing forest fuels for community protection in the interior of British Columbia: productivities and costs of thinning from below

Abstract

To reduce the potential occurrence and effects of a wildfire in a stand adjacent to a residential subdivision in the interior of British Columbia, the University of British Columbia's Alex Fraser Research Forest aimed to reduce forest fuels within the stand by thinning from below, skidding as much debris to the landing as possible, and then piling the remaining debris for burning. Feric, a division of FPInnovations, monitored the falling and skidding phases and a test piling operation in the winter of 2005, and determined the costs and productivities of these activities.

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Introduction

As more communities are built close to forests, the risk from wildfire increases in the urban–forest interface. In the interior of British Columbia, south of Williams Lake, a portion of the University of British Columbia's Alex Fraser Research Forest known as Knife Creek shares a boundary with a residential subdivision—houses are within 50 m of the forest boundary. Due to concerns about risks to the community or the forest should a fire occur, the Alex Fraser Research Forest wanted to reduce the fuel loading in the block, and thereby reduce the potential occurrence and effects of wildfire in the stand nearest the subdivision boundary. To achieve this objective, the Alex Fraser Research Forest planned to thin from below, skid as much debris to the landing as possible, and then pile the remaining debris for burning in the spring. All the trees to be cut, including dead and dying beetle-attacked trees, were pre-marked. As this stand is within the mule deer winter range, the thinning treatment would have the added advantage of improving the deer habitat. Feric, a division of FPInnovations, monitored the thinning phase of the operation during the winter of 2005, and examined the effects on fuel reduction. This report summarizes the thinning phase of the project. A detailed study of the forest fuel loading and potential fire behaviour is also being completed by Feric (Schroeder n.d.).

Objectives

Feric's objectives were to determine the operational costs and productivities associated with the falling and skidding phases of the thinning operation and with the fuel management treatments (piling and burning).

Site description

The study block is located in the xeric subzone of the Interior Douglas-fir (IDFxm) biogeoclimatic zone in the Knife Creek portion of the Alex Fraser Research Forest, 16 km southeast of Williams Lake, B.C. (Klinka et al. 2004). The stand is an uneven-aged, predominantly Douglas-fir stand with average age ranging from 80 to 100 years. The 3.8-ha block is a narrow strip of land between the Green Valley Estates Subdivision and a primary access road (Day and Mitchell 2006).

Treatments

One of the management objectives associated with this block is to maintain or improve mule deer winter range; the target stand structure therefore requires that the high density of large trees be maintained (Dawson et al. 2007). Treatments to reduce the fire hazard had been done in 1995, including pre-commercial thinning and piling and burning of the thinning debris and surface fuels.

In this study, beetle-killed trees[1] and danger trees were pre-marked for removal. Smaller Douglas-fir trees were marked to thin from below and to create a clumpy structure suitable as mule deer habitat. Saplings, poles, and unmarked trees were to be protected and retained. The contractor was instructed to remove the merchantable stems to the landing, manufacture them into sawlogs, and sort these into small and large sawlogs.[2]

Figure 1. A commercial leaf blower was used to assist in igniting the piles.

The contractor was also directed to bring as much non-merchantable material as possible to the landing, where pulp-sized material, tops, and limbs were piled for burning. The non-merchantable material remaining on the block was piled manually with rakes in the stand openings. There was no market for Douglas-fir pulp at the time of the study, so it was piled and burned with the slash. The piles were ignited by means of a propane tiger torch and a commercial leaf blower (Figure 1), and burned. To ensure complete combustion of all the debris, any unburned material was re-piled—both manually and mechanically—and a second burn was conducted.

The burning was not done until March 2006 because good venting was required on the day of the burn and on the following day in order to meet the smoke-management objectives for the airshed (Day and Mitchell 2006).

Study methods

The scheduled and productive hours were documented by mounting Servis recorders on the John Deere skidder and the Ford tractor. Because Feric was not on site every day to make observations, and because the machine operators frequently moved between skidding, bucking, decking, and falling during the same day, the operators also completed daily records of time spent on each activity during each shift. In addition, Feric conducted detailed timing using a hand-held data logger and a stop watch.

Photo points were established in the study area. Photos were taken before harvesting, after skidding, and after burning of the piles (Figures 2 to 4).

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1 Mountain pine beetle (*Dendroctonus ponderosae*) and Douglas-fir beetle (*Dendroctonus pseudotsugae*).

2 Large sawlogs had >15 cm top diameter and were a minimum 3 m long. Small sawlogs had 10 to 15 cm tops and were a minimum 3 m long.

Feric scaled sample pieces at the landing to obtain an average piece size. Feric monitored the falling and skidding phases of the harvesting operation but was not on site for the burning and re-piling. Therefore, the Alex Fraser Research Forest provided the cost and productivity information for the burning treatment. It also supplied data about the final harvest volume.

Harvesting system

All falling was conducted manually with a chainsaw. The faller sometimes used wedges and a peavey to help place the trees for easy skidding. Full trees were skidded to the landing where they were topped and limbed. During colder weather, some branches snapped off during falling and skidding and these were piled later. The two-person crew switched between falling, skidding, and bucking as needed.

Skidding was conducted with a Ford 1725 tractor equipped with a Farmi skidding winch (Figure 5) and custom-built grapple (Figure 6), a John Deere 540E line skidder (Figure 7), and a Honda ATV (Figure 8) equipped with a skidding arch (Figure 9). The tractor and skidder remained on site for the entire study, although the skidder was used for only three days. The ATV was on site for only the last three days of the study. The tractor and skidder were used mainly for the larger pieces, while the ATV was used to skid the smaller stems, the non-merchantable material, and bundles of slash. The Ford tractor with the grapple was also used at the landing to deck logs and to pile debris.

The sawlogs were removed from the site by a self-loading, short-log truck and then weigh-scaled at the mill in Williams Lake.

Results

The volume of sawlogs produced was 58.7 m^3 or 15.5 m^3/ha. This was much lower than the 350 m^3 originally planned for removal because residents in the adjacent subdivision requested that fewer trees be removed.

Figure 2. Photo point 9, east view, pre-harvest.

Figure 3. Photo point 9, east view, post-harvest.

Figure 4. Photo point 9, east view, post-burning.

Figure 5. Ford tractor equipped with Farmi skidding winch.

Figure 6. Ford tractor equipped with custom grapple.

Figure 7. John Deere 540E line skidder.

Figure 8. Honda ATV.

Figure 9. Skidding arch for the ATV. Figure

In part due to fewer stems being removed, the treatment provided less risk reduction than anticipated. So, although the treated study site had a lower probability of crown fire ignition and occurrence than the adjacent stand, some ladder fuels still exist and torching is likely to occur in extreme conditions (Schroeder n.d.). Any crown fires in the vicinity could result in long-distance ember transport and ignition throughout both stands.

Shift-level study

Table 1 shows the time spent by manual workers and equipment on each phase.

Detailed-timing studies

The time summaries and cycle elements for each phase are presented in Table 2 and in Figures 10 to 12. Delays longer than 10 min are not included and average cycle times for the skidding do not include decking or bucking because these activities did not occur in every cycle.

Costs

Harvesting costs are shown in Table 3.

Discussion

Based on the detailed-timing study, falling comprised 54% of the faller's time,

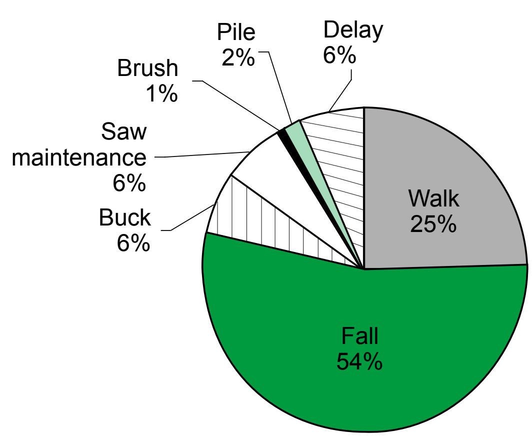

Figure 10. Detailed-timing summary for falling, based on 11.5 hours (285 trees) and an average falling time of 2.4 min/tree.

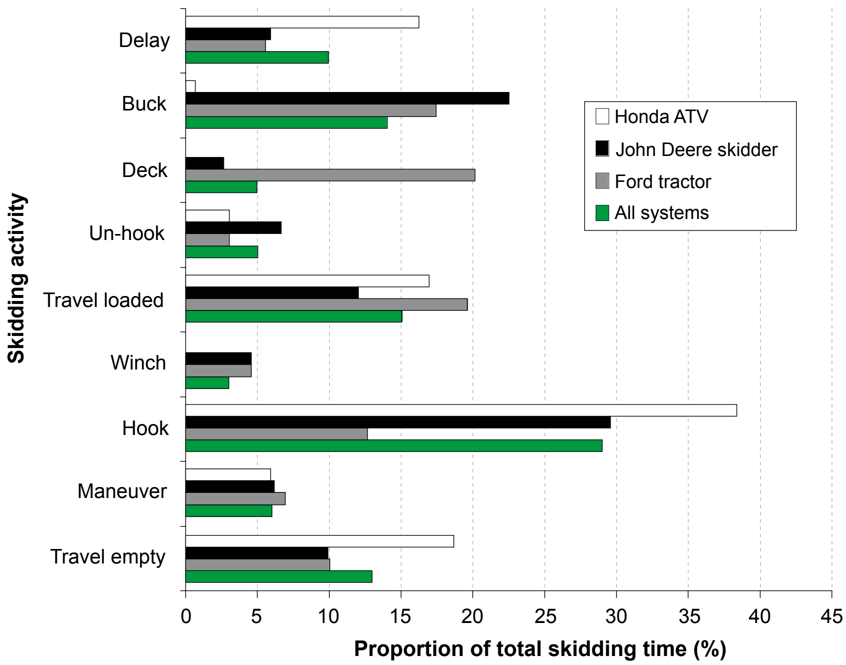

Figure 11. Detailed-timing summary for all skidding activities (see also Table 2).

while bucking, saw maintenance, and short delays (<10 min) each accounted for 6% of his time (Figure 10). The marked trees were scattered, therefore 25% of the faller's time was spent walking between them. His average cycle time was 2.4 min/tree with a range of 0.2 to 28.1 min/tree. The longer falling cycles occurred because frozen trees required the use of a peavey, and because some beetle-killed trees were large. Saw maintenance was higher when the faller

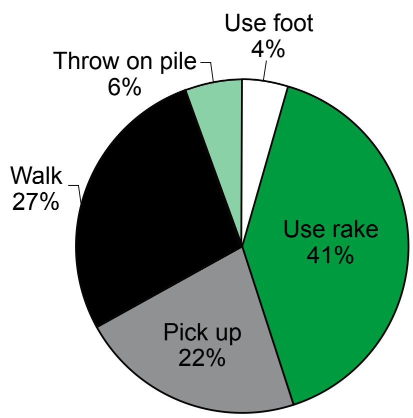

Figure 12. Detailed-time summary for manual piling, based on 1 hour of timing.

Table 1. Total time for manual workers and equipment by phase[a]

	Manual falling	Skidding			Piling		Total
		Ford tractor	John Deere skidder	Honda ATV	Manual	Ford tractor (re-piling)[b]	
Time (h)	41.5	75.5	12.5	20.5	62.0	4.5	216.5
% of total time	19.2	34.9	5.8	9.5	28.6	2.1	

a Based on Servis recorder charts and the operators' records.
b Re-piling occurred during the burning phase.

Table 2. Detailed-timing summary for skidding activities

	Cycles	Total time (h)[a]	Average skidding cycle time (min)[b]
Honda ATV	35	5.7	8.7
John Deere skidder	8	5.7	19.4
Ford tractor	8	2.5	11.1
All equipment	51	13.9	

a Total time as per Feric's detailed-timing study, including all delays.
b Average cycle time does not include bucking or decking because these activities did not occur during every cycle.

Table 3. Total cost for manual workers and equipment by phase[a]

	Manual falling	Skidding: Ford tractor	Skidding: John Deere skidder	Skidding: Honda ATV	Manual piling	Burning[b]	Total
Total time (h)	41.5	75.5	12.5	20.5	62.0	31.8	216.5
Rate ($/h)	50.00	50.00	70.00	37.50	30.55	46.67	
Total cost ($)	2075	3775	875	769	1894	2002[c]	11 390
Cost ($/ha)	546	993	230	202	498	527	2 997

a Calculated from operators' daily work records, Servis recorder charts, and detailed-timing summaries completed by Feric.
b Burning costs were provided by Don Skea of the Alex Fraser Research Forest.
c Includes labour, materials, and equipment costs.

was working at the roadside because the road dust on the bark of the trees dulled the saw quickly. To reduce saw maintenance, the faller first used an axe to de-bark the stem at the falling point. To avoid mixing the merchantable stems and the slash, the merchantable trees were cut and skidded first and then the faller returned to fall the smaller pieces. This saved the skidder operators from having to identify merchantable stems in a pile of mixed stems and slash, but meant the faller and skidder operator had to cover the same ground twice.

The results of the detailed-timing studies of the skidding equipment emphasized where each machine was most efficient (Figure 11). The combined time for "travel empty" and "maneuver" was similar for the tractor and skidder at 16%, but amounted to 25% for the ATV. The ATV operator had to dismount and manually move the ATV into position for some skids. "Hook" and "winch" together accounted for 18% of the operating time for the tractor, 34% for the skidder, and 38% for the ATV. The higher percentages for the latter two machines occurred because the pieces were scattered over the block and this affected the ability of the skidder to accumulate its average load of 10 pieces, and because the ATV operator needed time to re-pile the small non-merchantable pieces to make larger bunches. All three machines used approximately 20% of their total time for "travel loaded" and "unhook" combined but the ATV travelled faster and could cover more distance in the same time.

Bucking and decking were shared between the crew and cannot be compared directly because not every cycle contained these elements—these two activities took place only as needed. Overall, the skidder operators had a large quantity of non-merchantable material to handle; to increase efficiency, smaller pieces were piled to make larger bunches. During colder weather, tops and branches would snap off during falling or skidding, which required the operators to add them separately to the bunch or pile them later for burning.

The ATV was well suited to skidding the smaller pieces once they had been re-piled, by hand, into larger bunches. The ATV was able to skid many small pieces at one time (11 pieces were counted during one cycle) and travel speeds were fast (averaging 130 m/min over a distance of 330 m). The average cycle time for the ATV was 8.7 min (Table 2) and the average distance travelled was 230 m. The skidder was more suited to moving large bunches of bigger pieces. The skidder was used for only 12.5 h during the study, but moved a lot of wood during that time. The average cycle time for the skidder was 19.4 min. The tractor skidded some of the large pieces, but it also did most of the work on the landings where, using its grapple, it decked the processed logs and piled the debris for burning. When skidding, the tractor's average cycle time was 11.1 min.

During the detailed-timing study of the manual piling phase, the workers were continuously moving. They spent 41%

of the time using the rake to make piles, 22% picking up slash, and 27% walking to a central location to create larger piles (Figure 12). They used their feet 4% of the time to scrape slash into a small pile that they would then rake or pick up by hand to add to the larger piles. The manual piling operation was very efficient during the detailed-timing study, but a crew would not be able to sustain such a pace for an entire day; breaks would be needed. The walking time could be decreased by creating more piles, but this would add to the burning time and require more labour and supervision to ignite and re-pile the debris.

The stand contained lots of small, non-merchantable material that had to be felled and skidded to the landing for burning, or piled in the stand and burned later. However, because the stand had been thinned in 1995, it contained less material than would otherwise be expected. To maximize skidding production, handling of the nonmerchantable material needs to be kept to a minimum. Any handling that occurs should be done by hand if the pieces are small and the distances are kept short (i.e., piling in the stand). If the distance is longer, small pieces can be bunched and moved by the ATV. Larger pieces can be moved longer distances by the tractor or skidder. In general, larger equipment can move more material than smaller machines and is well suited to moving larger pieces. However, larger machines cost more to operate than smaller machines.

Overall, this fuel reduction treatment was expensive ($3000/ha), but within the range of the cost of other fuel reduction treatments (Day and Mitchell 2006) (Table 3). Although the treatment area was small (3.8 ha), over 550 m of boundary with the subdivision were treated.

Conclusions

The thinning treatment to reduce the fuel loading on the block required falling a few scattered trees and handling—sometimes multiple times—large quantities of non-merchantable debris. Every time pieces are handled, the productivity decreases and treatment costs increase. The study block had been pre-commercially thinned 10 years previously. Therefore, less debris was burned during this treatment than would be expected for this stand type at this age.

The equipment chosen for each activity was well matched to the piece size. The smaller equipment was used to move the smaller pieces and the slash, while the larger skidder was more suited to the larger pieces. The ATV skidded bunches of non-merchantable material to the landing quickly, although the operator had to pre-bunch the material to maximize the size of the bundles and production.

The manual piling was time consuming, but efficiencies could be realized by making more piles, thereby incurring less walking time, and by using the tractor to push some of the larger material into piles during the skidding phase. Skidding costs could be reduced by piling more material in the stand rather than bringing it to the landing for piling and burning, but this would affect the cost of the burning phase and increase the risk of escapes or damage to residual trees.

Together, the size of the area treated, number of trees to be removed, and the amount of material to be piled and burned determine the viability of the project. Fuel management treatments are labour intensive and therefore expensive, but the costs can be offset by removing more merchantable volume, spreading the fixed costs over a larger area, and minimizing the handling of the non-merchantable material.

Implementation

- Orient trees during falling to facilitate skidding.
- Fall trees into natural openings to minimize trail width and damage to residual trees. Debris from branches will then accumulate in a smaller area, which in turn facilitates the piling phase.
- Minimize walking time for the faller by falling merchantable material and non-merchantable material at the same time. Non-merchantable material could be bucked for easy identification and future piling.
- Match equipment to piece size. Use the ATV for slash and small stems, use the skidder for larger pieces and bunches, and use the tractor for in-between pieces and mixed bunches.
- Maximize the payload for the skidder by building larger piles at trailside, and then use the skidder to take the load to the landing.
- Minimize damage to residual trees by using rub trees or leaving high stumps along the trail edge, and by keeping the skidder on the trail and having the operator pull the line to the logs before winching them to the trail. The tractor has a lighter mainline than the skidder which is easier for the operator to pull long distances.
- Minimize handling of pieces by limbing and topping in the bush, creating larger bunches for skidding, and piling more slash in the stand for burning, but realize that the latter will affect the burning operation (e.g., more piles to ignite, increased risk of escapes or damage to residual trees).
- Skid in winter, because frozen branches and tops break off easily thus making it possible for the skidder to skid more pieces per load, resulting in fewer loads overall.

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