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Costs and benefits of seven post-harvest debris treatments in Alberta's forests

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Abstract

We surveyed fire behaviour experts and wildlife biologists to rank the importance of four factors that affect the costs and benefits of seven post-harvest debris treatments and to determine the overall costs of each treatment to the forest industry and Alberta's government. The four factors are fire behaviour potential, wildlife suitability, regeneration capability, and treatment costs.

Keywords:

Fire behaviour, Post-harvest site assessment, Post-harvest treatment, Wildlife habitat, Regeneration, Piling, Burning, Chipping, Debris disposal, Debris management, Alberta, Costs.

Introduction

Between 2001 and 2004, FPInnovations–Feric Division completed studies of the fire risk associated with different post-harvest debris treatments in four regions of Alberta (Baxter 2002, 2004a, 2004b, 2004c).[1] These studies investigated how treatments affected wildfire risk and the site factors (e.g., species, topography, weather, and human activities) that affect potential fire behaviour. The relationship between the treatments and fire behaviour is clearly important, but it is only one aspect of the overall costs and benefits associated with the treatments.

The objective of the present study was to examine the seven main debris treatments currently used in Alberta and to identify their costs and benefits. We examined four factors in this study: potential fire behaviour, wildlife suitability, regeneration potential, and treatment costs. The results of this analysis can guide forest managers in choosing the best treatment for a site based on a more complete understanding of the costs and benefits of each treatment, both for the forest industry and for Alberta.

Methods

Alberta's forest industry currently uses seven primary post-harvest debris treatments:

- complete removal of the debris from the cutblock by means of roadside processing
- at-the-stump processing with the debris left on the cutover
- spread the debris over the cutblock
- chip piled debris
- pile but do not burn the debris (coniferous debris)
- pile but do not burn the debris (deciduous debris)
- pile and burn the debris (coniferous and deciduous)

1. The reports are available at both of the following Web sites: http://fire.feric.ca and http://feric.ca

We surveyed 11 fire behaviour experts and 4 wildlife biologists from British Columbia, Alberta, the Northwest Territories, and the Yukon Territory to collect data on both the potential fire behaviour and the wildlife suitability following these treatments.[2] The surveys were accompanied by photographs of the treatments (Appendix I) to ensure clarity. Only one survey was not returned.

We asked the fire behaviour experts to rank the treatments in terms of their impact on potential fire behaviour, using the following factors:

- fuel continuity
- fuel load
- species (coniferous or deciduous)
- duration of the hazard (years)
- duration of the hazard (season)
- spotting potential
- ignition potential
- containment difficulty
- extinguishment difficulty
- potential rate of spread

Each factor was ranked on a scale from 1 to 6, and the scores for each of the seven debris treatments were totalled to represent the overall potential fire behaviour.

We asked the wildlife biologists to rate each treatment from 1 (poor) to 5 (highly suitable) based on its suitability for use of the site by small to medium-sized mammals, such as pine martens, squirrels, and mice. These rankings reflected the site's suitability as shelter or for food, depending on the species.

We tabulated the results from the fire behavior specialists and wildlife biologists, and ranked the treatments using the multiple account analysis approach described by Shaffer (1991). Multiple account analysis was developed to account for both the economic components and relative data, and uses a matrix to sum the ratings of individual factors and produce an overall ranking. Each of the four factors in our study received an individual ranking, and the four values were then summed to provide an overall ranking for each treatment.

The regeneration costs and treatment costs were collected through discussion and e-mail correspondence with experts in Alberta's forest industry.

Results and discussion

Potential fire behaviour

The debris treatments were ranked from best (least overall fire risk) to worst (highest overall fire risk) in terms of potential fire behaviour (Table 1).

Table 1. Ranking of the overall fire hazard for each treatment (lower ranks indicate a lower risk)

Rank	Treatment	Mean score	Relative fire risk
1	Pile and burn the debris (coniferous and deciduous)	21.0	Low
2	Complete removal of the debris by means of roadside processing	22.3	Low
3	Chip piled debris	33.6	Moderate
4	Pile but do not burn the debris (deciduous)	35.3	Moderate
5	Pile but do not burn the debris (coniferous)	42.9	High
6	Spread the debris over the cutblock	47.1	High
7	At-the-stump processing with the debris left on the cutover	51.4	High

2. The questionnaire is available from the author upon request.

The treatments fell into three risk potential groups: low, moderate, and high. The low-risk treatments (pile and burn the debris, complete removal of the debris by means of roadside processing) were designed to greatly reduce the amount of debris remaining on the site. The moderate-risk treatments (chip piled debris, pile but do not burn the deciduous debris) and the high-risk treatments (pile but do not burn the coniferous debris, spread the debris over the cutblock, at-the-stump processing with the debris left on the cutover) involved less aggressive treatments. Low risk resulted from decreased fuel loads remaining on the site after the treatment. Moderate risk resulted from modifying the distribution of the debris on the site. High risk resulted from heavier fuel loads and riskier distribution of the debris on the site.

The time of year when fires were likely to occur was raised as an issue by several respondents. The season influences the degree of curing of the grasses and other flammable vegetation in the cutblocks (i.e., their degree of dryness) and this, in turn, influences the fire risk, especially the risk of ignition. In the questionnaire, we instructed respondents to assume that the same conditions existed for all photos; therefore, the seasonal factor should have been accounted for in the responses.

The respondents also ranked the individual fire behaviour characteristics (Table 2) in order of least concern (duration of hazard) to greatest concern (ignition potential). Tree species (coniferous or deciduous) is not included in this table because it was incorporated in the overall ranking of fire risk for each of the seven debris treatments.

At-the-stump processing with the debris left on the cutover had the highest risk rating for 8 of the 10 fire behaviour factors. Complete removal of the debris had the lowest risk rating for 6 of the 10 factors. Piling and burning the debris was the best treatment or equal to the best in 5 of the 10 factors.

The duration of the hazard (season) was of least concern to the fire behaviour experts, whereas the greatest concerns were the ignition potential and the duration of the hazard (years). In most of the debris arrangements, the fuel is elevated and dries more than fuel that lies directly on the ground, leading to easier ignition. At-the-stump processing with the debris left on the cutover and spreading the debris over the cutblock had high ratings for ease of ignition, but this rating would decrease in the years following the treatment due to the fall of dry needles to the ground and the decomposition of fine fuels.

Range of responses for individual characteristics

The fire behaviour experts were generally consistent in their analyses of the fire behaviour characteristics. Only three

Table 2. Importance of the individual fire behaviour characteristics, as ranked by the experts (lower scores represent lesser importance)

Variable	Score
Duration of the hazard (season)	172
Containment difficulty	215
Potential rate of spread	244
Spotting potential	246
Intensity	255
Extinguishment difficulty	263
Fuel load	264
Fuel continuity	271
Duration of the hazard (years)	289
Ignition potential	290

combinations of treatments and factors produced large ranges in the responses:

- complete removal of the debris by means of roadside processing plus the duration of the hazard (years)
- complete removal of the debris by means of roadside processing plus the ignition potential
- piling and burning the debris plus the duration of the hazard (years)

The rankings of these combinations ranged from 1 to 6. The spotting potential of deciduous debris also had a moderately wide range in the responses. Variations in the perceptions of the amount of grass and other vegetation that would invade the cutblocks after the treatments (and the degree of curing of the grass) likely influenced the range of rankings. The spotting potential of deciduous debris probably produced variable responses because aspen debris is a relatively new problem in Alberta and has therefore received little study thus far.

Range of responses for intra-treatment variation

There was a larger range between the maximum and minimum scores for each individual treatment. The largest range in scores occurred for chipping piled debris and piling but not burning the debris (deciduous). Both are relatively new treatments and there was therefore little experience with them or research available to help respondents form opinions.

Table 3. Mean scores for the treatments based on their suitability for wildlife (high scores indicate high suitability)

Treatment	Mean score
Pile but do not burn the debris (deciduous)	4.5
Pile but do not burn the debris (coniferous)	4.5
At-the-stump processing with the debris left on the cutover	2.5
Spread the debris over the cutblock	2.5
Chip piled debris	1.5
Complete removal of the debris by means of roadside processing	1
Pile and burn the debris (deciduous and coniferous)	1

Wildlife suitability

Table 3 presents the mean scores for the treatments, ranked from highest suitability (5) to lowest suitability (1).

The three lowest-ranking treatments for wildlife suitability (chip piled debris, complete removal of the debris by means of roadside processing, and pile and burn the debris) were the three highest-ranking (best) treatments in terms of potential fire behavior. Only piling but not burning the debris (deciduous) received a moderate score for fire behavior and a high suitability for wildlife. The results suggest that treatments with moderate rankings for both potential fire behavior and wildlife suitability—a compromise between the two goals—will merit further examination.

Both at-the-stump processing with the debris left on the cutover and spreading the debris over the cutblock were ranked as moderate for wildlife suitability but had a high fire risk. Smaller mammals would use the surface debris, but once needles fell to the ground and smaller debris decomposed, the utility of the area for wildlife would likely decline, as fire risk declined.

The biologists raised the concern that piles or treatments are not habitats in themselves; wildlife require stands with a suitable structure close to the piles (generally less than 40 m to the cutblock's edge). A range of habitats is required by small to medium-sized mammals that prefer islands of trees located close to the debris piles. New provincial regulations define a minimum distance of 50 m between debris piles and the edge of cutblocks. These distances are farther than small mammals will generally travel in the open to reach and use the debris piles.

Regeneration capability

We also ranked the treatments based on the ease of planting seedlings after the harvest operations and the ease of the debris treatment. Initially, we had planned to travel to sites where different debris treatments had taken place and use sample plots to estimate the amount of exposed soil where planting could take place. Through discussions with forest industry representatives, we determined that most trees are regenerated by planting in Alberta and, therefore, the amount of exposed soil is not a critical factor that influences regeneration success. Instead, the tree planter is responsible for creating a suitable planting spot for the seedling. However, the different debris treatments will influence the cost of planting trees due to the amount of effort to create a planting spot, the ease of planting, and the survival rate. The planting cost after each treatment was thus investigated instead of estimating soil exposure at the treated sites.

We also contacted Feric's silvicultural operations researchers, since they have studied the factors that affect planting costs, and have interviewed planting contractors to discuss the factors they consider when preparing bids on a contract. In these interviews, the amount and arrangement of debris in a harvested block ranked very low in their list of the factors they believe influence the cost of their work. The factors they considered to be most important were:

- access to the blocks (fly in, walk, or drive)
- block size (larger blocks are easier, since they require fewer relocations of the crew)
- seedling size (larger seedlings are more expensive)
- site preparation (disking, mounding, or planting without prior treatment)
- availability of camp or motel accommodation
- slope or terrain of the planting site

If we concentrate on the amount of debris left in a cutblock and assume that the terrain and all other factors are similar, then the treatments that leave the most debris on the site will lead to the most expensive and difficult planting operations. Table 4 summarizes the rankings (from the best conditions for planting to the worst) based on this analysis.

Treatment costs

We contacted four forest industry companies and asked them to provide approximate costs for the post-harvest treatments that they use. We requested costs in \$/ha, but received some costs in $\$/m^3$. We used a volume of 250 m^3/ha to convert the latter costs into per-hectare values, since this is a commonly encountered volume in Alberta. Table 5 (page 6) presents the resulting treatment costs. If treatments are done in conjunction with the harvest, there is little additional cost, whereas costs are considerably greater if the company must return to the site after the harvest. For example, returning debris to the cutover using the skidder during its return trips results in little additional cost. In contrast, bringing debris treatment equipment to the site after the harvest will increase the cost per hectare.

The complete removal of the debris by means of roadside processing is least expensive because the debris is burned at roadside rather than in piles on the cutover.

Table 4. Ranking of the debris treatments based on the ease of planting after the treatments (lower rankings are better)

Treatment	Ranking
Complete removal of the debris by means of roadside processing	1
Pile and burn the debris	2
Pile but do not burn the debris; chip piled debris	3
At-the-stump processing with the debris left on the cutover; spreading the debris over the cutblock	4

Table 5. Treatment costs estimated by the forest industry

	Pile but do not burn the debris	Pile and burn the debris	Spread the debris over the cutblock	Complete removal of the debris by means of roadside processing	Chip piled debris	At-the-stump processing with the debris left on the cutover
	\$400–800/ha	\$475–875/ha	\$0.20/m³ if done while returning after extracting wood to roadside; \$250/ha if completed later	Cost is the same as burning at the landing: up to \$150/ha (\$0.40–0.60/m³)	No net cost when debris are used as hog fuel \$800/ha if the debris are not used as fuel	No additional cost if done at the time of harvest, but \$250/ha if workers must return to the site
Ranking	4	5	2	1	6	2

Conclusion and implementation

Our results showed that the fire risk and wildlife suitability factors were in conflict, since reducing the former promotes the removal of woody debris (fuel), whereas improving the latter encourages leaving debris in the block to provide habitat for animals. Reforestation costs increase when more debris is left on the site because planting becomes more difficult (thus, more expensive), although the cost increase is small. The treatment costs presented in Table 5 show that increased handling of the debris also increases cost. Table 6 summarizes the overall rankings based on totalling the rankings for each of the four factors.

The results show that complete removal of the debris by means of roadside processing received the lowest total number of points, making it the preferred treatment. This resulted from positive scores for low fire risk, low regeneration costs, and low treatment costs (since debris are removed during harvesting and require no additional treatment on the cutover). The next most-preferred treatments include piling but not burning the debris (for both coniferous and deciduous species) based on its high wildlife suitability, low planting costs, and low treatment costs. Piling and burning the debris was next; the wildfire risk and wildlife suitability benefits cancelled each other out, but a good score for reforestation costs due to the ease of planting improved its ranking. The lowest-ranked treatments gave similar scores because the treatments left considerable quantities of debris in the cutblock, increasing the fire risk and planting costs without improving wildlife habitat.

Other considerations for managing debris have recently gained in importance. Debris can now be chipped for biomass recovery for energy and this use will likely gain importance in the future. Accumulating this material at roadside would provide easier access to the biomass resource

Table 6. Combined overall rankings

Overall ranking	Total ranking score	Treatment
1	10	Complete removal of the debris by means of roadside processing
2	12	Pile but do not burn the debris (deciduous)
2	12	Pile but do not burn the debris (coniferous)
3	14	Pile and burn the debris
4	15	Spread the debris over the cut block
5	16	At-the-stump processing with the debris left on the cutover
6	17	Chip piled debris

produced by harvesting. When burning of piles is done, the smoke produced requires careful management. Proper planning (e.g., leaving the debris to dry before burning) will decrease overall costs and reduce the amount of smoke in critical areas. These options have not been included in the present analysis, but their importance will increase in the future.

Managers and planners can use this report to help choose among post-harvest debris treatments. Consideration of the four factors reviewed will enable managers to fully consider the costs and benefits, and achieve a well-balanced result.

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Appendix 1. Treatment photos

Left: Complete removal of debris in southern British Columbia.

Right: At-the-stump debris treatment in southern British Columbia.

Left: Spreading debris in central Alberta.

Right: Chipping debris in the Peace region of Alberta.

Left: Piling and not burning coniferous debris in southern Alberta.

Right: Piling and not burning deciduous debris in central Alberta.

Piling and burning debris in southern Alberta foothills.

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